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Achievement of Eighth Grade Students in Mathematics After

Megan Shanette Bray
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Megan Shanette Bray entitled "Achievement of Eighth Grade Students in Mathematics After." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Educational Administration.

Vena M. Long, Major Professor

We have read this dissertation and recommend its acceptance:

P. Mark Taylor, Joy T. DeSensi, Olga M. Welch

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a dissertation written by Megan Shannette Bray entitled "Achievement of Eighth Grade Students in Mathematics After Completing Three Years of the Connected Mathematics Project." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Educational Administration and Policy Studies.

Vena M. Long__
Major Professor

We have read this dissertation
and recommend its acceptance:

P. Mark Taylor

Joy T. DeSensi

Olga M. Welch

Accepted for the Council:

Anne Mayhew________
Vice Chancellor and
Dean of Graduate School

(Original signatures are on file with official student records.)

ACHIEVEMENT OF EIGHTH GRADE STUDENTS IN MATHEMATICS AFTER COMPLETING THREE YEARS OF THE CONNECTED MATHEMATICS PROJECT

A Dissertation
Presented for the
Doctor of Education Degree
The University of Tennessee, Knoxville

Megan Shannette Bray
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DEDICATION

This dissertation is dedicated to my husband, Ricky Bray, my children, Reagan and Ryleigh, and my mother, Gwynne Alexander plus numerous other family members. They have been my joy as I've traveled through this life. Together, they have kept me focused and motivated while always pointing toward the Lord who I have greatly relied on the get me through this chapter of my life.

ACKNOWLEDGMENT

This researcher would like to thank her husband, Ricky for surviving our pursuit during the last six years. He showed a great amount of patience throughout this dissertation. It wasn't always easy, but I pray that the final product will make him proud.

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Finally, the researcher wishes to acknowledge Dr. Kirk Kelly for providing the data for this study.

ABSTRACT

The purpose of this study was to examine the three- year effect of the *Connected Mathematics Project (CMP)* on the mathematics achievement of middle school students in a southeastern Tennessee public school district. This was accomplished by (1) comparing the mathematics achievement of eighth graders who have completed three years of *CMP* with their mathematics achievement after completing one and two years of *CMP;* (2) comparing the achievement of male and female students during the same period of time; and (3) comparing the mathematics achievement of historically underrepresented students after completing one, two, and three years of *CMP*.

In order to provide for a richer analysis of the *CMP* experience, the overall design employed quantitative and qualitative methodologies. The quantitative section of the study examined the mathematical achievement of almost 2,900 of the 2001-2002 eighth graders, over 3,000 of the 2000-2001 seventh graders, and over 3,100 1999-2000 sixth graders as evidenced by their Tennessee Comprehensive Assessment Program (TCAP) test scores. The qualitative segment of the study explored the experiences of the textbook adoption committee members, teachers, administrators, and parents.

Using the Tennessee Comprehensive Assessment Program mathematics total battery test score as the dependent variable, there was no significant difference between the mathematics achievement of students completing one or two years of *CMP*. However, there was a significant different in the mathematics achievement between students completing three years of *CMP* when compared to their mathematics scores after one and two years. There was also a significant difference between male and female

students after completing one and two years of CMP but no significant difference was detected after the completion of three years. Though there was a significant difference revealed in the achievement between African Americans and Non African Americans after completing one, two, and three years of *CMP* the gap closed slightly after completing three years. Overall, *CMP* students performed better on the state achievement assessment the longer they were being instructed using the standards based curriculum.

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CHAPTER I

THE NATURE AND SIGNIFICANCE OF THE PROBLEM

Introduction

For many mathematics teachers, the textbook is the primary guide to implementing the curriculum. Textbook selection is a major philosophical and financial commitment by districts. Textbooks play a central role in influencing mathematics learning for all students. For students to learn important mathematics, the text guiding their learning and the teacher's instruction must contain appropriate depth of content, encourage effective instructional strategies, identify a clear sense of purpose, and promote student thinking (Kulm, 1999). Many of the popular commercial textbooks used in U.S middle schools do not meet these basic criteria. Often the content being taught and the standards being tested on state assessments do not align (Richardson, 2001). The academic performance of American students suffer as a result.

American students' performance in mathematics has been the target of evaluation during the past few decades. Concerns about the poor performance of American students, based on evidence from national and international studies (Baker, 1997; Beaton, Mullis, Martin, Bonzales, Kelly & Smith, 1997; Kilpatrick, 1992; Kilpatrick, 1997; National Research Council, 1989; Schmidt, McKnight, & Raizen, 1996; Stevenson, 1998) have led to mathematics educational reform efforts including the development of new curriculum materials. In the late 1980's and early 1990's, the National Council for Teachers of Mathematics (NCTM) generated and published documents delineating standards for school mathematics curriculum, instruction and assessment (NCTM, 1989; 1991; & 1995.) These standards called for significant changes in the content and nature of mathematics curriculum and instruction.

Parallel to the introduction of these standards a southeastern Tennessee public school district was facing changes of its own. A new consolidation presented opportunities for change in all aspects of mathematics education. A committee of teachers and a curriculum specialist were charged with the task to review, evaluate, and make a recommendation for the adoption of new mathematics textbooks. Recognizing a need for significant mathematics curriculum reform in the middle grades in order to improve the learning of all students and influenced by research involving the NCTM generated standards, the committee presented a radical recommendation—the adoption of new standards based curriculum developed through funding from the National Science Foundation—Connected Mathematics.

This dissertation is a study with statistical analysis of student achievement after three years disaggregated by gender, historically underrepresented and socioeconomic status.

Background/Statement of the Problem

The adoption of a standards based mathematics program in the southeastern Tennessee public school district brought about numerous changes for administrators, teachers, students, and parents of elementary and middle school age children. Administrators have had to lend support to this math initiative by allowing teachers release time for mathematical staff development, accepting a different climate within the mathematics classrooms as students work collaboratively, and becoming knowledgeable of the overall *Connected Mathematics Project*. Teachers have had to engage in numerous hours of staff development centered around the big mathematical ideas in the units, focus and/or refine instruction toward an inquiry-based approach, and support students through the ongoing implementation. Students have experienced more hands on, inquiry-based, connection of mathematical concepts to real world and collaborative learning in math classes but have experienced the angst of change from what they previously have experienced in the mathematics classroom. Parents have been faced with mathematics that is significant, challenging and different from what they experienced as students. Some parents have found it difficult to aid their children with math homework. Some parents have sought assurance that this change in curriculum and instruction will provide their children the mathematical foundation needed to succeed at the next level.

In the United States there is a huge push for accountability from major corporations to the President and public education systems are in the forefront. Therefore, in the spirit of accountability the problem investigated in this study was to examine the three-year effect of the *Connected Mathematics Project (CMP)* on the mathematics achievement of eighth grade students in the southeastern Tennessee public school system as measured by the Tennessee Comprehensive Assessment Program (TCAP). The mathematics achievement data were disaggregated in three ways, historically underrepresented students, socioeconomic status, and gender. The existing research concentrates on a comparison between students' achievement using the *Connected Mathematics Project* and students' achievement using traditional mathematics programs as measured by various instruments. This study focused on students who had completed three academic years of CMP.

Rationale of the Study

The typical mathematics curriculum of a generation ago emphasized teaching facts, standard procedures, and skills to groups of passive recipients (Suydam, 1990). Students today must compete in a continually growing and technologically changing global economy in which science, mathematics, and technology skills are essential. The mathematics a person needs to know has shifted and a more integrated, child centered curriculum presented to more active, participating students has emerged in the past decade in response to deteriorating public confidence in the quality of American education (Brosnan, 1993).

To achieve the vision of a high quality mathematics education for every child, in 1989 the National Council of Teachers of Mathematics (NCTM) released a document titled "Curriculum and Evaluation Standards for School Mathematics", which centers on improving the quality of mathematics education in grades K-12. In this document there is a call for shared standards between states and districts as one of the means toward increased student achievement.

Standards based curricula were designed to provide materials directly aligned with NCTM standards. NCTM standards were developed through a series of focus sessions of various stakeholders ensure quality, to promote change, and to indicate goals

(NCTM, 1989). The standards make recommendations about what the classroom practice should be, what mathematics should be learned, and what guidelines can be used to judge students' performance while at the same time providing a framework for evaluating the effectiveness of the mathematics curricula (NCTM, 1999).

Evaluation of the standards based programs with regard to their effectiveness in improving mathematics achievement by middle grade students has primarily been focusing on a comparison with traditional mathematics curricula. The Third International Mathematics and Science Study (TIMMS) findings pointed to weaknesses in the traditional approach to teaching mathematics. Traditional mathematics provided a lecture style teaching methodology with only a slight chance for student interaction and low-level student questioning. Traditional mathematics education is seriously inadequate for twenty-first century students (Schifter and Fosnot, 1993) and future taxpayers. These weaknesses have been reaffirmed in many states as seen in the results of math achievement in middle schools as measured by the said states' mathematics achievement test scores (Schifter and Fosnot, 1993). This study is significant, as it will examine the human aspect of adopting and implementing an innovative curriculum and examine the effect a standards based curriculum has on the mathematical achievement of middle school students who have had the program for three consecutive years.

Research Questions

The quantitative analysis of this study focused on the following research questions:

1. Is there a significant difference in mathematics achievement among students who have had *CMP* for one, two, or three years as measured by the TCAP?

2. Is there a significant difference in mathematics achievement between African American and Non-African American students after one, two, or three years of *CMP* as measured by the TCAP?

3. Is there a significant difference in the mathematics achievement of students according to their identified socioeconomic status after one, two, or three years of *CMP* as measured by the TCAP?

4. Is there a significant difference between the mathematics achievement of male and female students after one, two, or three years of *CMP* as measured by the TCAP?

Purpose

The purpose of this study was to investigate the subsequent impact on student achievement for various subgroups of the population.

Significance of the Study

In recent years, the students in our country have begun to show improvement in the area of mathematics. The 1997 average SAT scores were at the highest level since 1972 (Burrill, 1998). Scores on the National Assessment of Educational Progress (NAEP) in 1996 for fourth, eighth, and twelfth grade students, in the area of mathematics, indicated an improvement over mathematics scores in 1990 and computation scores were higher for fourth and eighth grades than in 1973 (Burrill, 1998). Despite these improvements, there are still areas of great concern related to American students' mathematics achievement, particularly in the middle grades (Beaton, Mullins, Martin, Gonzales, Kelly, & Smith, 1997; Burrill; Stevenson, 1998). In spite of the fact that American students in fourth grade scored above the average on the TIMSS, American students in eighth and twelfth grades did "progressively worse" (Burrill, p.585).

Mathematics curricula has been one target of blame for the poor performance of middle school students on mathematics achievement measures. Reports from the TIMSS study (Beaton, 1997; Schmidt, 1997) indicated that middle school mathematics curricula in our country lack focus, provide little opportunity for students to be challenged, and cover a wide range of content with little depth.

For many middle school students, interest in mathematics in the middle grades drops off as they are exposed to a curriculum that is repetitious and non-challenging (AAAS, 2000). As a result, they do not extend their mathematical knowledge and understanding, leaving them unprepared to pursue a full range of career and academic opportunities (AAAS).

The curriculum has a significant impact on what is taught and learned in middle school mathematics programs. Mathematics taught as an integrated field of study rather than a collection of separate strands or standards allows for a deeper and more lasting understanding of connected mathematical ideas (NCTM, 1989). In K-12 mathematics education within the subject public school district, curriculum is changed every five years with the to adoption of a new textbook. This change usually occurs without analysis of the existing curriculum to determine the impact the curriculum has had on learning and student achievement. The effect curriculum has on student achievement in middle school mathematics programs is important and needs to be investigated. Therefore, this study is significant because it strives to link curriculum with student achievement.

Connected Mathematics Project

The National Science Foundation (NSF) funded five innovations of mathematical curriculum reforms at the middle school level: *MathThematics, Connected Mathematics, Mathematics in Context, MathScape,* and *Middle-School Mathematics Through Applications*. Each curriculum was designed and developed by a team of educators, teachers and mathematicians.

Connected Mathematics Project (CMP) is a standards based mathematics curriculum based on the content and principles of the National Council of Teachers of Mathematics (NCTM). Standards based mathematics curriculum emphasizes the development of conceptual understanding and reasoning whereas traditional mathematics focuses on memorization, rote learning, and the application of facts and procedures. *CMP* is a complete mathematics curriculum for grades six through eight developed at Michigan State University. It was funded from 1991-1997. The project directors were Glenda Lappan, William Fitzgerald, and Elizabeth Phillips of Michigan State University; James Fey of the University of Maryland; and Susan Friel of University of North Carolina. *CMP* is currently implemented in over 2,200 schools in all 50 states plus Washington, D.C. and Puerto Rico (NWREL, 1998). *CMP* was developed over a six-year period, 1991-1997, and has only been available since the 1997-1998 school year.

Dale Seymour Publishers distributes the version of *CMP* materials used in this southeastern Tennessee public school district. As the name implies, the authors created a curriculum that is rich in connections with other disciplines, everyday activities, meets the needs and special interests of middle school students, and makes connections to the real world.

The developers were guided by five fundamental mathematical and instructional themes:

- The curriculum is organized around a selected number of important mathematical concepts and process goals.
- The curriculum emphasizes significant connections among various mathematical topics that are presented and connections between mathematics and problems in disciplines that are meaningful to students.
- Instruction emphasizes inquiry and discovery of mathematical ideas through investigation of structurally rich problem situations.
- Students grow in their ability to reason effectively with information represented in graphic, numeric, symbolic, and verbal forms and in their ability to move flexibly among these representations.
- Selection of mathematical goals and teaching approaches will reflect the information processing capabilities of calculators and computers and fundamental changes such tools are making ways people learn mathematics and apply their knowledge to problems solving tasks (Lappan, Fey, Fitzgerald, Friel, & Phillips 1996).

Connected Mathematics encompasses a combination of theoretical curriculum perspectives: experiential, structure of the disciplines, and cognitive. When examining the central questions of these perspectives, this curriculum attempts to answer each question through problems that are organized around these perspectives. This curriculum attempts to answer each through problems that are organized around these three headings: Applications, Connections, and Extensions. Each investigative unit concludes with Mathematical Reflections. The educational aim of *CMP* is for students to become critical and creative thinkers equipped with problem solving strategies. *Connected Mathematics* breaks from the traditional math curriculum in that it does not include drill and practice learning. Basic skills, such as addition, subtraction, multiplication, division, fractions, percentages, reading charts and graphs and measurement are assumed to be mastered. These math concepts are integrated into each investigative unit through word problems, maps, tables, and charts (CMP, 1999). This curriculum demands that students be able to read.

An expert panel by the U.S. Department of Education's Mathematics and Science named *CMP* as an exemplary curriculum (U.S. Dept. Education, 2000). However, opponents of this curriculum contend the shortcomings include the limited number of users of this curriculum and the test of time. But according to the article, "What is Standing in the Way of Middle School Mathematics Curriculum Reform?" *CMP* has been extensively field tested with positive results on standard measures of achievement and measures of problem solving (Reys, Reys, Barnes, Been, & Papick 1998).

CMP is organized into eight units at each of the three grade levels. Each unit containing four to seven investigations, focusing on a set of content goals that connect with other units. The design aims for students to build their knowledge of important mathematical content throughout the entire curriculum. Students are initially introduced to ideas in grade six units and the concepts spiral into the seventh and eighth grade units. The sixth, seventh, and eighth grade units are listed in Table 1.

The *CMP* instructional model organizes the lesson into three phases: launch, explore, and summarize. During the launch, the teacher introduces the investigation to the students by providing background information or new ideas, reviewing previous material, or supplying directions and /or expectations for the learning experience. In the second phase, exploration, students actually "investigate" a problem usually in pairs. A shift occurs in the locus of authority, and teachers are no longer sources of truth (Schifter and Fosnot, 1993). Instead, the teacher's role during this time is as a facilitator of student experience through asking probing or focusing questions, monitoring, and encouraging students.

Summarizing is the final phase of each lesson. During this period, the class discusses its data and its strategies for developing the information. The teacher is responsible for guiding those strategies into problem-solving techniques and assessing the students' understanding of the major mathematical ideas. The summary of a lesson or investigation may or may not occur each class period, but will happen at the end of each investigation.

Table 1. CMP Sixth, Seventh, and Eighth Grade Units and the Mathematical Strand Covered

6th Grade Units	7th Grade Units	8th Grade Units
Prime Time *Number Strand*	**Variables and Patterns** *Algebra*	**Thinking with Mathematical Models** *Algebra (Functions)*
Data About Us *Probability & Statistics*	**Stretching and Shrinking** *Geometry & Measurement*	**Looking for Pythagoras** *Geometry & Measurement*
Shapes and Designs *Geometry & Measurement*	**Comparing and Scaling** *Number Strand*	**Growing, Growing, Growing** *Algebra (Exponential Growth)*
Bits and Pieces, Part I *Number Strand*	**Accentuate the Negative** *Number Strand*	**Frogs, Fleas, and Painted Cubes** *Algebra (Quadratic Growth)*
Covering and Surrounding *Geometry & Measurement*	**Moving Straight Ahead** *Algebra (Linear Relationships)*	**Say It with Symbols** *Algebra (Linear Equations)*
How Likely Is It? *Probability*	**Filling and Wrapping** *Geometry & Measurement*	**Hubcaps, Kaleidoscopes, and Mirrors** *Geometry & Measurement*
Bits and Pieces, Part II *Number Strand*	**What Do You Expect?** *Probability (Expected Value)*	**Samples and Populations** *Probability & Statistics*
Ruins of Montarek *Geometry & Measurement*	**Data Around Us** *Number Strand*	**Clever Counting** *Number Strand*

There are four strands or areas of study (see Table 1) that appear throughout *CMP* based on the NCTM Standards. Mathematical concepts are explored through these strands (algebra, geometry and measurement, number, and probability and statistics) and are studied in each of the twenty-four units. The units do not isolate the strands; but instead the units combine the strands through their natural relationships. Hence, mathematical ideas are developed across units, strands, and grade levels. For example, in the probability and statistics strand, *CMP* students first study data investigation by formulating questions, gathering data, organizing and analyzing data, and making decisions based on data in “Data About Us” and revisit the probability and statistics strand in “How Likely Is It”? In the seventh grade, students continue their study in the probability and statistics strand in the “What Do You Expect (Expected Value)”? Students conclude their mathematical development in the probability and statistics strand with the next to last *CMP* recommended unit, “Samples and Populations” (gathering data from samples to make predictions about populations).

In *CMP*, students work individually, in pairs, small groups, and as a large group. Individual work is usually during the launch phase of the lesson while cooperative groups, ranging in size of two to four, are encouraged for students to explore problems. The problems require students to gather data, look for patterns, and use problem solving strategies. At the conclusion of a lesson, students share strategies and solutions and teachers summarize mathematical ideas with the whole group.

Standards Based Curriculum Achievement Data

Schoenfeld presents preliminary data indicating students being taught with a standardized based curricula do as well on skills as students who study the traditional curricula, and they do better on understanding of concepts and problem solving. Also traditional performance gaps between majority students and poor or underrepresented minorities have not been eliminated but are diminished (Schoenfeld, 2002).

Schoenfeld documents the efforts by the Pittsburgh Public Schools since the early 1990's to implement standards based education in mathematics. Scores on concepts and problem solving increased with the implementation of the new curriculum. The lack of attention in basic skills is a major criticism from opponents of standards based curricula. However, the Iowa Test of Basic Skills (ITBS) show the reform curricula more than hold their own against traditional curricula with regard to skills. (Schoenfeld, 2002).

Reys and Reys conducted a study comparing the mathematics achievement of eighth graders from school districts in Missouri, which revealed significant differences in achievement between students using standards based curriculum materials for at least two years and students using other curriculum materials. The differences reflected significantly higher overall achievement of students using standards based material and significantly higher scores in most content strand areas than did the students using traditional curriculum (Reys, Reys, Lapan, Wasman, & Holliday 2003).

Researcher's Experience

The researcher has experience with standards based curriculum from a teacher's and an administrator's perspectives. The researcher taught elementary aged students using the system's adopted standards based curriculum for three years before transferring to the middle school. Prior to the first day of teaching class, the researcher participated in 12 hours of professional development regarding *CMP*. Over the course of the school year 35+ hours of total professional development pertaining to the teaching of *CMP* was completed. The researcher's assignment included teaching three 90-minute *CMP* classes daily. The researcher held weekly help sessions for mathematics teachers struggling with instruction of *CMP*.

The researcher's role as an administrator supervising those teaching *CMP* was considerable. The researcher facilitated workshops for the mathematics teachers in the building on a regular basis. Several lessons were modeled for novice teachers throughout the school year. Observations and evaluations with written feedback were conducted regularly. Encouragement and overall general support for the teachers and their use of the standards based curriculum was important to the researcher.

Textbook Adoption Committee

The middle school textbook adoption committee for the school district at the time of *CMP* adoption consisted of seven members. The committee members were selected by invitation from the mathematics supervisor. The only criteria the supervisor expressed for textbook adoption committee members was a willingness to participate in the textbook adoption process. The mathematics supervisor requested the textbooks to be considered for adoption from the publishers based on the approved middle school textbook list from the state of Tennessee. Members of the committee would meet regularly to discuss various aspects of the different textbook series. Little research on standards based curricula was available for the committee to consider at the time of the textbooks adoption. The committee did not have considerable evidence that the standard practice of adopting traditional textbook series in the past had had no noticeable impact on mathematics standardized test scores. Months of deliberation by the committee lead to the adoption of the standards based curriculum which one of the committee members was currently piloting, *CMP* (Roddy, 2003).

Definitions of Terms

There are several terms, phrases, and definitions that will be used throughout this study. Some of them are listed below.

1. **Connected Mathematics Project (CMP):** A middle school mathematics curriculum that is standards-based in content developed by Glenda Lappan, James T. Fey, William M. Fitzgerald, Susan N. Friel, and Elizabeth D. Phillips of Michigan State University and published by Dale Seymour Publications while supported by the National Science Foundation.
2. **Middle School:** A school that is specifically called a “middle school” and contains no grade above eighth or any grade below fourth: alternative schools are excluded (Vaccaro, 2000).

3. **Minorities:** Individuals of Non-European descent.
4. **SES:** Socioeconomic status as defined by participation and/or qualification for the federal free and reduced lunch program.
5. **Standards** B**ased Mathematics:** Mathematics curriculum based on the National Council of Teachers of Mathematics curriculum standards that define five mathematical standards and five process standards.
6. **Tennessee Comprehensive Assessment Program (TCAP):** Annual assessment given to students in grades third through eight in Tennessee published by CTB-McGraw/Hill.
7. **TIMMS:** Third International Mathematics and Science Study, a comparative achievement test of mathematics and science administered in 1994-95 at the fourth, eighth, and twelfth grades to over 40 countries was sponsored by International Association for the Evaluation of Educational Achievement (IEA).

Organization of the Study

This study will be organized into five chapters. Chapter I contains background for the problem, rationale of the study, research questions, significance of the study, and definition of terms. Chapter II includes a review of related literature, including standards based curriculum, constructivism, connected mathematics project, minorities, socioeconomic status, and gender. Chapter III describes the methodology. Chapter IV describes the findings and Chapter V presents the conclusions and questions for further study.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Students today must compete in a continually growing and technologically changing global economy in which science, math, and technology skills are essential. Such studies as *A Nation at Risk* and the *Third International Mathematics and Science Study* (TIMMS) provide data that show that many students score well below the international average in mathematics (Reys, & Reys, Barnes, Beem, Lapan and Papick, 1998). Parents, teachers, educational experts, and citizens across the country are concerned with the low mathematical performance of our students (Boaler, 1999).

The business world demands that employees be creative and critical thinkers and analytical decision-makers (Lappan, 1999). The effectiveness of traditional teaching methods is questioned for the ability to aid in the preparation of today's technological global economy. To compete in today's continually changing technological world and meet students needs, educators must teach students how to be collaborative problem solvers, creative and critical thinkers. Educators must also teach math skills that students retain for a lifetime by making math connections relate to students interest and to the real world.

Background

This newly consolidated public school district in southeastern Tennessee is one of the largest school systems in the state of Tennessee serving grades K-12 consisting of 80 schools with a total of 41,453 students. For many years there had been two separate public school systems in this southeastern Tennessee county. Those two systems were the City Public Schools, which was often referred to as the City system and was composed mostly of inner city schools populated with mostly African American students; and County Department of Education also known as the County system and was mostly suburban and rural schools where the population was predominately Caucasian. However, County Department of Education and City Public Schools consolidated in 1997, when the City decided to discontinue its operation of public schools (Chattanooga Times-Free Press, 1997). Tennessee state law mandates that the County provide a free public education. Consequently, the county, by law, had to provide education for its citizens. One of the enormous tasks for the new school system was to provide the students of the County with the best possible education in this technological competitive era. Many methods were discussed as to the best strategy to pursue in achieving this task. The County decided that the best approach for the new consolidated system would to standardize the curriculum. The first move towards standardizing the curriculum was the adoption of new mathematics programs at the elementary and middle school levels. Influenced by research involving the NCTM generated standards, the needed curriculum changes were considered by a committee of teachers and a curriculum specialist.

The mathematics curriculum specialist in this district selected these teachers based on knowledge of their mathematics teaching ability and willingness to participate on the mathematics textbook adoption committee. The textbook selection committee consisted of seven middle school mathematics teachers. These teachers varied in classroom teaching experience and represented urban, rural, and suburban schools. The committee reviewed ten textbook series from the state of Tennessee approved textbook list. The committee determined from current results on the mathematics section of state standardized test that middle school students were most deficient in problem solving than any other skill. Therefore, one of the primary considerations for the committee was to select a textbook series with a solid problem solving content (Roddy, 2003). The committee whole heartily recommended the *Connected Mathematic Project* as the textbook series that should be adopted to help standardize the mathematics curriculum in middle school during this period of reform.

Curriculum reform begins with the recognition of a need for educators to change what and how they are teaching to meet the needs of all students to achieve today's educational goals. Teachers, parents, educators, and all community members want to provide the best education for all students because educating citizens leads to economic and social prosperity of our communities and our country (Brahier, 2000). The need for change in education has been marked historically by three periods: the Post-Sputnik era, the 1960's civil rights movement, and the publishing of *A Nation At Risk: The Imperative for Educational Reform* in 1983 by the National Commission on Excellence in Education (Christensen, McDonnell, and Price, 1988). The most recent reform in mathematics began in the 1980’s with the integration of technology and a “major paradigm shift in the scientific study of mathematics learning” (Battista, 1999, p.1). Teachers are now expected to teach children content, and develop teaching methods that engage and challenge students, while developing students understanding and reasoning skills.

Educational leaders must be prepared for the elements and the process of change when implementing an innovative and controversial new mathematics curriculum. Often, implementation of a new curriculum requires teachers, parents, and students to alter how they think about mathematics, what they hold to be true about mathematics, and how they have traditionally done mathematics (Lappan, Fey, Fitzgerald, Friel, & Phillips 1996). Transformation of this magnitude can lead to frustration, confusion, and anger among teachers, parents, students, and other community members. It should be understood that curriculum reform initiates resistance factors because reform brings about change, which breaks away from tradition. A break from tradition always stirs animosity and fear of change. These feelings of fear are natural responses. It is important for educators to understand that “change is an ongoing process, not an event” (Speck, 1999, p. 217) that can happen in a short period of time. Leaders must understand that there will be teachers, parents, and community members who do not embrace the new philosophy or recognize the need for a change in curriculum. Leaders must also prepare teachers, parents, students and community members for the understanding that “Changing practice and implementing a new curriculum is hard work” (CMP, 1999, p. 1).

Change initiatives require persistence and trust among all stakeholders (Urbanski and Erskine, 2000). Leaders can aid the change process by preparing teachers to become catalysts of change. Preparation would include effective training of the teachers involved to gain new teaching methods, skills, and understanding of how to teach this standards-based curriculum. Professional development supports educators during the implementation phase of this curriculum. An effective leader of change must be perceptive, aware, and prepared.

Development of School Mathematics

Education in the United States early on was not designed for all nor was it free. However, by the end of the nineteenth century most cities and states had established publicly supported elementary schools and the majority of children falling within this age range attended school. Nevertheless, few cities and states had publicly supported high schools and graduating from a high school was rare (Senk and Thompson, 2003, p. 5).

In the nineteenth century, the mathematics taught in elementary schools consisted of arithmetic with whole numbers, fractions, decimals, and percents, broadened by work with measures of length, area, and volume (Senk and Thompson, 2003). Secondary schools were rare during the first half of the nineteenth century and those in existence were primarily used as college preparatory academics for males from privileged families. As the nineteenth century drew to a close dissatisfaction with the progression of elementary and secondary mathematics was evident in the academic world.

During the 1900-1950 time period mathematics instruction in elementary and secondary schools was fragmented. The mental discipline (drill) theory of the nineteenth century was still evident. Also a more child-centered approach to teaching mathematics evolved. “Advocates of this more child centered view recommended that the teaching of mathematics should involve engaging students in activities from which the teacher, through discussion with students, could help students reflect on fundamental ideas and develop powerful habits of mind” (Senk and Thompson, 2003). Arithmetic textbooks supportive to this theory emphasized less systematic drill and increased the focus on solving practical problems and doing project work.

The period between 1957 and 1970 the instructional material developed became known as “the new math” or “modern mathematics”. Higher-level mathematics was introduced at both the elementary and the secondary levels. Senk and Thompson records in both elementary and secondary schools the concepts of set and mathematical structure served as unifying ideas, precision in the use of mathematical language was emphasized, and guided discovery was encouraged as a teaching technique.

In the early 1970s “the new math” was criticized for being too theoretical and did not pay enough attention to basic skills (Kline, 1973 as cited by Senk and Thompson, 2003). Hence a “back to basics” movement emphasizing arithmetic computation and algebraic skills development emerged. This movement too was criticized for being too narrow in defining basic skills.

The 1987 report, *The Underachieving Curriculum*, released in the Second International Mathematics Study (SIMS) U.S. students did not score significantly above the international average on any test and in fact on many test U.S. students scored substantially below the international average. And “the National Commission of Excellence in Education cited declining SAT scores and an increase in remedial courses by colleges, businesses, and the military as evidence of a 'rising tide of mediocrity'" (Senk and Thompson, 2003 p. 9&10). The data cited from these reports led people to search for explanations for the poor levels of performance of mathematics students in American schools.

The United States has again undergone efforts to reform school mathematics education in the last two decades of the twentieth century. These efforts have been led by the National Council of Teachers of Mathematics (NCTM). The 1989 report *Curriculum and Evaluation Standards for School Mathematics,* published by the NCTM, lists five goals for all students: "(1) that they learn to value mathematics, (2) that they become confident in their ability to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically" (NCTM, 1989, p.5 cited Senk and Thompson, 2003, p.11).

The No Child Left Behind Act of 2001 (NCLB) also supports school mathematics reform. NCLB is a new law that sets strict requirements and deadlines for states to expand the scope and frequency of student testing, revamp their accountability system and guarantee that every classroom is staffed by a teacher qualified to teach in his or her subject area. The law also calls for the percentage of students proficient in reading and math to continue growing while the test score gap between advantaged and disadvantaged students narrow. One of the four basic points of NCLB is an emphasis on doing what works based on scientific research. The five goals of *Curriculum and Evaluation Standards for School Mathematics* can help to obtain the desired outcome for the mathematics portion of the NCLB Act if put into practice.

National Science Foundation

Penicillin, the atom bomb, and many other scientific contributions to American victory during WWII brought to the forefront for many citizens the value of scientific research. After the war there were few who opposed the proposition that sustained federal support of science and research was essential to the defense and welfare of the United States. The National Science Foundation (NSF) was established in 1950 by Congress after President Truman signed The National Science Foundation Act. The goals of the organization are to promote the progress of science, including mathematics; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes (1950). These goals have helped the United States to maintain leadership in discovery, learning and innovation across science, mathematics and engineering. NSF is the federal government's only agency dedicated to the support of education and fundamental research in all scientific and engineering disciplines.

In 1957 after the launch of Sputnik by the Soviet Union a desire to strengthen instructional programs in school mathematics and science awakened in the U.S. The NSF began to fund programs to create high-quality teaching materials for mathematics in elementary and secondary schools (Senk and Thompson 2003).

Standards Based Curriculum

Standards based curriculum is not something "new", but it has evolved over a period of time from a collective group of educational experts. Standards based curricula evolved with the launching of the mathematics standards movement by the NCTM. As mentioned previously, NCTM recommended goals for all students in the learning of mathematics. These goals require a more child-centered approach to the teaching and learning of mathematics in K-12 educational programs.

According to Goldsmith and Mark, standards based curriculum is the current method of curriculum reform that emphasizes the development of conceptual understanding and reasoning through engaging students through collaborative investigations, hands-on explorations, the use of multiple representations, and discussion and writing. Standards based curriculum emphasizes utilizing cooperative groups to teach collaboration when using manipulatives and to have class discussions in which students share problem-solving strategies.

Standards based curriculum embraces the constructivists' educational learning philosophy. Well-known learning theorists, John Dewey, Lev Vygotsky, Jean Piaget, and Jerome Bruner have been credited for contributing to the fundamental development of the constructivists thinking. Roblyer, Edwards, and Havriluk cite Willis, 1995, in the textbook *Integrating Educational Technology Into Teaching,* when defining the educational constructivists learning theory as a belief, "That humans construct all knowledge in their minds, so learning and his or her own unique version of the knowledge, are colored by background, experiences, and aptitudes (1997, p.56).

Constructivism

Constructivism was first associated with art during the time after the Russian Revolution around 1917. Constructivism was successful during this time because everyone believed the Revolution would lead to a better future. However, this belief was abandoned when the Communist Party gained control in Russia. Constructivism was then suppressed until after World War II (Hubbard, 2002, p. 37).

Constructivism in education, however, is a theory that is based on results of Piaget's child development research. Piaget's developmental stages (Cooney, Cross, and Trunk, 1993; Glover and Bruning, 1990; Reys et al., 1998) have been cited and have served as a model for the development of new mathematics models that describe how students learn. Educational psychology, which has served as the link between the disciplines of education and psychology (Walberg and Haertel, 1997) has two major learning paradigms in the twentieth century—behaviorism and constructivism.

The behavioral psychologist wanted to know what children learned, not how they learned. The cognitive psychologist believed that children should be actively involved in the learning process. They wanted to know how children learned. Today, modern cognitive psychologists, i.e. constructivists, are concerned with how children learn and what they learn (Post, 1992 as cited Clarkson, L.).

Major contributors to the behavioral psychology school of thought include Thorndike, Skinner, and Gagne (Reys et al.' 1998; Post, 1992). Behaviorism is grounded by stimulus-response theories that also include conditioned learning (Reys, et al., 1998). Behaviorism's presence in mathematics education provided a base for the exercise of drill and practice. The purpose of drill and practice was to reinforce the mathematical skill that was being taught. Advocates of this school of thought viewed the brain as a muscle that needed to be exercised with repeated practice in order for student learning to occur. The problem with this type of learning was that students viewed each skill as separate, unconnected activities. Behavioral objectives required observable measurable learning outcomes that were often divided into small obtainable parts (Goldin, 1990).

Constructivism is an educational philosophy that believes learners ultimately construct their own knowledge that then stays within them, so that each person's knowledge is as unique as they are (Barnes & Stanley, 2000, p.327). In constructivism the emphasis is placed on the student rather than the teacher. Constructivist theorists contend that teachers should create situations or present engaging math problems for students that will foster their creating of models in response to those situations. The student is encouraged to invent his own solutions and given the opportunity to build on prior knowledge. Constructivists suggest that students learn mathematics best when it is real for them. Educators can make mathematics real by providing an environment where exploration and discovery is encouraged, reasoning is expected and communication is required.

Constructivists like Vygotsky and von Glasersfeld emphasized that conceptual processing occurs within the individual. Though there are different interpretations of constructivism in mathematics education, all agree that the learner is actively constructing knowledge through ownership and involvement (Owen & Lamb, 1996). Supporting research suggests that learning would be more efficient if students were able to form connections that organize the out-of school mathematics experiences with the in-school mathematics (Hiebert and Carpenter, 1992); in other words, make real world connections. Also, Reys et al. (1998) suggest three basic beliefs for constructivism: “(1) knowledge is actively created or invented (constructed) by students, (2) students create (construct) new mathematical knowledge by reflecting on their actions, and (3) students need to dialogue with the teacher and each other to promote intellectual growth.” (p.19).

Tsuruda (1998) recommends constructivist/reform mathematics for middle school students because it is student-centered. “More than any other age group, middle school students need a curriculum that challenges them to think, discuss, and solve problems related to their lives” (p.3). Furthermore, the Professional Standards for Teaching Mathematics (National Council of Teachers of Mathematics, 1991) stresses that teaching and learning should move “away from merely memorizing procedures [and] toward[s] connecting mathematics, its ideas, and its applications” (NCTM, p. 3).

CMP Field Test Results

The Ridgeway, Zawojewski, Hoover, and Lambdin (2003) study compared the mathematical achievement of sixth and seventh grade students during the 1994-95 school year and during the 1995-96 year with eighth grade students. The study compared mathematics achievement of students who used *CMP* curricula and students who used traditional middle school mathematics curricula. The study found that gains made by the *CMP* students in basic skills were comparable to gains made by the non-*CMP* students. Also the study found that the *CMP* students at all three grade levels showed significantly greater growth than their non-*CMP* peers on the test requiring challenging, open-response, making connections and problem solving type responses.

CMP Achievement Data

Lapan et al. (1999) conducted a study examining the impact of a year-long implementation of two standards based middle grades mathematics curricula (one was CMP) on mathematics achievement. The study also involved a control group who used traditional mathematics curricula. The findings from this study include no significant differences were found between the groups with respect to traditional mathematics achievement. The students in the two standards based curricula significantly outperformed the control group in mathematics problem solving. No gender differences were found in either group. And the mathematics problem-solving scores for African American students using the standards-based curricula were significantly higher than African American students using traditional mathematics curricula (CMP Research and Evaluation Summary, 2003).

Riordan and Noyce (2001) conducted a study investigating the impact of standards based mathematics programs on student achievement in Massachusetts. There were twenty-one schools participating in this study. The schools were divided into two groups. One group consisted of a school that had implemented *CMP* for four years. The other group consisted of the remaining schools that had used *CMP* for either two or three years. The two groups were then matched with a comparison group using mean scores on previous state test, percentage of students receiving free or reduced-priced lunch, and racial and ethnic makeup. *CMP* students in both groups significantly outperformed students attending the comparison schools on the 1999 statewide standardized test (MCAS)(CMP Research and Evaluation Summary, 2003).

The Michigan Educational Assessment Program (MEAP) is a state mandated assessment. The results from the mathematics subtest of the MEAP for *CMP* seventh graders from 1991-2000 were compared to the results for all seventh grade students in Michigan. The average performance of *CMP* students was changed favorably compared to the state average. In fact many of the *CMP* schools had nearly eliminated students scoring in the lowest performance category (CMP Research and Evaluation Summary, 2003).

The Ann Arbor Public School District adopted and began phasing in *CMP* during the 1996-97 school year. Ann Arbor has been reporting a steady improvement in student mathematics achievement. The greatest gains were made by African American students, whose satisfactory achievement level increased from 22% to 39% (CMP Research and Evaluation Summary, 2003).

The Plano Independent School District in Plano, Texas is a largely affluent district. The achievement of CMP and non-CMP middle school students within the district were compared using scores on the mathematics subtest of the Texas Assessment of Assessment of Academic Skills (TAAS). Among the results submitted to the CMP Research and Evaluation Summary were that the CMP students' scores increased more than those of the non-CMP students. And economically disadvantaged and minority students in the CMP group showed more growth than both the CMP group as a whole and the corresponding students in the non-CMP group. The CMP students classified as gifted and talented already had high scores but even those scores increased slightly.

The Arkansas Statewide Systemic Initiative (ASSI) conducted a statewide evaluation of the CMP curriculum from 1995-1997. The study evaluated one year of implementation of the sixth grade curriculum in eight Arkansas school districts (O'Neal and Robinson-Singer, 1998). The study found that mathematics scores of CMP students showed positive and statistically significant growth that exceeded that of their non-CMP peers across the state (CMP Research and Evaluation Summary, 2003).

School districts in Minneapolis, Traverse City, Portland and others conducted similar studies comparing the mathematics achievement of CMP and non-CMP students. These districts had findings similar to the findings discussed above. For a great majority the CMP students outperformed non-CMP students of the state assessments on basic skills and problem solving open-ended type questions. Minority and economically disadvantage students seemed to have made the greatest gains.

African Americans

Throughout history, education has been thought of as the key to success, prosperity, and dreams. Many people have struggled against great odds in an attempt to become educated. For instance, slaves risked death to learn how to read and write for it was against the law to teach a slave to read or write (Tate, 1995). Education is the traditional opportunity through which many minorities, especially African Americans find their places in life. Education can take place in a variety of settings. However, most think of schools as the primary setting for educational needs of our youth. “Schools were established to provide opportunities for social and intellectual development to enable students not only to earn a living, but also to participate in the social and political life of the community” (Scruggs, 1979, p. 9). “By the 1940’s at the onset of World War II, 65% of Black children were enrolled in school. This was an impressive increase from the 45% of Black children enrolled in school in 1910. After World War II most states required school attendance of all children.” (Billingsley, 1992, p.172) The primary source of formal education of African American children is the public schools (Wilson-Jones, 1991). However, Fine (1991) pointed out, public schools in the United States were never designed for low income students and students of color. The first schools were merely to educate the elite.

The National Assessment of Educational Progress (NAEP) mathematics assessment gauges student mathematics achievement in grades four, eight, and twelve and is an ongoing national assessment of mathematics achievement in the United States. It provides information about what students know and can do in mathematics. It also provides factors that might influence students’ performance.

NAEP results show that, as a group, African American students typically score below their peers in all mathematics content areas. Moreover, these achievement differences grow as topics increase in complexity (Anick, Carpenter, and Smith 1981; Burton 1984; Dossey et al. 1988; Johnson 1984; Johnson 1989; Jones, Burton, and Davenport 1984; Strutchens and Silver 2000). Although there have been some achievement gains among African American students since 1980, these improvements have occurred mostly on those sections related to basic skills (Martin, 2000). On the 1996 NAEP mathematics assessment, 4% of African American students in eighth grade achieved at or above the proficient level, 24% performed at the basic level, and 72% performed below the basic level (Braswell, et al. 2001). Although the mathematics scores for eighth grade African American students did increase from 1996 to 2000, this increase was not a significant one. On the 2000 NAEP mathematics assessment, 6% of African American students in eighth grade achieved at or above the proficient level, 27% performed at the basic level, and 68% performed below the basic level (Braswell, et al. 2001).

Although African American students in eighth grade have made gains since 1990, the large gaps between African American and White students' mathematics performance have remained relatively unchanged (Braswell et al. 2001). The gap between these groups is greater in 2000 than in 1990. White students achieved 32 points higher on the NAEP mathematics assessment than African American students; 40 points higher in 1992; 39 points higher in 1996; and 39 points higher in 2000. Lubienski (2001) secondary analysis of the 1990 and 1996 NAEP mathematics assessment indicated that, although class was a factor in the achievement gap between African American and White students, race primarily accounts for the differences in mathematics achievement among these subgroups. Lubienski (2001) report that, in both 1990 and 1996, White students in the lowest socioeconomic subgroup scored equal to or higher than African American students in the highest socioeconomic subgroup. On the 1996 NAEP mathematics assessment, African American students in the eighth grade in the highest socioeconomic subgroup scored a significant 22 points lower than White eighth grade students in the lowest socioeconomic subgroup (Lubienski, 2001).

Studies completed during the development of CMP found “No significant differences between the groups with respect to traditional mathematics achievement.” (Lappan, et al. 1999). However, mathematics problem solving scores for African Americans were significantly higher than scores for African American students using traditional mathematics. In all of the above referenced studies that disaggregate their data minority students especially African American and Hispanic American using CMP curricula most often made greater gains on the mathematics subtest than comparable non-CMP students, minority and non-minority. African American students scores were still significantly lower than non-minority scores but the gains were greater.

Low SES

There are many documented factors that impact student achievement such as family structure, schoolmates, racial concentration in a particular school and socioeconomic status or poverty (Bankston & Caldas, 1998). Poverty is one factor that is consistently indicated to impact student achievement (Campbell & Silver, 1999). Poverty has been defined in numerous ways.

The rate of poverty among children in the United States is far higher than other advanced nations (Biddle, 1997). In 1997 Biddle also reports, using information from the 1990 Luxembourg Income Study, the child poverty rate in the U.S. exceeded 20%. It has also been noted that shifts in the industrial culture, political climate, and tax laws of our nation have generated a massive upward redistribution of income and wealth away from poor and middle class Americans (Biddle, 1997). Mantsios (1998) argued that the belief that the United States is a classless society is a myth and that there are distinct differences in the availability and/or opportunity for basic needs like "health care and education" (p.203 as cited by Clarkson, 2001) based on socioeconomic status.

Research has revealed some of the ways poor children are handicapped for education by their poverty. The homes of poor children provide less access to the books, writing material, computers, and other supports for education that are often present in middle class or affluent homes in America (Biddle, 1997). Biddle also notes that impoverished students are distracted by chronic pain and disease; have poorer nourishment; tend to live in communities that are afflicted by physical decay, serious crime, gangs, and drugs and numerous other problems in their personal lives. Poor children have a much harder time in school than their more affluent peers.

Secada (1992) concludes that "achievement disparity based on social class and racial/ethnic group membership can be detected almost as soon as students can be reliably tested." (p. 639 as cited by Clarkson, 2001). Low SES students often lag in mathematics achievement by the third grade, especially in urban schools (Fuson, Cruz et al. 2000). Middle and upper SES students enter school with higher achievement levels than low SES students. Research suggests that school performance is highly correlated to economic class (Mantsios, 1998 as cited by Clarkson, 2001).

Studies investigating the effects of child poverty on achievement are hard to find. Good data on the poverty of individual students or their families are not often gathered in

America (Biddle, 1997). The studies of poverty effects in schools usually work with indirect indicators, such as students' eligibility for free or reduced price meals (Biddle, 1997). However, when those studies have been conducted they have found that child poverty has a negative impact on school success (Biddle, 1997).

Gender

Gender equity in mathematics education is a complex issue. The existing literature available on gender equity is varied. A 1992 report from the American Association of University Women presents evidence that girls are not receiving the same quality of education as boys as reflected through achievement on standardized test (Sullivan, 1994). However, in 1989 Kimball and 1998 the National Science Board report that males and females take similar mathematics classes and achieve similar scores on standardized tests throughout the K-12 school years. In 1993 Raymond makes reference to the lack of statistically believable research that indicates men are more math proficient than women.

Mathematics is the key to full participation for all our citizens. Mathematics illiteracy is a personal loss for females and a devastating blow to our nation's economy. Women continue to be underrepresented in careers in mathematical and scientific arenas. Many girls avoid the math and science classes that are pathways to career options (Sullivan, 1994). Chang 2002 notes that the participation of women and minorities in the fields of science, mathematics, and engineering are dramatically lower than those of the general student population.

Research also indicates that excessive emphasis on the mechanics of mathematics inhibits learning (Sullivan, 1994). The standards based initiative supports this research with the call for group work by students. The collaboration that develops through group work provides numerous benefits. Difficult concepts or task often become manageable when working collaboratively.

Summary

This chapter presents much of the research literature related to the development of school mathematics, standards based curriculum, constructivism, and the *Connected Mathematics Project*. The review of related literature suggest students using *CMP* curriculum perform as well or better academically on state mandated standardized achievement test than non-CMP students. The literature further suggested that African American students are culturally programmed to behave cooperatively and to value relationships with others. Teaching *CMP* as the developers intend cultivates the manner in which African American students learn best. In addition, *CMP* achievement data indicates that females and students from low socioeconomic backgrounds using *CMP* outperformed those same categories of students using traditional curricula.

CHAPTER III

METHODS AND PROCEDURES

Introduction

This chapter describes the research design of the study. Specifically, the research design, research questions, selection of population, data gathering procedures, and data gathering instrument and data analysis with respect to student achievement are outlined in this chapter.

Research Design

Quantitative

The basic design of this part of the study employs quantitative methodology. Therefore, using quantitative methodology an examination of the mathematical achievement during the academic years 1999-2002 of middle school students in a southeastern Tennessee public school system was conducted. Mathematics achievement of the 1999-2000 sixth grade students, 2000-2001 seventh grade students, and 2001-2002 eighth grade students who completed the indicated academic school year with mathematics using the *CMP* curriculum was the focus for this study. Using existing data gleaned from the district office the mathematics scores for sixth grade students were compared to their scores as seventh and eighth graders while seventh grade students' scores were compared to their eighth grade mathematics scores.

Research Questions

The study will be organized around the following research questions:

1. Is there a significant difference in mathematics achievement among students who have had *CMP* for one, two, or three years as measured by the TCAP?

2. Is there a significant difference in mathematics achievement between African American and Non-African American students after one, two, or three years of *CMP* as measured by the TCAP?

3. Is there a significant difference in the mathematics achievement of students according to their identified socioeconomic status after one, two, or three years of *CMP* as measured by the TCAP?

4. Is there a significant difference between the mathematics achievement of male and female students after one, two, or three years of *CMP* as measured by the TCAP?

Limitations

The following conditions will limit the extent of the study:

1. The population under investigation will be limited to one public school district in southeastern Tennessee.
2. Existing student records provide limited demographic information and test scores for this study for the 1999-2000, 2000-2001, and 2001-2002 academic school years.

Delimitations

The following conditions are researcher-imposed limitations:

1. The sample of middle school students used in this study will be confined to those who had Connected Mathematics as sixth, seventh and eighth graders.

2. Only the twenty-one schools with middle school aged students within this southeastern Tennessee public school district will be included in this study.
3. The study will further be delimited to mean score comparisons from the 2000, 2001, and 2002 Tennessee Comprehensive Assessment Program (TCAP).

Assumptions

As with any study, there are assumptions:

1. The population under investigation had a consistent experience of CMP throughout their sixth, seventh, and eighth grade mathematics experience.
2. The student information (test scores and demographics) will be considered accurate and taken at face value.
3. The TCAP is an appropriate instrument for measuring the mathematics academic achievement of middle school students in Tennessee.

Selection of Population

There are eighty-one schools serving grades K-12 with a total of 41, 453 students in this southeastern Tennessee public school system. Twenty-one of those schools and just over 3,000 middle school- aged students' test scores were used in this study. Fifteen of the schools are middle schools, grades six, seven, and eight, two are schools housing grades K-12, one is an elementary/middle school combined and the remaining three are middle/high school combinations. This school system was chosen to conduct the research because of the newly implemented standards based mathematics program, *Connected*

Mathematics Project. These schools were selected based on the attendance of middle school aged children and the implementation of the standards based curriculum *Connected Mathematics Project*.

The twenty-one schools used in this study are geographically dispersed throughout this southeastern Tennessee public school district. Three are considered urban, eight are considered suburban, three are considered rural and seven are classified as magnet schools by this public school district's standards as defined by federal guidelines.

Data Gathering Procedures

To obtain permission to conduct the study in the southeastern Tennessee public school district, an e-mail was sent to the assistant superintendent's office, outlining the purpose of the research study. A letter granting permission to conduct the research in this district using existing student data was obtained. These data included student demographic information, i.e., gender, ethnicity, participation in the free or reduced lunch meal program and TCAP mathematics test scores. The data then was entered into the SPSS statistical program with careful checking for accuracy. Students were identified by student identification numbers.

Data Gathering Instrument

Tennessee Comprehensive Assessment Program (TCAP) is a state mandated exam administered annually to all students in grades third through eighth with the purpose of measuring student growth and comparing the growth to the larger population. This instrument is traditional, standardized, and a multiple-choice assessment.

According to the Tennessee Department of Education publication (September 2001), the primary goal of the TCAP Achievement Test is to provide a measure of knowledge and application skills in reading, vocabulary, language, language mechanics, mathematics, mathematics computation, science, social studies, spelling and word analysis.

Data Analysis

The district's eighth grade students from the twenty-one sites were separated into two groups: CMP students and non-CMP students. CMP students are students who have been in a CMP classroom (based on their continuous enrollment in a school within this district housing middle level age students) for their sixth, seventh, and eighth grade mathematics instruction. Non-CMP students are identified as students whose enrollment was not continuous in a Hamilton County middle school classroom for grades sixth, seventh, and eighth for reasons such as transfer into the school system or enrollment in Algebra I during their eighth grade year of mathematics instruction. This school district allows the high achieving students to take Algebra I during the eighth grade year for high school credit.

Using multiple regression, several relationships were explored. Specifically, relationships between the mathematics National Curve Equivalent (NCE) scores for sixth grade students compared to their scores as seventh and eighth graders while seventh grade students' scores will be compared to their eighth grade mathematics NCE scores. One-Way Analysis of Variance (ANOVA) will be computed to determine the existence of a significant difference between group means. The following groups will be used: male compared to female; African American students compared to Non African American students; free or reduced lunch qualifiers compared to non-free or reduced lunch qualifiers.

Summary

Chapter III presents the methodology used in the study. It includes: the research questions, population to be used in the study, data gathering procedures, data gathering instrument, and how the data sources will be used to answer the questions.

The findings of the study will be reported and discussed in Chapter IV. In Chapter V, the summary, conclusions, implications, and recommendations will be discussed.

CHAPTER IV

ANALYSIS

Introduction

This chapter presents the quantitative analyses of the numerical data that were supplied by the school district with regard to achievement. For the purpose of these analyses, the following were used as independent variables, where the Tennessee Comprehensive Assessment Program (TCAP) mathematics total battery score was the dependent variable:

- Race/ethnicity recorded according to federal guidelines,
- SES established by participation in the free or reduced meal program,
- Gender, and
- Curriculum participation.

Quantitative Findings

The demographic information is presented. Next, findings are presented in order, by research questions. Last, a summary of the findings is included.

Demographic Information

The researcher utilized data from twenty-one schools in the study. Of the schools included in the study fifteen were middle level, grades six, seven, and eight, two were schools containing grades K-12, one was an elementary/middle school combined and the remaining three were a middle/high school combinations. The schools were representative of a range of school settings including urban, suburban, rural, and magnet.

Research Question 1

Is there a significant difference in mathematics achievement among students who have had CMP for one, two, or three years as measured by the TCAP?

Using a Post Hoc Test for multiple comparison, the Scheffe, the researcher analyzed an N=3139 for students who have had CMP for one year, an N=3018 for students who have had CMP for two years, and an N=2893 for students who have had CMP for three years. The data analyses indicated no significant difference in mathematics total battery test scores between students who had CMP for one year and those who had CMP for two years. However, the data did indicate a significant difference in mathematics total battery test scores between students who had CMP for two years and those who had CMP for three years. There also was a significant difference in mathematics total battery test scores between students completing CMP for one year and those who had CMP for three years. Students completing CMP for three years performed better on the TCAP than they had the previous two years. These findings are presented in Table 2.

Table 2. 2000, 2001, & 2002 Comparisons of Normal Curve Equivalent Scores for Students Participating in the Connected Mathematics Project for three years.

Group statistics for students completing CMP

	Research Groups	Research Groups	Mean Difference	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
NCE Math Total	1st year of CMP	2nd year of CMP	-1.279	0.533	0.056	-2.59	0.03
		3rd year of CMP	-4.147	0.539	0	-5.47	-2.83
	2nd year of CMP	1st year of CMP	1.279	0.533	0.056	-0.03	2.59
		3rd year of CMP	-2.867	0.544	0	-4.20	-1.53
	3rd year of CMP	1st year of CMP	4.147	0.539	0	2.83	5.47
		2nd year of CMP	2.867	0.544	0	1.53	4.20

Research Question 2

Is there a significant difference in mathematics achievement between African American and Non-African American students after one, two, or three years of CMP as measured by the TCAP?

Race/ethnicity was recorded as one of two categories in this study: African American and Non-African American. The researcher utilized a T-Test to analyze the data according to race. The data represented an N=979 for African American and an N=2160 for Non-African American students who had CMP for one year. The data revealed a significant difference between African American and Non-African American students who had CMP for one year. An N=921 for African American and an N=2097 for Non-African American students completing CMP for two years was analyzed and revealed a significant difference favoring Non-African American students. The data further represented an N=895 for African American and an N=1998 for Non-African American students who completed three years of CMP. Though the range of difference between the means closed slightly the data again revealed a significant difference between African American and Non-African American students. These findings are presented in Tables 3, 4, and 5.

Table 3. 2000 Normal Curve Equivalent Mathematics Totals for African American and Non-African American Middle School Students.

Group statistics for students completing one year of CMP

		N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Non African American	2160	51.81	20.356	0.438
Total	African American	979	33.82	16.955	0.542

Table 4. 2001 Normal Curve Equivalent Mathematics Totals for African American and Non-African American Middle School Students.

Group statistics for students completing two years of CMP

		N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Non African American	2097	52.94	19.998	0.437
Total	African American	921	35.04	16.998	0.56

Table 5. 2002 Normal Curve Equivalent Mathematics Totals for African American and Non-African American Middle School Students.

Group statistics for students completing three years of CMP

		N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Non African American	1998	55.77	20.216	0.452
Total	African American	895	38.24	16.787	0.561

Research Question 3

Is there a significant difference in the mathematics achievement of students according to their identified socioeconomic status after one, two, or three years of CMP as measured by the TCAP?

The researcher was unable to answer research question 3 with the data retrieved from this school system. The researcher determined school systems in Tennessee were not required at the time of the study, 1999-2002 to record socioeconomic data for individual students. Therefore, the data needed to answer research question 3 are not available from the school system.

Research Question 4

Is there a significant difference between the mathematics achievement of male and female students after one, two, or three years of CMP as measured by the TCAP?

The researcher utilized a T-Test to analyze the data according to gender. The data represented an N=1574 for male and an N=1550 for female students who had CMP for one year. The data revealed a significant difference between male and female students who had CMP for one year. An N=1509 for male and an N=1496 for female students who had CMP for two years was then analyzed. A significant difference was also determined between male and female students who had completed CMP for two years. The difference between male and female students after completing two years of CMP was less than the difference between male and female students completing one year of CMP. The data indicated that male students still outperformed female students on the standardized achievement tests after two years of CMP. The researcher continued utilizing an N=1460 for male and an N=1429 for female students who had CMP for three years. The data revealed no significant difference between male and female students who had completed three years of CMP. These findings are presented in Tables 6,7, & 8.

Table 6. 2000 Normal Curve Equivalent Mathematics Totals for Male and Female Middle School Students.

Group statistics for students completing one year of CMP

	Gender	N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Male	1574	45.68	22.22	0.56
Total	Female	1550	46.76	19.83	0.504

Table 7. 2001 Normal Curve Equivalent Mathematics Totals for Male and Female Middle School Students.

Group statistics for students completing two years of CMP

	Gender	N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Male	1509	47.65	21.867	0.563
Total	Female	1496	47.3	19.741	0.51

Table 8. 2002 Normal Curve Equivalent Mathematics Totals for Male and Female Middle School Students.

Group statistics for students completing three years of CMP

	Gender	N	Mean	Std. Deviation	Std. Error Mean
NCE Math	Male	1460	50.7	21.215	0.555
Total	Female	1429	50.03	20.475	0.542

Summary

Chapter IV presents demographic information and the findings by research question after the data had been analyzed. These data indicate that *CMP* is not overwhelmingly effective for every group of students. There was a significant difference in academic performance on every level after completing one year of *CMP*. In most of the other cases once students completed two and/or three years of *CMP* there was no significant difference among the students with the exception of African American and Non African American students. There was a significant achievement gap between African American and Non African American students after one, two, and three years of *CMP* though the least significant difference was after completing three years of *CMP*. The data collected during the course of this study revealed increased achievement for individual students and less of an achievement gap among various subgroups of students in mathematics classes where *CMP* was the primary textbook series utilized.

CHAPTER V

RESULTS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

This final chapter recaps the study, examines the results of the analyses, and uses the results to address the research questions. This chapter also presents concluding remarks and discusses implications from the study and recommendations for future research.

The Study

The purpose of this study was to document the decision by a school district to adopt an innovative middle school mathematics curriculum and to investigate the three-year effects of *CMP* and examine the subsequent impact on student achievement for various subgroups of the population. Quantitative data were collected from student records in order to compare the achievement of *CMP* students over a three- year period. These data were also analyzed to examine the achievement gap between African American and Non African American students as well as male and female students who had completed three years of CMP.

Major Findings: Quantitative

The quantitative analyses addressed four research questions:

1. Is there a significant difference in mathematics achievement among students who have had *CMP* for one, two, or three years as measured by the TCAP?

2. Is there a significant difference in mathematics achievement between African American and Non African American students after one, two, or three years of *CMP* as measured by the TCAP?

3. Is there a significant difference in the mathematics achievement of students according to their identified socioeconomic status after one, two or three years of *CMP* as measured by the TCAP?

4. Is there a significant difference between the mathematics achievement of male and female students after one, two, or three years of *CMP* as measured by the TCAP?

The results of the quantitative analyses can be summarized in the following major findings. These findings are based on student achievement data as measured by the TCAP:

1. Students in CMP for three years performed better on the TCAP than did students completing CMP for one or two years.

2. Students in CMP for one year performed similar to students completing CMP for two years.

3. Non African American students performed better than African American students after completing one, two, and three years of CMP.

4. African American students completing CMP for three years performed slightly better when compared to Non African American students than did African American students completing one or two years of CMP when compared to Non African Americans completing the same.

5. The socioeconomic status of individual students was not recorded by this district during the time of the study.

6. There was an achievement gap between male and female students after completing one and two years of CMP.

7. The achievement gap between male and female students after completing two years of CMP shrank when compared to the first year of completion and after completing three years of CMP there was no significant difference noted between male and female students.

Mathematics scores for this district on the TCAP had been stagnant for the past several years. The area of problem solving was especially troublesome. Problem Solving test scores continued to decline despite specific attempts to improve them by the curriculum specialist. Mathematics test scores for this district started to climb after the adoption of *CMP*. After comparing the total battery mathematics test scores a significant difference was found in mathematics achievement of students completing three years of *CMP* when compared to students completing one and two years. Curriculum alone was not a significant predictor of the mathematics achievement of middle school students by ethnic group. However, CMP was a positive factor for African American students even though it was not significant.

The analysis of the performance of African American and Non African American students yielded disappointing yet promising results in terms of reducing the mathematics achievement gap. There was still a significant difference between the achievement of African American students and Non African American students but the gap size was slightly smaller after three years of CMP.

After comparing the total battery mathematics test scores of male and female students no significant difference was found in the mathematics achievement of students completing three years of CMP. These results were promising in terms of reducing the mathematics achievement gap between male and female students in the middle grades.

The researcher notes that it is difficult to interpret what test scores like the TCAP provide really means in relationship to the curriculum. And the score alone does not reflect what kind of instruction the student has received or the conditions that a child brings to the classroom. Therefore, test scores such as the ones used in this study should be used cautiously.

To bring consistency and quality to the instruction that students receive, standards were introduced. The standards developed by this district were heavily aligned with the NCTM standards. They were systematically introduced at the elementary, middle, and high school levels by lead teachers located in each school within this district. It is assumed the instruction in CMP classrooms in this study was standardized in practice and consistent with pedagogy and content outlined by the NCTM standards. It is also important to note that the previous mathematics learning experiences that the students brought to their classrooms were assumed to be similar. Most of the students in the study had a minimum of four or five years of traditional mathematics content and pedagogy and a maximum of three or four years of reform mathematics content and pedagogy. Most of these students were in their final year of elementary when this school district first introduced reform mathematics in elementary and middle school levels. Therefore, it is difficult to determine if the effects of CMP were minimized due to their previous experiences in traditional mathematics (Clarkson, 2001).

Reform in Middle School Mathematics

The major purpose of the NCTM standards is to raise the mathematics achievement of all students. Standards based curricula like CMP integrate “new” pedagogy to teach “new” mathematics content to all middle school students. Historically, the middle school curriculum had a heavy emphasis on arithmetic skills from elementary schools, which were taught through procedural instruction (National Advisory Committee on Mathematical Education, 1975 as cited by Clarkson, 2001). The NCTM standards also state that the teaching, learning, and assessing of mathematics should shift from rote memorization to conceptual understanding and reasoning. The demands in the *CMP* classrooms in this study were consistent with the beliefs of the mathematics educational community as outlined in the standards.

The data suggest that there are aspects of *CMP* that are effective in middle school classrooms and most of these can best be described as increasing the opportunity to learn. Professional development opportunities for teachers of *CMP* are important to recognize. Professional development experiences are an important part of successful implementation of curricular reform. Reform in middle school mathematics is extremely important because of the huge numbers of middle school teachers who were trained as generalists and are serving as mathematics teachers with little or no formal education beyond general college mathematics though with the No Child Left Behind legislature teachers are now being required to have special training in a specific subject area. These professional development experiences provided the teachers in this study with more mathematics content knowledge and also prepared teachers to implement the *CMP* lessons. These teachers and in turn the students seemed to benefit from the professional development experiences. Teacher and student benefits are definitely reasons *CMP* should continue to be implemented in this school district.

Implications

"Achievement in mathematics is often used as an indicator of 'how much' mathematics someone knows or possesses" (Secada, 1992). "Knowing mathematics" is defined as having the ability to identify the "basic concepts and procedures of the discipline" (National Council of Teachers of Mathematics, 1989). In reform mathematics like *CMP*, students are not simply asked to repeat basic facts or computational procedures. "Knowing mathematics" in reform mathematics curricula like *CMP*, means having a conceptual understanding of mathematics that enables the student to access a variety of strategies in order to solve a "worthwhile" problem. Traditional standardized testing alone does not always demonstrate "knowing mathematics." (Clarkson, 2001).

This study employed quantitative methodology. This analysis created comparable evidence of the *CMP* experience. Gradual changes on students' test scores should be expected because these scores also reflect what has happened in previous grades according to Grissmer's (2000) analysis of the mathematics data from the 1990, 1992, 1996, NAEP assessment. Continuing to monitor the mathematics progress of the students in this study through high school would generate better data over time to determine if *CMP* makes a difference in mathematics achievement.

Additionally, when school districts are considering reform mathematics for their students, it would be valuable for the decision makers to have prior knowledge of the misalignment of the curriculum to traditional standardized testing. The result of the misalignment may indicate little significant change in student achievement based on the students' standardized test scores. Using additional assessments that align with the reform mathematics content may provide students with the opportunity to demonstrate the depth of their mathematical knowledge that is currently not measured with the traditional standardized test. Decision makers in this district definitely should continue using *CMP* and in fact while monitoring student progress should prepare to adopt an updated version of the Program. However, the researcher would recommend to future districts considering adopting *CMP* or any other reform curricula to phase in the material over a two to three year period. This will allow for gradual acceptance and perhaps less of a dramatic adjustment for students, teachers, parents, and administrators shifting from traditional to reform mathematics.

Recommendations for Future Research

Middle school mathematics studies like this one can inform potential studies that examine the long term effects of reform in relationship to future mathematics course retention and achievement. Eventually, the future workforce will be the deciding factor of the success of the present day mathematics reform. The following study ideas for additional research are suggested:

1. Compare the achievement of students from various levels of CMP completion by socioeconomic status.

2. Compare the achievement of students from traditional middle school mathematics to the achievement of students from reform mathematics in middle school.

3. Compare the achievement of students from elementary mathematics from this same school district as they complete four years of a reform curriculum.

4. Continue this study with the same population as they proceed through high school mathematics courses.

In conclusion it is the belief of the researcher, possibility to learn summarizes the whole principle of *CMP*. Professional development opportunities provided teachers with more mathematics content and current mathematics knowledge. *CMP* classrooms provided students with a more hands on real life approach to learning mathematics.

This study contributes to the body of knowledge on reform mathematics and the achievement of middle school students and hopefully will also serve as a catalyst for continuing research in mathematics education.

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APPENDIX

Appendix A

District Pacing Schedule

District Pacing Schedule: Connected Mathematics Project
(Updated: 2002)

6th Grade	Data About Us Prime Time Bits and Pieces I Bits and Pieces II Shapes and Designs Covering and Surrounding How Likely Is It? Exploration: Ruins of Montarek
7th Grade	Bits and Pieces II Variables and Patterns Accentuate the Negative Comparing and Scaling Filling and Wrapping Stretching and Shrinking Moving Straight Ahead What Do You Expect? Exploration: Clever Counting
8th Grade	Moving Straight Ahead Filling and Wrapping Growing, Growing, Growing Say It with Symbols Looking for Pythagoras Frogs, Fleas, and Painted Cubes Exploration: Kaleidoscopes, Hubcaps, and Mirrors or Sample and Populations

VITA

Megan Bray was born Megan Shannette Gray on August 19, 1970, in Winchester, Tennessee. She was the first of four children born to Gwynne Russell. Megan attended school in Winchester and graduated from Franklin County High School in 1988.

In 1992, Megan graduated from Tennessee State University with a Bachelor of Science degree in Elementary Education. After teaching half a year in Franklin County and one year in Montgomery County, Tennessee, she accepted a teaching position in Chattanooga, Tennessee. In 1996, she graduated with a Master of Science degree in Educational Administration and Supervision.

In August of 1997, she accepted a teaching position with Hamilton County, Tennessee. In 2001, she was chosen to become a leadership fellows in Hamilton County. After a year of leadership training, she became the Assistant Principal of Chattanooga Middle Museum Magnet School in 2002.

In the fall of 1999, she entered the University of Tennessee to pursue the Doctor of Education Degree with a major in Educational Administration and Policy Studies. She has a special interest in urban middle school education and she expects to graduate Fall, 2005.

She is married to Ricky Bray and has two daughters, Reagan and Ryleigh.