CORRELATES OF MATHEMATICS ANXIETY AMONG AFRICAN AMERICAN HIGH SCHOOL JUNIORS

by

GLORIA LYNN JONES

(Under the Direction of Denise S. Mewborn)

ABSTRACT

Sixty-seven African American high school juniors in two high schools completed the Mathematics Anxiety Rating Scale for Adolescents (MARS-A), Mathematics Self-Efficacy Scale (MSES), and a demographic survey to assess mathematics anxiety. Analyses were conducted to examine relationships between mathematics anxiety and mathematics achievement, mathematics self-efficacy, mathematics success, and general academic success. Further analysis was conducted to investigate whether these variables differed as a function of gender. Interviews were conducted to investigate how a sample of participants described their mathematics experiences with high mathematics anxiety. The students' mathematics self-efficacy was inversely correlated with their mathematics anxiety. There was no statistically significant difference in the mathematics anxiety levels of males and females. For the male students, mathematics achievement and mathematics self-efficacy were significantly related to mathematics anxiety, where as mathematics success and general academic success were not. For the female students, mathematics self-efficacy, mathematics success, and general academic success were significantly related to mathematics anxiety, but mathematics achievement was not. For the total sample, the average level of mathematics anxiety was high based on the normative tables created by the instrument developers of MARS-A. Moreover, all of the variables were significantly related to mathematics anxiety except for general academic success. All of the students who were interviewed reported that they had experienced mathematics anxiety at some point in their mathematics career and, as a result, they had low confidence in continuing in honors level mathematics or the higher level mathematics courses and therefore, will not able to reach Advanced Placement (AP) Calculus or any of the other higher mathematics courses (Discrete Mathematics, AP Statistics) in their senior year.

INDEX WORDS: Mathematics Anxiety, Mathematics Self-Efficacy, Mathematics Achievement, Mathematics Tracking, African Americans, High School Mathematics, Correlates of Mathematics Anxiety

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GLORIA LYNN JONES

B.S., Norfolk State University, 1987

M.P.A., Clark Atlanta University, 1994

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GLORIA LYNN JONES

Major Professor: Denise S. Mewborn

Committee: Dorothy Y. White
Shawn M. Glynn

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
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DEDICATION

This dissertation is dedicated to my dear big sister, Theresa Lee, who stepped into my life as my mother away from home and as a supportive best friend through the most trying of times in this program. Reesa, I thank you for being there for me at every phase of this journey. I love you with all my heart.

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CHAPTER 1

INTRODUCTION

Rationale

Despite the mathematics curriculum reforms posited in the National Council of Teachers of Mathematics [NCTM] (1995) standards documents and the statements of equity and diversity contained in the No Child Left Behind (NCLB) Act, the achievement gap in mathematics for African American students continues to persist. Statistical data from sources such as College Board examinations and the National Assessment of Educational Progress (NAEP) highlight the achievement gap. For instance, in the 2007 SAT African American college bound seniors had the lowest average score in mathematics among the ethnic groups, scoring 149 points below Asian students. The African American female seniors scored 14 points below the average score of their male counterparts. Similar trends are seen in the 2007 SAT mathematics scores for the state of Georgia where this study was conducted. Georgia's African American seniors had the lowest average score in mathematics across ethnic groups, scoring 143 points below Asian students, who had the highest average. The African American female seniors at the state level scored consistent with the national score of 13 points below the average score of their male counterparts. The data further indicate that there are positive correlations between family income, parental level of education, and the number of higher mathematics courses taken by the students and SAT scores (College Board, 2007).

Although there are many diverse reasons for poor performance in mathematics, one variable that has not been explored in depth is mathematics anxiety. Mathematics anxiety is a pervasive problem in the teaching and learning of students in mathematics and other related fields. Zaslavsky (1994) reported that mathematics anxiety is widespread and can occur at any age in any race of people at different levels and of both genders. While some anxiety can be motivating, too much anxiety can cause "downshifting" in which the brain's normal processing mechanisms begin to change—narrowing perceptions, inhibiting short-term memory, and inducing more primal reactions (McKee, 2002). Tobias (1994) expressed that the heart of mathematics phobia [anxiety], as she has researched it, is lack of confidence. In the case of women and girls, this has to do with feeling that "mathematics is for boys" or in the case of disadvantaged minorities, "mathematics is for White people." I developed the following as a working definition of mathematics anxiety:

> Mathematics anxiety is both a cognitive dread of mathematics and a learned emotional feeling of intense frustration or helplessness about one's ability to do mathematics.

I prefer this definition as it points out the cognitive (worry) aspect of anxiety—negative thoughts about performance and potential negative consequences—as well as the learned emotionality symptoms such as (e.g., headaches, sweaty hands) when one is confronted with mathematics. These two aspects typically occur together in the order of worry then the perceived arousal of emotions (Spielberger, 1980).

Research (e.g., Steele, 1992, 1997) suggests that African American students experience some of the highest rates of mathematics anxiety, especially among female students. According to Zaslavsky (1994), people of all races and economic backgrounds fear mathematics, but women and minorities are most hindered. She pointed out that around the seventh grade most girls begin to doubt their ability to do mathematics. Because self-confidence and mathematics performance are so closely related, both constructs play a major role in girls' choices to continue on to higher mathematics courses in high school.

In general, many qualitative and quantitative studies have been conducted to measure and report the progress of females overcoming mathematics anxiety. Today, with some improvement, this struggle continues. Yet there has been scant to no research attention to the negative effects of mathematics anxiety among African American students. Thus, this study is designed to fill a gap in the literature about African American students and mathematics anxiety by looking for correlates with other factors that are known to affect success in mathematics.

Achievement Gap in Mathematics and Mathematics Anxiety

Researchers have found that the relationship between mathematics anxiety and mathematics achievement is significant (e.g., Ma, 1999; Quilter & Harper, 1988). Once mathematics anxiety takes shape, its relationship with mathematics achievement is consistent across grade levels (Ma, 1999).

Over the past two decades, the achievement of minority students in mathematics has been well documented (Secada, 1992; Tate, 1997). Tate examined the mathematics achievement of diverse groups from national trend studies and found that African American students continue to score at significantly lower levels than White and Asian American students. The NAEP gauges student mathematics achievement in grades 4, 8, and 12 and is the only ongoing assessment of mathematics achievement in the United States. NAEP results show that minority students typically score below their White peers in all mathematics content areas. The long-term trends show that achievement in mathematics improved a small to moderate extent for all students from 1973-1999 (Campbell, Hombo, & Mazzeo, 2000). Improvements for minority students have occurred mostly on those scales related to basic skills (Martin, 2000). Despite improvements across all ethnic groups, there were substantial gaps in mathematics achievement among different racial and ethnic groups. Moreover, these achievement differences grow as mathematics topics increase in difficulty (Strutchens & Silver, 2000). During the 1990s progress in narrowing the mathematics achievement gap slowed down, and the gap has been widening since 1999 (Lee, 2002).

Many explanations have been offered as to why the "achievement gap" still remains between African American and White or Asian American students despite the past mathematics education reforms in the United States. Poor mathematics performance in the United States cuts across cultural groups. Webb (1989) expressed that, "in [general], mathematics is a subject to be avoided and ignorance of the subject is often a point of pride" (p. 371). Yet, there are some disturbing patterns about the performance of African American students, particularly females, that needs to be further addressed.

According to the U.S. Census Bureau, of children younger than 18 living in families, 30% of African American children live in poverty, compared with 13% of White children (Proctor & Dalaker, 2002). Research has shown that low-income minority students are more likely to be clustered in low-ability mathematics classes (Finn, Gerber, & Wang, 2002). As African American enrollment in a school increases, the proportion of classes identified as "high ability" diminishes. Schools where African American students constitute the majority have less extensive and less demanding mathematics programs and have fewer qualified teachers than schools that have large White populations (Oakes, 2005). Approximately 33% of high school mathematics students in high minority schools and 30% of high school mathematics students in high poverty schools are taught by teachers without a teaching license or a major in mathematics related fields. This pattern can be contrasted with the figures reported in low minority and low poverty schools. Approximately 7% of high school mathematics students in low minority schools and 7% of high school mathematics students in low poverty schools are taught by teachers without a teaching license or a major in mathematics (Wirt, Choy, Rooney, Provasnik, Sen, & Tobin, 2004). As for the school district in this study, 2% of the classes were not taught by highly qualified teachers in the low poverty schools and 7% of the classes were not taught by highly qualified teachers in the high poverty schools (Georgia Department of Education [GaDOE], 2007). The fact that poor and minority students are less likely to be taught by teachers with strong pedagogical and mathematical content knowledge could be a contributing factor in the mathematics achievement gap. Furthermore, teachers in high-poverty schools reported less favorable working conditions than the well-resourced schools and identify student disrespect and lack of parental involvement as problematic (Quality Counts, 2003). Many experts asserted that the achievement gaps were the result of more subtle environmental factors. Being raised in a low-income family, for example, often means having fewer educational resources at home in addition to poor health care and nutrition—factors that contribute to lower academic performance (U.S. Department of Education, 2000).

Traditionally, mathematics was considered the preserve of White middle-class males and today, Asian American students as well, while mathematics anxiety was considered the preserve of females and disadvantaged minorities (Tobias, 1978). According to a 2003 report by the Education Trust, students of low-income families and students of color consistently have been short-changed by the United States' educational system. For decades, disadvantaged minorities have had the least qualified teachers, the least challenging curriculum and the poorest equipped schools in segregated settings. The Education Trust also reported that nationally, African American high school seniors have identical mathematics skills as White eighth graders.

In this study with African American high school juniors, poverty was somewhat controlled by selecting schools in middle-class communities. As mentioned earlier, the percentage of classes in the school district taught by teachers who are not highly qualified is relatively low. However, from various data sources (e.g., College Board, GaDOE, and NAEP) there still appears to be a significant achievement gap in mathematics between African American students and the other ethnic groups in these schools. Perhaps these students are struggling with mathematics anxiety and therefore are not able to perform at a higher level. This research study explored high mathematics anxiety and some possible correlates such as the participants' mathematics achievement, mathematics self-efficacy, and mathematics and general academic success of the students.

Purpose and Research Questions

The aim of this study was to test whether relationships exist between mathematics anxiety and mathematics achievement, mathematics self-efficacy, mathematics success, and general academic success among African American high school juniors in a suburban school district. The research questions that guided this study were:

1. What is the mathematics anxiety level of the African American high school juniors by gender and total group?
2. What is the relationship between mathematics anxiety and mathematics achievement by gender and total group?
3. What is the relationship between mathematics anxiety and mathematics self-efficacy by gender and total group?
4. What is the relationship between mathematics anxiety and mathematics success by gender and total group?

5. What is the relationship between mathematics anxiety and general academic success by gender and total group?
6. How do African American students with high mathematics anxiety and high mathematics achievement describe their experiences with mathematics?

Hypothesis

Preis and Biggs (2001) described a four-phase cycle of mathematics avoidance: In phase one, the person experiences negative reactions to mathematics situations. These may result from past negative experiences with mathematics and lead to phase two in which a person avoids mathematics situations. This avoidance leads to phase three: poor mathematics preparation, which brings the person to phase four: poor mathematics performance, generates more negative experiences with mathematics and brings the person back to phase one. The repetition of this cycle can gnaw at the mathematics anxious person's self-efficacy and confidence in his or her ability to do mathematics. This study is based on a similar model, namely the practices of "tracking" and "ability grouping" in the schools that have affected African American students in not gaining experience with and exposure to higher mathematics. As a result, the lack of practice with higher mathematics has led to low achievement and low performance on standardized mathematics tests, lack of confidence and low self-efficacy in one's ability to do mathematics, and mathematics avoidance which contributes to tracking and ability grouping in the first place. Finally, this cycle ends in high levels of mathematics anxiety and repeats itself all over again as depicted in Figure 1.

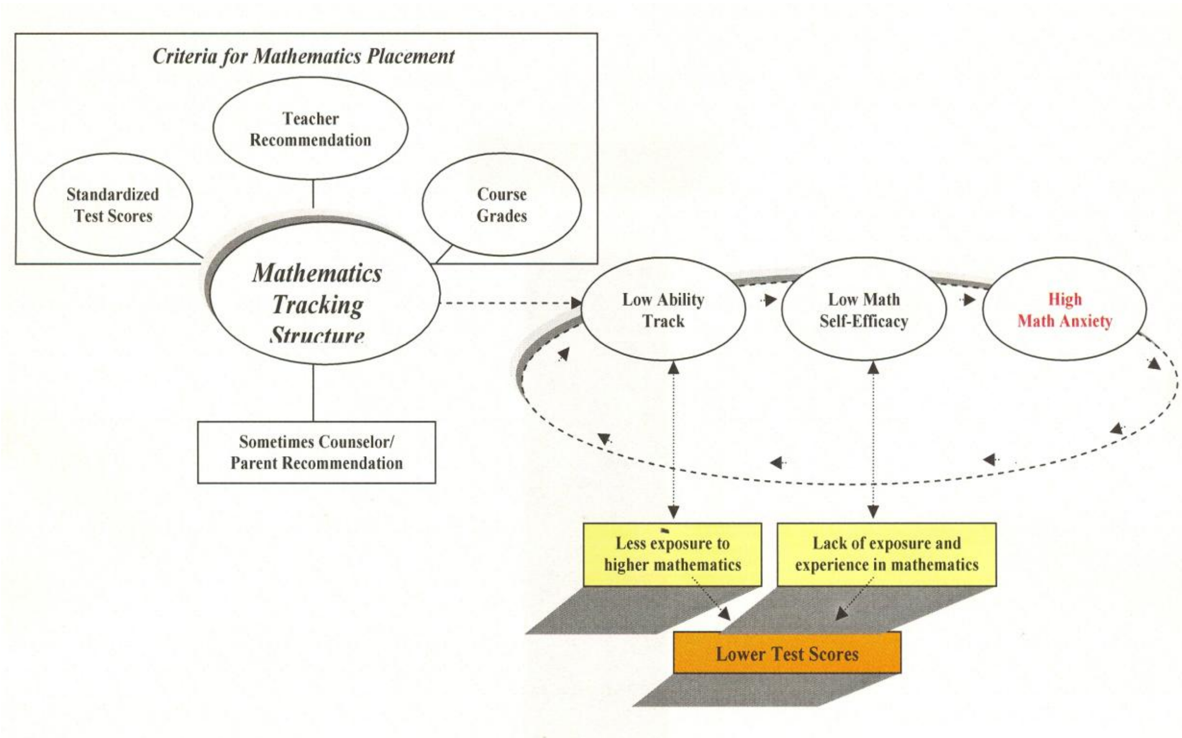

Figure 1. Model of the Hypothesis

This research study was conducted with African American students who were not disadvantaged necessarily by poverty but were grappling with other disparaging situations that may contribute to mathematics anxiety. One such situation was lack of self-confidence and low self-efficacy in mathematics. According to Dodd (1999), the lack of confidence is probably the mathematics anxious learner's greatest obstacle. This could explain the low number of African American high school students enrolled in Advanced Placement (AP) mathematics courses throughout the country, in general, and in the state of Georgia and Raven County Schools, in particular (College Board, 2007; GaDOE, 2007). In 2007 the Georgia Department of Education reported the enrollment status of AP Calculus and AP Statistics courses by race and gender in the two schools in this study. One of the schools had only 1 African American student out of 10 enrolled in AP Calculus. Of the 10 students enrolled, there were 2 males and 8 females. In AP

Statistics, 4 African American students out of 17 were enrolled. Of the 17 students enrolled, there were 7 males and 10 females. The other school had 6 African American students out of 22 students enrolled in AP Calculus. Of the 22 students enrolled, there were 11 males and 11 females. There was no AP Statistics course at that school during the time of the study.

With limited qualitative and quantitative research available on African American students' experiences with mathematics anxiety, this study was undertaken to add to that body of knowledge. It was useful to get first-hand accounts of the participants' mathematics experiences as they relate to mathematics anxiety.

CHAPTER 2

REVIEW OF THE LITERATURE

Mathematics Anxiety

Negative beliefs about mathematics are often exhibited in the condition known as mathematics anxiety. Traditionally, mathematics anxiety has been known to be an expression of general anxiety and not a distinct phenomenon (Olson & Gillingham, 1980), but more recent studies have shown mathematics anxiety to be more complex than general anxiety (Ingleton & O'Regan, 1998). Norwood (1994) emphasized that mathematics anxiety does not appear to have a single cause, but is, in fact, the result of many different factors such as truancy, poor self image, poor coping skills, teacher attitude, and an emphasis on learning mathematics through drill without understanding. Research has shown that mathematics anxiety is associated with many other constructs. For instance, according to Martinez and Martinez (1996), mathematics anxiety is a "construct with multiple causes and multiple effects interacting in a tangle that defies simple diagnosis and simplistic remedies" (p. 2). Some of these constructs include working memory (e.g. Ashcraft & Kirk, 2001), age (e.g. Gierl & Bisanz, 1995), gender (e.g. Bradley & Wygant, 1998), self-efficacy (e.g. Hackett & Betz, 1989; Pajares & Graham, 1999), attitude toward mathematics (e.g. Aiken, 1976; Betz 1978), self-confidence in learning mathematics (e.g. Kloosterman, 1988), test anxiety (e.g. Kazelskis, et. al, 2000), and general anxiety (e.g. Zettle & Raines, 2000). Ashcraft and Faust (1994) described mathematics anxiety as a "feeling of tension, apprehension, or even dread that interferes with the ordinary manipulation of number and the solving of mathematical problems" (p. 97). Tobias (1978) described it as "sudden death" (p. 46). As indicated by Zaslavsky (1994), mathematics anxiety is a condition that is traumatic and debilitating. Some of the symptoms include, but are not limited to, sweaty hands, palpitating heart, loss of concentration, a general sense of uneasiness, mild stomach pains or cramps, nausea, dizziness, muscle tightening, and headaches (Zaslavsky, 1994). The description is useful because it is inclusive of a wide range of symptoms that teachers can become aware of in their mathematics anxious students.

Researchers have rendered many definitions to describe the essence of mathematics anxiety. Kogelman and Warren (1979) indicated that it is an adverse reaction to mathematics, while Byrd (1982) concluded that it is any situation when one experiences anxiety "when confronted with mathematics in any way" (p. 38). Richardson and Suinn (1972), developers of the Mathematics Anxiety Rating Scale (MARS), concluded that it "involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary and academic situations" (p. 551). Tobias and Weissbrod (1980) define mathematics anxiety as "the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" (p. 65). In each of the definitions above, mathematics anxiety is considered to be a form of "state anxiety," an unpleasant emotional arousal that is specific to mathematics-related activities and instruction. It is debilitative in nature in that it can interfere with mathematics performance and inhibit subsequent learning.

Mathematics anxiety is a concept that has stimulated increasing interest from researchers since the late 1970s when a feminist, Sheila Tobias, (1978) discovered at Wesleyan University, a formerly all-male college that had recently gone coed, that the women's enrollment practices were indicating an aversion toward mathematics and quantitative related majors that would require taking mathematics classes. She found that boys' confidence in their ability to do mathematics was higher than the girls'. Girls avoided mathematics out of fear of being thought of as abnormal because mathematics was sanctioned by society as a male's field of study. Many of them stopped taking mathematics at crucial stages of their education. After careful reflection on the wave of mythical geneticists' views of why boys outperformed girls in mathematics, she was determined to test a hypothesis: that anxiety, rather than incompetence, controlled their academic choices.

Tobias (1993) suggested some reasons that students are unable to move beyond their paranoia in mathematics. The first reason given is that students focus on getting the right answer. When they cannot reach it, they are too embarrassed or afraid to learn from their mistakes. This pattern is linked to Tobias' second reason, which is that there is a sense in American culture that mathematical success is based on ability, not on effort or perseverance. This reasoning causes many students to give up in mathematics, leading them to believe that they are not predestined to be good at mathematics when they are faced with an insurmountable problem.

Resnick, Viehe, and Segla (1982) conducted a study of mathematics anxiety among college students and found that students in lower-level classes experienced more anxiety than students in higher-level classes. Is this true in high school mathematics as well? This could be construed in at least two ways: Does this mean that anxiety disappears with higher grade levels or that students with a high level of anxiety do not pursue higher level mathematics courses? Resnick and Segla (1992) also confirmed a moderate correlation between students' interest in mathematics and academics in general and their level of mathematics anxiety. College students who valued education and were interested in mathematics tended to be less afflicted with mathematics anxiety. Hembree's (1990) study supported this finding with a meta-analysis of 5th through 12th grade mathematics students. The researcher found a negative moderate correlation (r = -.31) with participants' MARS scores and mathematics achievement.

Contrary studies of 7th through 12th graders reported differently. Mathematics anxiety was lower in students who did not value mathematics (Meece, Wigfield, & Eccles, 1990; Wigfield & Meece, 1988). However, students with low perceptions of their own mathematics ability experienced more anxiety than their more confident counterparts (Meece, et al., 1990). Because the participants in my study were high school juniors (11th graders), they were taking either some of the highest mathematics courses offered to the juniors or finishing with the minimum for the mathematics requirement under the former Quality Core Curriculum (QCC) depending on which academic track the students were pursuing.

There are some cognitive explanations of mathematics anxiety. For example, in a study by Hopko, Ashcraft, Gute, Ruggerio, and Lewis (1998), it was found that mathematics anxious individuals have a deficient inhibition mechanism whereby working memory resources are consumed by task irrelevant distracters. The researchers asserted that "a consequence of this deficiency was that the performance of explicit memory was poorer for high anxious individuals" (p. 343). Another instance is in Ashcraft and Kirk's (2001) study of the social cognitive construct. They found that the effects of mathematics anxiety are greatest when a secondary task is being completed. For example, the researchers gave a test with simple arithmetic problems (e.g., 5 + 2 =?, 9 - 6 = ?). "Participants give the answer to each problem (7, 3), one by one, and then must recall the last number (2, 6) in each of the problems within that trial, in order" (p. 226). Multiple number tasks or any irrelevant distracters such as thoughts of worry can put a strain on working memory, which could result in sacrificing the earlier or relevant task, causing frustration and mathematics anxiety.

Tracking and Ability Grouping

In response to the dilemma of providing curriculum and instruction to a large and diverse student body with varied levels of ability, American schools have established differentiated structures traditionally referred to as tracks, ability-groups, streams, and levels (Gamoran & Weinstein, 1998; Oakes, 1992; Ogbu, 2003). “This differentiation continues throughout the grades through variations in curricular content, pace and quantity, culminating in distinct college preparatory and non-college preparatory programs and finer distinction among levels within the two” (Oakes, 1992, p. 12). The word “tracks” or “tracking” was used in this study to refer to the differentiated structure in secondary mathematics. Tracks are hierarchical categorizations of classes or groups (e.g., low, medium, high or advanced and honors). Most students are assessed early in middle school for placement in mathematics, which could predetermine their tracks for mathematics in high school. Normally students have the opportunity to state their preferences in the placement process, but the required criteria will ultimately determine the outcome. The criteria are:

1. Student’s prior and current achievement
2. Teacher recommendation
3. Standardized test scores in the subject area

Occasionally, parents and the school counselor will become involved in the process to make a more informed decision for student placement. In this study, the investigation was about the mathematics experiences of high mathematics anxious students and the role ability tracking in mathematics played. The participants in the school district were following one of the mathematics tracks depicted in Figure 2 based on the 2007 district mapping for secondary mathematics.

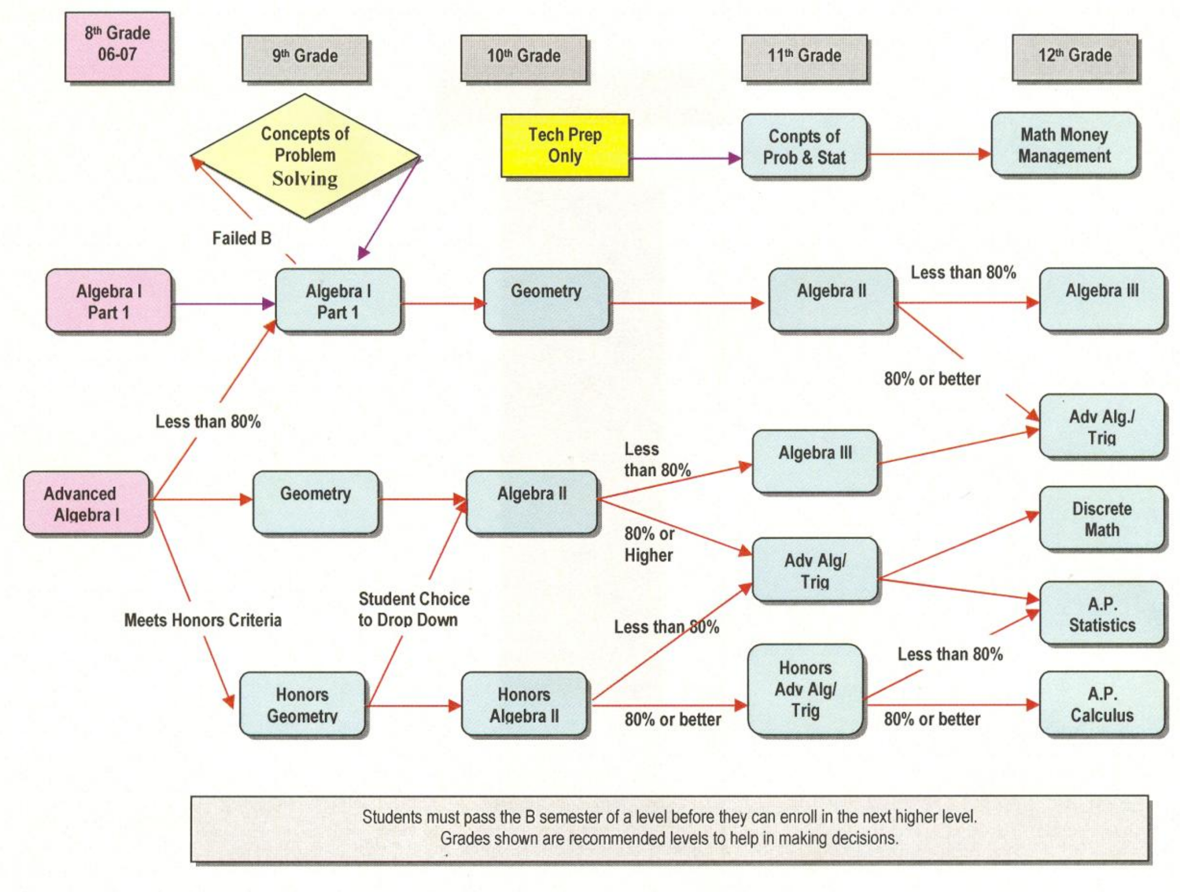

Figure 2. Mathematics Tracks 2007-2008

The practice of tracking has received harsh criticism because a disproportionate number of minority and low-income students are placed in low-ability tracks (Oakes & Lipton, 1992). Jeannie Oakes (1995) found in a San Jose study that "African American and Latino students were much less likely than White or Asian students with the same test scores to be placed in accelerated courses" (p. 686). Other studies have also revealed that exposure to higher level learning opportunities and high quality instruction was less frequent for students in low ability groups than for students in high ability groups. The lack of exposure and experience often precluded low ability tracked students from taking advanced classes. As a result, low ability tracked students tended to remain on low tracks throughout their academic careers (Braddock &

McPartland, 1990; Oakes, 1992). Oakes (1985) reported that it was the school's norm that high-track students sustained the disposition of conveying greater self-confidence in their academic competence.

The literature suggests that tracking students into low-level classes in mathematics could eventually lead to mathematics anxiety in the learner. Tobias (1993) contended that, "most people leave school as failures at mathematics, or at least feeling like failures. Some students are not even given a chance to fail; identified early as non-college material, they are steered away from pre-college [college preparatory] mathematics and tracked into business or 'general mathematics '" (p. 31).

Self-Efficacy, Self-Confidence, and Mathematics Anxiety

Schunk (2004) defined self-efficacy as personal beliefs concerning one's capabilities to organize and implement actions necessary to learn or perform behaviors at designated levels. In addition, self-confidence is the extent to which one believes one can produce results, accomplish goals, or perform tasks competently (Schunk, 2004). Being aware of self-efficacy information helps individuals determine how much effort they should expend in order to produce a desired result or complete a task. Bandura (1997) suggested that individuals attribute their self-efficacy to past experiences and how those experiences relate to them personally. The primary source of mathematics self-efficacy, therefore, is self-reflection on exposure to, or lack of exposure to mathematics classes (experiences). Bandura argued that if individuals have no basis on which to properly assess their ability, then their assessment will be flawed in the end. In other words, it is difficult for students to objectively evaluate themselves on topics for which they have little knowledge. Therefore, exposure to mathematics increases mathematics self-efficacy, especially if the outcome is positive, while lack of exposure to mathematics decreases mathematics self-efficacy. Past experiences, often time failures in mathematics, usually dictate students' opinions concerning their perception of their ability in mathematics that could ultimately affect their career choices in mathematics-related fields.

Students who have self-confidence that they are able and capable of doing well are much more likely to be motivated in terms of effort and persistence than students who believe they are less able and do not expect to succeed (Bandura, 1997; Eccles, Schiefele, & Wigfield, 1998; Pintrich & Schunk, 2002). Tobias (1994) found that the heart of mathematics anxiety was lack of confidence in mathematics. She argued that lack of confidence contributes to lack of experience and practice, and this, in turn, erodes confidence still more. Bandura viewed anxiety as a "co-effect" of self-efficacy expectations in that the level of anxiety is seen to co-vary inversely with the level and strength of self-efficacy expectations; as self-efficacy expectations are increased, anxiety should decrease and vice versa.

In this research study, a mathematics anxiety rating scale and a mathematics self-efficacy scale were used to find the average mathematics anxiety and mathematics self-efficacy levels among the participants. These questionnaires also provided scores that were used to analyze correlation between the two constructs.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Site and Population Selection

The research study took place in Raven County, Georgia high schools. Raven County had an estimated population for 2007 of 196,080. Since 1990, Raven County has been cited as being one of the fastest-growing counties in the country. At the time of the study, it was the fourth-fastest-growing county in the country. The Georgia Power Community and Economic Development Organization, in conjunction with the Environmental Systems Research Institute, (2007) reported that Raven County's estimated population by ethnic groups was 77.85% White, 16.99% black, 2.28% Asian, 2.87% Hispanic, and 3.01% other. This is a sharp decline in the number of White residents and a slight increase in the number of African American residents from the 2000 report which showed 81.38% White residents and 14.68% African Americans. Residents of Raven County were mostly middle to upper middle class in terms of socioeconomic status. The average household income was $84,260, with a median income of $72,290.

I selected Raven County as the site of the research for convenience because I am a 17-year resident of the county and have taught mathematics in the school district. Thus, I am familiar with the district, have working relationships with various employees of the district that helped me gain access to students, and it was economical for me to collect data there because I live in close proximity to the data collection sites. Most importantly, Raven County provided me with an opportunity to study African American students from average to well-to-do communities, which allowed me to exclude factors such as poverty or lack of school resources as contributing to mathematics anxiety.

For the 2007-2008 academic year, the school district enrolled 38,939 students. Of this total, 7,847 students were enrolled in the eight high schools. At the time of the study, there were six high schools with 40% or more African American Grade 11 students. None of these schools was Title I eligible. Three of the six schools had made the Adequate Yearly Progress (AYP) under the No Child Left Behind (NCLB) Act and had a graduation rate of about 81%. One of the six is the newest high school that just opened in 2007 and thus had not gone through a yearly evaluation yet. For this reason, this school was not considered in the study. From the three high schools that had made AYP, two of them had the higher percentage of African American Grade 11 students at 47% and 54%, respectively. However, only the school with the 54% African American population consented to participate in the study. Therefore, the third school with a 45% population of African American students was chosen to replace the second one. These two high schools (A and B) are located in different cities about 20 miles apart with an average household income of $80,832 and $72,528, respectively according to the Georgia Power 2007 report. Both schools offered the full range of higher mathematics courses in high school: Advanced Placement (AP) Statistics, AP Calculus, Discrete Mathematics, Pre-calculus, and Advanced Algebra and Trigonometry. These two schools were the selected sites for this study.

Data Gathering Methods

The focus of this study was African American high school juniors from the two selected schools. “African American,” as a categorical descriptor, includes many different segments of the American population referred to as “blacks” or Americans of sub-Saharan African ancestry (Encyclopedia of Public Health, 2002). For the purpose of this study, only black or African American students born in the United States were considered because there is existing research that suggests that the educational experiences of involuntary minorities (e.g., U.S.-born Blacks) and voluntary minorities (e.g., black immigrants) are quite different (Ogbu, 1992). In the junior year for most high school students, the concerns are about taking the college entrance exams (SAT, ACT), AP exams, and deciding which path they will take upon graduating from high school. Much of the preparation and decision making takes place and ends in Grade 11, especially for those students who plan to attend college and apply for early decision. Some of the juniors were taking their last minimal required mathematics course for graduation, while others will face the last required mathematics course in their senior year as shown in Table 1.

Table 1

2007-2008 School District Graduation Requirements for Secondary Mathematics

Graduation Requirements	College Prep	College Prep with Distinction	Career/Tech Prep	Career/Tech Prep with Distinction	Dual Diploma (College and Career/Tech Prep)	Dual Diploma (College and Career/Tech Prep with Distinction)
Mathematics	4 Units	4 Units	3 Units	3 Units	4 Units	4 Units
	(Must include Algebra I, Geometry, Algebra II, and at least one course higher than Algebra II)	(Must include Algebra I, Geometry, Algebra II, and at least one course higher than Algebra II)	(Must include Algebra I or Algebra I Part 1 and Algebra I Part 2)	(Must include one unit of Algebra I or Algebra I Part 1 and Algebra I Part 2)	(Must include Algebra I, Geometry, Algebra II, and at least one course higher than Algebra II)	(Must include Algebra I, Geometry, Algebra II, and at least one course higher than Algebra II)
	*This requirement may also be met with Algebra I Part 1, Algebra 1 Part 2, Geometry, and Algebra II.				*This requirement may also be met with Algebra I Part 1, Algebra I Part 2, Geometry, and Algebra II.	

*NOTE: Algebra I Part 1 and Algebra I Part 2 can only be taken with written permission from the Special Education Department. Algebra I Part 1, Algebra I Part 2, Geometry, and Algebra II may not fulfill admission requirements at certain four-year colleges and universities.

At the very least, it was probable that the juniors would have taken enough mathematics courses to articulate their mathematical experiences as they relate to mathematics anxiety. Although some students develop a dislike for mathematics in elementary school, students most commonly have negative experiences with mathematics between the seventh and tenth grades (Kogelman & Warren, 1978). Studying the eleventh-graders insured me their senior year for follow-up work if necessary.

Through the collaboration of the school district office of the assistant superintendent for leadership and services and the principals of the two selected schools, 534 juniors were invited to participate in the study. Invitations were extended to all juniors, regardless of race, at the request of school administrators. Of the invitees, 379 were African American. Five African American students from School A and 136 African American students from School B agreed to participate in the study. Upon receiving informed consent from the parents and the participants, two scale questionnaires, the Mathematics Anxiety Rating Scale for Adolescents (MARS-A) and the Mathematics Self-Efficacy Scale (MSES) were administered during school hours at the convenience of the students and the administrators. A short survey inventory also accompanied the questionnaires to gather demographic characteristics about each student (see Appendix A). I was able to use only 67of the participants' responses due to incomplete and bogus responses (e.g., MSES questions were answered with all 9s, which indicated "complete confidence" even for questions about calculus and zoology which the students had not been exposed to yet through the school) on the questionnaires and survey. The questionnaires were scored and sorted by gender and mathematics anxiety rating.

I selected four females and three males between the schools to follow up in an interview on the questionnaires and survey. In total, I interviewed seven participants, one from School A and six from School B. The criteria for the selection included: (a) high mathematics anxiety, indicated by score over 200, (b) high mathematics achievement, and (c) all high schooling in the Raven County School District. Criterion (c) was important so that the results of the participants' high school mathematics experiences, for the most part, could be attributed to their schooling in Raven County. If criterion (b) could not be fulfilled, then the medium and low tracks were alternative options. With the participants' and parental signed permission, I conducted one 30-minute interview session with each of the seven selected participants. Each interview was audio taped and transcribed. At the request of some parents, most of interviews took place at the homes of the students in the presence of their families. The only interview with a student from School A was conducted at the school at the convenience of the participant. It took approximately two weeks to complete all interviews due to scheduling. Students were reminded that their participation in the study was voluntary and did not influence their grades in any way.

Mathematics Anxiety Instrument

Mathematics anxiety is usually measured by questionnaire. Pioneering work in this area involved the creation of the 98-item Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972). A variety of abbreviated instruments subsequently have been developed, including revision and extensions of the MARS. These scales include the 12-item Fennema-Sherman Mathematics Anxiety Scale (MAS) (Fennema & Sherman, 1979), the 24-item Mathematics Anxiety Rating Scale-Revised (MARS-R) (Plake & Parker, 1982), and the 25-item abbreviated Mathematics Anxiety Rating Scale (sMARS) (Alexander & Martray, 1989). Although MARS has been the most widely used instrument, researchers have sought to find a version of the 98-item that was specifically designed for adolescents. None of the aforementioned scales is geared toward mathematics anxiety measurement in adolescent students. Richardson and Suinn (1972) responded to this void by developing the Mathematics Anxiety Rating Scale for Adolescents (MARS-A). The MARS-A is a revised form of the original MARS that involves changes in some words or the substitution of new items appropriate for adolescents. The students indicate on the instrument the level of anxiety or tension associated with given activities on a 5-point scale from "Not at all" to "Very much." The lowest possible total score is 98 (no anxiety), and the highest score possible is 490 (extreme anxiety). A normative test has been conducted on the MARS-A instrument for this age group to help in determining the cut-off scores for low and high anxiety. The scale has been tested for construct validity and reliability based upon findings by Betz (1978) and Dreger and Aiken (1957) that mathematics anxiety is predictive of low course performance in mathematics. Several normative tables by gender and grade level were generated from the study calculating the means, standard deviations, and percentile equivalents to determine cut-off scores. For the senior high school, the mean MARS-A score was 197.6 with a standard deviation of 58.12 (N = 483). With a sample of 1,313 students, the Spearman-Brown Split-half reliability coefficient was found to be .90 and using the Guttman Split-half Method, the reliability coefficient was .89. A coefficient alpha was also computed for an index of internal consistency and found to be .96. The MARS-A was used in this study along with the cut-off score that was provided to rate the participants on mathematics anxiety. In this study, scores over 200 were considered to reflect high mathematics anxiety.

Mathematics Self-Efficacy Instrument

The Mathematics Self-Efficacy Scale (MSES) is a 34-item test designed by Nancy Betz and Gail Hackett in 1993 that is intended to measure beliefs regarding ability to perform various mathematics -related tasks and complete mathematics /mathematics -related courses. The 1993 MSES is a revised version of 1983 MSES. Subjects are asked to indicate their degree of confidence in their ability to perform the mathematical task and complete the courses on a 10-point scale ranging from (0) "Extremely Difficult" to (9) "Not at all Difficult". Betz and Hackett (1983) reported internal consistency reliability values (coefficient alpha) of .96 for the total scale, and .92, .96, and .92 for the Tasks, Problems, and Courses subscales, respectively. According to the researchers, all MSES subscales and the total score were significantly related to mathematics anxiety and usually reveal an inverse or indirect relationship (i.e., *high-low, low-high*) between mathematics anxiety and mathematics self-efficacy. In the interest of ease and simplicity, the 1993 version of MSES was designed primarily for research and counseling uses, leaving out the Problems subscale. This particular version was used in this study. Total subscale scores are calculated by summing the responses to the subscale items. However, according to the developers, an overall confidence score (the sum of the ratings of all the subscale items) is more useful. Subscale ranges are as follows: 0 to 162 (Mathematics Tasks) and 0-144 (Mathematics -related Courses). A total score was obtained by summing the responses to all 34 items. The range is 0 to 306 that is divided by 34 to obtain an average ranging from 0 to 9. Note that "no response" is assumed to reflect "0" regarding the ability to complete the task and the difficulty of a course. One of the objectives in this study was to find the strength and direction of the correlation between scores on the MARS-A and scores on the MSES to determine if the students in my study were consistent with others studied in that there is an inverse relationship between mathematics anxiety and self-efficacy.

Survey Instrument

A six-question information sheet asked for demographic information such as gender, ethnic group, grade-level in school, self-reported number of mathematics courses and grades for both mathematics courses and overall grade point average, type of diploma seal expected and which mathematics courses will be taken in the senior year (see Appendix A). All participants were asked to complete a survey.

For the qualitative portion of the research, reliability is not as applicable as disciplined subjectivity throughout the process. With that said, in order to minimize researcher bias and thus reduce my subjectivity, I used a peer debriefer, member checking (via telephone and email), and discussed the findings with other experts and the participants for accuracy and alternative interpretations. I also maintained a journal and a log of occurrences and processes that were encountered throughout the study with the dates and time. Further, I gathered different kinds of data and cross-validated through:

- Mathematics Anxiety Rating Scale for Adolescents (MARS-A)
- Mathematics Self-Efficacy Scale (MSES)
- Demographic Survey
- Interview Transcriptions
- Researcher Journal and Log

A pilot test of the MARS-A instrument and the survey were conducted with high school seniors in Raven County to determine the amount of time it would take the average student to complete the questionnaire and survey questions. It was found that the questionnaire and survey took approximately 20 minutes to complete. Based on the finding, for the current study, 30 minutes were allowed for the high school juniors to complete the MARS-A questionnaire and survey. As for the administration of the MSES, the developers recommended no more than 15 minutes to complete the test. A total of 50 minutes was allowed for the completion of both scales (MARS-A and MSES) and the survey inventory. The scoring scales for each variable were as follows:

1. MARS-A (98 to 490);
2. MSES (0 to 9);
3. Mathematics Achievement (proxy = highest mathematics class, 0 to 14);
4. Mathematics Success—grade-point-average (0 to 4.7);
5. General Academic Success—grade-point-average (0 to 4.7)

After all approvals were granted, the study began in November and continued through December 2008. The study included administering the questionnaires and survey, scoring the responses, sorting by gender and mathematics anxiety rating, selecting participants for interview based on the aforementioned criteria, loading all quantitative data into SPSS 16, transcribing the audio-taped interviews, and finally analyzing both quantitative and qualitative data.

CHAPTER 4

DATA ANALYSIS

The purpose of the quantitative portion of this study was to determine the mathematics anxiety level of African American students by gender and to look for relationships among mathematics anxiety and mathematics achievement, mathematics self-efficacy, mathematics success, and general academic success with this student population. These analyses were conducted using the scores from the MARS-A and MSES. Additionally, the survey was used for demographic purposes as well as to extract current or highest mathematics course completed, mathematics grades, and general academic success as measured by grade point average. All quantitative analyses were conducted using the SPSS system, Version 16. To investigate whether mathematics anxiety, mathematics self-efficacy, mathematics achievement, mathematics success, and general academic success differed as a function of gender, independent samples *t*-tests were used to compare gender means and standard deviations on the aforementioned variables.

The purpose of the qualitative portion of this study was to investigate how African American students with high mathematical anxiety and high mathematics achievement described their experiences with mathematics. Qualitative data came from interviews with seven of the participants who scored at a high mathematics anxiety level on the MARS-A, yet were successful in mathematics and general academics (see interview protocol in Appendix B).

Quantitative Results

In analyzing the mean scores of male and female students, none of the variances for was significant by gender. The male and female mean scores for mathematics anxiety (240.44 to

214.45), mathematics achievement (10.60 to 10.57), mathematics self-efficacy (5.4 to 5.2), mathematics success (3.2 to 3.1), and general academic success (3.2 to 3.1) were not statistically different. Means and standard deviations are provided in Table 2.

Table 2

Means and Standard Deviations by Gender and Total Group

	Male (*n*=25)		Female (*n*=42)		Total (*N*=67)	
Variables	M	SD	M	SD	M	SD
Mathematics Anxiety	240.44	84.72	214.45	65.94	224.15	73.96
Mathematics Achievement	10.60	2.35	10.57	1.21	10.58	1.71
Mathematics Self-Efficacy	5.44	1.46	5.15	1.63	5.26	1.57
Mathematics Success	3.20	.57	3.10	.60	3.13	.54
General Academic Success	3.22	.52	3.12	.39	3.16	.45

Mathematics Anxiety and Gender

The total group reported moderately high mathematics anxiety with a mean score over 200 on the MARS-A (*M* = 224, *SD* =73.9). Based on the normative tables created by the instrument developers of MARS-A, the mean score of the total group for MARS-A places them in the 60th percentile. Overall, 48% of the females and 72% of males had high mathematics anxiety. The mean of the males' scores places them in the 80th percentile relative to others of the same age and gender who have completed the MARS-A. There was no statistically significant difference in the mean score of male students (*M* = 240.4, *SD* = 84.7) and female students (*M* = 214.4, *SD* = 65.9). These results are contrary to Pajares and Kanzler's (1995) study in which they found that high school females had a higher mean score for mathematics anxiety than males. In fact, shown in Table 3 are several other studies on mathematics anxiety that found the female mean score higher than the male mean score, unlike the current study where the male mean score was higher.

Table 3

Comparison of Means Scores of Mathematics Anxiety by Gender

	Male		Female		Total	
Mathematics Anxiety	M	SD	M	SD	M	SD
MARS-A (Current Study)	240.44	84.72	214.45	65.94	224.15	73.96
sMARS (Ashcraft & Kirk, 2001)	35.6	N/A	37.1	N/A	36.3	N/A
MARS-E (Satake & Amato, 1995)	56.89	20.44	62.92	20.70	59.79	20.72
MARS-E (Suinn et al., 1988)	53.8	12.19	55.70	13.54	54.18	12.09

Note: MARS-A range (98-490); sMARS range (25-125); MARS-E range (26-130).

Correlates of Mathematics Anxiety

In Chapter 1, I hypothesized that mathematics anxiety is part of a cyclical process that could start anywhere on the circle. For instance, if students experience poor mathematics performance, this could lead to the students being tracked subsequently into lower level courses or it could lead to the student avoiding higher level mathematics courses altogether, which means s/he would have less exposure to and lack of experience in higher level mathematics, which could lead to low mathematics self-efficacy, which could extend to poor performance on standardized mathematics or related tests, which could finally end in high mathematics anxiety and the cycle starts all over again (see Figure 1 in Chapter 1). To test this hypothesis, the mathematics anxiety levels of the participants in the study were correlated with the following variables by total group and by gender:

- Mathematics Achievement
- Mathematics Self-Efficacy
- Mathematics Success
- General Academic Success

Pearson's product-moment correlations were used to test for relationships among mathematics anxiety and the variables noted above. Table 4 presents the results of a standard correlation by gender and total group.

Table 4

Correlation and Regression between Mathematics Anxiety and Other Variables

	Mathematics Anxiety					
	Male (*n*=25)		Female (*n*=42)		Total (*N*=67)	
Variables	r	r^2	r	r^2	r	r^2
Mathematics Achievement	-.28*	.08	-.21	.05	-.24*	.06
Mathematics Self-Efficacy	-.44**	.20	-.56**	.32	-.48**	.23
Mathematics Success	-.02	.00	-.52**	.27	-.29*	.08
General Academic Success	-.06	.00	-.30*	.09	-.16	.02

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

The degree of association between two or more variables is reported by the Pearson product-moment correlation coefficient, *r,* which is a decimal number between -1.00 and +1.00. Correlation coefficients that fall close to either end of the continuum indicate strong direct or inverse relationships. These analyses were supplemented by a linear regression analysis that provides a measure of strength of the relationship or the amount of the shared variation in the dependent variable associated with the regression of the independent variables and is indicated by a coefficient of determination, represented by the symbol r^2. This ratio is given as a percentage or decimal number ranging from 0 to +1.00.

Consistent with previous research on mathematics anxiety (Betz, 1978; Hackett & Betz, 1989; Hembree, 1990; Ma, 1999; Meece & Wigfield, 1990; Tobias &Weissbrod, 1980), each of the hypothesized correlates of mathematics anxiety depicted in Table 4 significantly correlated inversely to mathematics anxiety with the exception of general academic success for the total group. The degree to which the variances are shared by mathematics anxiety and the other variables is expressed by r^2 values in Table 4.

Mathematics Achievement and Mathematics Anxiety

The correlation between student mathematics achievement and mathematics anxiety (r = -.24; N = 67) for total group was significant, $p < .05$. For males the correlation between mathematics achievement and mathematics anxiety (r = -.28; n = 25) also was significant, $p < .05$. However, for females the correlation for mathematics achievement (r = -.21; n = 42) was not significant. The variance shared by mathematics anxiety and mathematics achievement was 6% for the total group, $r^2 = .06$. For the males, mathematics anxiety and mathematics achievement shared 8% of the variance, $r^2 = .08$, while for females mathematics anxiety and mathematics achievement shared only 5% of the variance, $r^2 = .05$.

Mathematics Self-Efficacy and Mathematics Anxiety

The correlation between mathematics self-efficacy and mathematics anxiety (r = -.48; N= 67) for the total group was significant, p < .001. For males the correlation between mathematics self-efficacy and mathematics anxiety (r = -.44; n = 25) was also significant, p <.05. Likewise, for females the correlation for mathematics self-efficacy and mathematics anxiety (r = -.56; n = 42) was significant, p < .001. Mathematics anxiety and mathematics self-efficacy shared 23% of the variance, r^2 = .23 for the total group. For the males, mathematics anxiety and mathematics self efficacy shared 20% of the variance, r^2 = .20, while for female students, mathematics anxiety and mathematics self-efficacy shared 32% of the variance, r^2 = .32.

Mathematics Success and Mathematics Anxiety

The correlation between mathematics success and mathematics anxiety (r = -.29; N = 67) for the total group was significant, p < .05. For males the correlation between mathematics success and mathematics anxiety (r = -.02; n = 25) was not significant. However, for females the correlation for mathematics success and mathematics anxiety (r = -.52; n = 42) was significant, p < .001. Mathematics anxiety and mathematics success shared 8% of the variance, r^2 = .08 for the total group. For the males, no variance was shared between mathematics anxiety and mathematics success. However, for females, mathematics anxiety and mathematics success shared 27% of the variance, r^2 = .27.

General Academic Success and Mathematics Anxiety

The correlation between general academic success and mathematics anxiety (r = -.16; N = 67) for total group was not significant. Likewise for males the correlation between general academic success and mathematics anxiety (r = -.06; n = 25) was not significant. However, for females the correlation for general academic success and mathematics anxiety (r = -.30; n = 42) was significant, $p < .05$. Mathematics anxiety and general academic success have only 2% shared variance, ($r^2 = .02$) for the total group. For the males, no variance was shared by mathematics anxiety and general academic success. However, for females, mathematics anxiety and general academic success have 9% shared variance, $r^2 = .09$.

In summary, mathematics achievement, mathematics self-efficacy, and mathematics success were correlated inversely with mathematics anxiety. However, the relationship between general academic success and mathematics anxiety was not statistically significant for the total group. For the male students in this study, mathematics achievement and mathematics self-efficacy were correlated inversely with mathematics anxiety. For the female students, mathematics self-efficacy, mathematics success, and general academic success were correlated inversely with mathematics anxiety. Mathematics self-efficacy had the strongest relationship with mathematics anxiety for the females. Overall, the strongest relationship with mathematics anxiety was mathematics self-efficacy.

Qualitative Results

The interview transcripts from the sample population and a survey that was given to all the participants were used to gain further insight into the statistical data collected. Seven participants from Raven County School District, 3 males and 4 females, were selected for interviews. Each participant met three criteria (see Table 5): (a) high mathematics anxiety as determined by a score of 200 or higher on the MARS-A; (b) high mathematics achievement determined by the highest mathematics course taken; and (c) all high schooling was in Raven County Schools.

Table 5

Scores and Responses of Participants in Interview

Scoring Scales	F05	F20	F38	F40	M14	M15	M24
MARS-A	281	349	222	225	247	361	381
Highest Level in Mathematics	Alg. II	Alg. III	Alg. III	Alg. III	Alg. III	H Al II	H Al III
MSES	2.7	4.38	6.41	6.76	5.29	5.32	6.41
Mathematics GPA	3.0	3.0	3.25	4.0	3.6	3.17	4.33
General Academic GPA	3.0	3.5	3.2	3.2	3.6	3.5	3.8
Grade 9 Mathematics	Alg. I	H. G.	H. G.	H. G.	Geom.	Alg. I	Alg.I
Stepped-down in Mathematics	No	H. G.	H Alg. II	H. Alg. II	No	No	Repeat
PSAT or SAT Scores	N/A	400	560	58%	N/A	57%	56%
Top Prospective College Choice	Savan.	Duke	N/A	Emory	J. Hopk.	Miami	MoreH
Perspective College Major	N/A	P-Med	N/A	BioMed	P-Med	BAdm.	Mgmt
Mathematics for Senior Year	Alg. III	Adv. A/Trig	Adv. A/Trig	Adv. A/Trig	Adv. A/Trig	Adv. A/Trig	Alg. III

Note: The PSAT scores compare to the SAT scores by placing a zero behind the percentage number. The highest SAT score that can be obtained per section is 800.

Each participant was interviewed individually in a 30-minute audio-taped session. Pseudonyms were used in lieu of names for confidentiality. Note that (F) and (M) prefixes followed by a number were assigned to represent female and male respondents respectively.

There were a total of eight questions asked in the interview. Some of the related questions were paired for a more in-depth discussion. Several common themes were evident across participants: (a) enjoyment in mathematics, (b) origin of high mathematics anxiety, (c) motivation and family support, and (d) college preparation.

Most of the participants claimed they enjoyed mathematics up through the 8th grade. Many of them attributed this enjoyment to having teachers who were humorous and hands-on. For instance, over 50% of the respondents took Algebra I in eighth grade and did extremely well with the exception of M24 who repeated Algebra I in the ninth grade to gain a stronger foundation. This means that these students started high school mathematics in Geometry or Honors Geometry. However, nearly 50% of the respondents confessed that it was Geometry or Honors Geometry that gave them high mathematics anxiety and decreased their self-efficacy in mathematics due to bad teachers, confusion, and low grades. Respondent F20 claimed, "In Honors Geometry I was very stressed-out and failed every test. I had to step down to regular Geometry to maintain my GPA. As for my teacher, if it was not done her way, it was incorrect." Similarly, respondent F05 explained, "I have always loved mathematics until I got to Geometry. I found it to be quite different from Algebra I and II." Other respondents claimed it was Algebra II or Honors Algebra II that caused them to stress in mathematics for some of the same reasons such as the teachers were not hands-on and they did not understand the teachers' style of teaching. Respondent F38 claimed, "Honors Algebra II was not a good experience due to the teacher's style of instruction. Most of the students were failing." From the surveys it appears as though all of the interviewed participants had rebounded by either stepping down from or avoiding the more stressful honors mathematics classes or by seeking some form of tutoring to get through the stressful times.

During stressful moments and beyond, all of the respondents claimed their mother was the number one motivator for them doing well in mathematics and overall. Most of the mothers had either studied or were working in the field of nursing, accounting, or business management. In the interview respondent M24 replied, "My mother is always here for me. She is the business manager for me and my twin brother's company." Another respondent, F40, replied that "My mom motivates me. She is an accountant and is very good in mathematics, but my dad and grandparents also support me."

All of the respondents were college bound with about 85% of them exploring the fields of medicine or business at some of the top schools such as Johns Hopkins, Duke, and Morehouse. All had taken the PSAT and a few had also taken the SAT and Duke ACT with scores ranging from 50 to 60 on the PSAT mathematics section and 400 to 570 on the SAT or Duke ACT. Although most of the students' standardized SAT scores in mathematics were higher than the school district's average of 480 and the state's average of 499, these scores alone may still not be high enough to compete for entry into the colleges and universities of their interest (GaDOE, 2007). Yet more importantly, whether it is due to stepping down to a lower level mathematics class or repeating Algebra I in the ninth grade to gain a stronger foundation, none of the respondents will be eligible to take AP Calculus, AP Statistics, or Discrete Mathematics in their senior year. The bottom line is that only students who maintain honors level mathematics from 9th grade on will be eligible to take AP Calculus or any of the other higher level mathematics courses in their senior year according to the school district tracking map in mathematics. In addition, the students who have maintained honors enrollment up through the tenth grade or who have reached Advanced Algebra Trigonometry by grade 11 can take any of the higher level mathematics courses in their senior year except for AP Calculus (see Figure 2 in Chapter 2). This is unfortunate as the 2007 SAT data reporting found a strong positive correlation between mathematics achievement and students' SAT scores. The implication is that if these students are not able to move into the higher mathematics courses in their senior year, then they may be looking at their highest mathematics SAT scores already.

Through the interview process I gained some insights that helped me interpret the quantitative data. For instance, from the discussion of the surveys during the interviews, it was clear that all of the students were academically sound overall despite stepping down from advanced and honors mathematics classes. In fact, I learned that those students who opted to step down to regular mathematics requested to do so instead of being recommended to do so. I also learned that the students had done exceptionally well in the mathematics that they decided to continue with, despite the few moments of mathematics anxiety. This might explain why there was no significant correlation between mathematics anxiety and mathematics success or with general academic success among the male students. Mathematics self-efficacy had the greatest inverse correlation with mathematics anxiety among the total group. Just from the responses to the interview questions, it is evident that these students' confidence in their mathematical ability was somewhat shaken from their mathematics anxious experience. For example, F20 responded, "Just my mom is my motivator. She is very smart in 'mathematics' and made all A's. She is an accountant right now and likes numbers. I am not motivated in 'mathematics' anymore. I am just doing what is required to graduate." This student's horrible experience in Honors Geometry led to avoidance of higher honors level mathematics and to high mathematics anxiety as suggested by Preis and Biggs (2001).

According to the surveys for all participants in this study, about 67% of the participants were taking grade level mathematics (Algebra II or Honors Algebra II), 27% were taking above grade level mathematics courses (Algebra III, Advanced Algebra Trigonometry, and Honors Advanced Algebra/Trigonometry), and 6% were taking below grade level mathematics courses (Geometry, Honors Geometry, and Mathematics Money Management). Only four males and two females will be eligible to take AP Calculus or any of the other higher mathematics offered at these schools. Additionally, only one male and one female will be eligible to take Discrete Mathematics or AP Statistics. All of these students who are eligible to take the higher mathematics in their senior year had either low mathematics anxiety scores or did not receive all of their schooling in the Raven County School District and therefore, did not meet the criteria for an interview. A major difference in these students who are eligible to move into higher mathematics and those who were interviewed is that the eligible students had higher mathematics self-efficacy scores. The majority of the remaining students in this study were mostly taking mathematics courses that were appropriate for their grade level (e.g., Algebra II) or lower.

The findings in the qualitative portion of this study agree with Bandura's theory about how past failures in mathematics, as was expressed by respondents F20 and F38, usually dictate students' perceptions of their ability in mathematics that could ultimately affect their mathematics career path. Perhaps the students who were interviewed will fully rebound from their past inadequacy in mathematics and be willing to pursue their college dreams of majoring in mathematics related fields without experiencing high mathematics anxiety.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

I hypothesized that mathematics anxiety is part of a cyclical process that could start anywhere in the cycle. For instance, if a student experiences poor mathematics performance, this could lead to the student being tracked subsequently into lower level courses or it could lead to the student avoiding higher level mathematics courses altogether, which means s/he would have less exposure to and lack of experience in higher level mathematics, which could lead to low mathematics self-efficacy, which could lead to poor performance on standardized mathematics or related tests, which could finally end in high mathematics anxiety and the cycle starts all over again. The aim of this study therefore, was to test by gender and total sample whether relationships exist between mathematics anxiety and mathematics achievement, mathematics self-efficacy, mathematics success, and general academic success among a group of African American high school juniors. Further, a qualitative portion of the study was aimed at exploring the experiences of participants with high mathematics anxiety who were successful in mathematics. Many studies have focused on disadvantaged minority students including African Americans and their mathematics achievement, mathematics success, mathematics self-efficacy, and general academic success (Betz, 1978; Hackett & Betz, 1989; Lee, 2002; Ma, 1999; Martin, 2000; Tate, 1997). However, very limited research has been conducted with a focus on mathematics anxiety among this group. Tobias (1978) found that traditionally, mathematics anxiety was considered the preserve of females and disadvantaged minorities. The major difference between this study and earlier studies was that this study focused on middle to upper middle class African American high school juniors who were not disadvantaged by poverty. This focus allowed me to exclude factors such as lack of school resources and other poor conditions as contributing to mathematics anxiety among the students. The current study was designed to fill the gap and to add to the body of knowledge concerning mathematics anxiety among African American high school students. I developed a working definition of mathematics anxiety that was used to guide the study and share with the students who were interviewed:

> Mathematics anxiety is both a cognitive dread of mathematics and a learned emotional feeling of intense frustration or helplessness about one's ability to do mathematics.

With the exception of the mathematics anxiety variable, gender differences found in the other variables were minimal and consistent with those found in SAT data reporting by race and gender (College Board, 2007). The mean score for mathematics anxiety for the male students in this study was somewhat higher than the female mean score, although not statistically significant. This finding is a departure from the findings in the literature as similar studies have traditionally found females to have a higher mean score than males. The total sample group had high mathematics anxiety and low mathematics self-efficacy, which supported my claim that the participants, while not likely to be hindered by poverty or lack of school resources, could be grappling with mathematics anxiety.

All of the independent variables correlated significantly and inversely with mathematics anxiety in the total group except general academic success. Many of the students, especially males, had high mathematics anxiety but did well in their general academics. This is not surprising to me as I have experienced students who stressed over mathematics but enjoyed other subjects and did very well in them. For males, mathematics success and general academic success did not account for the variance in mathematics anxiety. No significant correlations exist in these areas. As for the females, mathematics achievement was not significantly correlated with mathematics anxiety. Thus, their mathematics level was not a predictor or result of mathematics anxiety.

Most of the participants who were interviewed took Algebra I in the eighth grade and had a positive experience, which left them with high mathematics self-efficacy entering ninth grade. However, over 50% of the respondents said that it was Geometry or Honors Geometry that decreased their mathematics self-efficacy due to low grades, bad teachers, and confusion. All of the students who were interviewed had experienced high mathematics anxiety at some point that caused them to drop down from honors level to regular level courses or to avoid pursuing higher honors mathematics classes all together. None of these students will be able to take AP Calculus or AP Statistics during their senior year based on the school district mathematics tracking schedule.

All seven of the respondents replied that their mother was either their sole motivator or the key motivator in their mathematics success. Most of the mothers were professionals in the fields of nursing, accounting, and business. King (1995) found a positive relationship between the mother's level of education and African American students' mathematics self-efficacy. In this study, however, the results were quite different in that the mothers were all professionals, yet their children's mathematics self-efficacy scores were somewhat low indicated by 6.4 or lower for males and 5.8 or lower for females (see Table 5 in Chapter 4).

Mathematics self-efficacy was the most consistent predictor of mathematics anxiety in explaining mathematics anxiety. Based on the results of the quantitative and qualitative data collected, the model of the hypothesis in Figure 1 was relatively accurate in that there was evidence of a circular cycle where poor performance led to lack of mathematics confidence, mathematics avoidance, limited mathematics exposure and practice in more challenging mathematics classes, and finally to mathematics anxiety, which could continue to promote poor performance.

Conclusions

The African American high school juniors in this study who had great family support, professional parents, lived in middle to upper middle class communities, and attended well resourced schools had high mathematics anxiety and low mathematics self-efficacy. Controlling for poverty in this study did not erase high mathematics anxiety and low mathematics self-efficacy among this group. This finding parallels Steele's (1997) finding that middle and upper socioeconomic statuses were no precursor for higher achievement among minority students.

Secondly, the high school mathematics tracking map for the school district in this study may be a key source of mathematics anxiety for some of the students. I discerned from the interviews that the students who had entered 9th grade Geometry or Honors Geometry felt a sense of pride because they were in an advanced track. However, many of these students encountered challenges in geometry and chose to step down to a lower level mathematics track, causing some of the students to experience other stresses (e.g., peer pressure, status pressure) aside from mathematics anxiety. One of the participants, F40, responded that, "It stressed me to know that I was behind my peers who went on to take Honors Advanced Algebra/Trigonometry, while I had stepped down to Algebra III." There is no opportunity for those students who step down from honors level mathematics to reach AP Calculus in their senior year. In other words, stepping down from honors level mathematics at any point in high school disqualifies the student from taking AP Calculus in the senior year. Although AP Calculus is not the end all for mathematics, it is a prerequisite for being accepted to a mathematics related program at many prestigious universities and colleges (College Board, 2007). For this reason, I am concerned that only six students from this study were eligible to take AP Calculus in their senior year and then if and only if they complete Honors Advanced Algebra/Trigonometry in the 11th grade with an 80% or better.

Finally, the participants in this study present a profile that departs from the findings of earlier research in that the females did not show a higher level of mathematics anxiety than the males, and the total group's mathematics anxiety mean score was high relative to the national norms found with similar instruments to the MARS-A (see Table 3 in Chapter 4). Because this study involved only African American students, it is not possible to make claims about the interaction of race and mathematics anxiety. However, these findings suggest that further study of the connection between mathematics anxiety and race should be undertaken.

Implications of the Research

Given the historically low performance of African American students in mathematics on standardized tests (e.g., College Board and NAEP) over the years and the current awareness of the important role that mathematics anxiety plays in the performance of students during their adolescent years, a careful description of African American students' experiences with high mathematics anxiety could be valuable for in-service teacher professional development, pre-service teacher education, classroom practice, counseling/advising, parental involvement, and curriculum design. For example, teachers may stereotype female students as more anxious based on the existing literature, but this study suggests that African American male students are at least as anxious as their female counterparts. Thus, teachers may need to attend more carefully to their African American male students and provide them with additional support. In addition, geometry was a significant source of anxiety for the students interviewed in this study. Previous research (Fuys, Geddes, & Tischler, 1988; Usiskin, 1982) has shown that geometry is a difficult subject for many students. Now that a link to mathematics anxiety has been detected, school systems might want to revise the sequence of their mathematics classes, particularly for high achieving students who are tracked to encounter geometry in ninth grade.

Moreover, awareness of the experience of high mathematics anxiety among African American adolescents could be useful in getting high school mathematics teachers who teach African American students to put student mathematics anxiety at the front of their minds and perhaps use these findings from this study. For instance, if teachers knew that mathematics anxiety levels were generally higher among African American students than among the general population, those who teach classes populated predominately by African American students might want to implement some of the anxiety reduction strategies that appear in the literature (e.g., Byrd, 1982; Hembree, 1990; Martinez & Martinez, 1996; McKee, 2002; Tobias, 1994). Finally, the findings of this study suggest that authors of studies on mathematics anxiety should be careful to describe their sample in terms of race, gender, and socioeconomic status so as to provide a more detailed picture of the manifestation of mathematics anxiety in high school students.

Recommendations for Future Research

Future research might investigate the effects of the order in which high school students are required to take mathematics. In other words, what difference would it make if students took mathematics in this order: Algebra I, Algebra II, Geometry, etc., as opposed to the traditional order: Algebra I, Geometry, Algebra II, etc.? The state of Georgia has recently implemented an integrated mathematics curriculum in the schools that places significantly more emphasis on geometry in middle school and spreads geometry instruction in high school across three courses. A replication of this study with students who have experienced the new Georgia curriculum could help to identify if geometry is the primary culprit of high levels of mathematics anxiety in high achieving students. Another future research possibility would be to replicate this current study across racial and socioeconomic groups for a comparative analysis or for a different subgroup such as Latinos. Latino students tend to have some of the same challenges in mathematics as African American students (College Board, 2007; NAEP, 1999). Also, future research might replicate this study for a different age group (e.g., middle grades, elementary grades). Finally, this research can be extended to other settings such as rural and urban school districts to paint a more detailed picture of the occurrence of mathematics anxiety among students.

Research Limitations

One of the limitations of this study is the reliance on students' self-reported information. Because mathematics anxiety is a debilitating condition as mentioned earlier in the paper, it may be "too sensitive" for some participants to converse about comfortably. Additionally, this research study was limited to African American high school juniors in a suburban school district. My aim was not to study a case primarily to understand other cases. In this study, I sought only to understand, describe, and interpret how mathematics anxiety may relate to other key variables for a group of participants in a methodical manner.

Closing Statement

This research was appropriate for me because of what I brought from my own experiences. I am an African American doctoral candidate in mathematics education at the University of Georgia. I am also a Georgia-certified mathematics teacher and have taught mathematics for three years in the school district in which the research study was conducted. I currently serve on the faculty for LaGrange College, supervising and evaluating teacher candidates in their field work. Because of this research study, I am now more keenly aware of the teacher candidates' presentations and styles of teaching mathematics and the effect that these variables may have on their students' self-efficacy, which this study has demonstrated to be a major component of mathematics anxiety.

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APPENDICES

APPENDIX A

Survey Inventory

Code: ______________________________ Grade: ___________________________

Race: _______________________________ Gender: __________________________

Home #: _____________________________ Cell #: ___________________________

Email Address: ________________________ English Teacher: ___________________

1. Did you attend one of the Henry County High Schools for both 9th and 10th grade?

   Yes ____ No ____

2. List the mathematics courses you have taken in high school so far and the letter grade that you earned in each course?

Courses	Grade Received
______________________	__________
______________________	__________
______________________	__________
______________________	__________

3. What mathematics course are you currently taking? ______________________

4. Do you plan to take a mathematics course in your senior year? If so what mathematics course will you take?

   Yes ______ Course ____________________

   No ______

5. What is your grade point average (GPA)? ______________

6. What type of diploma seal will you receive at graduation? ______________

APPENDIX B

Interview Questions

1. Tell me about your mathematics experiences in school and out of school.
2. Do you remember enjoying mathematics in school; if so, in which mathematics subject(s)? What do you remember about the teacher who taught the subject(s)? What grade did you receive in the course(s)?
3. Does mathematics stress you? Tell me about that.
4. What or who motivates you in doing well in mathematics?
5. What support group has influenced your mathematics success (e.g., teacher, family member, peer group, church, etc.)?
6. Do you receive tutoring or other type of assistance in the mathematics course(s) that stress you?
7. How did you do on the PSAT for the Mathematics portion? Are you scheduled to take the SAT anytime soon?
8. Do you plan to attend college right after high school? Have you decided what you would like to major in?

APPENDIX C

Mathematics Class Ranked

1. Concepts of Problem Solving
2. Concepts of Problem Solving and Statistics
3. Mathematics Money Management
4. Algebra I, Part 1
5. Algebra I, Part 2
6. Algebra I
7. Advanced Algebra I
8. Geometry
9. Honors Geometry
10. Algebra II
11. Honors Algebra II
12. Algebra III
13. Advanced Algebra Trigonometry
14. Honors Advanced Algebra Trigonometry