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## **The Effects of Changing from a Traditional Mathematics Curriculum to an Integrated Mathematics Curriculum on Student Mathematics Learning in Georgia**

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The University of Southern Mississippi

THE EFFECTS OF CHANGING FROM A TRADITIONAL MATHEMATICS  
CURRICULUM TO AN INTEGRATED MATHEMATICS CURRICULUM ON  
STUDENT MATHEMATICS LEARNING IN GEORGIA

by

Catherine Lynn Mallanda

Abstract of a Dissertation  
Submitted to the Graduate School  
of The University of Southern Mississippi  
in Partial Fulfillment of the Requirements  
for the Degree of Doctor of Philosophy

December 2011

## ABSTRACT

# THE EFFECTS OF CHANGING FROM A TRADITIONAL MATHEMATICS CURRICULUM TO AN INTEGRATED MATHEMATICS CURRICULUM ON STUDENT MATHEMATICS LEARNING IN GEORGIA

by Catherine Lynn Mallanda

December 2011

In 2005, the state of Georgia adopted a new integrated mathematics curriculum, the Georgia Performance Standards (GPS), which included a task-based approach for instruction. The purpose of this study was to determine if the new Georgia Performance Standards for mathematics increased students' mean mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores or induced changes in the distribution of students' scores on the PSAT/NMSQT. In addition, it was determined whether the level of course the student took, the type of implementation of the GPS curriculum or the preparation for implementation affected the PSAT/NMSQT scores. The results of the study indicated there was a statistically significant relationship between the GPS curriculum and students' mean mathematics scores for year one of implementation, but not for year two. Results also showed a change in the distribution of test scores for students scoring in the lower half of the range of possible scores. This study did not reveal any indication that following the specific practices of the GPS had an effect on the PSAT/NMSQT scores. In addition, the department chairman indicated while students benefitted from the GPS as it provided a more challenging curriculum and required students to make more mathematical connections, there were significant challenges for the students and teachers.

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A Dissertation  
Submitted to the Graduate School  
of The University of Southern Mississippi  
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for the Degree of Doctor of Philosophy

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## CHAPTER I

### INTRODUCTION TO THE STUDY

#### Background

With the creation of the No Child Left Behind Act of 2001 (NCLB), the federal government created a new sense of urgency for improving education in America (No Child Left Behind Act [NCLB], P.L. 107-110 (HR1), 20 U.S.C. 6301*et seq.*, 2002). The purpose of the act was to ensure that all students had “a fair, equal and significant opportunity to obtain a high-quality education” (LaMorte, 2008, p. 470). In addition, students were required to demonstrate their achievement on “state academic assessments” (LaMorte, 2008, p. 470). One way for states to achieve this goal is to make sure that all students have access to a high-quality curriculum.

Phi Delta Kappa audited the Georgia Quality Core Curriculum (QCC) in 2001. The findings determined the QCC was not rigorous or demanding enough for every student. In addition, the QCC included more objectives than could be taught in one year and provided little guidance for teachers. Evaluating a multitude of State and National assessments, including the National Assessment of Educational Progress (NAEP) in which Georgia students scored below national average, it was clear that Georgia’s students were not making enough gains and that the achievement gap was not narrowing. At that point the State Board of Education charged the Georgia Department of Education with developing a new mathematics curriculum. The purpose of the new curriculum was to alleviate the following concerns: a lack of rigor and focus, a lack of usability by teachers to truly guide classroom instruction, and a lack of student-centered versus teacher-centered instruction (Georgia Department of Education, n.d.b).

In 2005, Georgia adopted the Georgia Performance Standards (GPS) for mathematics. Each performance standard had four components. There was a content standard for each one of the following: “numbers and operations, measurement, geometry, algebra and data analysis and probability” (Georgia Department of Education, n.d.b, p. 2). In addition, each course included “process standards emphasizing problem solving, reasoning, representation, connections, and communication” (Georgia Department of Education, n.d.b, p. 2). Within each standard were sample tasks to use for instruction, samples of student work, and additional information about curriculum alignment with student assessments. One of the charges of the GPS curriculum development task force was to provide performance standards, rather than objectives, to guide teachers’ instructional practices (Georgia Department of Education, n.d.b).

The GPS performance standards were based upon the Japanese model of mathematics curriculum and constructed similarly to North Carolina’s mathematics standards. Instead of more traditional single subject courses, the new curriculum integrated the topics of algebra, geometry, and statistics into courses called Math I, Math II, Math III, and Math IV. The standards were based on reasoning and thinking skills and the application of mathematics to real world problems (Georgia Department of Education, n.d.a). The GPS curriculum was developed with the input of “teachers and educators from both K-12 and higher education, with input from leaders in business, government, and industry” (Georgia Department of Education, 2007b, p. 1). The developers utilized the standards set forth by the National Council of Teachers of Mathematics, the American Statistical Association, Achieve, and the College Board to create the GPS curriculum. The purpose of the new curriculum is to have more Georgia

students reach and “be successful in higher-level (mathematics) courses” (Georgia Department of Education, 2007b, p. 1). Determining whether the new GPS curriculum, in fact, increases student achievement is critical. The importance of this is emphasized by the public expressions of concern from parents, students, teachers, and administrators regarding its implementation.

Criticism of an integrated or standards-based curriculum began when the National Council of Teachers of Mathematics (NCTM) produced the *Curriculum and Evaluation Standards for Schools* in 1989 (Senk & Thompson, 2003). Before adopting a new curriculum that integrated mathematics standards, critics wanted proof that the new curriculum would increase student achievement. Critics were wary of the emphasis on process and feared there would be a “decline in basic skills” (Senk & Thompson, 2003, p. 16). In addition, moving from teacher-centered direct instruction to a student-centered discovery approach begged the question what will teachers be doing and will all students learn in a cooperative learning setting. One way curriculum developers have created a standards-based curriculum is by arranging consecutive integrated courses which incorporate different content and process standards (Senk & Thompson, 2003). However, this can in fact lead to a disintegration of curriculum if great care is not taken to review and base learning on the previous year’s topics (Usiskin, 2003). Since this review of the previous year’s material is necessary, the time needed for the review can limit the time for new learning. Because an integrated curriculum generally alternates between content strands, students can lose the understanding of mathematical systems (Usiskin, 2003). In addition, geometry topics usually take a back seat to algebra topics (House, 2003). In Georgia, fear of the unknown or solid research to support academic

achievement has created groups such as Georgia Parents for Math who would like to see a return to a single subject mathematics curriculum. Getting input from the community members during the process of curriculum development and instructional materials adoption can create understanding of the purpose and goals of the curriculum and thus prevent this controversy (National Council of Teachers of Mathematics, 2000).

### Theoretical Framework

Because the United States has fallen behind other countries in student achievement, there has been more public outcry for making sweeping changes in the educational system. A key component to improving student achievement is assurance that all students have access to a strong and viable curriculum (Marzano, 2003).

Politicians, professional organizations, curriculum developers, and educational leaders all play a role in determining and implementing curriculum (Georgia Department of Education, 2007b).

What is being taught in the classroom is being influenced more by political interest than ever before. Historically, this became prominent in the 1950s when Russia became the first nation to explore space. As a result, Congress acted to improve the mathematics and science curriculum in the United States (Oliva, 2009). Since education is not addressed in the United States Constitution, the Tenth Amendment places the responsibility of a public education system in the hands of the states (U.S. Const. amend. X). While this stops the federal government from mandating a national curriculum, their political influence is still felt in classrooms today.

One way in which the federal government plays a part in public education is through funding. In 2009, approximately 7.7% of the funding received by the state of

Georgia for education was received from the federal government (Georgia Department of Education, 2009). This revenue was earmarked for specific program such as Title I funds for the economically disadvantaged (Elementary and Secondary Education Act, P.L. 89-10, 79 Stat. 27, 1965). This use of funds gave the federal government the ability to influence what schools are doing. The Congress imposed its influence on curriculum through legislation that affects vocational education, special education and gender. The No Child Left Behind Act has established that schools must demonstrate Adequate Early Progress by student performance on assessments (NCLB, 2002). Thus, what the students are being taught is being affected by legislation. On occasion the judiciary branch of government will influence curriculum in the schools through case law (Oliva, 2009). The United States Department of Education also can influence the curriculum.

State Departments of Education, State School Boards, and state legislator have the most direct impact on curriculum. In the state of Georgia, the state contribution of educational funding is approximately 48% of the total revenues (Georgia Department of Education, 2009). Each year the state legislature creates a budget for education giving legislators direct influence over what programs to fund (Quality Basic Education Act, 2011). This is one area where educational leaders can assert their influence. As budgetary discussions are being held, the district superintendents have to be willing to prioritize and lobby for curriculum and instructional money that will directly impact student learning (Oliva, 2009). Glatthorn (2000) stated that “Principals have a professional responsibility to exercise their influence at the state level” (p. 33). They must keep abreast of new initiatives and understand the political climate (Glatthorn, 2000).



In the state of Georgia, all public schools must teach the curriculum adopted by the state school board (O.C.G.A. § 20-2-140, 2011). When a curriculum is developed, it must be determined what is going to be taught, how it will be taught, and how it will be assessed (Oliva, 2009). There are a variety of models that can be followed to develop a curriculum. The Tyler model was based on selecting key objectives for student learning and analyzing these objectives as to their importance (Tyler, 1949). English's model began curriculum development by focusing on developing learning objectives based on what students should be able to do each grade level (English, 1992). Another component of the curriculum to consider is instruction. It is essential to investigate how students learn best in order to determine the approach to instruction (Oliva, 2009).

The constructivist learning theory is based on the basic premise that students learn best when they can base new learning on what they already know and they have a new learning experience to expand their understanding of each essential concept (Oliva, 2009). Students in a constructivist classroom concentrate on problem solving to enhance their conceptual framework (Glatthorn, 2000). The constructivist theory is the basis of the new Georgia Performance Standards (GPS). Teachers develop new concepts through tasks that allow students to follow through a series of investigations that lead them to connect what they already know to a new mathematical concept.

The school leader plays an important role in the implementation of a new curriculum. This begins with the philosophical movement from the principal as a school manager to the principal as a leader of learning (Oliva, 2009). Two different models of leading for learning have evolved over recent years. The instructional leader is a principal who develops a shared vision and ensures that all decisions about teaching and

learning are in line with that vision (Hallinger, 2003). The transformation leader also believes in the shared vision but serves more as a facilitator of the stakeholders by truly embracing the idea of shared decision making (Hallinger, 2003). What is most important regardless of which leadership theory is subscribed to is the emphasis on student learning. The principal must be willing to determine what is necessary to successfully implement the new curriculum and ensure that the teachers have the resources and training to be successful (Glatthorn, 1994).

The GPS can be described as an integrated curriculum based on the constructivist theory of learning. When implementing the GPS, teachers are expected to facilitate the learning of new concepts. Algebra, geometry, statistics, and probability concepts are taught intertwined from Kindergarten through twelfth grade (Georgia Department of Education, 2007a).

In 1989, the National Council of Teachers of Mathematics (NCTM) set out to establish standards for what students should learn before graduating from high school. Their intent with this original document and the subsequent revisions was to improve equity for learners of mathematics (National Council of Teachers of Mathematics, 2000). After NCTM produced their first standards guide, the National Science Foundation (NSF) solicited the creation of a new integrated curriculum that could help improve student achievement in mathematics. The NSF's movement led to the production of three new mathematics curricula: the Core-Plus Mathematics Project, the Secondary Mathematics Core Curriculum Initiative, and Applications/Reform in Secondary Mathematics. In addition the Systemic Initiative for Montana Mathematics and Science (SIMMS) and the University of Chicago School Mathematics Project developed similar integrated

curriculum (Senk & Thompson, 2003). All of these curriculum were designed with the same goals: to improve instruction, application and the conceptual understanding of mathematics, and to integrate more real world problem solving. According to Senk and Thompson (2003), using traditional assessments the students utilizing the integrated curriculum performed as well as other students. The students utilizing the SIMMS program did not demonstrate statistically different scores on the Preliminary SAT/National Merit Scholarship Qualifying test (PSAT/NMSQT) from those involved in a traditional curriculum. However, on the National Assessment of Educational Progress and the Second International Mathematics Study, students utilizing an integrated curriculum scored higher than their counterparts utilizing a traditional curriculum (Swafford, 2003).

In contrast, Teuscher's (2008) study of 500 students in Advanced Placement Calculus some utilizing a traditional single subject curriculum and others an integrated curriculum indicated that single subject students scored significantly better in some areas such as algebraic skills. In addition, the study reported those utilizing the single subject curriculum were superior in solving problems both requiring connections between mathematical skills and those not requiring connections. McCaffrey et al. (2001) conjectured that it may not be the curriculum but the instruction necessary to properly teach an integrated curriculum causing this lack of achievement. In their study of a large urban school district which had instituted two different integrated curriculum programs along with a traditional curriculum in the district's high schools, they concluded tenth graders emerged in an integrated mathematics program had the same student achievement scores as those in an equivalent geometry course. More importantly, they found that

students in the integrated class performed higher when their teachers used more reform approaches such as mathematical reasoning, making connections, and problem solving. In other words, implementing an integrated curriculum alone will not increase student achievement, this curriculum must be paired with a change in instruction (McCaffrey, 2001).

Steinglein (2003) suggested that the successful implementation of any integrated curriculum will depend heavily on the teachers' use of the curriculum. The report warned that the professional development needs of these teachers will go beyond a general overview and must include the modeling of sample lessons and provide an ongoing mentorship program. Also, Steinglein recommended that school leaders who supervise teachers implementing an integrated mathematics curriculum will need to find time for teachers to collaborate more often than for teachers implementing a traditional curriculum. Embedding staff development during the school day to support instruction was also recommended as a necessary feature for teachers implementing an integrated curriculum approach for mathematics instruction (Steinglein, 2003).

#### Statement of the Problem

During the year 2001, students in the state of Georgia continued to achieve at a lower level than their peers across the nation in the curriculum area of mathematics (Georgia Department of Education, n.d.b.). After an independent review, the state determined a need to revamp the mathematics curriculum to improve student achievement (Georgia Department of Education, n.d.b.). As reported by the Atlanta Journal-Constitution, the dramatic change between the Georgia Performance Standards (GPS) and a traditional curriculum of single subject courses created controversy among

both educators and parents (Dodd & Perry, 2010; Diamond, 2008; Dodd, 2011). Without evidence that the new curriculum would indeed improve student learning, there was a strong public outcry to return to a traditional curriculum.

### Statement of Purpose

Each day teachers across the nation enter the classroom ready to instruct students. The teacher general has the freedom to choose from a variety of instructional strategies and to differentiate instruction for individual students, but the curriculum that must be taught is predetermined by state and local school boards. The purpose of this study was to determine if the new Georgia Performance Standards (GPS) for mathematics, which were adopted by the state of Georgia in 2005, increased students' mean mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores or induced changes in the distribution of students' scores on the PSAT/NMSQT. In addition, it was necessary to determine whether the level of the course the student took, the type of implementation, or the preparation for the implementation of the GPS curriculum affected the PSAT/NMSQT scores.

### Research Questions

The implementation of the Georgia Performance Standards began in the fall of 2005 with sixth grade students. These students were juniors in Georgia high schools during the time this study was conducted in 2011. This study examined the following questions and the correlating hypotheses:

1. Is there a difference in tenth grade students' mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores for

students who utilized the new Georgia Performance Standards (GPS) versus the tenth grade students who utilized the Quality Core Curriculum (QCC) standards?

H<sub>1</sub>: There will be no difference between the mean scores of students utilizing GPS standards and the scores of students utilizing the QCC standards on the PSAT/NMSQT.

2. Is there a difference between the distributions of tenth grade students' mathematics PSAT/NMSQT scores for students who utilized the new GPS standards versus the students who utilized QCC standards?

H<sub>2</sub>: There will be no difference in the distribution of students' scores for those utilizing the GPS or QCC standards on the PSAT/NMSQT.

3. Is there a relationship between the tenth grade mathematics PSAT/NMSQT scores and the extent to which the schools followed the recommended practices of the new GPS standards?

H<sub>3</sub>: There will be no relationship in the scores of students based on the extent to which the schools followed the recommended practices of the new GPS standards.

#### Rationale/Significance of the Study

The PSAT/NMSQT is considered a good indicator of success on the college entrance exams (College Board, 2006). This study looked to see if there was a difference in mean PSAT/NMSQT mathematics scores or the distribution of scores based on the two different curriculum models. Additionally, the study analyzed the impact of implementation fidelity of the GPS curriculum on the PSAT/NMSQT scores. As accountability in education becomes more prevalent, it is imperative for school leaders to

understand what impact the curriculum is having on student learning and what changes could be made to improve the curriculum and its implementation.

#### Assumptions

This study operated under the following assumptions:

1. All tenth grade students regardless of their abilities took the test since it was funded by the state of Georgia.
2. Mathematics department chairs answered all survey questions openly and honestly.

#### Delimitations

The study was delimited to the following:

1. The sample was taken from a single, suburban school district which included sixteen diverse high schools.
2. Academic achievement was limited to student scores on the mathematics section of the PSAT/NMSQT.
3. The data collected through the survey was limited to one mathematics department chair at each of the sixteen high schools and was conducted through US postal mail.

#### Definitions

Georgia Performance Standards for Mathematics (GPS). The Georgia Performance Standards for Mathematics curriculum was developed and adopted by the state of Georgia in 2005. The purpose of the GPS was to increase the preparedness of Georgia students for higher level mathematics courses (Georgia Department of Education, 2007b).

Integrated mathematics curriculum. An integrated mathematics curriculum structures such that each course includes strands of algebra, geometry and statistics topics and utilizes a student-centered discovery approach to instruction (Georgia Department of Education, 2007a).

No Child Left Behind (NCLB) Act of 2001. The purpose of NCLB legislation was to ensure all students had equal access to a high quality public education including a rigorous curriculum. Schools must demonstrate progress in yearly state achievement assessments which are used to measure the Adequate Yearly Progress of the school (No Child Left Behind Act, 2002).

Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT). The PSAT/NMSQT test was sponsored by both the College Board and the National Merit Scholarship Corporation that serves as a practice test for the SAT reasoning test, a college entrance exam. The PSAT/NMSQT has fewer items than the SAT and not as high a level of mathematics questions (Milewski & Sawtell, 2006).

Traditional mathematics curriculum. The sequence of mathematics courses that includes Algebra I, Geometry, and Algebra II.

#### Summary and Organization of the Study

The Georgia Performance Standards were implemented in order to improve student achievement. With the lack of research to ensure the citizens of its success, this curriculum reform was highly controversial. This study looked at the scores of tenth grade students on the PSAT/NMSQT as compared with the students who utilized the previous single subject curriculum to eliminate some fear that students are not learning as much and will not have a harder time being accepted into post-secondary institutions. In



Chapter I, the researcher has introduced the study. In Chapter II, the literature is reviewed. The methodology of the study is explained in Chapter III. The data and findings are presented in Chapter IV, and Chapter V explores the implications and recommendations of the study.

## CHAPTER II

### REVIEW OF LITERATURE

#### Introduction

The purpose of this study was to evaluate the affects of the integrated mathematics curriculum on student achievement in the state of Georgia. Implementation of the Georgia Performance Standards (GPS), the Georgia integrated mathematics curriculum, began in the fall of 2005 when the Class of 2012 entered the sixth grade; therefore, the Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) was the first national test these students took that was available for comparison in this study. At the time the study was conducted the GPS had been implemented for six years starting with sixth grade students. The state of Georgia has funded the PSAT/NMSQT for all tenth grade students and results of that test were available for the graduating Class of 2012 and 2013. This presented the opportunity for the researcher to compare the results with those of the previous two classes which utilized a traditional mathematics curriculum.

When looking closely at a change in curriculum, it is essential to understand why the change is taking place and what is influencing the change. Next, understanding how curriculum is developed is paramount for success. School leaders play an important role in the success of any curriculum. The new Georgia mathematics curriculum includes a change in instructional strategy as well as an integration of mathematics topics. The intention was for students to learn through carefully designed discovery tasks. This approach is grounded in the constructivist theory of learning. Finally, the validity of reorganizing the mathematical topics to create more connections between the traditional

branches of algebra, geometry, and data analysis was investigated in this study. Integrated mathematics curricula are not new, but most of the research has been conducted on specifically designed programs that districts have adopted as opposed to a state developed curriculum.

### Political Framework

Before any curriculum is delivered at the classroom level, there are many different influences that impact the curriculum as well as the structure of the implementation of the selected curriculum. These different entities, such as professional organizations, teacher unions, and politicians, have their own individual agendas. While states have the responsibility for educating all youth and thus will influence curriculum, at an increasing pace education has become a key topic in national political arenas.

If education is a power left to the states through the United States Constitution, then how can the federal government create legislation on educational issues? The General Welfare Clause of the United States Constitution preamble states:

We the People of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America (U.S. Const. pmb., n.d.).

In addition, Article I section 8 states:

The Congress shall have Power To lay and collect Taxes, Duties, Imposts and Excises, to pay the Debts and provide for the common Defense and general

Welfare of the United States; but all Duties, Imposts and Excises shall be uniform throughout the United States;... (U.S. Const. art. I, § 8).

These two sections of the constitution have been used by the United States Congress to introduce legislation that has affected school curriculum, the treatment of minority groups, and federal funding.

The National Defense Education Act of 1958 is generally thought of as the first legislation that established national influence on curriculum (National Defense Education Act, P.L. 85-864; 72 Stat. 1580, 1958). With the Russians establishing space exploration with the launch of Sputnik, this legislation was enacted to ensure that the United States did not fall behind the communist nation. Specifically, the act started a student loan program in the areas of science, math, and foreign language; created fellowship programs for those pursuing careers in higher education and offered professional development for teachers at the high school level. The ripple effect of this increase in funding was a movement to improve mathematics and science curriculum and instruction at the K-12 level (Flattau, Bracken, Van Atta, Bandeh-Ahmadi, de la Cruz, & Sullivan, 2006).

### *Legislative Influences*

Another arena that legislation has influenced using the General Welfare clause was the protection of minority groups such as individuals with disabilities and women (U.S. Const. pmb.). While Sputnik was the most obvious reason for the creation of the National Defense Education Act (National Defense Act, P.L. 85-864; 72 Stat. 1580, 1958), in 1947 the President's Commission on Higher Education proposed the goal of having one-third of all United States citizens earning a college diploma by 1960 (Flattau et al., 2006). Since that time, there have been a variety of reports on education conducted

under presidential order that have influenced what is being taught in schools. In 1983 under the direction of President Reagan, the National Commission of the Excellence in Education distributed *A Nation at Risk* (National Commission of Excellence in Education, 1983). This commission made some astounding discoveries about the state of the educational system across the nation. The report revealed deficiencies in curriculum, expectations, and time spent on learning and teaching. The commission recommended (a) strengthening graduation requirements in all core subject areas, (b) instituting more rigorous and measurable standards, (c) lengthening the school day and year, (d) improving teacher preparation programs, and (e) providing the adequate financial support necessary to make these changes (National Commission of Excellence in Education, 1983). While this report mandated no changes, it influenced widespread reforms in the educational system. Porter, Smithson, and Osthoff (1994) conducted a study in 1991 that determined while states may have adopted many of the recommendations from *A Nation at Risk Act* there was little if any true increase in emphasis on higher order critical thinking skills.

#### *Federal Funding Influences*

The other arena in which the federal government was able to influence education was through financial legislation. Beginning with the *Elementary and Secondary Education Act* in 1965 (Elementary and Secondary Education Act, P.L. 89-10, 79 Stat. 27, 1965), the federal government established a foothold in education by providing funding. In 1994, Congress passed the *Goals 2000 Educate America Act* (Goals 2000 Educate America Act, P.L. 103-227, 1994). Based on reaching certain educational goals

by the year 2000, this act allowed for grants to states that would develop and implement standards-based reforms. These reforms were based on the following beliefs:

- Curriculum needs to be challenging and clearly defined in terms of what students will know and be able to do at each level;
- The learning environment must support high expectations for all students;
- Schools must concentrate on results to measure success of learning (Goals 2000: Educate America Act, P.L. 103-227, 1994).

Based on these common beliefs, states were given funds to create plans that included a wide range of educational reforms.

The most recent reauthorization of the *Elementary and Secondary Education Act* is the *No Child Left Behind Act* (NCLB) (No Child Left Behind Act, P.L. 107-110 (HR 1), 20 U.S.C. 6301*et seq.*, 2002). Led by President George W. Bush, this federal legislation was designed to make sweeping reforms to education. The law mandated that each school demonstrate Adequate Yearly Progress (AYP) or face corrective action. AYP was based on students in all subgroups meeting or exceeding standards on state designed assessments. These assessments were to be tied to rigorous state standards in both reading and mathematics. While each state was mandated to design its own accountability plan, the law mandated that all third through eighth grade students must be tested. Second, NCLB established school choice for those students who were in Title I schools that did not make AYP. NCLB required that students must not only be afforded the opportunity for school choice, but they must also be provided transportation to another school. Any economically disadvantaged student who attended a school not making AYP was to be offered free tutoring funded by Title I money (U. S. Department

of Education, 2006). A common side effect to testing only mathematics and reading is the narrowing of curriculum as low-performing students were given more time in these subject areas. This created a different type of achievement gap with higher-performing students given exposure to a wide variety of curriculum whereas low-performing students only concentrate on the content areas that require mandatory testing (Rothstein & Johnson, 2009). In addition, NCLB dictated that state and local boards of education utilize scientifically based research to establish curriculum and instructional programs. This supported the belief that all children learn in the same way and that there is one solution to what currently ails the educational system, which may in turn discourage individual innovation (Hlebowitsh, 2009).

#### *Disparity Among States*

Many opponents of NCLB have pointed to the disparity among states. The assessment and cut-scores to determine AYP were developed by each state individually. In a comparison by Barton (2009) of state cut-points and the National Assessment of Educational Progress (NAEP) state scores, there are many states where the results on the state assessment do not have similar results to the NAEP test (p. 18). For example for eighth grade reading, eighty-three percent of Georgia students were reaching the proficient level on the state test yet only sixty-seven percent were meeting the basic level and only twenty-five percent are meeting the proficient level on the NAEP test in 2005 (Barton, 2009). This discrepancy existed in many states which illuminates the need to reauthorize the bill. One option considered was to look at growth in achievement; however, a call for a national assessment became the focus (Barton, 2009)

In 2010, the Race to the Top initiative (American Recovery and Reinvestment Act of 2009, P.L. 111-5, 123 Stat, 2009) was created by the United States Department of Education to disseminate funding to states that were willing to make specific plans to improve student learning. One of the criteria was to “adopt standards and assessments that prepare students to succeed in college and the workplace and to compete in the global economy” (U.S. Department of Education, 2009, p.1). Clearly, this would influence the state curriculum for the states that chose to accept this grant money. The first Race to the Top grants were awarded to Delaware and Tennessee which received \$100 million and \$500 million respectively (U.S. Department of Education, 2009). Georgia, under the direction of Governor Sonny Perdue and State School Superintendent Kathy Cox, submitted an application for a Race to the Top Grant. Local school districts and superintendents were given the option on whether or not to be part of the grant proposal. Only 23, or 12.7%, of the local districts elected to participate (State of Georgia, 2010). As instructional leaders the school districts had to investigate what was being proposed and decide whether this would be in the best interest for their students.

#### *Common Core National Standards*

Most attempts toward establishing a nationalized curriculum have been a collaborative effort between “governors, chief state school officers, local superintendents, teachers’ unions and discipline-based professional organizations” (Elmore & Fuhman, 1994, p.1). The call for a national curriculum has been based on a desire to improve the rigor of curriculum and eliminate the variability among the states (Barton, 2009). Most recently the National Governors Association and the Council of Chief State School Officers developed a Common Core Standards initiative (Common Core Standards



Initiative, 2010). The goal of this initiative was to create common standards across participating states in English Language Arts and Mathematics. The plan was that the established standards would be research-based, internationally benchmarked, and reflective of current state standards. They would allow students to be college and work ready by incorporating rigorous content, problem solving, and application skills. While this may be the closest to a national curriculum, the spirit of the reform was to have students well prepared regardless of where they live (Common Core State Standards Initiative, 2010). Proponents of national standards look to future generations to compete internationally. In addition, with current economic times many states do not have the resources necessary to revise their state curriculum and assessments. These national standards could provide clear goals, while the states could invest in professional development of teachers to reach these goals. Elmore (1994) suggested that National standards could provide a basis to improve equality in our schools. However, many opponents of the national standards reflect on past attempts which resulted in extremely low minimum standards. With many states already invested in improving education, there is a concern that new standards may eliminated the positive changes that have already been established (Elmore, 1994). Additionally, teaching to the new assessments based on the standards may eliminate creative and enriching learning experiences (Hlebowitsh, 2009).

While it is clear the federal government influences education in many ways, it is State Departments of Education, State School Boards, and state legislators who impact education most directly. Each state has statutes providing for a free public education. In Georgia state code there are provisions to tax residents in order to support the educational

system (Ga. Const. Art. VIII, § I, Para. I, 1906). With this responsibility comes the ability to create rules and regulations about all aspects of education. The Georgia Department of Education is charged with overseeing the distribution of funds and the adherence to state and federal regulations. The State Board of Education enacts rules for the operation of schools in accordance with the Official Code of Georgia. In 1985, the Quality Basic Education Act declared that all students in Georgia must be offered a rigorous, meaningful curriculum (Quality Basic Education Act, O.C.G.A. § 20-2-130, 2011). At that time, the State Board of Education adopted the Quality Core Curriculum (QCC). Based on the initiatives of the above mentioned federal legislation, the state ordered an in-depth analysis of the QCC by Phi Delta Kappa that determined a total curriculum revision was necessary (Georgia Department of Education, 2010).

Lusi (1994) recommended that for a state to implement system-wide reform, it should not only redesign the standards to include higher-order thinking and problem-solving skills, but the state should also assess students differently. In addition, the state must plan for significant professional development so that teachers could learn new strategies to activate these skills. According to Lusi (1994), a change in state policy alone would not invoke the changes that are desired for a curriculum redesign of this magnitude. Georgia's response was to begin the process by creating the Georgia Performance Standards (GPS) (Georgia Department of Education, 2010). The performance standards were designed to give explicit guidance for teachers to not only know what should be taught but to what depth. Examples of student work and suggested instructional tasks were also provided (Georgia Department of Education, 2010). While all areas of curriculum are shifting to performance standards, in the state of Georgia, the

mathematics curriculum has undergone the greatest shift from traditional single subject courses to an integration of topics.

### Curriculum Development

The State Board of Education determines the curriculum and standards being taught at each grade level in each course (Oliva, 2009). It also determines what assessments will be given statewide and the requirements to earn a high school diploma. Usually at the state level, less district personnel are directly involved in the process, but it is important for leaders to be active participants in the state curriculum development and to provide professional development for teachers who will be implementing the new curriculum (Oliva, 2009).

According to Oliva (2009), curriculum development is the planning, implementation, and evaluation of what is being taught to students. Curriculum development involves many choices, including (a) what courses to teach using varying viewpoints, (b) the determination of what programs to implement, and (c) how to organize the curriculum. Curriculum development is a comprehensive process which focuses on what will happen in the classroom. When making curriculum decisions, it is essential to get all stakeholders involved in the process (Oliva, 2009). However, one drawback to including all stakeholders is the breadth that the curriculum expands as individual interests are placated (Massell, 1994). This can mean the success or failure of the reform.

There are two approaches to determine who should be involved in writing a curriculum. Some curricula have been developed by professional experts and then additional stakeholders are given the opportunity to be part of the revision process. The

State of California mandates this process by state law. Other development strategies have included all stakeholders from the very beginning of the process (Massell, 1994). Both strategies have their own unique strengths and weaknesses. When teachers were included in the design of the curriculum, they more readily accepted the new state standards (Porter et al., 1994). Regardless of the type of input, there will be stakeholders who do not participate until after the curriculum is implemented and they become directly affected. Thus the role of the curriculum developers does not end when the curriculum is implemented; they must be ready to hold public forums to explain the changes.

With state curriculum reform, the developers have to determine to what level of detail they will specify the curriculum. The curriculum may be extremely detailed or based on universal themes, or it may be divided by subject or overarching skills. The curriculum could focus on the standards, instruction, or the students' performance level (Massell, 1994). Philosophically curriculum can be developed by either creating the standard based on what is to be taught or a performance standard based on what a student should be able to do, which is linked to the assessment of the students (Barton, 2009). Glatthorn recommended against states being extremely specific and instead providing a framework that allows districts the ability to differentiate the needs of their students (2000). He believed states should set broad educational goals, graduation requirements, and general standards for each subject and state assessments (Glatthorn, 2000). The current Georgia Performance Standards go well beyond this recommendation; they include very specific goals and objectives for each course (Georgia Department of Education, n.d.b). Robert Marzano (2003) recommended five action steps in creating a curriculum. First, it must be determined what standards are essential for all students.

According to Marzano (2003) this will increase the amount of time available for instruction on these essential standards. There must be adequate time for students to understand the content and the content must be logically organized (Marzano, 2003).

The key element in Tyler's curriculum development model was centered on selecting objectives for curriculum (1949). Objectives must be solicited from not only the needs of the learner but also based on priorities of society and curriculum experts. Once the massive amount of objectives are compiled, then they must be analyzed for importance. First, the objective must clearly align with the vision and mission of the school. In addition, the objective must be analyzed based on sound principles of learning such as whether or not it can be expected to be learned and given the length of time necessary to be learned. This process of screening leaves developers with a set of realistic objectives. Tyler's model then proceeds to selecting, organizing, and evaluating these behavioral objectives (Oliva, 2009).

English (1992) states that "curriculum is a document...and its purpose is to focus and connect the work of classroom teachers in schools" (p.2). He believed that an effective curriculum must be consistent from classroom to classroom, be continuous from year to year, and provide for flexibility. According to English, all students are not the same and teachers should be able to adjust the sequencing and pacing without altering the design of the curriculum. English's (1992) model for curriculum development begins by determining what outcomes are desired. There are a wide variety of stakeholders that should be involved in developing outcomes, and consensus on the selected essential curriculum must be reached, otherwise the curriculum could be too large in scope. Next, the gaps between what students are learning and what it is students should be learning

must be measured in order to arrange the learning outcomes and the sub skills necessary to reach these outcomes. Aligning the skills by year, unit, and classroom lessons becomes the last step. Once an overall curriculum is developed each district or school must have a working curriculum guide. This guide should be closely aligned with assessments and textbooks. It should have a realistic time designation (English, 1992).

Regardless of development model, once it is determined what is to be taught, curriculum developers need to focus on how it will be taught. In order to do this, they must consider how students learn (Battista, 1999). Teachers have an individual style for their instruction and students learn in a variety of ways. According to Oliva (2009), there must be a balance between these and what the curriculum developer deems as the best way to instruct. The philosophies of learning of the curriculum developer and teacher must be in line or there will be resistance to implementation of the new curriculum. The alignment of the written standards, the assessment, and instruction is critical if there is to be successful implementation. Glatthorn (1994) explained that alignment should be completed by the teachers who are expected to utilize the curriculum. During the alignment process, it will be clear if only mastery standards have been included in all three elements (Glatthorn, 1994).

When curriculum developers begin their task, they envision how they expect teachers to instruct the students. Glatthorn (1994) and Reeves (2000) shared that the implementation of the curriculum will vary greatly from classroom to classroom if there is not a balance between what the developer deems as the correct implementation and the teachers' abilities to adapt it to their individual styles. This "mutual accomplishment" indicates that the teachers will develop units that include all the essential standards and

determine the best ways to teach these strategies (Glatthorn, 1994, p. 58). This is in direct conflict with the implementation of the new Georgia mathematics curriculum. The standards were prearranged into units and included tasks that students are supposed to complete that emphasize discovery learning. Another factor related to successful curriculum development is, a quality curriculum has a limited number of standards to allow enough time for teachers to successfully instruct students (Glatthorn, 1994). The Georgia curriculum has not followed this guideline. Clearly, the amount of rigidity puts the success of implementing the new curriculum at risk.

The assessment of students' learning is the next critical step. With the No Child Left Behind Act of 2001 (No Child Left Behind, P.L. 107-110 (HR1), 20 U.S.C. 6301 *et seq.*, 2002), testing has become an important factor in education. Most often states develop criterion-referenced tests in key grade levels to assess Adequate Yearly Progress (Oliva, 2009). If states reform curriculum to increase problem solving and application of concepts yet keep traditional testing methods, there will be a lack of acceptance of the new curriculum (Battista, 1999). Curriculum developers must balance these dual purposes by creating new assessments that match the goals of the curriculum. Only when the curriculum aligns with the assessments will it begin to measure what a child knows and negates the outside influences (English, 1992).

Once the new curriculum has been implemented, it is essential to evaluate the program. Robbins and Alvy (2003) recommend that educational leaders should encourage evaluation of all school programs to determine whether they are having an effect on students' achievement or if there are any problems with program implementation. Having a predetermined cycle for review can facilitate looking at new

research in curriculum and instruction. In addition, the cycle of reviews allow a wide variety of stakeholders to come together to make needed improvements (Robbins & Alvy, 2003). While it is the principal's responsibility to evaluate the program, it takes teacher involvement to sustain the effort. While some faculty may resist this process, it cannot be ignored since student learning is at stake. Jason (2003) recommended that a thorough evaluation program should include both formative and summative evaluations. While the summative evaluation will analyze the outcomes of the program, it is the formative evaluation that indicates which parts of the curriculum are being successful and what needs to be changed. Jason (2003) explained, if it is determined that changes are needed, then the program will need to be re-evaluated to see if student learning has improved. It is recommended that the program evaluation should be a continual process (Jason, 2003).

Jason (2003) recommended that faculty should embrace the notion of program evaluation as supporting the mission of the school in order for it to make great strides. Additionally, it is the leader's responsibility to convey the message that program evaluation is not about pointing fingers but instead revising what is being done to improve student learning. With this, the leader should promote reflection as a technique for improvement. However, the goal is to instill a positive attitude in others if this evaluation is to provide for meaningful improvement (Jason, 2003). One recommended strategy to begin this evaluation is to have stakeholders take a close look at schoolwide data. By investigating student performance, it can be determined if there needs to be an adjustment to the curriculum, the instruction, or the assessment of students. This type of meaningful evaluation can bring about significant change (Robbins & Alvy, 2003). The



results of the faculty collectively reflecting on the systems as a whole have powerful implications for student achievement. These practices are in line with transformational leadership theory (Jason, 2003).

### Instructional and Transformational Leadership

The role of the principal has evolved in recent years. In the past, the primary role was management of the school. With the No Child Left Behind Act of 2001 (No Child Left Behind Act, P.L. 107-110 (HR 1), 20 U.S.C. 6301*et seq.*, 2002) and the determination of each public school in the United States' Adequate Yearly Progress, principals must be immersed in teaching, learning, and the assessment of students. Research has shown that the school principal's leadership is "a key contributing factor when it came to explaining successful change, school improvement, or school effectiveness" (Hallinger, 2003, p. 331). Sergiovanni in conversation with Brandt (2007) suggested that this is best accomplished when teacher leaders take on this role and "principals ought to be leaders of leaders" (p.xiii). The principal is responsible for establishing the framework for these school leaders to discuss and modify curriculum to benefit student achievement. Perhaps most importantly in improving learning is the attitude of the principal toward curriculum development and instructional improvement. More educational leadership training programs and school leadership professional organizations are concentrating on developing school leaders' understanding of curriculum and instruction (Oliva, 2009). Only when principals comprehend the importance of curriculum and instruction will they be more likely to make these components the focus of their daily work.

Instructional Leadership and Transformational Leadership are the two prominent models for school leaders today (Hallinger, 2003). While both emphasize curriculum and instruction, the methodologies vary as to how the leader is to support these areas.

Hallinger's (2003) model of instructional leadership includes three dimensions. First, the school must have a mission and goals that are supported by all stakeholders. It is the principal who should facilitate the creation of the mission and goals and then communicate them so that everyone involved in the school knows what is most important. Next, the principal must oversee the curriculum and instruction of the entire school. This includes working with other school leaders in order to monitor and adjust the curriculum and instruction as student weaknesses are identified. Creating a culture of learning is the third dimension of instructional leadership. This is done by "protecting instructional time, promoting professional development, and maintaining high visibility" (Hallinger, 2003, p. 332). This model guides school leaders to become the instruction leader of their schools, who are the individuals in the school whose responsibility it is to ensure all decisions are made in support of the mission of the school (Jacobs, 1998).

Hallinger (2003) implicated that an instructional leader should delegate managerial tasks and focus on curriculum and instruction in the school. In order to achieve this, the principal must establish a culture within the school to focus on teaching and learning. Leaders must spend their days in classrooms working with teachers on making improvements (Hallinger, 2003). The visits have to be purposeful in nature and focus on student learning, not just evaluating teachers (Schmidt, 2002). This is done in order to meet established student achievement goals. The instructional leaders must monitor the curriculum and protect instructional time (Marzano, 2003). Scott, Ahadi and

Krug (1990) discovered the most successful principals were not operating differently from other principals, but they did ensure their decisions and daily activities were curriculum driven.

Transformation Leadership differs in that it emphasizes shared decision making (Hallinger, 2003). The transformational leader includes the whole community to create a shared vision and mission for the school. The transformational leader, like the instructional leader, understands the importance of curriculum and instruction to student learning but believes that it is not one individual that serves as the instructional leader. Instead, he or she seeks to work with stakeholders to link individual and organizational goals (Hallinger, 2003). Robbins and Alvy (2003) reported that the current climate of mandatory use of a prescribed state curriculum seems to be in direct conflict with the bottom-up focus of transformational leadership. The principal must seek to create this balance for teachers so that their attitude toward the mandated curriculum does not sabotage student learning. One way to do so is to create a forum for teachers to discuss curriculum within grade levels and vertical alignment. The teachers could create local curriculum guides that include state standards but hold true to the beliefs of the faculty (Robbins & Alvy, 2003).

Glatthorn (1994) reported that the implementation of a new curriculum does not happen very often and successful implementation starts with a leader who emphasizes curriculum work already. With this foundation, they are able to support teachers during the transition. The leader must communicate to the teachers that it is natural for a drop in student performance before an increase. Finding innovative ways for teachers to work together during the implementation years is essential. In addition, Glatthorn (1994)

recommended that the leader needs to ensure that the teachers have any resources they may need, including specified professional development. As implementation begins, it is suggested that the principal should be involved in the ongoing evaluation of the new curriculum (Glatthorn, 1994).

### Constructivist Theory

Constructivism is one theory of cognitive development. Piaget (1971) and Kant (1781) were the first to lead the way in constructivist theory. Both subscribed that learning occurs by constructing new knowledge through experience. Piaget believed that ideas are individual creations based on how new knowledge is adapted to what the individual already knows, which he called accommodation. Each new experience either confirms or alters what the individual believes to be true. This suggests that the same knowledge shared with two different individuals will not lead to similar conclusions as each will have his or her own personal filter (Glaserfeld, n.d.). Kant (1781) tried to combine the idea that not only experience but also analysis leads to knowledge (Brooks & Brooks, 1993). Over time, constructivist theory has evolved into the basic premise that humans play an active role in obtaining knowledge. They inherently seek to organize their experiences. While the experiences are personal, we are all part of a bigger social structure which contributes to our assimilation of knowledge. In addition, the individual is always seeking to reach a level of equilibrium when new knowledge brings doubt to what was believed to be true (Mahoney, 1996).

Those educators who subscribe to constructivist theory believe that students learn best when they can experience new learning (Glatthorn, 2000). Instruction by a constructivist would start with what the students already know and then create activities

and questions to learn new concepts (Oliva, 2009). Brooks and Brooks (1999) state “constructivist teachers recognize that students bring their prior experiences with them to each school activity” (p. 22). Lessons created by a constructivist would consist of teaching through problem solving. Students would work together in collaborate groups on a scaffold assignment. As a cumulating activity, students would demonstrate their learning with an authentic assessment (Glatthorn, 2000).

Particularly applicable to mathematics is the idea of scientific constructivism. Scientific constructivism (Battista, 1999) is based on two tenets of learning: abstraction and reflection. Abstraction is the way in which the brain takes in the new learning. The brain must then reflect on these items to put them into a context that it already understands. This works as a continuous cycle for students to get to new depths of understanding (Battista, 1999).

According to Brooks and Brooks (1993) when states mandate what objectives are to be taught and constructivists focus how learning should occur, it is up to the teacher to meld the two in a cohesive package. This starts by engaging students in the learning by making it relevant. Students do not have to love the curriculum in order for a teacher to intrigue the students in the subject. This theory suggests that this can be done by posing a question to the students based on a particular interest they have. In this case, the teacher would need to provide resources and then give students time to try and answer the question on their own. As the students become engaged, the teacher then directs them toward the more specific content of the curriculum. It is necessary to make sure the question the teacher asks will lead to the objectives intended as it is common to oversimplify the process and thus not have new learning (Brooks & Brooks, 1993).

Many curricula being developed today simply have too many objectives and not enough time to go through the process of deep learning (Marzano, 2003). While Georgia's new curriculum included discovery tasks that provide these more engaging questions there is not enough time to cover all of the objectives in one year (Georgia Department of Education, 2010). When the teacher poses the engaging question to the student, there is a tendency for the teacher to break the concept down into small pieces, but this does not allow the students to truly take responsibility for the learning (Brooks & Brooks, 1993). Jaworski (1996) claimed this is enhanced when students work together as a community of learners. This will take time, and the curriculum must be narrow enough for students to focus and discover. A teacher cannot determine what will be engaging without understanding the child's point of view. In addition, what works for one child is not going to work for all children. Teachers must adjust the curriculum when they realize that a student does not have all the prerequisites. The purpose of assessment is not just to determine what a child knows, but to give the teacher feedback on how to adjust instruction (Brooks & Brooks, 1993; Reeves, 2006). Jacobs (1998) contended if a teacher embraces the tenets of constructivist learning theory, then traditional classroom instruction is no longer sufficient and new instructional methods must be utilized for students to reach higher levels of understanding. The constructivist model may be seen by many teachers as a way to move away from the strict standards-based movement to a more creative, innovative teaching approach (Jacobs, 1998).

Today's emphasis on accountability appears to be in direct conflict to the constructivist model. With the focus on test scores, there must be a balance created to ensure learning for understanding not just doing well on high stakes tests (Battista, 1999).

Brooks and Brooks (1999) suggested that an increase in these test scores does not necessarily indicate more learning but instead better test preparation. It is in the best interest of students to ensure authentic learning is occurring in schools across the nation (Brooks & Brooks, 1999). This will only occur when assessments are redesigned to look at what a student can create.

With the move toward standards-based curriculum and the comparison to more successful foreign educational systems comes the demand of re-evaluating how we teach. While the practices of a constructivist teacher are reminiscent of the principles set forth by the National Council of Teachers of Mathematics (NCTM) with the emphasis on problem solving and integration, the council does not support any one learning theory and believes that multiple approaches may produce the same results, but clearly an integrated approach is similar to the constructivist model (Stiff, 2001).

#### Integrated Mathematics

Usiskin (2003) defines integration as “the simultaneous consideration of different aspects of knowledge” (p.13). Beginning with Euclid’s *Elements* (300 B. C.), the idea of integrating different branches of mathematics into units or themes was not foreign. This continued as Newton (1687) discovered calculus in the 1680s. Not until Euler’s *Elements of Algebra* in 1770 was algebra studied independently of geometry (Usiskin, 2003). With this historical perspective, it is interesting that today the single subject curriculum is considered the traditional mathematics curriculum.

Mathematics curriculum in the United States has changed dramatically since the first common schools in the 19<sup>th</sup> century. Then, the focus was on repetitive practice in order to learn arithmetic (Senk & Thompson, 2003). Dissatisfaction with this model led

to one of the first examples of a professional organization's influence on curriculum when the National Education Association (NEA) formed a committee to look at secondary school studies (Senk & Thompson, 2003). The NEA recommended that all students should learn algebra, geometry, and some advanced algebra, but during this time only college-bound students enrolled in high school. Moving into the twentieth century, more students went on to secondary school and the mathematics curriculum was split into tracks based on post-secondary plans. Those aspiring to attend a college were exposed to a much more rigorous mathematics curriculum than other students. While the National Science Foundation (NSF) formed by Congress in the 1950 was delegated the task of adopting a national policy for improvement of the study of sciences and mathematics, not until the launch of Sputnik in 1957 was this considered to be an endeavor of national importance (Senk & Thompson, 2003).

In the 1960s, the School Mathematics Study Group supported by the NSF was the first to promote a curriculum that would integrate mathematical concepts on a small scale such as combining the second year of algebra with trigonometry (Usiskin, 2003). The model was dubbed "new math" and focused on concepts, connections and problem solving. The 1970s brought a public outcry to return to a more traditional math, but the poor results by American students on the National Assessment of Education Progress (NAEP) in 1972 prompted a return to the idea that basic skills were not enough (Senk & Thompson, 2003). When the National Commission of Excellence in Education released a *Nation at Risk* in 1983 combined with the poor performance of American students compared to international students in the Second International Mathematics Study



(SIMS), it was clear the nation needed to reform mathematics education (Senk & Thompson, 2003).

The National Council of Teachers of Mathematics (NCTM) has produced four documents outlining what students should learn about mathematics before graduating from high school: *Curriculum Evaluation Standards for School Mathematics* (NCTM, 1989), *Professional Standards for Teaching Mathematics* (NCTM, 1991), *Assessment Standards for Mathematics* (NCTM, 1995), and *Principles and Standards for School Mathematics* (NCTM, 2000). This latest set of standards was a collaborative effort with the National Science Foundation and the National Research Center. These documents have helped to shape the integrated mathematics curriculums that are being developed across the nation. The NCTM Standards have created a focus for curriculum developers where students reach certain levels of understanding each year on a smaller number of topics which they will use the following year as they learn new concepts. NCTM (2000) suggested this depth of understanding could eliminate the time spent each year on reviewing and sets a standard for mathematics education that is essential to meeting the deficit in mathematics learning across the nation. While this deficit is still occurring for a variety of reasons such as a lack of exposure to higher level mathematics, variability in teacher quality, or a general lack of interest, NCLB clearly expects all students to be proficient in the study of mathematics (National Council of Teachers of Mathematics, 2000).

NCTM (2000) stated that “curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades” (p.14). A coherent curriculum is one in which strands are interconnected. The

relationships between the mathematics curriculum strands are utilized to increase problem solving and connect new concepts to previously learned concepts. Organizing the curriculum and its instructional materials in a way that emphasizes depth versus breadth is more conducive to student success (NCTM, 2000). NCTM (2000) holds that the level of conceptual understanding at each grade level must be clearly articulated to allow teachers to plan meaningful lessons that will lead to understanding instead of memorizing processes. More recently NCTM has developed an extension of their *Principles and Standards* and created *Curriculum Focal Points* for kindergarten through eighth grade. The focal points provided areas of emphasis within grade level combining knowledge, skills, and concepts to create an integrated approach to mathematics curriculum (National Council of Teachers of Mathematics, 2010).

The curriculum principle along with the focal points established by NCTM has led to a movement toward adopting an integrated mathematics curriculum. This integrated curriculum can be adapted in various ways. The unified concept employs teaching the same mathematics concepts across courses that study the separate branches of mathematics (House, 2003). Integrated curriculum can also be accomplished by merging “the branches of mathematics into single course” (House, 2003, p. 4). The sophistication or amount of integration may vary. Some integrated curriculums focus on units where each unit includes aspects of different branches of mathematics. Other integrated curriculums teach multiple branches within the same year, but treat each branch separately (House, 2003). Still other integrated curriculums follow this approach, but place emphasis on the connections and interactions between the individual strands (Usiskin, 2003). This is the basis of the new integrated mathematics curriculum in

Georgia. The Georgia Performance Standards (Georgia Department of Education, n.b.d.) intended to encourage more mathematical reasoning, improve the communication of mathematics, make connections to other mathematical topics, and make connections across disciplines.

An integrated mathematics curriculum can mean different things at different grade levels (House, 2003). The elementary level may follow a unified approach while at the high school level there may be a merging of concepts. In grades K-5, the Georgia Performance Standards (GPS) focused on mathematical reasoning and problem solving using manipulatives and technology. The GPS for grades 6-8 begins to address the topics of traditional algebra and geometry courses so that by the end of the eighth grade students have completed most of the first year of algebra and almost half of a traditional geometry course. In high school, students take a series of courses that integrate numbers and operations, algebra, geometry, and data analysis and probability focusing on the connections between them. In general, all integrated curriculums mandated classes to be student-centered with a greater emphasis on problem solving and application to new situations. In order for this to be accomplished, the curriculum materials for a standards based class must be very different from the traditional courses (Georgia Department of Education, n.d.b). For example instead of computational exercises, there must be more realistic problem solving in which students in small groups use a variety of strategies to solve (Senk & Thompson, 2003).

Students in the United States are lagging behind their counterparts around the world on achievement tests (Georgia Department of Education, 2007a). When the Second International Mathematics Study (International Association for the Evaluation of

Educational Achievement, 1982) found that high school seniors enrolled in a calculus class had the same scores as the average student in other countries. Those students in the United States who were not in advanced curriculum courses scored well below the international average. When further investigating the instruction of successful students, researchers found that a wider variety of instructional strategies were used, more time was spent on new material, and more student-centered activities were utilized (Senk & Thompson, 2003). A Trends in International Mathematics and Science Study (U.S. Department of Education Institute of Education Sciences, 2007) was conducted in 1995, 1999, 2003, and 2007 for the purpose of investigating fourth and eighth grade mathematics achievement of students in the United States as compared to their international counterparts. Students at each grade level were given tests in both science and mathematics. Scores on the TIMSS test were estimated based on the expected range of scores for each country. Each country's average score was then categorized in three ways: as significantly higher than the United States, not different from the United States or significantly lower than the United States (Gonzales et al., 2000). Looking at the eighth grade scores for the studies conducted in 1999 ( $N = 37$ ), 2003 ( $N = 45$ ), and 2007 ( $N = 48$ ) (see Table 1), the United States scores were higher than the international average, but significantly lower than thirteen other countries in 1999, nine other countries in 2003, and five other countries in 2007. In the most recent study, the average United States eighth grade students' scores were lower than five Asian countries, with six percent of the students scoring at or above the advanced mathematics benchmark (U.S. Department of Education Institute of Education Sciences, 2007). The United States score has significantly increased from a score of 492 in 1995 to a score of 508 in 2007

(Gonzales et al., 2007). Also, the eighth grade students performed significantly better than the TIMSS average score in the content areas of numbers (10 points) and data and chance (31 points) but significantly lower in the area of geometry (20 points). The cognitive domains of knowing (14 points) and reasoning (5 points) were significantly higher than the average TIMSS scores, but the area of application showed no difference (Gonzales et al., 2007). This study illustrated that the United States improved in mathematics scores and exceeded the TIMSS average scores in a number of areas, yet the eighth grade students in the United States scored significantly below the top scoring countries.

Table 1

*Trends In International Mathematics and Science Study (TIMSS) scores of the highest scoring countries and the United States in the years 1999, 2003 and 2007*

	1999		2003		2007
Singapore	604*	Singapore	605*	Chinese Taipei	598*
Korea	587*	Republic of Korea	589*	Republic of China	597*
Chinese Taipei	585*	Hong Kong SAR	586*	Singapore	593*
Hong Kong SAR	582*	Chinese Taipei	585*	Hong Kong SAR	572*
Japan	579*	Japan	570*	Japan	570*
Belgium-Flemish	558*	Belgium-Flemish	537*	United States	508
Netherlands	540*	Netherlands	536*		
Slovak Republic	534*	Estonia	531*		
Hungary	532*	Hungary	529*		
Canada	531*	United States	504*		
Slovenia	530*				
Russian Federation	526*				
Australia	525*				
Finland	520*				
United States	502				

\* Average score is significantly higher than the United States average score ( $p < .05$ )

Adapted from U.S. Department of Education Institute of Education Sciences. (2007). *Trends in international mathematics and science study*. Retrieved from National Center for Educational Statistics: [http://nces.ed.gov/timss/results07\\_math07.asp](http://nces.ed.gov/timss/results07_math07.asp)

Senk and Thompson (2003) shared that an integrated curriculum has advantages which could improve mathematics achievement across the United States. Integrated curriculum builds connections over a long period of time where problems are real world and students become more engaged. Because of the continual nature, there is less of a chance of students forgetting content. Additionally, students' learning styles differ, which means some students may be more successful in different branches of mathematics; therefore, an integrated approach appeals to the learning styles of a wider variety of students (Senk & Thompson, 2003).

The TIMSS study was also conducted in video format in both 1995 and 1999 (Stigler & Hiebert, 2004). The purposes of the study were to be able to see the differences in the average mathematics classrooms, determine the amount that policy affected the instruction, and learn about alternative ways to teach mathematics. The first study included Germany, Japan, and the United States. It was clear that teaching was cultural, while the homogeneity among the countries was astounding. The second video study expanded the study to include the United States and six countries that performed higher on the 1995 TIMSS mathematics achievement test. It was discovered that there was not one consistent practice, such as length of time spent on a problem or the amount of time spent in skills versus problem solving, that was consistent among these more successful countries. The true difference was how the countries implemented problems that mandated students to make connections and problem solve. In the United States, these problems were altered by the teachers to become procedural problems or the steps were supplied to the student by the teacher. This did not occur in the other countries.

This indicates a need to focus on professional development in instructional practices for problem solving (Stigler & Hiebert, 2004).

Desimone, Smith, Baker, and Ueno (2005) utilized the data of the TIMSS video study to take a closer look at the reasons the difference in conceptual teaching may occur. One typically cited reason for the United States scores was the lack of structure in the curriculum and instructional strategies. It was determined that teachers in the United States utilized computational and conceptual strategies the same amount as other countries. In addition, teachers in the United States did not perceive that increasing the amount of conceptual strategies would deter from the computation skills. Also, there was no link between class size or teacher training and the use of conceptual strategies. One area that differed between the United States and other countries was that teachers used more conceptual strategies with high achieving versus low achieving students which was in contrast to international data (Desimone, Smith, & Ueno, 2005). These results confirm that while curriculum reform may influence what is being taught, it is the implementation of the curriculum which affects student achievement.

After NCTM (1989) produced their first standards guide, the National Science Foundation (NSF) solicited the creation of new curricula that would support the new curriculum, instruction, and assessment standards (National Science Foundation, 2011). Specifically, the curricula would provide high level, rigorous mathematics instruction for all students, integrate technology, and provide for more real-world problem solving. The NSF grants led to the production of five new mathematics curricula: (a) the Core-Plus Mathematics Project, (b) the Interactive Mathematics Project, (c) the Applications/Reform in Secondary Mathematics, and (d) the Systemic Initiative for

Montana Mathematics and Science (SIMMS). The University of Chicago School Mathematics Project developed a similar integrated curriculum (Senk & Thompson, 2003). All of these curricula were designed with the same goals to improve instruction, application, and the conceptual understanding of mathematics, and to integrate more real world problem solving (Swafford, 2003). NSF understood that curricula so fundamentally different from the traditional curriculum would need extensive support. This led to the creation of four curriculum implementation centers. The Curricular Options in Mathematics Programs for All Secondary Students (COMPASS) was created to specifically support high school implementation while at the same time promoting the five integrated curricula (Allen, St. John, & Tambe, 2009). Research has been conducted on each of these integrated or reform curricula to help quell the naysayers of change.

The principles of the Core Plus Mathematics Project (CPMP) (Core Plus Mathematics Project, 2010) included the understanding of patterns, real-life problem solving, application of mathematical concepts, and integrating technology into mathematics. This curriculum included three common courses and two optional fourth year courses. Each course was divided into topical units that were explored as it pertains to the more traditional mathematical subjects. Changing from traditional instruction to a classroom where the teacher served as the facilitator of small collaborative groups who explored a lesson over several days was imperative for the successful implementation of CPMP. Teachers received a two-week summer training session in CPMP prior to implementation. A study was conducted to compare test scores of CPMP students and traditional curriculum students as they completed both course one and course two (Schoen & Hirsch, 2003). On the nationally normed Iowa Tests of Educational



Development, overall there was no significant difference between the student test scores regardless of curriculum utilized. This was also true when comparing student scores on the SAT Reasoning Test and the ACT. When investigating the grades of students in their freshman college math course, it was determined the CPMP students were as prepared as their traditional counterparts (Schoen & Hirsch, 2003). An additional study of the CPMP curriculum only focused on the student's understanding of algebra and functions (Huntley, Rassmussen, Villarubi, Sangtong, & Fey, 2000). Algebra was a focus over all three years of instructions with emphasis being placed on the graphical, numerical, and symbolic understanding of algebra. After creating their own instrument that assessed all three areas, the researchers compared CPMP students to a control group and found the CPMP students scored higher in the areas of problem solving and modeling skills (Huntley, Rassmussen, Villarubi, Sangton, & Fey, 2000). Yet, in pure algebra manipulation the control group was superior. Lack of mathematical skills was one of the major criticisms of reform curriculums (Huntley, Rassmussen, Villarubi, Sangtong, & Fey, 2000).

MATH Connections (Math Connections, 2010) was another curriculum developed through a NSF grant. The goals of this curriculum was to bridge students mathematical knowledge to the business world, increase overall math ability, empower students, and utilize the core curriculum outlined by NCTM. This curriculum blended the topics of a traditional curriculum into three courses. Each course had a theme which linked to a real-world issue. The students were expected to complete experiments and observe mathematics patterns in order to discover an underlying formula. Teachers received a two-week summer training in MATH Connections curriculum before

implementation. Research compared matched groups of student scores on the Connecticut Academic Performance Test, the PSAT, and the SAT. There was no statistically significant difference on the mean scores of any of the tests, but the MATH Connections students did do as well as traditional curriculum students on the same assessments. When a further study was done based on the mathematics ability of the students entering college, there was evidence that the MATH Connections curriculum made a significant difference on student achievement (Cichon & Ellis, 2003).

The Interactive Mathematics Program (IMP) (Webb, 2003) was created around the same instructional strategies as MATH Connections. Algebra and geometry were integrated across four years. There was an additional emphasis on students' expression of mathematical concepts. Most of the overall results were the same, but one school did show a statistically significant increase in SAT scores and another showed an increase in overall grade point averages for students in IMP (Webb, 2003).

The Systematic Initiative for Montana Mathematics (SIMMS) (Lott et al., 2003), like the integrated mathematics curriculum adopted by Georgia, was developed as a statewide curriculum reform. This blended curriculum, based on the constructivist philosophy, emphasized students learning problem-solving through modeling, applying mathematical concepts, and utilizing graphing calculators. SIMMS also altered their assessment of students to focus on these key principles. In looking at results on the Preliminary SAT (PSAT) and a created open-ended task, there was no significant difference between the students using the SIMMS or traditional curriculum. In fact, the mean student scores were slightly higher for comparable traditional students at several levels. In addition to achievement at the secondary level, this study attempted to

determine the level of success of SIMMS students in the freshman college mathematics course. The SIMMS students did have the largest percentage of students successfully completing this first college mathematics course (Lott et al., 2003).

A later study, which took place after a revision of the Core-Plus, IMP, Math Modeling in Our World (MMOW) and SIMMS, was completed only with districts who had districtwide adoption of these reform curricula (Harwell et al., 2007). The students in this study had completed three years of mathematics instruction. Another difference in these implementations was the professional development available to teachers. The districts utilized three different deliveries for teacher training - a two-week summer institute, bi-weekly training throughout the year, or a twenty-hour mentorship program. When investigating student achievement on the Stanford Achievement Test that included both opened-ended and multiple choice questions, students in general achieved above the national average. All three were above the proficiency level in the open-ended questions with MMOW scoring highest. The Core-Plus curriculum students had the highest scores on the multiple choice tests in comparison to their prior math knowledge (Harwell et al., 2007).

In contrast, Teuscher's (2008) study of 500 students in Advanced Placement Calculus some utilizing a traditional single subject curriculum and others an integrated curriculum indicated that single subject students scored significantly better in some areas such as algebraic skills. In addition, those utilizing the single subject curriculum were superior in solving problems, both requiring connections between mathematical skills and those not requiring connections. McCaffrey et al. (2001) conjectured that it may not be the curriculum but the instruction necessary to properly teach an integrated curriculum

causing this lack of achievement. In their study of a large urban school district which had instituted two different integrated curricula programs along with a traditional curriculum at its high schools, they concluded tenth grade students in an integrated mathematics program had the same student achievement scores as those in an equivalent geometry course. More importantly, they found that students in the integrated class performed higher when their teachers used more reform approaches. In other words, implementing an integrated curriculum alone did not increase student achievement, this curriculum must be paired with an effective change in instruction (McCaffrey et al., 2001).

The successful implementation of an integrated mathematics curriculum will depend heavily on the teachers' use of the curriculum (McCaffrey et al., 2001). The professional development needs for teachers should go beyond a general overview and must include modeling sample lessons and an ongoing mentorship program for the teachers. Stenglein (2003) recommends that leaders will need to find time for teachers implementing an integrated mathematics curriculum to collaborate more than for those implementing a traditional mathematics curriculum. Embedding staff development in the school day to support instruction may also be necessary (Stenglein, 2003).

While the No Child Left Behind Act of 2001 (NCLB, 2002) mandated that students demonstrate Annual Yearly Progress (AYP) on state assessments, many critics of an integrated mathematics program are concerned about student achievement on high stakes tests such as college entrance exams (NCLB, 2002). The PSAT/NMSQT, which serves as a practice test for the SAT reasoning test, is slightly less difficult than the SAT but serves as a good predictor of future scores (Milewski & Sawtell, 2006). The National Merit Scholarship Corporation uses the PSAT "to identify pools of candidates" to be

considered for scholarships (Milewski & Sawtell, 2006, p. 1). A study by Milewski and Sawtell (2006) determined that students who had studied more years of a subject were likely to score higher on the PSAT; therefore, “Students who took more rigorous math courses had higher mean PSAT/NMSQT scores” (Milewski & Sawtell, 2006, p. 4). It would be reasonable to conclude that the institution of the Georgia Performance Standards (GPS) curriculum, which is more rigorous and moves the first year of algebra to the middle school, should result in increases in PSAT/NMSQT scores (Georgia Department of Education, 2007a).

### Summary

The curriculum determines what a student will be taught. Decisions regarding curriculum, its implementation, and assessment are integral to the work of all school leaders. As the United States lags further behind other nations, there has been an outcry for mathematics reform. When educational systems look at developing new curricula, it is essential to understand the influences of the government and professional organizations which have been calling for reform for a more rigorous mathematics curriculum for all students. Developing this curriculum required an in-depth analysis of what students should learn and the best ways to instruct them. In the state of Georgia, the recently implemented integrated mathematics program has left many stakeholders with questions. By looking at the results of previously attempted integrated mathematics programs, there is no clear research to support an improvement in student learning. This study investigated the success of the new Georgia curriculum and its implementation with hopes that it will serve as additional information as revisions are made. This chapter has reviewed the literature. In Chapter III, the methodology of this study is described. In

Chapter IV, the findings of the study are presented. A summary of the study, the implications and recommendation of this study are presented in Chapter V.

## CHAPTER III

### METHODOLOGY

#### Introduction

In 2005, the state of Georgia changed from the Quality Core Curriculum (QCC) to the Georgia Performance Standards (GPS) for Mathematics. The purpose of this study was to determine if the new integrated mathematics curriculum adopted by the state of Georgia increased students' mean mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores or changed the distribution of the scores on the PSAT/NMSQT. In addition, it was necessary to determine if following the recommended practices of the GPS affects the PSAT/NMSQT scores. This is a cross-sectional study since the groups of students were predetermined and performance was measured before and after the curriculum change. Because the change in curriculum became a controversial issue, the results of this study could be beneficial to all stakeholders. This chapter describes the research design, the participants, and the procedures used to collect data. The method for analyzing the data is described.

#### Research Questions and Hypothesis

1. Is there a difference in tenth grade students' mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores for students who utilized the new Georgia Performance Standards (GPS) versus the tenth grade students who utilized the Quality Core Curriculum (QCC) standards?  
H<sub>1</sub>: There will be no difference between the mean scores of students utilizing GPS standards and the scores of students utilizing the QCC standards on the PSAT/NMSQT.

2. Is there a difference between the distributions of tenth grade students' mathematics PSAT/NMSQT scores for students who utilized the new GPS standards versus students who utilized QCC standards?  
  
H<sub>2</sub>: There will be no difference in the distribution of students' scoring for those utilizing the GPS or QCC standards on the PSAT/NMSQT.
3. Is there a relationship between the tenth grade mathematics PSAT/NMSQT scores and the extent to which the schools followed the recommended practices of the new GPS standards?  
  
H<sub>3</sub>: There will be no relationship in the scores of students based on the extent to which the schools followed the recommended practice of the new GPS standards.

### Research Design

This was a quasi-experimental design with both a quantitative and qualitative component. The quantitative component consists of scores on the PSAT/NMSQT during the participants' second year in high school. Two years of data from the 2007-2008 and 2008-2009 school years are considered for those who utilized the QCC mathematics curriculum. Two years of data from the 2009-2010 and 2010-2011 school years are considered for those who utilized the GPS mathematics curriculum. In addition, the distribution of the tenth grade mathematics PSAT/NMSQT scores are compared regarding to curriculum utilized. For the purpose of the study, the curriculum utilized and the year of implementation of the GPS curriculum were the independent variables. The PSAT/NMSQT scores were the dependent variable.

The qualitative component included a survey of the high school mathematics department chairmen in the district. This information was used to correlate the extent to



which schools followed the recommended practices of the GPS and the PSAT/NMSQT scores. Additional general perceptions questions asked of the department chairs were correlated to the 2009 and 2010 PSAT/NMSQT scores for each school to identify significant practices.

## Participants

### *School District*

The school district included in this study is a large, suburban district located in the Southeast section of the United States. The district currently serves over 106,000 students. There are 114 schools, including sixteen high schools, and over 14,000 employees.

### *Study Participants*

The study included four years of tenth grade students from all high schools in a large suburban district in Georgia, which was between 6709 and 7451 students per year. The district is diverse; however, each class is similar in student population. Each class should be representative of the overall school district. The PSAT/NMSQT school summary report for tenth grade students was collected from each high school for the years 2007 through 2010. During the 2007-2008 and 2008-2009 school years, students utilized the Quality Core Curriculum for mathematics. During the 2009-2010 and 2010-2011 school years, students utilized the Georgia Performance Standards curriculum. Since the state of Georgia funded the tenth grade student participation in the PSAT/NMSQT, all students who took the test are included in the study. In addition to student test scores, each high school mathematics department chairman was asked to complete a survey to determine whether the extent to which schools utilized the

recommend practices of the GPS had any relationship with the PSAT/NMSQT scores in 2009 or 2010.

### Instrumentation

#### The Preliminary SAT/National Merit Scholarship Qualifying Test

(PSAT/NMSQT) is a norm-referenced test used as a practice test for the SAT and to determine candidates for the National Merit Scholarship Program (Milewski & Sawtell, 2006). This test was established in 1959 and more than 3.5 million students participate each fall (College Board, 2010). The PSAT/NMSQT evaluates verbal, mathematics, and critical reading. This study focused on the mathematics portion of the test. There are two twenty-five minute mathematics sections per test that consist of thirty-eight questions. Twenty-eight of the questions are multiple choice and ten questions required student-produced responses (College Board, 2010). Scores range from 20 to 80 on each section. Reliability coefficients on the mathematics portion were reported as .87 ( $SEM=4.0$ ). In addition, content validity is ensured through the test's design (College Board, 2010). All of the test questions are pretested within the SAT (College Board, 2006).

A survey of the high school mathematics department chairmen was developed to determine if the extent to which schools followed the recommended practices of the GPS at each high school in the district and the overall satisfaction with the design of the curriculum. The questionnaire survey was conducted to obtain information about the level of the course the student took (percent taking Accelerated mathematics courses and percent take Math Support courses), type of implementation of the GPS curriculum (following unit order and utilizing performance tasks), and preparation for implementation (percent of teacher completing training, perception of adequate training,

and perception of adequate resources). Additionally, three open-ended questions concerning benefits and challenges of implementation of the GPS on the students and teachers were asked. The survey was distributed to a panel of experts whose feedback was used to make changes to the final product.

#### Data Collection Procedures

Permission to conduct research was obtained from the school district. The researcher then sought permission from the Institutional Review Board (IRB) to conduct the study. Once IRB approval was given, the researcher then contacted each school principal to obtain permission to include their school's test data and to survey the mathematics department chair. Once the principal gave permission, the researcher obtained the PSAT/NMSQT school summary report for tenth grade students for the test given in October of 2007, 2008, 2009, and 2010. Schools were coded by a letter of the alphabet.

The survey was sent through the mail. Included in the mailing was a description of the purpose of the study and the participants and informed consent and contact information for the researcher. The participants were ensured anonymity as each response will be coded by corresponding alphabetical school code. The survey took about fifteen minutes to complete.

#### Data Analysis

After receiving permission for the Institutional Review Board of both the school district and the University of Southern Mississippi, the school PSAT/NMSQT summary reports were gathered from each of the sixteen high schools for the 2007 through 2010 test administration. Each school was coded by letter. For each school year, the mean

mathematics PSAT/NMSQT score was recorded for each school. Using SPSS, a fully repeated measure Analysis of Variance (ANOVA) was conducted to determine if there is a significant difference in scores based on mathematics curriculum utilized and year of implementation along with the interaction between the curriculum and year. A two-way Chi Squared analysis was conducted to determine if there was a significant difference in the distribution of scores based on the curriculum utilized.

Perception data was measured by mean score based on the responses from the researcher designed survey. A simple correlational analysis relating these survey items and the scores of the 2009 and 2010 PSAT/NMSQT was conducted. Hierarchical multiple regression was used to assess the ability of following the unit order outlined in the GPS curriculum and using the state provided performance tasks for instruction to explain the PSAT/NMSQT scores in 2009 and 2010. In addition, the data received from the open-ended questions at the end of the questionnaire was analyzed to determine if specific themes existed. All statistics were tested for significance using the standard alpha level,  $\alpha=.05$ .

#### Changes to Mathematics Instruction Before and After the Georgia Performance Standards

The Georgia Performance Standards (GPS) for mathematics were developed to provide a more rigorous curriculum for all students in the state of Georgia. The most significant change in the implementation was the increased rigor of the mathematics courses taught in middle school. When students have completed the redesigned Math 6, 7, and 8 courses, they should have learned 80% of the topics in the Quality Core Curriculum (QCC) Algebra I course, about half of the geometry topics, plus statistics and probability included in the high school courses (Georgia Department of Education,

2007a). Because of this, students utilizing the GPS have been exposed to higher level mathematical concepts before they take their tenth grade Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) than those who utilize QCC.

The high school mathematics courses in the GPS are organized by units where each unit requires knowledge from previously learned materials and includes both algebra and geometry whereas the QCC curriculum separated Geometry into an independent course. In addition, the QCC had alternate mathematics courses for college preparatory and career technology diploma requirements while with the adoption of the GPS standards was the movement to one high school diploma so that all students take the same mathematics courses. The GPS curriculum includes support courses for Math I, II, and III. The support course is a mathematics elective that the student takes simultaneously with the core course. The purpose of the support course is to provide more time for struggling students to work on concepts and receive immediate remediation. While the QCC did not have a course to be taken simultaneously, it did have an option to take Algebra I over two years.

The GPS included a change in instructional philosophy. Each unit included a sample of student tasks that have been designed to have students gain understanding of mathematical concepts through discovery with the teacher serving as the facilitator of learning. These tasks are not mandated but the higher order thinking questions included on the End of Course and Georgia High School Graduation Tests are based upon the tasks. There was no such instructional component in the QCC.

## Summary

The results of this study provide the first norm-referenced test results available to evaluate the implementation of the Georgia Performance Standards mathematics curriculum. This chapter has presented the methodology for the study. The data and findings are presented in Chapter IV. Chapter V explores the implications and recommendations of the study.

## CHAPTER IV

### RESULTS

#### Introduction

In an attempt to address the low mathematical achievement of students in the state of Georgia, a new integrated mathematics curriculum was introduced in 2005 (Georgia Department of Education, n.d.b.). This approach replaced the traditional discrete courses and instead included a combination of algebra, geometry, and statistics in a performance based/discovery learning approach. This change was highly debated among all stakeholders. This study investigated the Preliminary SAT/National Merit Qualifying Test (PSAT/NMSQT) scores of students across a four year span. For the first two years students utilized the traditional discrete course of the Quality Core Curriculum (QCC) and the last two years students were engaged in the integrated courses of the Georgia Performance Standards (GPS). The results for each of the three research questions are described below. All statistics were tested for significance using the standard alpha level,  $\alpha=.05$ .

#### Results

All high schools in a large school district in the Southeast section of the United States ( $N = 15$  in 2007,  $N = 16$  in 2008, 2009, 2010) participated in this study to examine the impact of the newly developed integrated mathematics curriculum (QCC and GPS) on PSAT/NMSQT scores of tenth grade students. School summary reports were obtained from the school district. Since the State of Georgia paid for all tenth grade students to take the PSAT/NMSQT, all tenth grade students in the school district present on the day of the test in the 2007, 2008, 2009, and 2010 were included in the study. The high

schools ranged in size from 217 to 673 students ( $M = 457.91$ ,  $SD = 83.93$ ). Of the students that self-reported gender and ethnicity, the majority of participants were female (50.7%), and reported themselves as white (47.9%), as illustrated in Table 2.

Additionally, the mathematics high school department chair at each school ( $N = 16$ ) was asked to complete a survey. Eight department chair surveys (50%) were returned. The average time a department chairman had been serving in the capacity was 4.69 years ( $SD = 2.74$ ), and all but one person was the department chairman during the implementation of the new GPS curriculum. The survey of mathematics department chairmen was conducted to obtain specific information about the level of course the student took (percent taking Accelerated Mathematics courses or percent taking Math Support courses), type of implementation of the GPS curriculum (following unit order and utilizing performance tasks), and preparation of the implementation (percent of teachers completing training, perception of adequate training, and perception of adequate resources) of the GPS curriculum on the PSAT/NMSQT scores in 2009 and 2010. Additionally, three open-ended questions concerning benefits and challenges of implementation of GPS on the students and teachers were asked. This research was approved by the Institutional Review Board for the Protection of Human Subjects in both the school district and the University of Southern Mississippi.

Table 2

*Student Demographic Data by Year*

Year	Variable	Students	Percentages
2007	Gender		
	Female	3721	51 %
	Male	3573	49 %



Table 2 (continued).

*Student Demographic Data by Year*

Year	Variable	Students	Percentages
	Ethnicity		
	Asian	373	5.25 %
	African American	2044	28.82 %
	Hispanic	773	10.90 %
	White	3492	49.24 %
	Other	410	5.78 %
2008	Gender		
	Female	3794	51.25 %
	Male	3609	48.75 %
	Ethnicity		
	Asian	356	5.00 %
	African American	2110	29.56 %
	Hispanic	863	12.09 %
	White	3400	47.63 %
	Other	410	5.74 %
2009	Gender		
	Female	3370	50.56%
	Male	3295	49.44 %
	Ethnicity		
	Asian	353	5.42 %
	African American	1851	28.40 %
	Hispanic	729	11.18 %
	White	3210	49.25 %
	Other	375	5.75 %
2010	Gender		
	Female	3650	50 %
	Male	3652	50%
	Ethnicity		
	Asian	364	5.62 %
	African American	1994	30.81 %
	Hispanic	884	13.66 %
	White	2889	44.65 %
	Other	340	5.25 %

### Descriptive Statistics

In the fall of 2007, 7307 tenth grade students took the PSAT/NMSQT at fifteen high schools. An additional high school was opening the following year, and there were  $N = 7451$ ,  $N = 6709$ , and  $N = 7381$  tenth grade students tested respectively over three years. The mean mathematics PSAT/NMSQT score of each high school was utilized for this study. Since student enrollment at each school was similar, no adjustment was made for number of students tested at each school. Table 3 contains descriptive statistics for the PSAT/NMSQT scores for all four years.

Table 3

*Descriptive Statistics for PSAT/NMSQT scores from 2007 to 2010*

Variable	N	Min	Max	Mean	SD	Skew/SE
QCC <sup>1</sup>						
2007	15	32.20	51.50	42.16	5.38	-.095
2008	16	34.10	52.00	43.31	4.87	.051
GPS <sup>2</sup>						
2009	16	34.40	52.20	43.59	1.20	4.80
2010	16	34.80	52.80	43.31	4.89	.034

<sup>1</sup>Quality Core Curriculum

<sup>2</sup>Georgia Performance Standards

### Statistical Results

In order to address the first hypothesis, regarding a difference in average tenth grade mathematics PSAT/NMSQT scores for schools that utilized the new GPS standards

versus the QCC standards, a year (1<sup>st</sup> or 2<sup>nd</sup>) x curriculum (QCC or GPS) fully repeated measures ANOVA was conducted. Results indicated a significant year x curriculum interaction ( $F(1,14) = 13.968, p = .002$ ). An analysis of simple effects of curriculum at year 1 indicated that students using the GPS curriculum had higher PSAT/NMSQT scores than students utilizing the QCC ( $F(1,14) = 23.96, p < .01$ ) but not so at year 2 ( $F(1,14) = 0, p = .983$ ; see Figure 1). There was no main effect of year ( $F(1,14) = 3.437, p = .085$ ), but there was a significant main effect of curriculum ( $F(1, 14) = 5.717, p = .031$ ), with GPS scores higher ( $M = 43.45, SD = 4.77$ ) than QCC curriculum scores ( $M = 42.75, SD = 5.07$ ).

In order to address the second hypothesis, regarding a difference in the distribution of tenth grade mathematics PSAT/NMSQT scores when utilizing the new

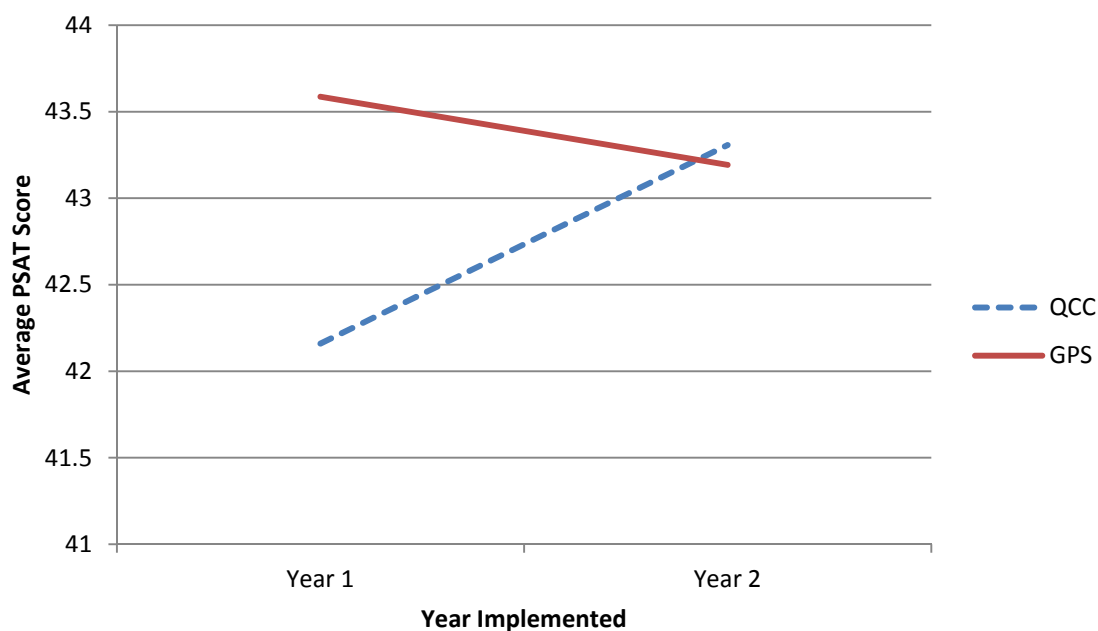


Figure 1. Change in Mean Scores by Curriculum Over Time

GPS curriculum versus the QCC curriculum, the scores were divided in four ranges: 20 to 34, 35 to 49, 50 to 64 and 65 to 80, as shown in Table 4.

Table 4

*Frequency Distribution (Percentages) of Student Mathematics PSAT scores from 2007-2010*

Scores <sup>1</sup>	2007	2008	2009	2010
65-80	278 (3.8%)	293 (3.9%)	262 (3.9%)	272 (3.7%)
50-64	1668 (23%)	1966 (26%)	1687 (25.1%)	1748 (23.7%)
35-49	3340 (46.1%)	3642 (48.2%)	3643 (54.3%)	3896 (52.8%)
20-34	1964 (27.1%)	1660 (22%)	1117 (16.7%)	1465 (19.8%)

<sup>1</sup>PSAT/NMSQT scores range from 20-80

A two-way Chi Squared Analysis was conducted and indicated a difference in the pattern of the scores over the four years, Likelihood Ratio  $X^2(9, N = 27901) = 269.45, p < .01$ . To determine which range of scores was creating a change in pattern, the Chi-Squared analysis was conducted multiple times including and excluding different ranges as shown in Table 5. When the Chi Squared Analysis was conducted without the two lowest performing groups, there was no significant change in distribution of the students' scores between 50 and 80, Likelihood Ratio  $X^2(3, N = 8174) = 1.57, p = .67$ , indicating that the two lowest performing groups were responsible for the change in pattern.

Table 5

*Chi Squared Analysis Results on the Distribution of PSAT/NMSQT scores*

Students	$X^2$	<i>df</i>	<i>p</i>
All	269.45	9	<.01
Excluding scores in 20-49 range	1.57	3	.67
Difference in Chi Square	267.88	6	<.01

In order to address the third hypothesis, a difference in schools mean PSAT/NMSQT scores based on following the recommended practices of the GPS curriculum was investigated both quantitatively and qualitatively. Descriptive statistics and simple correlations among predictor variables (percent of student taking Accelerated Mathematics courses, percent of students taking Math Support courses, following unit order, utilizing performance tasks, percent of teachers completing training, adequate training, and adequate resources) and between predictor and criterion variables (PSAT/NMSQT scores in 2009 and 2010) appear in Tables 6 and 7. Having adequate resources was moderately positively correlated to the school following the order of the units as designated by the GPS. Additionally, having adequate resources was negatively correlated to the percent of teachers who were trained before teaching the courses of the GPS.

Simple correlations between predictor and criterion variables indicated that for both PSAT/NMSQT scores in 2009 and 2010 only the percentage of students enrolled in a Math Support class along with the corresponding math course was correlated, with a higher percentage of students in Math support related to lower PSAT/NMSQT scores. No other significant relationships were discovered.

Table 6

*Descriptive Statistics for Survey Items (N=8)*

Variable	Min	Max	Mean	SD	Skew/SE
AccMath <sup>1</sup>	10	35	17.76	8.60	1.88
Math Supp <sup>2</sup>	15	80	43.54	19.61	1.06

Table 6 (continued).

*Descriptive Statistics for Survey Items (N=8)*

Unitorder <sup>3</sup>	2	4	3.5	.76	-1.76
Tasks <sup>4</sup>	1	4	2.38	1.06	-.06
%trained <sup>5</sup>	21	100	62.6	28.07	-.711
Training <sup>6</sup>	1	4	2.38	1.19	-.383
Resources <sup>7</sup>	1	4	2.5	.93	0

<sup>1</sup>Advanced mathematical students could follow an Accelerated Math track allowing them to complete 1.5 years of curriculum in one year. The Accelerated Math I course was taught at both the eighth and ninth grade level. The percent of student enrolled in this program was self-reported by department chairmen.

<sup>2</sup>Math Support courses were available for struggling mathematics students. The purpose of the course was to review and preview topics in the corresponding Math I, II or III course. The percent of students enrolled in the program was self-reported by department chairmen.

<sup>3</sup>GPS course included units to be taught in a specific order over the course.

<sup>4</sup>GPS included performance tasks that were to be utilized by teachers to deliver the curriculum in a performance-based/discovery learning model.

<sup>5</sup>Prior to the implementation of the curriculum, the State Board of Education along with Regional Educational Service Agency and local districts provided training for teachers.

<sup>6</sup>Indicates the percentage of teachers who participated in formal training prior to teaching the GPS curriculum as self-reported by the department chairmen.

<sup>7</sup>Resources include textbook, workbooks and performance tasks.

Table 7

*Simple Correlations Among Predictor with Criterion Variables (N=8)*

	Predictor Variables						
	AccMath <sup>1</sup>	MathSupp <sup>2</sup>	Unit order <sup>3</sup>	Tasks <sup>4</sup>	%trained <sup>5</sup>	Training <sup>6</sup>	Resources <sup>7</sup>
AccMath		-.651	-.065	.187	-.090	.389	-.107

Table 7 (continued).

*Simple Correlations Among Predictor with Criterion Variables (N=8)*

MathSupp	.233	.330	.208	.299	.198		
Unitorder		.445	-.544	.080	.816*		
Tasks			-.141	.326	.655		
%trained				.438	-.719*		
Training					-.195		
Predictor with Criterion Variables							
	AccMath <sup>1</sup>	MathSupp <sup>2</sup>	Unitorder <sup>3</sup>	Tasks <sup>4</sup>	%trained <sup>5</sup>	Training <sup>6</sup>	Resources <sup>7</sup>
PSAT2009	.476	-.805*	-.461	-.440	.187	-.298	-.535
PSAT2010	.433	-.770*	.271	-.511	-.390	-.306	-.543

<sup>1</sup>Advanced mathematical students could follow an Accelerated Math track allowing them to complete 1.5 years of curriculum in one year. The Accelerated Math I course was taught at both the eighth and ninth grade level. The percent of student enrolled in this program was self-reported by department chairmen.

<sup>2</sup>Math Support courses were available for struggling mathematics students. The purpose of the course was to review and preview topics in the corresponding Math I, II or III course. The percent of students enrolled in the program was self-reported by department chairmen.

<sup>3</sup>GPS course included units to be taught in a specific order over the course.

<sup>4</sup>GPS included performance tasks that were to be utilized by teachers to deliver the curriculum in a performance-based/discovery learning model.

<sup>5</sup>Prior to the implementation of the curriculum, the State Board of Education along with Regional Educational Service Agency and local districts provided training for teachers.

<sup>6</sup>Indicates the percentage of teachers who participated in formal training prior to teaching the GPS curriculum as self-reported by the department chairmen.

<sup>7</sup>Resources include textbook, workbooks and performance tasks.

\*p < .05 two-tailed test

Hierarchical multiple regression was used to assess the ability of the predictors measures (unit order and task implementation) to explain the PSAT/NMSQT scores in

2009 and 2010, after controlling for the influence of percentage of students enrolled in Math Support courses as seen in Table 8. The percentage of students enrolled in Math Support courses were entered at Step 1, explaining 65% of the variance in the 2009 PSAT/NMSQT scores ( $R^2 = .648$ ,  $F(1, 6) = 11.037$ ,  $p = .016$ ) and 59% of the variance in the 2010 PSAT/NMSQT scores ( $R^2 = .592$ ,  $F(1, 6) = 3.241$ ,  $p = .026$ ). After entering unit order and task implementation in Step 2, the total variance explain in 2009 was 73%, with a change in  $R^2$  of .086 ( $F(2, 4) = 3.668$ ,  $p = .121$ ), and in 2010 the total variance explained was 71%, with a change in  $R^2$  of .116 ( $F(2, 4) = 3.241$ ,  $p = .143$ ). In both models, only the enrollment in Math Support related to student overall PSAT/NMSQT scores.

Table 8

*Hierarchical Regression of Predictor Variables on PSAT/NMSQT Scores (N=8)*

Step 1		PSAT/NMSQT Scores 2009				
		$R^2 = .648$				
		$F(1, 6) = 11.037, p = .016$				
	<i>b</i>	<i>t</i>	<i>p</i>	<i>pr</i> <sup>2</sup>	<i>sr</i> <sup>2</sup>	
Y-intercept	55.612	14.773	<.001			
Math Support <sup>1</sup>	-.265	-3.322	.016	.648	.648	
Step 2		PSAT/NMSQT Scores 2009				
		$\Delta R^2 = .086$				
		$\Delta F(2, 4) = .642, p = .573$				
	<i>b</i>	<i>t</i>	<i>p</i>	<i>pr</i> <sup>2</sup>	<i>sr</i> <sup>2</sup>	
Y-intercept	63.247	7.800	<.001			
Math Support	-.235	-2.604	.060	.629	.452	
Unit Order <sup>2</sup>	-2.172	-.878	.429	.162	.052	
Tasks <sup>3</sup>	-.550	-.303	.777	.023	.006	
		$R^2 = .733$				
		$F(2, 4) = 3.668, p = .121$				
Step 1		PSAT/NMSQT Scores 2010				
		$R^2 = .592$				
		$F(1, 6) = 8.717, p = .026$				
	<i>b</i>	<i>t</i>	<i>p</i>	<i>pr</i> <sup>2</sup>	<i>sr</i> <sup>2</sup>	



Table 8 (continued).

*Hierarchical Regression of Predictor Variables on PSAT/NMSQT Scores (N=8)*

Y-intercept	54.442	13.902	<.001		
Math	-.245	-2.952	.026	.593	.593
Support					
Step 2	PSAT/NMSQT Scores 2010				
	$\Delta R^2 = .116$				
	$\Delta F(2, 4) = .798, p = .511$				
	<i>b</i>	<i>t</i>	<i>p</i>	<i>pr</i> <sup>2</sup>	<i>sr</i> <sup>2</sup>
Y-intercept	63.428	7.738	.002		
Math	-.218	-2.386	.075	.587	.415
Support					
Unit Order	-2.860	-1.144	.316	.246	.095
Tasks	-.057	-.031	.977	.0002	.00006
	$R^2 = .709$				
	$F(2, 4) = 3.241, p = .143$				

<sup>1</sup>Math Support courses were available for struggling mathematics students. The purpose of the course was to review and preview topics in the corresponding Math I, II or III course. The percent of students enrolled in the program was self-reported by department chairmen.

<sup>2</sup>GPS course included units to be taught in a specific order over the course.

<sup>3</sup>GPS included performance tasks that were to be utilized by teachers to deliver the curriculum in a performance-based/discovery learning model.

The department chairmen were asked three open-ended questions regarding the implementation of the curriculum. The responses were coded and analyzed for recurring themes (see Table 9). Those surveyed indicated that the implementation of the GPS benefited students in two ways: providing a more challenging curriculum that required deeper conceptual understanding through higher-order thinking and requiring students to make connections among mathematical concepts. When asked what the greatest challenge to students was during the implementation of the GPS the following themes were indicated:

1. The curriculum does not allow for basic computational and algebraic skill development which hinders students as they try to learn new concepts.

2. With many standards being introduced at much earlier grade levels, the students lack the mental maturity to understand these more difficult concepts.
3. With the amount of standards, there is a lack of time for students to solidify their understanding.
4. Students see the curriculum as fragmented as they move between algebra and geometry and many cannot see the connections.

The implementation of the GPS curriculum also challenged the teachers. Many department chairmen cited the lack of resources that could be utilized immediately in the classroom. Additionally, they felt the training was inadequate, all teachers did not receive this training, and the training failed to address exactly what the standards indicated in terms of depth of understanding and rigor. The training did not give teachers the skills to teach in a performance based classroom. While that might have been the intention of the training, many teachers struggled to be able to adjust their delivery to implement the new curriculum.

Table 9

*Frequency Distribution (Percentages) Summary of Themes from Open-Ended Responses of Mathematics Department Chairmen (N=8)*

Question 1	Greatest Benefit for Students of Implementing GPS	Frequency (Percent)
	Providing a more challenging curriculum that requires deeper conceptual understanding through higher order thinking	5 (62.5%)
	Requiring students to make connections among mathematical concepts.	2 (25%)
Question 2	Greatest Challenge for Students During Implementation of GPS	Frequency (Percent)
	Lack of basic skills both computational and algebraic	5 (62.5%)

Table 9 (continued).

*Frequency Distribution (Percentages) Summary of Themes from Open-Ended Responses of Mathematics Department Chairmen (N=8)*

	Lack of intellectual maturity to comprehend material	4 (50%)
	Lack of time to solidify understanding	3 (37.5%)
	Student cannot make connections between topics	3 (37.5%)
Question 3	Greatest Challenge for Teachers During Implementation of GPS	Frequency (Percent)
	Lack of ready to use resources	4 (50%)
	Lack of training on delivery model and depth and rigor of the standards	4 (50%)

#### Summary

This study found differences in student distribution of test scores on the PSAT/NMSQT after the implementation of the GPS curriculum. The number of student scores in the lowest quartile of scores diminished with the implementation of the integrated curriculum. It is also clear from the correlation analysis results of the survey responses that as the perception of adequate resources increased so did the strict adherence to following the order of the units outlined in the GPS, and as the perception of adequate resources decreased, so did the percentage of teachers who completed training before teaching the GPS courses. The survey revealed that the PSAT/NMSQT scores decreased based on the percentage of students enrolled in Math Support classes designed to support struggling students. Analysis of the open-ended questions indicated there were many concerns about the implementation and the benefits and challenges it provided to

students and teachers. In Chapter V, conclusion, implications, and recommendations will be drawn based on these results.

## CHAPTER V

### SUMMARY, CONCLUSIONS, IMPLICATIONS & RECOMMENDATIONS

#### Introduction

The purpose of this study was to determine if the Georgia Performance Standards (GPS) adopted for mathematics in 2005 (Georgia Department of Education, 2007b) increased student mean mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores or resulted in changes in the distribution of student scores on the PSAT/NMSQT. Additionally, to determine whether following the recommended practices of the GPS curriculum affected the PSAT/NMSQT scores was investigated. Chapter V includes an overall summary of the study, conclusions that can be drawn from the results of the study, and recommendation for further investigation.

#### Summary of the Study

##### *Statement of the Problem*

In an investigation of a multitude of State and National Assessments, including the National Assessment of Educational Progress, students in the state of Georgia achieved a lower level than their peers across the nation. After an independent review of the mathematics curriculum by Phi Delta Kappa, the state determined a need to revamp the mathematics curriculum to improve student achievement. Consequently, Georgia adopted the Georgia Performance Standards (GPS) in 2005 (Georgia Department of Education, 2007b). At the high school level algebra, geometry, and data analysis units were integrated into courses identified as Math I, Math II, and Math III. Each mathematics unit was made up of standards which were to be taught using problem-solving tasks. The new curriculum altered the mathematics curriculum along with the

instructional methods of the teacher (Georgia Department of Education, n.d.b). The purpose of the new curriculum was to expand student accessibility to rigorous mathematical content (Georgia Department of Education, 2007b). Historically, the integrated mathematics curriculum has received criticism as many felt it made no sense to change without the guarantee of improved student learning (Senk & Thompson, 2003). The dramatic change between the Georgia Performance Standards (GPS) and a traditional curriculum of single subject courses created controversy among both educators and parents in Georgia (Dodd & Perry, 2010; Diamond, 2008; Dodd, 2011).

### *Statement of Purpose*

Teachers across the nation enter the classroom every day ready to educate students. For most schools in the United States, the teacher is allowed to choose from a variety of instructional strategies and can differentiate instruction for individual students; however, the curriculum that must be taught is predetermined by state and local school boards (O.C.G.A. § 20-2-140, 2011). The purpose of this study was to determine if the new Georgia Performance Standards for mathematics, adopted by the state of Georgia in 2005, increased student mean mathematics PSAT/NMSQT scores or resulted in changes in the distribution of students' scores on the PSAT/NMSQT. In addition, the study determined if the following recommended practices of the GPS affected the PSAT/NMSQT scores.

### *Research Questions*

The implementation of the Georgia Performance Standards began in the fall of 2005 with sixth grade students. At the time of this study, these students were juniors in high school. This study examined the following questions:

1. Is there a difference in tenth grade students' mathematics Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) scores for students who utilized the new Georgia Performance Standards (GPS) versus the tenth grade students who utilized the Quality Core Curriculum (QCC) standards?

H<sub>1</sub>: There will be no difference between the mean scores of students utilizing GPS standards and the scores of students utilizing the QCC standards on the PSAT/NMSQT.

2. Is there a difference between the distributions of tenth grade students' mathematics PSAT/NMSQT scores for students who utilized the new GPS standards versus the students who utilized QCC standards?

H<sub>2</sub>: There will be no difference in the distribution of students' scores for those utilizing the GPS or QCC standards on the PSAT/NMSQT.

3. Is there a relationship between the tenth grade mathematics PSAT/NMSQT scores and the extent to which the schools followed the recommended practices of the new GPS standards?

H<sub>3</sub>: There will be no relationship in the scores of students based on the extent to which the schools followed the recommended practices of the new GPS standards.

### *Study Design*

This was a quasi-experimental design with both a quantitative and qualitative component. The quantitative component consists of scores on the PSAT/NMSQT during the participants' second year in high school. Two years of data from 2007 and 2008 are

considered for those who utilized the QCC mathematics curriculum. Two years of data from 2009 and 2010 are considered for those who utilized the GPS mathematics curriculum. Using the mean mathematics PSAT/NMSQT score for each school, a fully repeated measure Analysis of Variance (ANOVA) was conducted to determine if there was a difference in scores based on the main effects of curriculum and the year of implementation, and any interaction between the curriculum and year of implementation. In addition, the distribution of the tenth grade mathematics PSAT/NMSQT scores were compared over the four-year period. The number of students scoring in the following ranges was calculated: 20-34, 35-49, 50-64 and 65-80. A two-way Chi Squared Analysis was conducted to determine if there was a difference in the distribution of scores based on the curriculum utilized. For the purpose of the study, the curriculum utilized and the year of implementation of the GPS curriculum were the independent variables. The PSAT/NMSQT scores were the dependent variable.

The qualitative component included a survey of the high school mathematics department chairmen in the district. The survey included specific information about the level of course the student took (percent taking Accelerated Mathematics courses or percent taking Math Support courses), type of implementation of the GPS curriculum (following unit order and utilizing performance tasks), and preparation of the implementation (percent of teachers completing training, perception of adequate training, and perception of adequate resources). Additionally, three open-ended questions concerning the benefits and challenges of the implementation of GPS on the students and teachers were asked. A correlational analysis relating these survey items and the scores of the 2009 and the 2010 PSAT/NMSQT scores was conducted to determine if the extent



to which schools followed the recommended practices of the GPS affected the PSAT/NMSQT scores. The open-ended questions asked of the department chairs were analyzed for reoccurring themes.

### *Survey of Major Findings*

The study determined there was a significant year by curriculum interaction in tenth grade mathematics PSAT/NMSQT for schools that utilized the new GPS standards versus the QCC standards. While the students who were tested during year one of implementation of the GPS showed an increase in scores over the scores of those utilizing the QCC, this was not so during year 2. There was no main effect of year but there was a significant main effect of curriculum. There was a difference in the pattern of the distribution of student scores across the four years. With the implementation of the GPS, there were less students scoring in the 20-49 range. There were no changes in the distribution of students scoring in the upper two quartiles.

A correlational analysis determined that there was not a relationship between PSAT/NMSQT scores and following the recommended practices of the GPS curriculum in terms of the order in which the units were taught as designated in the GPS curriculum, nor the use of the performance tasks for initial instruction. The only significant relationship indicated that students concurrently enrolled in Math Support courses had lower PSAT/NMSQT scores.

Utilizing a coding mechanism, the researcher found reoccurring themes among the department chairmen's perception of the benefits and challenges of implementing the GPS for both students and teachers. Students benefitted from the new curriculum by being exposed to a more rigorous curriculum and making more mathematical connections

between concepts. The challenges to the students included the lack of mental maturity to understand complex concepts, lack of basic skills, lack of time for in-depth understanding, and not all students made connections leading to a feeling of confusion for the students. The challenges that teachers faced included the lack of usable resources and inadequate training.

### Conclusions

While this study failed to indicate widespread increases in student achievement with the implementation of the GPS curriculum, the study did indicate student mathematics scores on the PSAT/NMSQT were the same regardless of an integrated or traditional curriculum helping to eliminate the fears of stakeholders. Looking at the literature surrounding implementation of an integrated curriculum, it appears that the results of this study are aligned with past research. Studies on the integrated curricula created with financial support of the National Science Foundation indicated similar results. Students who utilized the Core Plus Mathematics Project showed no significant difference in SAT or ACT scores as compared to a traditional curriculum (Schoen & Hirsch, 2003). The Mathematics Connections curriculum had similar scores when compared to its counterparts on the Connecticut Academic Performance Test, PSAT/NMSQT and SAT (Cichon & Ellis, 2003). Additionally, the state created Systematic Initiative for Montana Mathematics indicated no difference in PSAT scores as compared to traditional counterparts (Lott et al., 2003). Clearly an integrated curriculum is not hindering the learning of mathematics, but there is no empirical evidence of improvement on these college entrance exam tests.

In this study during the first year of implementation of the GPS, students' scores increased greatly while during the second year they declined. One explanation could be the emphasis placed on strict implementation during the first year, but by the second year many teachers moved away from that intended curriculum. While the study was conducted over only two years, it is not possible to determine if the decline would continue, but it is essential to consider the barriers present that may have caused this effect.

Because an integrated curriculum requires students to build more connections, utilizes more engaging real-world problems, and appeals to different learning styles, there is an assumption that student achievement scores should increase (Senk & Thompson, 2003). The GPS intended to encourage more mathematical reasoning, improve the communication of mathematics, make connections to other mathematical topics, and make connections across disciplines (Georgia Department of Education, n.d.b.). Providing a more challenging curriculum and making more connections were two common benefits to students indicated by the department chairmen; therefore, the lack of increases in PSAT/NMSQT mathematics scores may not be attributed to the GPS curriculum itself but to the implementation of the curriculum. It was clear from the survey results that the fidelity of the implementation was questionable. Marzano (2003) describes this as a disconnect between the "intended curriculum, implemented curriculum and attained curriculum" (p. 23). The intended curriculum is the standards set out by the state. The implemented curriculum is what is delivered to the students. When there is a difference in the intended and implemented curriculum, what the students attain will be

compromised (Marzano, 2003). Without strict implementation, it is not possible to accurately analyze the strength of the curriculum and its design.

To improve the strict implementation of the curriculum, teacher buy in must occur at the very beginning of the process. Kegan and Lahey (2001) believe only through the change of individual behaviors can systemic change occur. This indicates the needs for each teacher to be committed to the implementation of any new program. Porter et al. (1994) support this theory as they believe including more teachers in the development of the curriculum is directly related to the success of implementation. Additionally, Glatthorn (2000) believed that the state should provide a broad framework that allows for individual student and teacher differentiation. If there is flexibility in the curriculum for adaptation to the beliefs of the teacher, then it is more likely to be implemented in the intended way.

The idea of implementing an integrated mathematics curriculum has historically come under great criticism. Senk and Thompson (2003) cited the belief that students show a “decline in basic skills [when engaged in an integrated mathematics curriculum]” (p. 16); while House (2003) indicated the perception of a lack of time for learning and understanding of related concepts is a common complaint. Both of these authors were echoed by the department chairmen in the survey conducted by the researcher of this study. Additionally, the teachers felt students’ understanding was fragmented. These concerns are reflected in the design of the curriculum. There has long been a concern about having too much breadth and not enough depth of the mathematics curriculum. As long as this perception remains among the teachers, the integrity of the implementation of the curriculum is compromised.

Several other barriers to strict implementation may have affected the overall results of the study, including the instructional method required. The GPS used a constructivist-based approach to learning by teaching through tasks. This demands a change in instructional approach, without which the implementation cannot be successful (Jacobs, 1998). The survey of department chairmen indicated a lack of commitment to using the state provided performance tasks ( $M=2.38$ ). McCaffrey (2001) suggested that it might not be the curriculum as much as the instruction of the curriculum that leads to maintaining status quo. This is supported by the findings in the TIMSS video studies (Stigler & Hiebert, 2004), which compared teaching practices in a variety of countries. In the 1995 study (Stigler & Hiebert, 2004), teachers were asked if they implemented the reforms outlined in the National Council of Teachers of Mathematics documents. While most teachers claimed they did implement these reforms, the videos showed little evidence of these reforms in the classroom. In the 1999 study (Stigler & Hiebert, 2004), it was discovered that when teachers in the United States did not implement “making connection” problems as diligently as those in more successful countries most often the teachers simplified these into procedural problems (Stigler & Hiebert, 2004, p. 15). Pairing this with the perceived lack of implementation, as indicated by the survey participants of this study on a variety of measures, leads to the conclusion that strict implementation of any curriculum is essential for success.

Another key to successful implementation of a new curriculum is the professional learning (Glatthorn, 1994). There was not a significant relationship between the perception of adequate training and test scores; however, not all teachers received training before teaching the courses ( $M= 62.6\%$ ). The TIMSS study indicates a need to

train teachers on how to implement higher-order thinking questions (Stigler & Hiebert, 2004). Since not all the teachers were trained nor did the department chairmen give the training a high rating of adequacy ( $M=2.38$ ), the success of the curriculum may have been hindered. Lusi (1994) states significant professional development is needed for teachers to learn new strategies. Stenglen (2003) suggested that the most successful staff development is job embedded. This was not the format for the training on the GPS curriculum. Training on the new GPS curriculum consisted of a minimum of a three day workshop offered the summer before the new course was to be implemented (Georgia Department of Education, 2010).

The distribution of student scores for this study indicated a change of pattern with the implementation of the new curriculum for those students scoring below a fifty on the PSAT/NMSQT. This is consistent with the findings of Schoen and Hirsch (2003) during their study of the implementation of the Core-Mathematics Project. In their comparison of matched students, the advanced students showed no difference in achievement based on the curriculum utilized. The Core-Mathematics Project (Core Plus Mathematics Project, 2010) like the GPS exposes students to more rigorous material at an earlier grade than the traditional curriculum. In the GPS curriculum, eighth grade students completed 80% of the concepts taught in QCC Algebra I course and 50% of the concepts taught in QCC Geometry course (Georgia Board of Education, 2007a). In the QCC curriculum, lower performing students were placed in an Algebra course that spanned over two years, thus they did not complete Algebra until the end of the tenth grade. The access to a rigorous curriculum for all students could be one explanation for the change in the distribution of the scores. With the GPS curriculum came the introduction of Math

Support courses. These courses were designed to provide more instructional time for low performing mathematics students. The courses were taken concurrently with the Math I, II, or III course as a way to review and preview important concepts, but they did not have formal curriculum standards. A large percentage of students ( $M=43.54\%$ ) in the district were taking these courses. In Doug Reeves' (2000) study of 90/90/90 schools, which are schools with 90% of students receiving free or reduced lunch, 90% are ethnic minorities, and 90% meet or exceed standards on academic assessments, he found that the amount of time spent on curriculum impacted student achievement. While in the study it was determined that enrollment in Math Support courses indicated lower PSAT/NMSQT scores, fewer students scored between 20 and 34 with the implementation of the GPS curriculum, indicating that the additional time spent on mathematics provided for by Math Support classes may be a successful strategy to bring about academic gains.

#### Limitations of the Study

There were limitations to this study. The data was analyzed from only one district in the state of Georgia and was specific to the Georgia Performance Standards not all integrated curricula. Only two years of PSAT/NMSQT scores were available for those utilizing the GPS curriculum, making it difficult to look at trends in the data. Due to the small sample size of the survey, there was a lack of power in the correlation results, limiting the conclusions that could be drawn from the implementation of the new curriculum.

#### Implications for School Leaders

With the advent of high stakes testing and school accountability through the No Child Left Behind Act of 2001 (No Child Left Behind Act, 2002), school leaders are

bound more than ever to focus on ways to improve student learning. The state of Georgia believed that implementing a new rigorous mathematics curriculum was one step to achieve this goal. Schlechty (2005) describes a need for disruptive innovations which require systemic changes if leaders truly want to have great schools. The GPS curriculum not only provided a more rigorous mathematics learning for all students but it mandated that teacher change to a constructivist-learning instructional model. This type of change to the norms of the school can be very painful, and thus, some leaders will turn away from an innovation versus doing the work to gain buy-in from the teachers (Schlechty, 2005). Leaders must understand the dynamics of change. People are naturally resistant to change, but disruptive innovations are more likely to be successful if leaders get faculty to help lead the movement (Schlechty, 2005). The theory of transformation leadership supports this notion as it is not one person who leads change but a group that must serve as instructional leaders of a school (Hallinger, 2003). Leaders need to be aware of this natural resistance and be prepared for the process that will need to occur for change to be sustained. Doug Reeves (2009) believed decreasing the implementation gap can be accomplished by good leaders. Leaders should highlight immediate success, continually recognize teachers for outstanding practice, always put success of students as a priority regardless if the practice is popular, and focus the education profession as a commitment to service (Reeves, 2009). Leaders play a key role and are responsible for sustaining change that will improve student learning. This study indicated the adoption of the GPS did not include systemic changes to the norms of mathematics classrooms across the school system and consequently was hindered from being successful.



The underlying conclusion from this study is that school leaders need to look at ways to remove barriers from the implementation of any new program or curriculum. By being proactive before the implementation by critically analyzing the new curriculum with the teachers and gaining the buy-in to implementation plus having a thorough monitoring plan during implementation which leads to making adjustments to the curriculum as necessary, the school leader can provide a supportive environment to foster the successful implementation of the curriculum. This study indicates professional learning opportunities are a key to the success of an integrated mathematics curriculum. If these opportunities are not provided to teachers or resources provided are inadequate, then it is the responsibility of other leaders to look for options to ensure successful implementation. If the leader does not have the funds available to provide this support at the school level, the leader should use his or her political influence within the district and at the state level to ensure the students and teachers have what they need to be successful. Without proper implementation, student learning will suffer.

#### Recommendation for Future Research

The Georgia Board of Education made two changes that will hinder the future of an integrated mathematics curriculum. Because 17% of third-year high school students statewide had earned one or less Carnegie units of mathematics credit, a state rule was implemented that changed the Math Support courses to count as core mathematics credit (Georgia Board of Education, 2011). Currently, students must earn four Carnegie units of mathematics credit. Those students who complete Math I, Math I Support, Math II and Math II Support will have earned enough credits to graduate. In the long term, this means exposure to less mathematics curricula. While universities still have more

rigorous requirements for admission, students are eligible to graduate high school with exposure to less mathematics. At the same time, additional courses were added that divide the GPS standards into discrete courses of GPS Algebra, GPS Geometry, GPS Advanced Algebra and GPS Precalculus. Each local district was given the discretion to choose whether to offer the GPS as an integrated or discrete system (Georgia Department of Education, 2011; Dodd, 2011). Research reveals successful implementation of curriculum takes between five and seven years; therefore, results of this study are preliminary at best (St. John, et al., 2004). The school district included in this study will be changing to the discrete courses rather than keeping the integrated approach for teaching mathematics. These changes taking place eliminate the ability to monitor the trend in PSAT/NMSQT scores over a longer period of time, which would have been advantageous. Even with the new discrete courses, support courses will be provided for struggling students. Research to track the academic achievement of the students who participate in support courses could provide meaningful feedback to leaders as they look at ways to increase student achievement through innovation. Since there are no curriculum standards for support courses and each school formats these courses in different ways, further investigation into what structures and strategies in the support courses are most influential would allow us to maximize student learning and plan for meaningful professional learning for teachers of these courses.

#### Concluding Remarks

The GPS mathematics curriculum was implemented surrounded by much controversy. This lack of commitment to the curriculum resulted in subsequent barriers that ultimately caused the state to redesign the curriculum within three years. This study

demonstrated that students performed as well, utilizing the Georgia Performance Standards based integrated mathematics curriculum, as those utilizing the Quality Core Curriculum on the mathematics portion of the PSAT/NMSQT. This can be attributed to lack of rigorous implementation and professional learning on how to teach within the constructivist learning model. The most significant result of the study was the improvement of student scores in the bottom quartile, which could be the result of a more rigorous curriculum being available to all students or the introduction of more time spent on mathematics during the school day. Hopefully, the results of this study can provide insight to school leaders as the state faces another new mathematics curriculum implementation during the 2012-2013 school year with the introduction of the Common Core Standards.

## APPENDIX A

## Survey

**Mathematics Georgia Performance Standards Implementation**

Part I: Please answer the following questions about your high school's mathematics program as accurately as possible. Schools will be coded by letter and never identified to ensure anonymity.

1. At what high school do you serve as the department chairman?  
\_\_\_\_\_
2. How many years have you served as the department chairman? \_\_\_\_\_ years
3. Were you the chairman during the initial implementation of the Georgia Performance Standards mathematics curriculum? \_\_\_\_ yes \_\_\_\_ no
4. What percentage of students at your school participates in the Accelerated mathematics program? \_\_\_\_\_ %
5. What percentage of your school's Math I students are also enrolled in Math I Support? \_\_\_\_\_ %
6. What percentage of the teachers in your school participated in training before teaching the new Georgia Performance Standards? \_\_\_\_\_ %

Part II: For the following statements, select the response that best reflects the practices at your school.

	5-Always	4-Frequently	3-Sometimes	2-Occasionally	1-Never
7. The units of the Georgia Performance Standards mathematics curriculum are taught in the order designated by the state.	5	4	3	2	1
8. The provided tasks of the Georgia Performance Standards are utilized for initial instruction.	5	4	3	2	1



## APPENDIX B

## COVER LETTER TO MATHEMATICS DEPARTMENT CHAIRMEN

## Mathematics Georgia Performance Standards Implementation

Dear Mathematics Department Chairman,

I am a doctoral candidate at The University of Southern Mississippi conducting research to determine the effects of the new Georgia Performance Standards in Mathematics on student learning. As a former mathematics teacher and with the impending changes to the curriculum, I am interested in investigating any correlations between PSAT/NMSQT scores and the implementation of the standards. You were selected as a participant because of your role as the mathematics department chairman at your school. Your thoughts are important to the study. If you agree to complete this 15-minute survey, you will be asked questions regarding the Georgia Performance Standards courses, instruction, training and general overall perception.

Your participation is completely voluntary with all responses being confidential. Anonymity will be maintained by coded school locations alphabetically. No school or school district will be identified in the study. There will be no compensation for participation and refusing to participate or discontinuing participation will involve no penalty. The records of this study will be kept private. In any report of this study that might be published, the researcher will not include any information that will make it possible to identify a participant. No specific individuals, schools, or districts will be identified in the data.

Questions concerning the research study should be directed to Catherine Mallanda at 770-633-1858 or through email at [cmallanda@aol.com](mailto:cmallanda@aol.com).

I have included a self-addressed, stamped envelope for you to return your completed survey.

Thank you in advance for your participation,  
Catherine L. Mallanda

**This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, Mississippi 39406-001, (601) 266-6820.**

## APPENDIX C

## COVER LETTER TO PRINCIPALS

## Mathematics Georgia Performance Standards Implementation

Dear Principal,

My name is Catherine Mallanda. I am a doctoral candidate at The University of Southern Mississippi conducting research to determine the effects of the new Georgia Performance Standards in Mathematics on student learning. I have submitted an application to the Cobb County School District for permission to conduct research and I hope that you will give permission to include your school in my study. I will be gathering the school summaries of tenth grade PSAT/NMSQT scores for the school years 2007/2008, 2008/2009, 2009/2010, and 2010/2011. In addition, I will be conducting a 15-minute survey of the high school mathematics department chairman to ask questions regarding the Mathematics Georgia Performance Standards implementation.

The records of this study will be kept private. In any report of this study that might be published, the researcher will not include any information that will make it possible to identify a participant. No specific individuals, schools, or districts will be identified in the data.

I would greatly appreciate your school's participation in this research project. If you have any questions concerning the research study, please call me at 770-633-1858 or email me at [cmallanda@aol.com](mailto:cmallanda@aol.com).

Sincerely,

Catherine L. Mallanda

**This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, Mississippi 39406-001, (601) 266-6820.**

## APPENDIX D

## Institutional Review Board Approval



## THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147  
 Hattiesburg, MS 39406-0001  
 Tel: 601.266.6820  
 Fax: 601.266.5509  
 www.usm.edu/irb

**HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE  
 NOTICE OF COMMITTEE ACTION**

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 11032804

PROJECT TITLE: **The Effects of Changing from a Traditional Mathematics Curriculum to an Integrated Mathematics Curriculum on Student Mathematics Learning in Georgia**

PROPOSED PROJECT DATES: 01/01/2011 to 01/01/2012

PROJECT TYPE: **New Project**

PRINCIPAL INVESTIGATORS: **Catherine Mallanda**

COLLEGE/DIVISION: **College of Education & Psychology**

DEPARTMENT: **Educational Leadership & School Counseling**

FUNDING AGENCY: **N/A**

HSPRC COMMITTEE ACTION: **Exempt Approval**

PERIOD OF APPROVAL: **03/31/2011 to 03/30/2012**

Lawrence A. Hosman  
 Lawrence A. Hosman, Ph.D.  
 HSPRC Chair

4-1-2011  
 Date





## THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147  
 Hattiesburg, MS 39406-0001  
 Tel: 601.266.6820  
 Fax: 601.266.5509  
 www.usm.edu/irb

### HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **C11032804**

PROJECT TITLE: **The Effects of Changing from a Traditional Mathematics Curriculum to an Integrated Mathematics Curriculum on Student Mathematics Learning in Georgia**

PROPOSED PROJECT DATES: **01/01/2011 to 01/01/2012**

PROJECT TYPE: **Previously Approved Project**

PRINCIPAL INVESTIGATORS: **Catherine Mallanda**


COLLEGE/DIVISION: **College of Education & Psychology**

DEPARTMENT: **Educational Leadership & School Counseling**

FUNDING AGENCY: **N/A**

HSPRC COMMITTEE ACTION: **Exempt Approval**

PERIOD OF APPROVAL: **07/21/2011 to 07/20/2012**

  
 \_\_\_\_\_  
 Lawrence A. Hosman, Ph.D.  
 HSPRC Chair

7-21-2011  
 \_\_\_\_\_  
 Date



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