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ELEMENTARY TEACHERS' PERCEIVED MATHEMATICS ANXIETY AND
TEACHING EFFICACY IN RELATIONSHIP TO STUDENTS' MATHEMATICS
ACHIEVEMENT

by

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A dissertation submitted in partial fulfillment of the requirements
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Major Professor: Rosemarye Taylor

ABSTRACT

The focus of this research was to determine to what extent, if any, there were relationships among elementary teacher anxiety about learning mathematics, their anxiety about the mathematics they teach, their mathematics teaching efficacy beliefs, and their students' mathematics achievement. The researcher also investigated potential intervening variables such as gender, grade level taught, level of college degree, and years of teaching experience, that may influence these relationships. Teachers ($N = 119$) from 11 elementary schools in a west central Florida school district participated in this study and completed the Mathematics Anxiety and Teaching Efficacy Survey. Survey data on mathematics anxiety and teaching efficacy were analyzed and correlated with mathematics achievement data, as measured by the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest.

Through a review of the research results and related literature, the researcher concluded that there was not a statistically significant relationship between teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and student achievement. However, mathematics teaching efficacy was significantly correlated in a positive direction with student achievement. Review of the data also revealed that there was a statistically significant positive correlation between teachers' perceived mathematics anxiety and anxiety about teaching mathematics. Additionally, there was a significant negative correlation between anxiety about teaching mathematics and mathematics teaching efficacy.

This work is dedicated to my parents, Henry and Frances Sasser, for their love, encouragement, and support throughout this endeavor.

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THE PROBLEM AND ITS CLARIFYING COMPONENTS

Introduction

According to the National Center for Research on Teacher Education ([NCRTE], 1991), "mathematics is an area in which many people in our society do not feel comfortable" (p. 23). Mathematics is a subject that is capable of producing a variety of emotional reactions, ranging from contentment to repulsion. Elementary teachers are often anxious when questioned about mathematics, even when it is in the context of their teaching practices. Elementary teachers exhibit mathematics anxiety because they do not consider themselves strong in the area of mathematics (NCRTE). Mathematics anxiety is a discomfort connected to the learning or teaching of mathematics. According to social cognitive theory, an individual's beliefs about his or her capabilities and competence to affect the performance of all students, known as teaching efficacy, will affect how much stress and anxiety one experiences when facing daunting situations (Bandura, 1997). A low sense of teaching efficacy to manage academic demands created by increased accountability measures may result in vulnerability to heightened anxiety.

Because of the No Child Left Behind (NCLB) Act of 2001 and high stakes accountability, educators and administrators have examined student achievement and student success in the area of mathematics (NCLB, 2002). NCLB has required states to use assessments to measure school accountability. Accountability, coupled with a focus on assessment and student achievement, has placed greater emphasis on a teacher's ability to teach mathematics. The emphasis on accountability could intensify elementary

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teachers' mathematics anxiety and decrease their teaching efficacy. It was these issues of anxiety and efficacy as they related to mathematics which were the topics of this study.

According to Ingersoll and Perda (2009), the supply of mathematics and science teachers has been lower than the supply of teachers in any other subject area. Additionally, teacher quality has been the topic of recent reports from the National Mathematics Advisory Panel (2008) and the National Council on Teacher Quality (2007). It was noted in both reports that the quality of mathematics teachers can significantly impact student achievement. It was, therefore, recommended that teacher preparation and professional development programs be strengthened in order to increase mathematical and pedagogical content knowledge. Pedagogical content knowledge refers to the representation and understanding of how particular ideas and specific subject topics are structured and represented in order to meet the diverse interests and needs of learners (Shulman, 1987). Although the shortage in quality mathematics teachers has occurred at all levels, the National Council on Teacher Quality reported that effective elementary teachers were essential to producing high achievement in the area of mathematics. Elementary teachers must have a deep understanding of the mathematics they teach coupled with a strong level of teaching efficacy (National Council of Teachers of Mathematics [NCTM], 2000).

In order to improve student achievement in the area of mathematics, school administrators must understand the influence that mathematics anxiety and mathematics teaching efficacy have on students' ability to learn mathematics adequately and appropriately. The present research was initiated to examine the relationships between

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elementary teacher anxiety about mathematics, their anxiety about the mathematics they

teach, their mathematics teaching efficacy beliefs, and their students' mathematics

achievement. This study was focused on student achievement success on the

Mathematics Florida Comprehensive Assessment Test (FCAT) and various factors that

could influence student success in the area of mathematics. Those factors, which have

been introduced in this chapter, formed a conceptual framework for the study and were

the major topics for which literature and related research were reviewed.

<u>Conceptual Framework</u>

Definition of Mathematics Anxiety

Mathematics anxiety has been framed as "an irrational dread of mathematics"

(Fauth & Jacobs, 1980, p. 487). Mathematics anxiety can be described as a negative

view of mathematics that may result in uneasiness when provided with mathematical

tasks (Wood, 1988). Hembree (1990) indicated that individuals with high levels of

mathematics anxiety often reported lower levels of enjoyment, self-confidence, and

motivation when provided with mathematical tasks. Trujillo and Hadfield (1999) framed

the concept of mathematics anxiety as a feeling of discomfort in response to situations

involving tasks that may impact or influence someone's self-esteem.

Mathematics anxiety is more than a mere dislike toward the subject of

mathematics. It can be related to low self-confidence (Bessant, 1995; Dodd, 1999;

Stuart, 2000), test stress, fear of failure, and negative dispositions toward learning of the

subject (Bessant). Mathematics anxiety has been characterized with physical symptoms such as tension, apprehension, panic, and fear when asked to perform mathematical tasks (Ashcraft, 2000; Gresham, 2007; S. Smith, 1997). Symptoms of mathematics anxiety are outward and have led researchers to believe that anxiety related to mathematics is more physiological rather than psychological (Bower, 2001; Perry, 2004).

A sense of loneliness can be developed due to an individual feeling that he or she is the only one facing mathematics anxiety. One of the greatest obstacles facing individuals with mathematics anxiety has been identified as a lack of confidence (Dodd, 1999). Mathematics anxiety may be created "when teachers place too much emphasis on memorizing formulas and applying rules" (Dodd, p. 296). Mathematics anxiety may result from a teacher's failure to realize the connection between academic performance and the students' feelings about themselves and the mathematical concepts being studied.

Mathematics anxiety is an adverse reaction to mathematics based on previously encountered upsetting experiences and is a common occurrence for many students today. Mathematics anxiety has been described as an inability by an intelligent person to cope with quantification of mathematics (Perry, 2004). Bower (2001) noted that mathematics anxiety frustrates many learners and interrupts their ability to perform, thus resulting into lower levels of achievement and increased levels of defeating attitudes and dispositions.

Factors of Mathematics Anxiety

Several factors have been correlated to levels of anxiety in the area of mathematics. Various factors have been found to increase mathematics anxiety such as

an inability to handle frustration, extreme numbers of school absences, poor self-concept, teacher and parent attitudes toward mathematics, as well as an emphasis on learning mathematics through rote drill with minimal understanding (Norwood, 1994). Norwood investigated the relationship between teacher mathematics anxiety and teaching practices. The results indicated a statistically significant relationship between mathematics anxiety and specific teaching practices. There was a slight tendency for mathematics anxious teachers to implement more traditional methods of teaching rather than innovative instructional strategies and techniques. Teachers who have demonstrated high levels of mathematics anxiety typically have taught more to skills than to concepts and have rarely implemented small group and individualized instruction (Norwood, 1994).

Vann (1992) conducted a study examining the relationship between seventh, eighth, and ninth grade students and their parents. The mathematics anxiety level of the mother, as well as the gender and ability level of the student may be used as a predictor to identify the student who may be at risk of developing anxiety related to mathematics. Just as parental anxiety and beliefs related to mathematics may serve as contributing factors in mathematics anxiety, teachers with mathematics anxiety may also pass this fear along to their students (Fiore 1999; Vann). In a case study involving eight adult learners, Zopp (1999) found that incidents outside of a curricular context, such as moving during school years, may have contributed to mathematics anxiety among the subjects.

An additional source for mathematics anxiety has resulted from various myths and long held beliefs (Preis & Biggs, 2001). According to Preis and Biggs, several myths leading to mathematics anxiety include the following beliefs: (a) women are not capable

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of performing well mathematically; (b) some people can naturally understand mathematics, whereas other are not capable of similar activities and tasks; (c) mathematics is hereditary and a child's performance in the subject can be predicted by the mathematics ability level of their parents; (c) mathematics understanding should be a natural ability; and (d) if a problem cannot be solved immediately by an individual, he or she should not pursue a solution. These beliefs and myths often inhibit a person's capability to perform mathematically and heighten levels of anxiety toward the subject.

<p align="center">Mathematics Anxiety and Elementary Teachers</p>

Teachers who are anxious about mathematics may have an increased motivation to deliver mathematics instruction in a way that will not produce anxiety in their students. According to Battista (1986), the mathematical knowledge of elementary teachers was related to their learning of mathematical pedagogy as measured by exams but was not related to their teaching performance. In a study of 38 elementary teachers, Battista indicated that poor attitudes toward mathematics and limited knowledge of the subject matter demonstrated may inhibit their learning and use of effective methods for teaching mathematics (Battista). The data used in this study did not support the claim that mathematics anxiety inhibited the learning of mathematics pedagogy. Teachers identified as having high levels of mathematics anxiety learned how to teach mathematics as well as those with lower levels of anxiety (Battista).

Based on their previous backgrounds and experiences, elementary teachers may, "identify and confront their own personal levels of mathematics anxiety prior to entering

the classroom as teachers" (Trujillo & Hadfield, 1999, p. 2). Trujillo and Hadfield

administered a survey to 50 elementary teachers enrolled in a mathematics methods

course. All participants were given the Revised Math Anxiety Rating Scale (R–MARS),

and several respondents with high levels of mathematics anxiety were interviewed. The

participants with high levels of mathematics anxiety indicated that they had bad

experiences in mathematics classes previously taken, and many of them did not have

support at home. Trujillo and Hadfield suggested that mathematics specialists, those

teachers who excel in the area of mathematics, be used to alleviate passing on

mathematics anxiety, since teachers who suffer from high levels of mathematics anxiety

may not be very effective in the delivery of mathematics content. It has been inferred

that some elementary teachers tend to teach mathematics in a very traditional format,

versus using modern instructional strategies and techniques that include the use of

manipulatives, the incorporation of problem solving, and the differentiation of content to

meet individual student needs (Trujillo & Hadfield, 1999).

<center>Mathematics Anxiety and Content Knowledge</center>

Teacher content knowledge has been considered as an essential component

affecting what and how students learn. "A strong command of meaningful mathematical

content and a positive attitude toward the subject are critical attributes for educators

charged with teaching mathematics to children" (Quinn, 1997, p. 108). Teachers'

knowledge has been described using the following three categories: (a) subject matter

knowledge, (b) pedagogical content knowledge, and (c) curricular knowledge (Shulman,

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1986). A teacher's mathematical knowledge has been referred to as the quantity and organization of mathematical knowledge in the mind of the teacher. Pedagogical content knowledge has been determined to be comprised of the most useful representational forms of the content, the most powerful analogies, examples, illustrations, explanations, and demonstration. It has been viewed as the way of representing the content in a comprehensible manner (Shulman, 1986). Pedagogical content knowledge incorporates "an understanding of what makes the learning of specific topics easy or difficult, the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (Shulman, 1986, p. 9). Curricular knowledge of mathematics includes the knowledge of instructional materials and methods used to teach mathematics, such as knowledge of alternate texts, manipulatives that can be utilized to represent mathematical concepts, and the use of graphing technology or software (Shulman, 1986).

Teachers who have not acquired mathematical competence during their educational training will most likely not have another opportunity to acquire it (L. Ma, 1999). Teacher preparation programs in the United States have focused on instructional strategies based on how to teach mathematics rather than on the content of mathematics alone (NCRTE, 1991). The National Commission on Teaching and America's Future (1997) indicated there was no system in place in the US for teachers to gain access to the necessary knowledge they need in order for their students to be successful. As part of a two-year study, the commission recognized that most schools and teachers were not capable of achieving the goals outlined in the new educational standards. Their capacity

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to achieve these goals was not limited due to their unwillingness, but instead was possibly related to their lack of knowledge in how to achieve them (National Commission on Teaching and America's Future, 1997).

> Explicit knowledge of mathematics was necessary in order to help others learn; that is, although just 'being able to do it' might be sufficient for some occupations, teachers need to explicate mathematical ideas, procedures, and relationships–whether to themselves or to students (NCRTE, 1991, p. 21).

Specific teaching responsibilities such as selecting examples, creating assignments, and responding to questions, have been derived from the teachers' understanding of the mathematics involved. Teachers need an understanding of mathematical concepts that have been aligned with the accepted knowledge of the field. The NCRTE contended that teachers' understanding of subject matter and curricular knowledge shapes all teaching tasks such as correcting papers, responding to questions, using manipulatives, or illustrating a concept or point during class time. "Many would claim that teachers need understandings of mathematics that are more than just correct, that they need to understand underlying meanings and connections" (NCRTE, 1991, p. 21).

Mathematics Anxiety and Student Achievement

Hembree (1990) examined the relationship between mathematics anxiety and achievement through a meta-analysis of 151 research studies conducted on mathematics anxiety. Based on the analysis, Hembree noted that higher levels of mathematics anxiety were consistently related to lower mathematics performance across all grade levels. The results, after investigating the relationship between mathematics anxiety and performance

with regard to effect size, indicated that students with lower mathematics anxiety consistently outperformed students with higher levels of mathematics anxiety. However, no evidence was found to support or suggest that poor performance resulted in mathematics anxiety.

Betz (1978) concluded similar results in examining the relationship between mathematics anxiety and performance in mathematics for students enrolled in three distinct university courses. Mathematics achievement was evaluated using scores on the Mathematics section of the American College Test (ACT). The results of the Pearson product-moment correlations conducted in the study were statistically significant and indicated that there was a general tendency for higher levels of mathematics anxiety to be associated with lower mathematics achievement test scores (Betz).

Teaching Efficacy

The concept of teaching efficacy was based on Bandura's concept of self-efficacy, or an individual's ability to produce desired results and forestall detrimental ones through actions (Bandura, 1997). The phrases teaching efficacy and teacher self-efficacy are represented as interchangeable terms throughout the literature. Self-efficacy beliefs "govern most of human functioning and mediate how individuals think, feel, motivate themselves, and behave" (Swars, 2005, p. 139). Teaching efficacy has influenced various aspects of decision making through goal setting, motivation, persistence, perceived ability, and interest. According to Tschannen-Moran and McMaster (2009), "teacher

self-efficacy is a teacher's perceived capability to impart knowledge and to influence student behavior" (p. 228).

Teaching efficacy has been considered to be a two-dimensional construct based on Bandura's theoretical framework (Bandura, 1986). The first factor, personal teaching efficacy, refers to teachers' beliefs in their skills and abilities to teach effectively. The second factor, teaching outcome expectancy, represents a teachers' beliefs that effective teaching can bring about student learning without considering external factors such as home environment, parental influences, or family background (Swars, 2005). Efficacy beliefs have been primarily shaped and developed as a result of previous performance and experiences (Bandura, 1986). According to Swars (2005), "individuals engage in tasks and activities, interpret the results of their actions, use the interpretations to develop beliefs about their capabilities to engage in subsequent tasks or activities, and act in relationship with the beliefs created" (p. 144).

According to Goddard, Hoy, and Woolfolk-Hoy (2004), "teachers' sense of efficacy is a significant predictor of productive teaching practices" (p. 4). Teachers with strong perceptions of self-capability have employed classroom strategies that are well planned and better organized when compared to those with lower self-efficacy beliefs. According to Gibson and Dembo (1984), teachers' sense of efficacy and student achievement have been positively correlated. "The higher teachers' sense of efficacy, the more likely they are to tenaciously overcome obstacles and persist in the face of failure" (Goddard et al., 2004, p. 4).

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Self-efficacy expectations have been important factors influencing attitudes towards mathematics and mathematics performance. Mathematics anxiety has been viewed as a result of low mathematics self-efficacy according to social learning theory (Hackett & Betz, 1989). According to Hackett and Betz, "mathematics anxiety should be related to mathematics self-efficacy, but mathematics self-efficacy is considered the more important predictor of future mathematics-related performance, and a predictor of mathematics anxiety as well" (p. 262).

<u>Purpose of the Study</u>

The purpose of the study was to determine to what extent there were relationships among elementary teacher anxiety about learning mathematics, their anxiety about the mathematics they teach, their mathematics teaching efficacy beliefs, and their students' mathematics achievement. The researcher also investigated potential intervening variables such as gender, grade level taught, level of college degree, and years of teaching experience, that may influence these relationships.

A dissertation completed by Hadley (2005) identified that there were no significant relationships between either mathematics anxiety, or anxiety about teaching mathematics, and student achievement in mathematics. This finding did not support the notion that mathematics anxiety, as well as anxiety about teaching mathematics, related to student achievement, thus reinforcing the need to investigate the relationship between these factors.

Through identifying teachers' perceived mathematics anxiety using the Mathematics Anxiety and Teaching Efficacy Survey (Appendix A) and analyzing the relationship between the survey scores and student achievement, the researcher sought to determine the extent to which the anxiety of teachers about learning mathematics, their anxiety about teaching mathematics, and mathematics teaching efficacy were related to student achievement. Further analyses were conducted to determine how specific demographics contributed to the levels of reported mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy.

Jackson and Leffingwell (1999) noted that students often experience their first distressing experience with mathematics in third or fourth grade, therefore the researcher decided to focus the study on responses from teachers who taught in the third, fourth, and fifth grade. According to several research studies, student achievement is enhanced when teachers have more than a few years of experience (Darling & Hammond, 2000; Hawkins, Stancavage, & Dossey, 1998; Murnane & Phillips, 1981). Based on research provided by Aritomi and Coopersmith (2009) on the Schools and Staffing Survey conducted by the National Center for Education Statistics, the results of the survey were grouped by the researcher into three similar categories based on years of experience (1-3 years, 4-19 years, and 20 or more years).

Significance of the Study

Based on the results of the study, school administrators will be provided with information regarding the relationship between mathematics anxiety, anxiety about

teaching mathematics, and mathematics teaching efficacy and student achievement. These relationships, if they exist, will help school administrators in making decisions on how to help support teachers in their efforts to improve student mathematics achievement. According to the National Council of Supervisors of Mathematics (2008), "student achievement in mathematics is unlikely to improve significantly beyond current local, regional, state, national, or provincial levels until mathematics education leaders assume and exercise professional responsibility and accountability for their own practice and the practice of the teachers they lead" (p. 1). School administrators must ensure that students are taught by highly qualified and well-informed mathematics teachers. Because teacher quality has a large impact on student understanding of mathematics, school administration should ensure that "mathematics instruction is provided by teachers who possess the mathematical knowledge about the content and curriculum necessary to meet the needs of every student" (National Council of Supervisors of Mathematics, p. 17).

According to a report from the National Mathematics Advisory Panel (2008), mathematics anxiety is related to low mathematics grades and poor scores on standardized tests of mathematics achievement. This report indicated that little is known about the factors related to mathematics anxiety, although they noted that potential risks include low mathematics aptitude, low working memory capacity, and negative teacher and parent attitudes. The National Mathematics Advisory Panel also recommended that research be conducted to assess potential factors associated with mathematics anxiety.

The information provided as a result of this study may therefore assist district and school administrators to make decisions regarding the design of staff development

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opportunities in the area of mathematics for their teachers. The staff development offered should focus on developing deeper mathematical content knowledge and improving pedagogical effectiveness in order to maximize student learning, decrease mathematics anxiety levels of teachers, and increase levels of mathematics teaching efficacy.

School administrators will also be able to use this information about mathematics anxiety to make decisions when making choices about hiring and retaining teachers. Teachers should be knowledgeable of research-informed teaching practices and effective instructional strategies necessary for increasing student understanding of mathematics. The results of this study may provide insight with regard to specific demographic variables that may have an influence on student achievement, as well as on levels of mathematics anxiety, anxiety about teaching mathematics, and teaching efficacy.

Additionally, universities will be able to support students enrolled in undergraduate elementary education programs and may consider the findings when developing and increasing curricular programs or philosophies with regard to the delivery of mathematics and the implementation of instructional practices. Finally, this study was intended to provide additional research for the body of knowledge regarding the potential impact of mathematics anxiety and teaching efficacy of elementary teachers and student achievement success on the mathematics portions of accountability assessments.

Statement of the Problem

Mathematics anxiety and the influence it has on student achievement may impact a student's ability to learn mathematics adequately and appropriately. Elementary

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teachers who possess high levels of mathematics anxiety may inadvertently pass on negative feelings and dispositions to their students (Wood, 1988). Negative consequences of mathematics anxiety developed in elementary school have been important for both students and adults, because mathematics has been prominent in measures of achievement used for class level placement, entrance into special programs, college and graduate school admissions, as well as for careers (Pajares & Graham, 1999).

Research Questions

1. To what extent, if any, is there a relationship among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?

2. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

3. To what extent, if any, is there a mean difference in elementary teachers' perceived anxiety about teaching mathematics based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

4. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender, (b)

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grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

5. To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

Delimitations of the Study

1. The study was delimited to the survey responses of instructional personnel at 11 elementary schools in a west central Florida school district during the 2009-2010 school year.

2. The data were collected only for instructional personnel who taught mathematics at one of the 11 elementary schools in grades 3, 4, or 5 during the 2008-2009 school year and remained in an elementary teaching position in 2009-2010.

Limitations of the Study

1. The study was limited in that self-reported data were analyzed, and teachers may not have accurately reported their feelings when responding to items within the survey.

2. Teachers may have differed in their ability to recall their anxiety about mathematics in a college level course because of the number of years that have passed since they were enrolled in a college level mathematics course and the variance in time among teachers.

3. Self-reported data regarding anxiety may have differed based on changes in grade level teaching assignments in the 2009-2010 school year from the 2008-2009 school year.

4. Self-reported data regarding teaching efficacy may have been influenced by previous knowledge of how well their students performed on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest.

5. There was limited diversity for the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) due to a very small range of values.

6. There was limited variability in ethnicity for the population used in this study.

Assumptions

1. It was assumed that the participants responded accurately and honestly to the questions on the Teacher Mathematics Anxiety and Teaching Efficacy Survey.

2. It was assumed that the Florida Comprehensive Assessment Test (FCAT) adequately measured student performance in mathematics.

<center>Definition of Terms</center>

The following definitions were provided to clarify the terminology used in the study.

Anxiety about Teaching Mathematics--Anxiety about teaching mathematics refers to the "nervousness of teachers about the mathematics they currently teach" (Hadley, 2005, p. 5). For purposes of this study, anxiety about teaching mathematics was measured by the Anxiety about Teaching Mathematics (ATM) scale (Hadley, 2009).

Florida Comprehensive Assessment Test (FCAT) --"The Florida Comprehensive Assessment Test (FCAT) is part of Florida's overall plan to increase student achievement by implementing higher standards. The FCAT, administered to students in Grades 3-11, consists of criterion-referenced tests (CRT) in mathematics, reading, science, and writing, which measure student progress toward meeting the Sunshine State Standards (SSS) benchmarks" (FLDOE, 2009a).

FCAT Achievement Levels--"Achievement levels describe the success a student has achieved on the Florida Sunshine State Standards tested on the FCAT. Achievement levels range from 1 to 5, with Level 1 being the lowest and Level 5 being the highest. To be considered on grade level, students must achieve Level 3 or higher" (FLDOE, 2009b, p. 6).

Mathematics Anxiety--"Mathematics anxiety 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 life and academic situations" (Richardson & Suinn, 1972, p. 551). For purposes of this study, mathematics anxiety was measured by

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the Abbreviated Math Anxiety Scale (AMAS) instrument, (Hopko, Mahadevan, Bare, & Hunt, 2003).

Teaching Efficacy--"Teaching efficacy has been identified as a variable accounting for individual differences in teaching effectiveness" (Gibson & Dembo, 1984, p. 569). Efficacy is characterized by an individual's beliefs about their capabilities to produce designated levels of performance that exercise influence over events impacting their lives (Bandura, 1997). For purposes of this study, teaching efficacy was measured by the Mathematics Teaching Efficacy Belief Instrument (MTEBI) (Enochs, Smith, & Huinker, 2000).

Methodology

FCAT Mathematics data from 2009 were collected for elementary teachers in a west central Florida school district. Quantitative data, compiled from the Mathematics Anxiety and Teaching Efficacy Survey (Appendix A), were analyzed with FCAT Mathematics data. Student achievement data included the class averages for the percentage of students scoring at levels 3-5 on the 2009 FCAT mathematics subtest. The FCAT data were matched to each participating teacher's completed survey using the teacher survey code assigned to each participant. Table 1 displays the research questions, data sources, and statistical procedures used in the study.

Table 1

Research Questions, Data Sources and Statistical Procedures

Research Question	Data Source	Statistical Procedure
1. To what extent, if any, is there a relationship among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?	2009 Mathematics FCAT achievement results Mathematics Anxiety and Teaching Efficacy Survey (Part I, II, III)	Pearson's Product Moment Correlation
2. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?	Mathematics Anxiety and Teaching Efficacy Survey (Part I, Part IV)	Factorial ANOVA
3. To what extent, if any, is there a mean difference in elementary teachers' perceived anxiety about teaching mathematics based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?	Mathematics Anxiety and Teaching Efficacy Survey (Part II, Part IV)	Factorial ANOVA
4. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?	Mathematics Anxiety and Teaching Efficacy Survey (Part III, Part IV)	Factorial ANOVA
5. To what extent, if any, do teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?	2009 Mathematics FCAT achievement results Mathematics Anxiety and Teaching Efficacy Survey (Part I, II, III, IV)	Multiple Regression

A copy of the University of Central Florida Institutional Review Board (IRB) approval form was included with the request to conduct research letter (Appendix B). A request to conduct research was approved by a west central Florida school district.

Research Process

The researcher visited each elementary school and administered the Mathematics Anxiety and Teaching Efficacy Survey (Appendix A) using an electronic format. The data from the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest were accessed from the district office for each of the 128 third, fourth, and fifth-grade teachers in the 11 schools for the 2008-2009 school year. The data included the class averages for the percentage of students scoring at levels 3-5 on the mathematics portion of the FCAT. The achievement test data were matched to each participating teacher's completed survey using the teacher survey code assigned to each participant.

Population

The target population for this study included all 128 third, fourth, and fifth-grade teachers employed at 11 elementary schools (100%) in a west central Florida school district during the 2008-2009 school year.

Instrumentation

An electronic survey was used to collect data regarding mathematics anxiety, anxiety about teaching mathematics, and teaching efficacy. Data from the elementary teachers were collected through the completion of the Mathematics Anxiety and

Teaching Efficacy Survey (Appendix A). This survey was comprised of four separate

sections. The first section included the Abbreviated Math Anxiety Scale ([AMAS],

Hopko et al. (2003). The second section included the Anxiety about Teaching Math

(ATM) scale (Hadley, 2009). The third section was comprised of items from the

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), (Enochs, Smith, &

Huinker, 2000). The fourth section included questions regarding demographic

information.

Cronbach's alpha was computed as evidence of internal consistency reliability on

the Mathematics Anxiety and Teaching Efficacy Survey. In addition, exploratory factor

analysis was conducted as evidence of construct validity for the instrument.

Data Collection Procedures

The researcher requested student achievement data from the district's Research

and Accountability Department. The data requested included the percentages of third,

fourth, and fifth-grade students for each teacher scoring levels 3-5 on the 2009 Florida

Comprehensive Assessment Test (FCAT) mathematics subtest. The researcher requested

a list of teachers who taught mathematics in third, fourth, and fifth grades during the

2008-2009 school year.

Participant contact for data collection took place during a brief presentation at a

district-wide elementary principal's meeting in October 2009. Each of the 11 district

elementary principals received a research information packet that included detailed

information about the research and a copy of the survey instrument. The principals were

asked to select a date during December of 2009 in which the researcher could visit the

school in the afternoon and have participating teachers complete the online survey in a

computer lab setting. The researcher requested that the principals email the researcher

with a letter indicating whether or not they were willing to grant permission for the

teachers to complete the survey along with a date and preferred time for the survey to be

completed in a computer lab setting.

One week prior to visiting the school, the researcher sent an email with an

attached letter to participating teachers in the study (Appendix D). During the initial

school visit, teachers met in a computer lab to complete the survey instrument. The

researcher had a sealed envelope for each teacher with the teacher survey code inside. A

verbal description of the study was provided by the researcher to the group of teachers.

The link for the survey was loaded on every computer by the researcher before the

teachers arrived. Teachers were directed to complete the survey electronically. The

researcher stayed in the room while teachers completed the surveys. Following the initial

school visits, the researcher monitored the status of participation of each elementary

school.

<div align="center">Data Analysis</div>

For this research, descriptive statistical analysis was conducted for each

composite scale that makes up the Mathematics Anxiety and Teaching Efficacy Survey.

An alpha level of .05 was used to determine statistical significance for the five research

questions.

Summary

Chapter 1 of this study provided an overview of the study including a brief introduction to the topics of mathematics anxiety and teaching efficacy as they relate to student achievement. The problem statement and its clarifying components were presented along with the research questions, information about the methodology and design components associated with the study.

Chapter 2 provides the reader with a review of relevant literature on the study topic. The methodology and procedures used for data collection and analysis are outlined in Chapter 3. Chapter 4 contains a description of the results of the data analysis and Chapter 5 provides a summary of the findings of the study, the implications for practice, and recommendations for future research.

CHAPTER 2
REVIEW OF THE LITERATURE

<u>Introduction</u>

Do we hate math, as so many of us say we do, because one elementary-school teacher made us afraid of it? Did we simply start off on the wrong foot and get stuck there? Or have we accepted someone's assumption about our kind of mind and what we thought was the nature of mathematics? Were we too young from a neurological point of view, when we were first exposed to numbers? Or was too much going on during our adolescent years, when we should have been concentrating on algebra? Does the fault lie in the curriculum, in the subject, in ourselves, or in the society at large? (Tobias, 1993, p. 32-33).

For so many people in our society, mathematics has many negative connotations.

Over 30 years ago, it was recognized that elementary teachers are often in the group who

have the most severe instances of mathematics anxiety (Burton, 1979). Unfortunately,

evidence suggests that it is still the case today (Harper & Daane, 1998). According to

Tobias (1993), mathematics anxiety refers to a failure of nerves, not intellect, when asked

to solve complex mathematics problems. "High levels of anxiety can devastate a

student's ability to perform, resulting in poor academic progress and high dropout rates"

(Arem, 2010, p. xi). According to Arem, "Math serves as a 'critical filter' in determining

many educational, vocational, and professional options" (p. xii). Mathematics avoiders

or those who are anxious towards mathematics may find themselves shut out of

rewarding and profitable careers.

A thorough analysis was conducted by examining the theoretical and empirical

research on mathematics anxiety, teaching efficacy, and student achievement success.

Exhaustive searches of multiple educational and psychological research databases,

including electronic and print material, provided the foundation for the conceptual

framework of this research. In reviewing the literature, the researcher sought to explore and examine the constructs of mathematics anxiety and teaching efficacy as it related to students' mathematics achievement.

This chapter was designed to provide the reader with a foundation for understanding mathematics anxiety and teaching efficacy. A clear conceptual understanding of both the construct of mathematics anxiety and teaching efficacy is essential to fostering and improving student achievement in the area of mathematics. This chapter is composed of two distinct sections, one providing support for the next.

The first section of this chapter supplies the reader with knowledge about the concept of mathematics anxiety. Within this section, the reader will find definitions, as well as the causes and effects of mathematics anxiety. The concept of mathematics anxiety is further developed through a discussion of the relationships between mathematics anxiety and avoidance, memory systems, subject avoidance, gender, and transmission. The reader is provided information on the impact mathematics anxiety may have on elementary teachers, as well as the performance and achievement outcomes associated with mathematics anxiety.

The second section provides background information about self-efficacy, teaching efficacy, and the resulting impact it has on student achievement. Within this section, information is presented regarding the relationship between mathematics anxiety and mathematics teaching efficacy.

Mathematics Anxiety

Definition of Mathematics Anxiety

"Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of life and academic situations" (Richardson & Suinn, 1972, p. 551). Tobias (1993) extended the definition to include a fear of mathematics shaped by a negative emotional reaction to the subject rather than an inability to be successful in mathematics. Similarly, Gresham (2007) defined mathematics anxiety as a feeling of tension, panic, or helplessness experienced when a person is asked to perform mathematical operations or while solving mathematics problems. Mathematics anxiety can be described as a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem (Trujillo & Hadfield, 1999; Wood, 1998).

According to Bursal and Paznokas (2006), mathematics anxiety is multidimensional with affective and cognitive roots. The affective component has been related to behavioral or physical reactions, symptoms and feelings that lead to panic, tension, helplessness, fear, shame, distress, inability to cope, sweating, shaking, difficulty breathing, loss of ability to concentrate, which may in turn lead to math avoidance. The affective factor has been negatively correlated with mathematics performance. The cognitive component has been related to concern regarding performance and negative performance expectations. According to Wigfield and Meece (1988), this component has

been positively correlated to the effort that students put into mathematics and the importance they have attached to the subject.

Mathematics anxiety has been identified by several symptoms including negative emotional, mental, and physical reactions to mathematical thought processes and problem solving which may be caused by life experiences with mathematics that were discomforting or unrewarding (Arem, 2010). Based on these symptoms, Gresham (2007) referred to mathematics anxiety as an "I can't syndrome" (p. 182). "Math acts like a fine magnifying lens, bringing into sharper focus a host of other academic deficiencies, like poor study skills, knowledge gaps, or inadequate test preparations or test-taking skills" (Arem, p. 1).

Hadfield and McNeil (1994) indicated that the origins of mathematics anxiety can be divided into three main sources, including environmental, intellectual, and personality. The environmental factors that have been said to serve as sources for mathematics anxiety included insensitive teachers, parental pressure, negative experiences in the classroom, mathematics presented as a rigid set of rules, and lecture style classrooms (Tobias, 1987). Trujillo and Hadfield (1999) suggested that environmental factors may include the lack of perceived usefulness of mathematics in everyday life. Intellectual sources may include student attitude, lack of persistence, lack of confidence or productive dispositions, self-doubt, instruction directed toward mismatched learning styles, and a lack of perceived usefulness of mathematics (Sloan, Daane, & Giesen, 2002). Personality factors influencing mathematics anxiety have included low self-esteem, viewpoints that

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regard mathematics as a male domain, and the reluctance to ask questions based on timidity.

Relative to this study, mathematics anxiety refers to a fear of mathematics shaped by negative emotional reactions, feelings of tension, helplessness and unease which interfere with the solving of mathematical problems and tasks in both academic and real world situations. Mathematics anxiety is conveyed as a lack of applied understanding, as well as a discomfort, which often leads to avoidance of the subject and perpetuates negative dispositions towards mathematics. Mathematics anxiety is connected closely to mathematics instruction and mathematics related activities, therefore it has the potential to interfere with student performance in mathematics and may hinder subsequent learning.

Factors of Mathematics Anxiety

According to Arem (2010), several different reasons have existed for the onset of mathematics anxiety. These reasons include (a) embarrassments, (b) negative life experience associated with learning mathematics, (c) social pressure and expectations, (d) desires to be perfect and high demands for correctness, (e) poor teaching methods, (f) negative self-talk, (g) cultural myths, and (h) gender stereotyping (Arem). Those who have exhibited anxiety due to embarrassment report incidents dating as far back as first grade where they quivered with self-consciousness when called upon to answer a mathematics problem in front of the class (Arem). The fear of public speaking, as well as stage fright, has often been associated with embarrassment over mathematics.

Individuals who may have had mathematics anxiety that included discomfort or fear might be able to identify an event in their lives that was emotionally disturbing and that could have been associated with learning mathematics. Often times, an illness or interruption in education can cause a critical gap in one's schema for mathematics. Harper and Daane (1998) indicated that past influences causing mathematics anxiety for teachers included aspects not directly related to the mathematics classroom.

Mathematics anxiety has also been a result of social pressure and expectations. Individuals may have been frustrated with learning mathematics because they were reprimanded at some point in their lives when they did not seem to comprehend mathematics quickly enough. Relatives, peers, and classmates may have discouraged mathematics achievement by stating that they were "never good in the subject either." According to Arem (2010), social support has been related to the decision to take advanced courses in mathematics and the grades achieved in these classes.

Those who have strived for perfection may struggle with anxiety related to mathematics. Many individuals have feared getting a wrong answer to a mathematics problem, because it may reflect poorly on their academic abilities. They have often tried to avoid situations that may emphasize their weaknesses and their resultant feelings of incompetence or lack of intelligence (Arem, 2010).

Instruction

Poor teaching methods may serve as a contributing factor to an individual's anxiety towards mathematics. Individuals may be able to recall elementary or middle

school teachers who either really did not like mathematics or were not trained well to teach mathematics (Arem, 2010). Some teaching methods that have contributed to anxiety include (a) teachers rushing through material or giving few practice problems to reinforce the concepts presented, (b) using lecture as the only delivery method for instruction when students need hands-on mathematics experiences, and (c) the limitation of whole group instruction instead of incorporating collaborative and cooperative learning groups to help students learn mathematics (Arem, 2010; Harper & Daane, 1998;).

Instructional techniques that have been considered to influence the onset of mathematics anxiety include (a) the emphasis of drill and practice, (b) insistence on only one correct method for solving a problem, (c) fear of making a mistake, (d) use of lecture as the primary lesson delivery method, (e) emphasis on basic skills as opposed to conceptual understanding, (f) memorization of formulas, (g) administration of timed tests, (h) frustration with the amount of time required to solve word problems, and (i) dedication of class time to seat work and whole group instruction (Gresham, 2007; Harper & Daane, 1998). These more traditional methods and approaches have been facilitated primarily by the teacher. In addition to the aforementioned techniques, Cornell (1999), indicated that the following pedagogical practices contribute to heightened mathematics anxiety: (a) the assumption that mathematical processes and procedures are inherently simple, (b) the incorporation of unique mathematics vocabulary without sufficient explanation of terminology, (c) the sequential nature and pace of instructional delivery, and (d) the decision to teach mathematics in isolation without providing

connections to its relevancy in the world. The incorporation of these techniques and methods to deliver instruction may increase the chances of fostering mathematics anxiety among students.

"Your internal mind can play an important role in your math performance and could easily be a negative or destructive influence on you" (Arem, 2010, p. 20). Negative self-talk includes talk that is detrimental and blocks an individual's ability to do mathematics. This negative self-talk can result in complete loss of self-confidence in mathematics which is one of the most important aspects of achieving mathematics success. This talk is not only played by the individual, but may be brought on by someone else when they make statements either deliberately or unintentionally that negatively impact one's ability to learn mathematics. Teachers have been reported to have ridiculed their students and have made comments to them about their inability to learn mathematics (Arem, 2010). According to Clute (1984), "confidence in one's ability to learn mathematics is significantly correlated with mathematics achievement" (p. 56). Therefore, individuals lacking confidence in their ability to perform mathematics were more likely to lack respect for or trust in their instincts or judgments in learning or teaching the subject (Clute).

Jackson and Leffingwell (1999) conducted a study of 157 students in a college level elementary mathematics education course by requesting that the participants describe their worst or most challenging mathematical classroom experience. In addition, the subjects were surveyed to identify areas and factors that would have provided them with a more positive experience. Only 11 (7%) of the respondents had positive

mathematics experiences during their educational progression from kindergarten through college. Participants indicated problems occurring in three clusters of grade levels in which mathematics anxiety was attributed to instructional behavior. These grade bands of anxiety occurred specifically in (a) grades three and four, (b) high school, and (c) freshman year of college. Many difficulties arose at the elementary level in regard to difficulty of material, especially related to fractions, timed tests in competition with peers, and memorization of multiplication tables (Jackson & Leffingwell). Problems arose from gender bias and the perception of insensitive and uncaring instructors. For those participants who identified high school experiences, instructor behavior that influenced mathematics anxiety included angry behavior, especially when students requested assistance of further clarification, unrealistic expectations, embarrassment of individuals in front of their peers, gender bias, insensitive attitudes, and the avoidance of responding to student questions. Additional areas identified at the collegiate level included communication and language barriers, the belittling of students for not having the capacity to recall prerequisite knowledge, the quality of instruction, age discrimination, and the evaluation of instruction (Jackson & Leffingwell).

Student Behaviors

Jackson and Leffingwell (1999) reported several overt and covert behaviors that increased mathematics anxiety among the participants. The overt behaviors were identified as either verbal or non-verbal, but were easily discernible. Several examples of overt behaviors that added to the anxiety of students included verbal comments,

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nonexistent feedback, insufficient explanations, and the avoidance of proximity to students. Covert behaviors that were described in the study included sighing in a demeaning fashion, the avoidance of eye contact, and creating excuses and explanations for denying assistance to students. Instructors, according to Jackson and Leffingwell, needed to be aware of the impact that their behaviors have on students and to understand that mathematics anxiety could persist and continue.

Mathematics Anxiety and Avoidance

Hembree (1990) conducted a meta-analysis of 151 studies on the construct of mathematics anxiety illustrated that mathematics anxiety and the number of high school mathematics courses, as well as the number of college mathematics courses taken, had a negative correlation. Those exhibiting high mathematics anxiety have avoided taking mathematics courses and were, therefore, less practiced and educated in mathematics. As a result, they have often been less qualified to pursue career paths involving mathematics. Hembree suggested that mathematics anxiety can threaten mathematics achievement.

Preis and Biggs (2001) shared a four phase cycle of mathematical avoidance that could result from mathematics anxiety. The four phases included: (a) negative reactions to mathematical situations, (b) avoidance of mathematical situations, (c) poor mathematics preparation, and (d) poor performance in mathematics. As individuals progress through these four phases, more negative experiences are generated and the cycle begins again. This repetitive cycle has often convinced those with high mathematics anxiety that they cannot learn mathematics.

Avoiders use past histories of failures to predict future *failures*. They become so adamant with their 'I can'ts' and their I couldn't' that, just as self-prophesized, they don't. They do not do well in mathematics and they ultimately do not continue in it (Elliott, 1983, p. 783).

According to Ashcraft and Krause (2007), people who have exhibited mathematics anxiety may avoid situations that involve mathematics because the tasks may incite anxiety. Those experiencing mathematics anxiety have often avoided tasks that involve mathematics ranging from taking an exam to balancing and maintaining financial records. "Math anxiety leads to a global avoidance pattern-whenever possible, students avoid taking math classes and avoid situations in which math will be necessary, including career paths" (Ashcraft & Krause, p. 247). The avoidance of mathematics could lead to individuals being less skilled in mathematics based on their limited practice of mathematical tasks.

<center>Mathematics Anxiety and Memory Systems</center>

Arem (2010) has written that mathematics anxiety can negatively influence one's long-term and working memory, thereby impacting mathematics learning, mastery, and problem solving. According to Arem, long-term memory refers to the brain's capacity to store information for long periods of time, whereas working memory allows an individual to hold information in an active state, so that it can be utilized immediately or processed for long-term storage. An individual's long-term memory has provided the capacity to store information such as mathematical facts, principles, formulas, equations, and procedures learned while taking mathematics courses for long periods of time. Students with very good long-term memories have found ways to relate, categorize, and organize

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newly acquired information with material previously stored so that they can retrieve and update the information when needed. Anxiety has been known to impact the ability to access information from long-term memory and compete with mathematical tasks for the available working memory resources (Arem, 2010; Beilock & Carr, 2005).

Anxiety can generate intrusive uncertainties about situations that occupy the part of the working memory that would normally be dedicated to the execution of specific skills while solving problems (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Beilock & Carr, 2005). Mathematics anxiety influences cognitive processing by compromising working memory resources whenever the anxiety is stimulated. Decreased capacity of the working memory has resulted in large increases in reaction time and errors and in lower mathematics performance when compared to those individuals not illustrating mathematics anxiety. Anxiety and intrusive worrying can hinder a large portion of the working memory, preventing it from focusing interest on the task. Based on the results of Ashcraft and Kirk's work, mathematics anxiety "disrupts the on-going, task relevant activities of working memory, slowing down performance and degrading accuracy" (p. 236).

Mathematics Anxiety and Gender

> We know that there are differences in interest in mathematics between the sexes. We are only beginning to know what causes such differences, and, even more important, whether they are innate or learned. Do girls do poorly in math because they are afraid that people (especially boys) will think them abnormal if they do well, or is it because girls are not taught to believe that they will ever need mathematics? Do girls do certain kinds of math better than boys? Which kinds? At what ages? And are there some different ways to explain key concepts of math that would help some girls understand them better? (Tobias, 1993, p. 74).

"Girls who fail are three times more likely to attribute their lack of success to the belief that they 'simply cannot do math' " (Tobias, 1993, p. 63). People of all races and socio-economic backgrounds have displayed fear of mathematics; however, women and minorities have been most hindered by it (Zaslavsky, 1999). The stereotype that women are not as proficient in mathematics as men has continued to exist in society. The research conducted by Zaslavsky indicated that girls begin to doubt their ability to perform mathematically around seventh grade. Tobias (1993) supported the belief that differences in mathematics anxiety between male and females did not exist from birth, but surfaced as children reached adolescence.

Kelly and Tomhave (1985) conducted a study investigating the mathematics avoidance of female education majors in college. The results showed that a high proportion of female elementary majors were mathematically anxious. "Women elementary school teachers, who constitute the majority of elementary school teachers, may be perpetuating math anxiety with young girls in their own classrooms" (p. 52). Based on the findings of this study, the researchers recommended that qualified mathematics teachers, who had an understanding of mathematics anxiety and its causes, should help and teach those mathematically anxious individuals that were interested in becoming teachers.

> The belief that females have an inborn, unalterable inferiority when it comes to doing math is among the myths that induce them to evade mathematics. Unproven beliefs about the innate intellectual inferiority of any specific group in relation to another affects the group's attitude toward math (Zaslavsky, 1999, p. 48).

In a study conducted by Bernstein, Reilly, and Coté-Bonnano (1992), females were found to not have higher levels of mathematics anxiety when compared to males until the beginning of high school. Prior to the age of 14, males and females were found to be similar in their feelings of mathematics anxiety. By the age of 14, however, females became more mathematically anxious than males. Although gender may have had little to no impact on anxiety during childhood, female students began to experience mathematics anxiety and lag behind their male counterparts in the intermediate years through high school (Alkhateeb, 2001; Bernstein et al.; Malinsky, Ross, Pannells, & McJunkin, 2006). Female students have also reported higher levels of mathematics anxiety at the high school and college levels when compared to their male counterparts (McLaughlin, 2002; Pajares & Urdan, 1996). These students indicated that a gap in confidence and a difference in beliefs about mathematics may have begun to surface in high school and been further defined in the college years (Pajares & Urdan).

Sorensen and Hallinan (1986) found in schools that implement ability grouping, that girls were less likely to be placed in higher-ability mathematics groups than were boys of the same ability. Similarly, Chipman and Thomas (1987) noted that both parent and teachers expected girls to experience poor achievement in mathematics. The failure to perform mathematically has been accepted as a characteristic of being female, and successes have often been discounted. Chipman and Thomas stated that girls developed lower confidence in their mathematical ability than did boys. Tobias (1993) noted that although males have admitted fear of mathematics, fear has been more debilitating to females.

Male and female students may have acquired different beliefs about their ability to experience success in mathematics as a result of differential treatment in the classroom (Chipman & Thomas; Gallagher & Kaufman, 2005; Golombok & Fivush, 1994). Incorrect answers for females have been attributed to their poor ability, anxious behaviors, and limited confidence in their ability to perform mathematical tasks, whereas male students have been given more feedback regarding the quality of their work and thus have heightened confidence in their ability to perform (Gallagher & Kaufman; Golombok & Fivush). Males have been provided more opportunities to generate correct answers and have been offered more support to work through problems until they arrive at a correct solution (Golombok & Fivush, 1994). Hernandez-Garduno (2001) found that teachers' expectations directly influenced student achievement, and that higher mathematics and science expectations have been geared towards male students.

Transmission of Mathematics Anxiety

Parents, especially parents of girls, often expect their children to be nonmathematical. If the parents are poor at math, they had their own sudden-death experience; if math was easy for them, they do not know how it feels to be slow. In either case, they will unwittingly foster the idea that a mathematical mind is something one either has or does not have (Tobias, 1993, p. 53).

Researchers have supported the premise that high levels of anxiety lead to the transmission of anxiety, and a fear of mathematics in students (Hembree, 1990; Kelly & Tomhave, 1985; Lazarus, 1975; Martinez & Martinez 1996; Tobias, 1993; Vinson, 2001). "It has been well established that parents' and teachers' expectations influence children's math achievement and their beliefs about their ability to learn math" (Arem, 2010, p. 17).

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Teachers and parents who were afraid of mathematics have often passed on this anxiety to the next generation by modeling behaviors of their own discomfort with the subject.

"Since math is taught in all the elementary grades, these teachers had ample opportunities to pass their math fears and uncertainties onto their impressionable students" (Arem, 2010, p. 19). Many teachers have admitted to feeling uncomfortable about teaching mathematics. According to Lazarus (1975), if a teacher exhibits tenseness or uneasiness about mathematics, students may internalize this and acquire the belief that mathematics is difficult and not enjoyable. Mathphobia, according to Lazarus, illustrates a fear of mathematics that has been socially accepted and has been exemplified by parents' bragging about performing terribly in mathematics or making excuses for their children's lack of success in mathematics. Lazarus expressed his opinion that mathematics anxiety, though having begun in elementary school, may not surface until students have progressed to higher levels of mathematical coursework.

Elementary teachers who exhibit high levels of mathematics anxiety are more likely to unintentionally communicate their own negative feelings towards mathematics to their students (Wood, 1988). Numerous researchers and authors have addressed this tendency of teachers with high levels of mathematics anxiety to pass it on to their students, thus resulting in a cycle of mathematics anxiety (Gresham, 2007; Hembree, 1990; Kelly & Tomhave, 1985). Jackson and Leffingwell (1999) expressed the belief that students often experienced their first traumatic encounter with mathematics in the third or fourth grades. Harper and Daane (1998) linked these negative experiences related to mathematics that occurred during elementary school to mathematical avoidance

by students in secondary mathematics courses. However, in his study, Bush (1989) found no significant differences in changes in mathematics anxiety between students of mathematically anxious teachers and those not exhibiting mathematics anxiety. The contention that mathematics anxiety could be transmitted from teachers to students was not supported by the results of this study. There was no significant relationship between teachers' mathematics anxiety and changes in the mathematics anxiety levels of their students. Bush indicated that mathematically anxious teachers did not appear to use different teaching practices than their not mathematically anxious counterparts. Widmer (1982) found that elementary teachers who had prior unpleasant experiences with mathematics were determined to provide their students with pleasant and enjoyable mathematical experiences.

Mathematics Anxiety and Elementary Teachers

Malinsky et al. (2006), in focusing their work on post-secondary students, noted that many students entering higher education institutions were not well prepared for mathematics courses at the university level and exhibited varying levels of mathematics anxiety. Mathematics anxiety has been common among college students and was a factor limiting educational and career choices. Elementary education majors have displayed one of the highest levels of mathematics anxiety on college campuses (Kelly & Tomhave, 1985). Alsup (2004) viewed these high levels of mathematics anxiety as having the potential to inhibit elementary teachers from achieving success in teaching mathematics.

Meyer (1980) surveyed 120 elementary teachers and found that 44 females (41%) and four males (33%) indicated they disliked the subject. When asked to explain their rationale for dislike of the subject, three males (50%) and 34 females (64%) out of the total population based their comments on experiences with previous teachers. Although the question was not directly related to mathematics anxiety, this finding provided some insight into the attitudes of teachers towards mathematics. In another study, Kelly and Tomhave (1985) studied five groups of undergraduate elementary education students and each group was administered the Mathematics Anxiety Rating Scale (MARS) instrument. The results of this study indicated that those who were training to teach mathematics to the youngest students were often the most anxious about mathematics. These results are alarming because effective mathematics instruction and deep conceptual understanding of content at the primary level depends not only on the experiences that teachers provide every day in the classroom, but also on the understanding of the mathematics they are teaching, coupled with the knowledge of instructional tasks and strategies that will enhance learning (Van de Walle, Karp, & Bay-Williams, 2010).

Harper and Daane (1998) identified levels of anxiety in elementary teachers when they were faced with teaching activities associated with mathematics. They analyzed the mathematics anxiety levels of 53 elementary teachers before and after a mathematical methods course. The resulting data indicated that problem solving was one of the main contributing factors fostering mathematics anxiety in teachers (Harper & Daane). Mathematics anxiety has been attributed to an emphasis on the right answer and the correct method, fear of making mistakes, and frustration with the amount of time that it

took to calculate word problems. Helplessness, inferiority, and insecurity have proved to

be manifestations of mathematics anxiety that have been common in elementary school

pre-service teachers and have led to mathematics avoidance (Dodd, 1999).

Trice and Ogden (1987) investigated the mathematics performance of 40

elementary teachers in their first year of service. Teachers were observed three times

teaching lessons in their classrooms, and their lesson plans were analyzed to determine

the amount of time devoted to mathematics instruction. The teachers completed the

Revised Mathematics Anxiety Rating Scale (R-MARS) as part of the study. Based on the

results of their investigation, the researchers indicated that teachers with the highest

mathematics anxiety scores avoided teaching mathematics. The teachers who indicated

having the most anxiety planned the smallest amount of time for mathematics instruction

and were observed teaching subjects other than mathematics during the time allocated for

mathematics instruction. During the interviews, the most mathematically anxious

teachers indicated a slight dislike for teaching mathematics.

<div align="center">Anxiety and Attitude about Mathematics</div>

According to Tobias (1993), "performance is influenced by beliefs, perceptions,

prior experience, and self-esteem" (p. 73). Attitudes towards mathematics appear to be

interconnected with the effects of mathematics anxiety. Aiken (1970) defined attitude as

"a learned predisposition or tendency on the part of an individual to respond positively or

negatively to some object, situation, concept, or another person" (p. 551). Neale (1969)

described attitude towards mathematics as a collective measure of "a liking or disliking

of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (p. 632). This definition can be extended to include students' affective responses to the importance or unimportance of mathematics (Ma & Kishor, 1997).

Ruffell, Mason, and Allen (1998) posited that the most dominant factor in shaping the disposition of students towards mathematics has been teacher attitudes. Starting as early as kindergarten, teacher attitudes about mathematics have influenced student attitudes. Jackson and Leffingwell (1999) noted that students were less motivated to learn when they believed that teachers did not want to be there and that they did not enjoy a specific subject or teaching. "A teacher who is in love with a subject tends to infect students with a similar enthusiasm. A teacher who hates and fears mathematics, who seeks excuses to exclude it from the daily curriculum, likewise influences students" (Burton, 1979, pp. 131-132).

Tobias (1993) wrote, "The most important elements in determining success at learning math are motivation, temperament, attitude, and interest" (p. 100). Several studies have been conducted to investigate student attitudes and feelings about the study of mathematics. Although attitudes may be altered, many college level students have developed a negative attitude and disposition towards mathematics (Walmsley, 2000). Morris (1981) viewed attitude toward mathematics almost as important as mathematics aptitude and credited parents, teachers, and peer expectations for the resultant attitudes. Ball (1990) indicated that prospective teachers' feelings about mathematics were related to how they, themselves, experienced mathematics as well as their substantive

understandings of the discipline. Individuals' approaches to solving problems were "shaped by their self-confidence, their repertoire of strategies, what they were able to remember about related concepts, as well as what they believed about the fruitfulness of trying to figure out a problem in the first place" (Ball, 1990, p. 461).

Brady and Bowd (2005) indicated that mathematics anxiety related to teaching mathematics could be described as a recurring phenomenon. In their study, they found that "negative experiences with formal mathematics instruction led many participants to discontinue their study of the subject, or discouraged them from pursuing formal mathematics instruction" (Brady & Bowd, p. 45). Many of the respondents in their study noted that their background experience with mathematics had not prepared them to teach the subject with confidence, thus providing the potential for their anxiety to be replicated and transmitted to their students.

The results of a study conducted by Bessant (1995) indicated that favorable attitudes toward mathematics might be associated with lower levels of mathematics anxiety. Conversely, negative attitudes regarding mathematics may be directly connected to increased mathematics anxiety. In this study, 173 Canadian university students who were enrolled in a variety of mathematics courses responded to a 35-item, Likert-format, mathematics attitude scale as well as the MARS. The MARS scores for the respondents were negatively correlated with attitude results for the student-reported scales of Enjoyment of Mathematics and Scientific Value of Mathematics.

Mathematics Anxiety and Content Knowledge

Mathematics anxiety is related to both the content knowledge and the instructional strategies and methods implemented in the classroom by elementary teachers. "Teachers' comfort with, and confidence in, their own knowledge of mathematics affects both what they teach and how they teach it" (National Council of Teachers of Mathematics [NCTM], 1991, p. 132). Ball addressed the potential impact on students' learning outcomes when teachers mathematical content knowledge was limited (Ball, 1990). Mathematical concept knowledge has been strongly correlated to the ability of teachers to create a learning environment that fosters mathematics achievement and productive dispositions for students (Ball, 1998). Stevens and Wenner (1996) agreed with Ball on elementary teachers' need for a high level of conceptual understanding of mathematical content in order to teach the fundamental concepts of mathematics. Teachers with mathematics anxiety have often tended to use lecture and rote learning as part of their instructional delivery to avoid uncomfortable questions posed by their students (Norwood, 1994).

Many elementary teachers have chosen the educational profession because of a genuine desire to enrich the lives of their students. Training and professional development have frequently been focused on liberal arts and on the art and science of teaching, as opposed to specific preparation in mathematics. Burton (1979) did not find it difficult to understand why teachers' conceptual understanding of the basic principles of elementary mathematics might be weak. The lack of a strong foundation in mathematics, coupled with the fear of the subject itself, has often fostered the development of

mathematics anxiety. An ability to learn mathematics oneself has not equated with helping someone else understand mathematics concepts (Burton). "Teachers must be able to generate explanations or other representations, often on the spot in response to a student question" (Ball, 1990, p. 458).

Education in the United States has provided evidence to support the fact that "low-quality school mathematics education and low-quality teacher knowledge of school mathematics reinforce each other" (L. Ma, 1999, p. 145). Teachers must understand how to translate mathematics into clear representations that allow students to make connections between unfamiliar mathematical content and previously learned ideas. According to L. Ma (1999), "the real mathematical thinking going on in a classroom, in fact depends heavily on the teacher's understanding of mathematics" (p. 153). As part of a comparative study, L. Ma illustrated the disparity between the mathematical understanding among United States and Chinese elementary teachers as it related to classroom teaching practices. The results of the study indicated that "although U.S. teachers may have been exposed to more advanced mathematics during their high school or college education, Chinese teachers display a more comprehensive knowledge of the mathematics taught in elementary school" (L. Ma, 1999, p. xx). Mathematical content knowledge has been fundamental to good instruction, especially at the elementary level, where teachers have been charged with building a foundational level of understanding. In order "to improve mathematics education for students, an important action that should be taken is improving the quality of their teachers' knowledge of school mathematics" (L. Ma, 1999, p. 144).

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Ball (1998) indicated that prospective elementary teachers have often been more apprehensive about teaching mathematics when compared to any other subject area. Many prospective elementary teachers have not had positive learning experiences with mathematics. Thus they have acquired feelings of anxiety and inadequacy which they bring to their educational program (Ball). This fear and anxiety has led many educators to take only the minimum mathematics courses required for certification. Consequently, the mathematical content knowledge of many elementary teachers has been comprised solely of what they have recalled from their experiences in both elementary and secondary mathematics courses (Ball).

Mathematics Anxiety and Student Achievement

Several research studies have indicated a statistically significant relationship between mathematics anxiety and mathematics achievement (Ashcraft, 2002; Betz, 1978; Hembree, 1990; X. Ma, 1999; Sherman & Wither, 2003). Higher levels of anxiety have often been associated with lower levels of performance. Dissecting the factors and implications of mathematics anxiety has led to greater understanding of how it affects achievement (Cavanagh, 2007). Ashcraft found that mathematics anxiety not only had an impact on academic performance, but also on career choice.

Hembree (1990) deduced that a relationship existed between mathematical anxiety and lower performance or mathematical achievement. The results of Hembree's meta-analysis of 151 studies indicated that higher achievement was consistently accompanied by a reduction in mathematics anxiety. Hembree reported an average

correlation of -.31 between mathematics anxiety and mathematics achievement for college students. This negative relationship appeared at both elementary and secondary levels with an average correlation of -.34 for all students. The results of this meta-analysis provided evidence that mathematics anxiety inhibited performance involving mathematical tasks and that reduction in anxiety could be connected with improvement in mathematics achievement (Hembree).

Sherman and Wither (2003) conducted a longitudinal study of 66 students over five years to further examine the relationship between mathematics anxiety and mathematics achievement. The researchers concluded that there was a relationship between mathematics anxiety and mathematics achievement. However, they did not find sufficient evidence to indicate whether poor mathematics achievement caused mathematics anxiety or whether there was a third factor influencing the relationship. Sherman and Wither indicated the necessity for researchers to raise questions over the assumption that mathematics anxiety was a cause of poor achievement in mathematics.

Ashcraft and Kirk (2001) wrote that mathematics anxiety could lower mathematics performance by contributing to an avoidance of mathematics which could result in lower competence. Hembree (1990) had also observed that individuals with higher mathematics anxiety experienced greater mathematical avoidance as evidenced the limited mathematics courses taken in high school and in college. This was linked to an inhibition of the capacity of the working memory, thus significantly interfering with the learning and mastery of mathematical concepts.

In a study consisting of 81 students enrolled in a college mathematics survey course, those with high mathematics anxiety scored lower, on average, on a mathematics achievement test when compared to the students with low mathematics anxiety (Clute, 1984). The results of this study reinforced the importance of considering anxiety level in planning the program and instructional delivery used in teaching mathematics. Clute noted that anxiety level "appears to be a factor that needs to be considered in predicting mathematics achievement" (p. 56).

In contrast, some studies have indicated that a positive relationship between mathematics anxiety and mathematics achievement may exist (Bush, 1991; Resnick, Viehe, & Segal, 1982). Bush (1991) argued that when mathematics performance was improving, mathematics anxiety may increase. This contradiction with previous research may have been attributed to the sample of students that were included in this study. These students had extensive exposure to mathematics and were either gifted or had intentions to enter a career for which they would need quantitative skills (Bush, 1991). Similarly, the results of the study conducted by Resnick, Viehe, and Segal led the researchers to question the influence that a reduction in mathematics anxiety would have on improving mathematics achievement. The sample of students only included college students who exhibited high levels of mathematics achievement and limited levels of mathematics anxiety.

Hadley (2005) investigated the mathematics anxiety of elementary teachers and its relationship with student mathematics achievement. In this study, 850 elementary teachers completed a survey that assessed (a) their level of mathematics anxiety, (b) their

anxiety about teaching mathematics, (c) mathematics instructional practices, and (d) the amount of additional pedagogical training in which they may have participated. Although a positive relationship was found between anxiety about mathematics and anxiety about teaching mathematics, no relationship was found between the anxiety measures and the mathematics achievement of the teachers' students. According to Hadley (2005), "efforts to decrease teachers' anxiety about mathematics or anxiety about teaching mathematics as a means of improving student achievement may be unproductive" (p. 77).

Etgeton (2004) conducted a study to determine if there was a relationship between third grade student achievement and the levels of mathematics anxiety exhibited by the teacher. Etgeton surveyed 45 elementary teachers in order to determine levels of mathematics anxiety. The results of the study indicated that there was no statistically significant relationship between student scores and the self-reported anxiety levels.

<center>Teaching Efficacy</center>

<center>Self–efficacy</center>

In Bandura's (1986) social cognitive theory, individuals have been said to possess a self-system that enables them to exhibit a certain measure of control over their thoughts, feelings, motivations, and actions. Bandura (1997) suggested that individuals maintain beliefs about their capabilities to produce certain levels of performance which may have exercised influence over events that affect certain outcomes in their lives.

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According to Bandura (1986), self-efficacy is the judgment or perception of one's ability to perform a designated task and produce desired results through their own individual actions. Tschannen-Moran, Woolfolk-Hoy, and Hoy (1998) believed that self-efficacy was different from self-concept, self-worth, and self-esteem because it was based specifically on a particular task. Enochs, Smith, and Huinker (2000) defined self-efficacy as "when people not only expect specific behavior to result in desirable outcomes, but they also believe in their own ability to perform the behaviors" (pp. 194-195). Bandura (1997) believed that the behavior of individuals could be predicted better by self-efficacy beliefs than by their actual capabilities and that if people did not believe in their capacity to produce a desired outcome, they would have little motivation or incentive to act at all or to persevere when challenges arose.

"Self-efficacy influences all aspects of decision making and outcome production through goal setting, motivation, perceived ability and interest" (Swachkamer, 2009, p. 3). Bandura (1977) delineated the construct of self-efficacy into two dimensions, efficacy expectations and outcome expectations. "Outcome and efficacy expectations are differentiated because individuals can believe that certain behaviors will produce certain outcomes, but if they do not believe that they can perform the necessary activities, they will not initiate the relevant behaviors, or if they do, they will not persist" (Gibson & Dembo, 1984, p. 570). An efficacy expectation has been defined as the conviction that one can successfully execute the behavior necessary to generate the desired outcome. An outcome expectancy has been described as an individual's estimate or prediction that a given behavior will lead to certain identified outcomes. Self-efficacy, as defined by

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Pajares and Urdan (1996) was specific to the situation and not a generalized expectancy. Tschannen-Moran et al. (1998) concurred in the following explanation: "The efficacy question is, Do I have the ability to organize and execute the actions necessary to accomplish a specific task at a desired level? The outcome question is, If I accomplish the task at that level, what are the likely consequences?" (p. 210).

Bandura (1997) noted that a strong sense of efficacy enhanced accomplishment and the well-being of an individual in a variety of ways. Those who had a high self-efficacy and maintained high assurances in their capabilities approached hard tasks as challenges to be mastered rather than seeing them as something to be avoided. Highly efficacious people have set themselves challenging goals and maintained strong commitments to reaching their own individual set of expectations. These individuals have heightened and sustained their efforts when confronted with failure. Those with high self-efficacy have the ability to quickly recover their sense of efficacy after facing a failure or setback. Highly efficacious individuals have typically attributed failure to insufficient effort or deficient knowledge and skills that can be learned and acquired. These individuals have approached threatening situations with a strong assurance that they can exercise a high level of control over the situation. Bandura (1997) indicated that outlooks defined by high efficacy produce personal accomplishment, reduce stress, and lower the capacity for depression.

Alternatively, those individuals with low efficacy have turned away from difficult tasks which may have been viewed as personal threats (Bandura, 1997). These people have had low aspirations coupled with weak commitments to their goals. Individuals

with low self-efficacy have concentrated on their personal deficiencies, obstacles, or adverse outcomes when faced with difficult tasks rather than concentrating on successful results. Individuals with low self-efficacy have often reduced their efforts and given up quickly when faced with difficult situations (Tschannen-Moran et al., 1998). When faced with setbacks or failure, these individuals have been slow to recover their sense of efficacy. Additionally, those exhibiting low efficacy may fall victim to stress and depression.

It was Bandura's (1997) belief that self-efficacy beliefs shape how people think, feel, motivate themselves, and behave. Diverse effects are produced by these beliefs through cognitive, motivational, affective, and selection processes. According to Bandura (1997), people with high self-efficacy are more likely to set high expectations and goals, set difficult challenges, and are committed to meeting those challenges. For these individuals with high levels of self-efficacy, actions are often guided by anticipating successful outcomes instead of focusing on areas of personal deficiency. The motivation of these individuals has been thought to be stronger if they believe that their goals can be attained and adjusted based on progress. Regarding affective processes, Bandura (1997) indicated that self-efficacy beliefs regarding coping capabilities affect how much stress or depression individuals may experience in threatening or difficult situations. Self-efficacy varies inversely with anxiety state during a stressful or challenging situation (Bandura, 1986). In reference to selection processes, self-efficacy beliefs can frame the course of one's life by shaping the types of activities and environments an individual may choose (Bandura, 1997). People often avoid

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activities and situations that exceed coping capabilities; however, they undertake

challenging activities and select situations that they perceive they have the capacity for

handling.

According to Bandura (1986), individuals have formed their self-efficacy beliefs

by interpreting information from four main sources. The strongest source has been noted

in the interpretation of an individual's previous performance or mastery experiences.

This source has produced the most authentic evidence of whether one can master the

necessary skills needed to succeed in a particular field. Individuals engage in activities,

interpret the results of their actions, use their interpretations to create beliefs about their

capability to engage in subsequent activities or tasks and then act in response to the

created beliefs. Outcomes that have been interpreted as successful have often raised self-

efficacy, whereas those interpreted as failures have had the effect of lowering self-

efficacy. "Successes build a robust belief in one's efficacy, especially when success is

achieved early in learning with few setbacks" (Tschannen-Moran & McMaster, 2009, p.

230).

The second source of self-efficacy beliefs has been based on observations of

others performing tasks or vicarious experiences. Bandura had, as early as 1977,

discussed the merits of vicarious experiences in allowing others to see threatening

activities without adverse consequences. This source has been determined to be weaker

than mastery experiences in creating self-efficacy beliefs. Good (2009) addressed the

value to individuals, uncertain about their own abilities, of watching someone else

successfully complete an activity and subsequently realizing that they had the capacity to

accomplish the activity. Tschannen-Moran & McMaster (2009) addressed the persuasive

power of observers who had very similar models in teaching situations.

> People actively seek proficient models who demonstrate the competencies to
> which they aspire. Competent models transmit knowledge and teach observers
> effective skills and strategies for managing task demands through their behavior
> and by revealing their thinking about the task at hand (p. 230).

The third source, verbal persuasion, may include exposure to verbal judgments

given by other individuals. "Verbal persuasion involves verbal input from others, such as

colleagues, supervisors, and administrators, that serves to strengthen a person's belief that

he or she possesses the capability to achieve a desired level of performance" (Tschannen-

Moran & McMaster, 2009, p. 229). Bandura (1977) wrote that through verbal

persuasion, people were directed, through suggestion, into believing that they could cope

successfully with what has previously overwhelmed them. In education, teachers have

often received verbal persuasion through professional development workshops that

provide new strategies as well as persuasive claims of its usefulness (Tschannen-Moran

& McMaster). "Verbal persuasion alone may not be a powerful source of self-efficacy;

however, in partnership with other sources of efficacy, it may provide teachers the

encouragement necessary to expend effort toward realistic goals aimed at strengthening

their teaching skills" (Tschannen-Moran & McMaster, p. 230).

Lastly, the fourth source of self-efficacy beliefs, according to Bandura (1986)

included physiological and emotional states such as anxiety, stress, and mood states.

Bandura believed that individuals could measure their degree of confidence by the

emotional state that they exhibited as they considered an action. "A person's level of

arousal, whether perceived positively as anticipation or negatively as anxiety, can

influence his or her self-efficacy beliefs" (Tschannen-Moran & McMaster, 2009, pp. 230-231). Bandura believed that these four sources continually interacted and maintained a reciprocal relationship with regard to how they affected one's judgment and influence performance. Each of these sources may play important roles in the development of self-efficacy.

Efficacy in Teaching

Teaching efficacy has been defined, based on an extension of Bandura's conceptualization of self-efficacy, as a future-oriented construct that relates to teachers' beliefs in their competence to organize, plan, and provide activities required to attain educational goals and objectives which affect the performance of all students, regardless of their motivation or ability (Gabriele & Joram, 2007; Skaalvik & Skaalvik, 2008; Tschannen-Moran et al., 1998). The expressions teaching efficacy and teacher self-efficacy are used by researchers interchangeably throughout the literature. "Teacher self-efficacy is related, but not identical to teacher effectiveness in that perceived evidence of past successes and failures strongly influences a teacher's expectations about her or his future performance" (Gabriele & Joram, p. 62). Skaalvik and Skaalvik have stressed that teacher self-efficacy will increase if teachers believe that student achievement and behavior can be influenced and impacted by the education they receive.

When applied to teaching, self-efficacy beliefs have indicated teachers' evaluations of their abilities to bring about positive student change (Gibson & Dembo, 1984). Teachers who believe student learning can be influenced by effective teaching,

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coupled with the confidence in their own ability, "should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback" (Gibson & Dembo, p. 570). Gabriele and Joram (2007) asserted that, "teacher self-efficacy primarily influences a teacher's adoption of new ways of teaching by increasing her or his willingness to take risks and persist through the difficulties and setbacks that accompany the implementation process" (p. 61).

Bandura (1997) categorized teaching efficacy into: (a) general teaching efficacy and (b) personal teaching efficacy. General teaching efficacy referred to a teacher's perception that instruction could affect student learning outcomes. This type of efficacy belief has been referred to as an outcome expectancy or the perception that a task can be completed. If a teacher believes that students can learn mathematics and that it can be taught, the teacher will persevere in teaching the subject matter with confidence. In contrast, the teacher who believes a student will not be able to learn mathematics through instruction is showing evidence of poor perceptions of general teaching efficacy.

Bandura's (1997) second category, personal teaching efficacy, described teachers' beliefs in their effectiveness. He believed personal teaching efficacy could influence teachers to avoid tasks that they believed were beyond their own personal capabilities. Swackhamer (2009), expanded on Bandura's explanation, commented that personal teaching efficacy referred to teachers' confidence in teaching different strategies to assist student learning.

Swars (2005) discussed the differing characteristics that were exhibited in teachers with varying levels of teaching efficacy. Teachers with a high sense of efficacy

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were often confident when they were able to have an influence on student learning. Those with a low sense of efficacy experienced a sense of ineptness in working with students. Teachers with high levels of efficacy believed that their work was meaningful and that they had a positive impact on learning, whereas teachers with lower efficacy were often frustrated and discouraged about teaching.

There are several different factors that have influenced teaching efficacy. Teaching efficacy has been correlated with instructional strategies implemented in the classroom, as well as with teachers' willingness to embrace educational reform, their commitment to teaching, and student achievement (Swars et al., 2006). "Teachers with high efficacy beliefs generate stronger student achievement than do teachers with lower teacher efficacy" (Ross & Bruce, 2007, p. 50). Teachers with higher teaching efficacy maintained high academic standards, upheld clear expectations for students, concentrated on academic instruction, required students to remain on task, and attended more closely to the needs of students with lower ability. Therefore, they were more likely to be successful in generating greater gains in student achievement (Dembo & Gibson, 1985; Ross & Bruce). These teachers were also more likely to take ownership for the outcomes of their specific actions within the classroom. Teachers who maintain high self-efficacy have attributed their actions to their performance rather than to factors beyond their control such as students' abilities or their own individual personal experiences (Ross & Bruce). These teachers have established very high standards for themselves and have accepted responsibility when these standards were not attained. Tschannen-Moran et al. (1998) indicated that teaching efficacy could be correlated to school-level variables such

as climate of the school, behavior of the principal, the overall sense of school community, and decision-making structures.

"Mathematics teacher efficacy and mathematics anxiety have a negative relationship, with highly efficacious elementary pre-service mathematics teachers possessing, in general, lower levels of mathematics anxiety" (Swars, 2008, p. 140). In another study, Swars, Daane, and Giesen (2006) revealed "a significant, moderate negative relationship between mathematics anxiety and mathematics teacher efficacy" (p. 306). Teachers with the highest degrees of mathematics anxiety have been viewed as maintaining the lowest levels of mathematics teaching efficacy.

Tschannen-Moran et al. (1998) provided a cyclical model of teaching efficacy that could be utilized to develop professional development opportunities for teachers to improve their self-efficacy. These authors believed that establishing one's personal teaching efficacy required an analysis of the teaching task and a self-assessment of personal teaching competence. In this model, each situation necessitated teachers considering the task in connection with their capacity to successfully perform the action. Through cognitive processing, the results of both the analysis of the teaching task and the assessment of individual teaching efficacy could be measured and determined (Tschannen-Moran et al.).

Teachers feel efficacious for teaching particular subjects to certain students in specific settings, and they can be expected to feel more or less efficacious under different circumstances. A highly efficacious secondary chemistry teacher might feel very inefficacious teaching middle school science, or a very confident rural sixth grade teacher might shudder at the thought of teaching sixth graders in the city. Even from one class to another, teachers' levels of efficacy may change. Therefore, in making an efficacy judgment, a consideration of the teaching task and its context is required. In addition, it is necessary to assess one's strengths and weaknesses in relation to the requirements of the task at hand (Tschannen-Moran et al., 1998, p. 228).

In order to improve mathematics teaching efficacy, Gabriele and Joram (2007) noted that it was necessary to provide teachers with several opportunities that focused on the value of investigating student thinking in mathematics.

In the case of reform-based mathematics teaching, the ability to notice and appreciate various examples of student thinking during a lesson provides the teacher with a critical source of efficacy information for continued motivation to teach the kinds of lessons that are characteristic of reform-based mathematics teaching. Helping teachers to value the intricacies of student thinking and having a clear picture of how it develops are likely to play a key role in the successful shift from teaching in traditional ways to teaching in reform-oriented ways (Gabriele & Joram, 2007, p. 73).

The comfort level of teachers has been another important factor to mediate when attempting to improve mathematics teaching efficacy. It is essential for teachers to feel comfortable with both exploring and solving the mathematical content, as well as with delivering instruction on the content. J. Smith (1996) outlined the following four interrelated components of mathematics instruction that would help to improve efficacy beliefs: (a) choosing mathematical problems of significant content that require students to be engaged; (b) predicting student reasoning; (c) generating and directing dialogue as opposed to being the sole authority with respect to the mathematics; and (d) teaching mathematical content, rules, or well-planned procedures. Using this model for improving

efficacy beliefs, teachers must "value their students' constructive activity and introduce elements of accepted mathematics where appropriate" (J. Smith, 1996, p. 397).

By allowing teachers to reflect on past experiences and the feelings associated with these experiences, teaching efficacy has been projected to improve (J. Smith, 1996; Swars et al, 2006). When teachers are aware of those feelings, it may be helpful to provide them with activities and learning experiences that allow them to feel mathematical success (Ross & Bruce, 2007; Swars et al., 2006). J. Smith (1996) indicated that the efficacy level of teachers will vary depending on the students and the context of the situation. In order to improve the quality of mathematics instruction, educational leaders must begin to understand the conceptions of teachers and how they are related to the practices they implement in the classroom (Swars et al., 2006). Attempts to improve the quality of mathematics instruction in schools must be accompanied by the careful consideration of teachers' beliefs in relation to their practice.

Mathematics Anxiety and Mathematics Self-Efficacy

Studies have indicated a link between mathematics anxiety and mathematics self-efficacy or the beliefs that one has in their ability to learn mathematics. Hackett (1985) studied the effects of mathematics self-efficacy on mathematics anxiety and found that mathematics self-efficacy had a direct effect. Hackett's investigation indicated that mathematics self-efficacy was a stronger predictor of mathematics anxiety than other factors such as prior high school mathematics experience or gender.

Cooper and Robinson (1991) also examined the relationship of mathematics self-efficacy beliefs and mathematics anxiety. Their study included 229 undergraduate students at a mid-western university, and the results indicated that mathematics self-efficacy was negatively correlated with mathematics anxiety.

Pajares and Kranzler (1995) analyzed the relationship between mathematics self-efficacy and mathematics anxiety in 329 high school students. The results of this study illustrated that students' self-efficacy beliefs about their mathematical capabilities had strong direct effects on mathematics anxiety. In a similar study conducted by Swars (2004), a significant, moderate negative relationship between mathematics teaching efficacy beliefs and mathematics anxiety was found among elementary pre-service teachers. The pre-service teachers who exhibited the highest levels of mathematics teaching efficacy demonstrated the lowest degrees of mathematics anxiety, and the pre-service teachers with the lowest levels of mathematics teaching efficacy had the highest levels of mathematics anxiety. Limited knowledge of mathematics, combined with mathematics anxiety and low self-efficacy with respect to teaching mathematics, could limit the opportunities provided to elementary students to learn mathematics with deep conceptual understanding.

Swars et al., (2006) investigated the relationship between mathematics anxiety and mathematics teaching efficacy. The researchers surveyed 28 elementary pre-service teachers and found a statistically significant negative relationship between mathematics anxiety and mathematics teaching efficacy. Participants who exhibited high levels of mathematics anxiety demonstrated lower levels of mathematics teaching efficacy. Based

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on interviews conducted as part of the study, the researchers suggested that participants with both low and high anxiety felt confident in their ability to teach mathematics. Those with low anxiety felt confident in their content knowledge, whereas those with high levels of anxiety felt that they could relate to students that grappled with the acquisition of mathematics (Swars et al.).

According to Bursal and Paznokas (2006), teachers experiencing different mathematics anxiety levels had significantly different confidence levels in their ability to teach elementary mathematics. Bursal and Paznokas measured the mathematics anxiety levels and confidence levels to teach mathematics of 65 pre-service elementary teachers. The confidence scores of participants in different mathematics anxiety groups were compared and analyzed. The results of the study indicated that most of the participants in the low and moderate anxiety groups exhibited and demonstrated confidence to teach mathematics, whereas teachers exhibiting high anxiety did not exhibit the confidence to teach mathematics effectively. Negative correlations were found between pre-service teachers' mathematics anxiety and their confidence scores to teach elementary mathematics. Based on the results of this study, Bursal and Paznokas suggested that educational leaders should design college level mathematics methods courses in a manner that allowed all teacher candidates opportunities to reduce their anxieties about mathematics by developing positive attitudes toward, and productive dispositions about, teaching mathematics.

Tobias (1993) viewed mathematics as a relationship between an individual and a discipline that was purported to be difficult and reserved only for an elite few. Knowing

that a negative relationship existed between mathematics anxiety and teaching efficacy in pre-service elementary teachers, Ball (1990) had earlier noted that "the mathematical understandings that prospective teachers bring are inadequate for teaching" (p. 464). He believed that elementary teachers were in need of support to deepen their mathematical content knowledge, to manage their mathematics anxiety, and to improve their mathematics teaching efficacy.

<div align="center">Role of Educational Leader</div>

Fauth and Jacobs (1980) spoke to the role of educational leaders, "Educational leaders must acknowledge that the study of mathematics and the acquisition of mathematical competence is essential for full participation in tomorrow's society" (p. 489). Educational leaders could be of assistance to teachers in dealing with mathematics anxiety, thereby improving teaching efficacy (Fauth & Jacobs). Anxiety about mathematics has typically appeared in the early years of school. Teachers could foster the importance of developing positive attitudes towards mathematics, and administrators and educational leaders could play a role in this process. Fauth and Jacobs indicated that educational leaders needed to go beyond the identification of teachers with mathematics anxiety. They needed to provide staff development programs designed to help mathematically anxious teachers overcome their fears.

Changes in curriculum and school organization have also been suggested as helpful to teachers facing mathematics anxiety and low teaching efficacy beliefs. Fauth and Jacobs (1980) suggested the use of a specialist or a staff member passionate about the

subject to teach all the mathematics classes for a specific grade level. This might be one intervention that could break the cycle of mathematics anxious teachers. Fauth and Jacobs advocated for school leaders to direct their efforts toward interventions that would assist teachers in providing curriculum experiences for their students that fostered productive dispositions towards mathematics.

Harper and Daane (1998) identified the following factors as decreasing the mathematics anxiety of pre-service teachers: (a) working with a partner while solving mathematics, (b) working in cooperative learning groups, (c) working with small groups or in learning centers, (d) using mathematics manipulatives, (e) writing about mathematics through the incorporation of student journals, (f) doing fieldwork in a local elementary school, and (g) participating in problem solving activities. Gresham (2007) indicated that upon completion of a mathematics methods course, elementary teachers attributed reduction in their mathematics anxiety to specific factors including the use of concrete manipulatives, the implementation of non-traditional teaching methods, and the passion and enthusiasm exhibited by the professor towards the content of the course. Gresham found in her study that a majority of the participants noted that their levels of mathematics anxiety could have been decreased if not prevented, as early as elementary school, if the mathematics instruction they had received as a student included the incorporation of concrete manipulatives.

In order to improve the mathematics teaching efficacy, Gabriele and Joram (2007) stated that it was necessary to provide teachers with opportunities that fostered the value of investigating student thinking in mathematics. Additionally, focusing on teachers'

comfort level was viewed as an essential developmental aspect of improving mathematics teaching efficacy. They believed it was imperative that teachers were comfortable with exploring and solving mathematical content and with the delivery of classroom instruction (Gabriele & Joram). J. Smith (1996) remarked that teachers could incorporate several different components of mathematics instruction in order to establish and improve their efficacy beliefs. Educational leaders could assist teachers by encouraging them to choose problems that required students to engage with significant mathematical content, predict student reasoning when problem solving, generate and direct discourse as opposed to being the only authority on mathematics in the classroom, and allow for the incisive portrayal of mathematical content, rules, or procedures (J. Smith, 1996).

Allowing teachers to reflect on past experiences, as well as the feelings associated with those experiences has been predicted to assist in the improvement of teaching efficacy in the area of mathematics (J. Smith, 1996; Swars, 2005; Swars et al., 2006). Once teachers have established an awareness of those feelings, it has been beneficial to provide them with learning experiences with which they were successful (Ross & Bruce, 2007; Swars, 2005; Swars et al.).

Tschannen-Moran et al. (1998) indicated that educational leaders can help improve teaching efficacy by providing staff development in which the teaching task has been analyzed prior to implementation of professional development. When professional development is provided related to mathematics content for elementary teachers, it should incorporate scaffolding of reform-oriented mathematics activities. Ball (1990) posited that to effectively create professional development that reduced mathematics anxiety, but

at the same time improved mathematics teaching efficacy, the current measure of

elementary teachers' mathematical understanding needed to be considered.

Summary

> To be an active, concerned member of this world, you must use the power of
> math. To be successful in school; to have a rewarding, stimulating career; to get
> the jobs you want; to be an involved citizen; to have a knowledge of personal
> finances, the nation's economy, and the technological advances of modern-day
> society-all these require you have an understanding of math (Arem, 2010, pp.
> 191-192).

Although elementary teachers have been charged with an exceptionally important

role to stimulate an excitement for learning mathematics, according to Wood (1988), they

cannot be expected to generate an enthusiasm or excitement for a subject for which they

are anxious about. "Any feeling that prevents you from learning mathematics in a natural

way as you did as a young child, or from performing in a way that demonstrates what you

learned, is math anxiety" (Kitchens, 1995, p. 7). Mathematics anxiety seldom has a

single cause or a single effect. Mathematics anxiety has "multiple causes and multiple

effects, interacting in a tangle that defies simple diagnosis and simplistic remedies"

(Martinez & Martinez, 1996, p. 2).

Mathematics anxiety is often created by the classroom teacher and develops from

an early age. According to Harper and Daane (1998), if elementary teachers understand

the factors attributing to mathematics anxiety and the sources of their own anxiety, they

may be better able to promote an atmosphere that inhibits mathematics anxiety among

students. By reducing mathematics anxiety in the classroom, educators can assist future

generations of students to have confidence in their capacity to understand and do

mathematics (Harper & Daane). Cavanagh (2007) noted that dissecting the causes and implications of mathematics anxiety will lead to greater understanding. "Because this math anxiety may affect their own achievement and that of their future students, it is incumbent upon us as teacher educators to find ways to lessen the math anxiety of our students" (Malinsky et al., 2006, p. 279).

The information presented in this chapter served to provide a theoretical basis for mathematics anxiety and teaching efficacy in relationship to student mathematics achievement. As evidenced by the research presented in this chapter, mathematics anxiety and mathematics teaching efficacy beliefs have been correlated with having an impact on student achievement. The researcher sought to examine the impact that demographic variables, in conjunction with mathematics anxiety and mathematics teaching efficacy, had on student achievement in the area of mathematics. Chapter 3 contains the methodology that was used in conducting the research.

CHAPTER 3
METHODOLOGY

Introduction

This chapter includes an overview of the methodology and procedures utilized to examine the connection among elementary teachers' anxiety about learning mathematics, their anxiety about the mathematics they teach, their mathematics teaching efficacy beliefs, and their students' mathematics achievement. Specifically, the data analysis served to determine the extent to which relationships, if any, existed among teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. Further analysis sought to investigate the influence that other potential intervening variables such as gender, level of college degree, and number of years of teaching experience have on these relationships. The statistical procedures used for analysis along with rationale validating the procedural choices are included.

This chapter is organized into eight sections. The problem statement can be found in section one. Section two describes the population for this research. Sections three and four consist of the data collection process and instrumentation utilized to gather research. The research questions and data analysis are included in sections six and seven. Lastly, a summary of this chapter is located in section eight.

Statement of the Problem

Mathematics anxiety and the influence it has on student achievement may relate to a student's ability to learn mathematics adequately and appropriately. Elementary teachers who possess high levels of mathematics anxiety may inadvertently pass on negative feelings and dispositions to their students (Wood, 1988). Negative consequences of mathematics anxiety developed in elementary school have been important for both students and adults, due to the role mathematics plays in measures of achievement used for class level placement, entrance into special programs, college and graduate school admissions, as well as for careers (Pajares & Graham, 1999).

Research Questions

1. To what extent, if any, is there a relationship among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of the students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?

2. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

3. To what extent, if any, is there a mean difference in elementary teachers' perceived anxiety about teaching mathematics based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

4. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

5. To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

<div align="center">Population</div>

The target population for this study included all third, fourth, and fifth grade teachers employed by a west central Florida school district during the 2008-2009 school year. This population consisted of 128 teachers in 11 elementary schools across the county. Of the teachers invited to participate, surveys were completed by 119 (92.97%) teachers and all 11 elementary schools were represented. The researcher determined that all of the teacher surveys from the 11 elementary schools would be included ($N = 119$) in the study.

<u>Setting of the Study</u>

The school district used for this study is located in one of sixty-seven counties in the state of Florida, and is situated along the western coast of Florida, approximately 60 miles north of Tampa. As of 2008, the county had a population of approximately 140,000 residents with more than 90% of the population living outside of the two incorporated towns in the county (U.S. Census Bureau, 2009; Wikipedia.com, 2009). According to the 2008 Census, the racial makeup of the county was 94.0% white, 3.3% black, 4.4% Hispanic, 1.2% Asian, 1.1% multiracial, and 0.3% from other races (U.S. Census Bureau).

Based on the 2007-2008 Florida School Indicator Report, the school district listed 2,334 full-time employees with 1,092 of these being instructional positions, of which approximately 400 (37%) of these teachers held a master's degree or higher (FLDOE, 2009c). The average number of years of experience for teachers in the school district was 14.23.

During the 2007-2008 school year, the school district enrolled 16,174 students in pre-kindergarten through 12th grade in 11 elementary schools, four middle schools, three high schools, and six charter, alternative, and special school center sites (FLDOE, 2009c). The racial make-up of the students from the school district was reported as 84.7% white, 4.4% black, 4.7% Hispanic, 1.5% Asian, 4.3% multiracial, and 0.4% from other races (FLDOE, 2009c). The district student population consisted of 16.3% disabled, 4.6% gifted, 41.8% free or reduced lunch, and 1.3% ELL (FLDOE, 2009c).

Data Collection

Prior to any initial data collection, the researcher requested and was granted permission by the assistant superintendent of the school district to conduct research at each of the 11 elementary schools pending the verbal approval of the principal at each school site. The data collection process was initiated with a request for student achievement data from the school district's Research and Accountability Department. The data requested included the percentage of students who scored 3-5 on the 2009 FCAT mathematics subtest by third, fourth, and fifth grade, disaggregated by teacher. Also requested was the list of teachers who taught mathematics in third, fourth, and fifth grade during the 2008-2009 school year.

Interest in this study and participant contact for data collection was initiated during a district-wide meeting of elementary principals. The researcher was given permission to distribute a copy of the Teacher Mathematics Anxiety and Teaching Efficacy Survey instrument (Appendix A) at the meeting with the goals of (a) explaining the research, (b) outlining the research questions, (c) describing the purpose and the significance of the study, and (d) describing what participation on the part of the teacher entailed. The list of teachers who taught mathematics in third, fourth, and fifth grade during the 2008-2009 school year was given to each principal so that they could identify the teachers who would be asked to participate in the study. The principals were given a letter requesting permission to conduct research at each school site (Appendix E) and asked to email the researcher permission to access the teachers at the school. The principals were asked to select a date during December 2009 in which the researcher

would visit the school in the afternoon to have participating teachers complete the online survey in a computer lab setting. As a gift of gratitude for considering participation, each school administrator received a complimentary copy of Tobias' (1993) text, *Overcoming Math Anxiety*, to add to the professional libraries at their school site.

One week prior to visiting the school, the researcher sent an email to third, fourth, and fifth grade teachers inviting them to participate in the study (Appendix D). During the initial school visit, teachers met in a computer lab. A description of the study was provided by the researcher to the group of teachers. The researcher had a sealed envelope for each teacher containing an index card with each teacher's survey code and the website address to complete the Teacher Mathematics Anxiety and Teaching Efficacy Survey instrument. Teachers were directed to follow the link to complete the survey electronically. The participants were informed that their answers were confidential and that at no time would they be asked to provide their names. To further ensure confidentiality, each teacher was given a six-digit numeric survey code assigned by the researcher in order to match survey responses to student achievement data. After opening the online survey, each participant was asked to enter the survey code and each was informed that by entering this number consent to participate in the study was given. The participant was then prompted to respond to several questions.

At the end of the data collection process for participants, the researcher analyzed the data. Teachers' survey responses were matched to their students' achievement data. Following completion of the study, the researcher contacted the principals at participating

schools to inform them that the research was completed and available for their review. The results for individual participants remained confidential.

Instrumentation

An electronic survey was used to collect data regarding mathematics anxiety, anxiety about teaching mathematics, and teaching efficacy. Data from the elementary teachers were collected through the completion of the Mathematics Anxiety and Teaching Efficacy Survey (Appendix A). The survey instrument consisted of 12 questions with 46 items in total and was comprised of four separate sections. These four sections included: (a) the Abbreviated Math Anxiety Scale (AMAS), (b) the Anxiety about Teaching Math (ATM) scale, (c) the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), and (d) demographic information.

The Mathematics Anxiety and Teaching Efficacy Survey consisted of multiple choice and open-ended response items. The first item required respondents to enter a teacher survey code which served as their informed consent to participate in the study. The second item, which asked if the respondent taught third, fourth, or fifth grade mathematics during the previous year, was a screening question used to determine eligibility for participation.

Abbreviated Math Anxiety Scale (AMAS)

Part I of the Mathematics Anxiety and Teaching Efficacy Survey included the Abbreviated Math Anxiety Scale (AMAS) (Hopko, Mahadevan, Bare, & Hunt, 2003).

Permission to use the instrument was obtained by the researcher from Dr. Derek Hopko

of The University of Tennessee (Appendix C). This section consisted of one question

stem with nine related items. All nine items were unchanged from the author's original

instrument. This 9-item Likert scale survey was designed to measure mathematics

anxiety and investigated an individual's feelings of anxiety toward mathematics.

Responses were based on a 5-point Likert-type scale for all items, ranging from 1 (low

anxiety) to 5 (high anxiety). The total score represented a summation of all nine items.

Results could range from 9, indicating no mathematics anxiety, to 45, indicating very

high mathematics anxiety. There were two subscales included in the AMAS, the

Learning Math Anxiety scale (LMA) and the Math Evaluation Anxiety scale (MEA).

Examples of the type of items included as part of the LMA scale were "having to use

tables in the back of a math book" and "listening to a lecture in math class". Examples of

items included as part of the MEA scale were "thinking about an upcoming math test 1

day before" and "taking an examination in a math course".

Hopko et al. (2003) conducted a study to develop and establish the psychometric

properties of the AMAS. The 9-item AMAS was created with a development sample and

the reliability and validity were tested using an additional independent sample. There

were 1,239 undergraduate students that participated in this study (729 females, 510

males). Approximately 91% of the participants were white, and 9% of the participants

were non-white. An exploratory factor analysis was conducted on the 9-item AMAS and

a two-factor solution was identified that accounted for 70% of the variance. The two

factors were best interpreted using the initial subscale designations of Learning Math

Anxiety (LMA) and Math Evaluation Anxiety (MEA). There were five items included in

the LMA factor and four items included as part of the MEA factor. Internal consistency

was found to be excellent for the AMAS ($\alpha = .90$), as well as for the LMA ($\alpha = .85$) and

MEA subscales ($\alpha = .88$). Test-retest reliability was also very good on the AMAS ($r =$

.85), as well as for the two subscale factors LMA ($r = .78$) and MEA ($r = .83$). Strong

convergent validity was found between the original MARS–R and the AMAS ($r = .85$)

(Hopko et al.). A confirmatory factor analysis was conducted on a third replication

sample and results provided strong support for the 9-item abbreviated measure with the

attainment of excellent goodness-of-fit values ($\chi^2 = 50.81, 26$ *df)*. Standardized path

coefficients were reported for the revised model and ranged from .43 (LMA) to .86

(MEA).

<center>Anxiety about Teaching Math (ATM) Scale</center>

Part II of the Mathematics Anxiety and Teaching Efficacy Survey included the

Anxiety about Teaching Math (ATM) scale (Hadley, 2009). Permission to use this scale

was obtained by the researcher from the author (Appendix C). This scale was designed to

measure mathematics teaching anxiety and parallel the abbreviated Math Anxiety Scale

(AMAS) where possible, altering the focus from learning mathematics to teaching

mathematics. The AMAS was designed to investigate the specific anxiety a teacher may

have about teaching mathematics in the elementary classroom. The instrument included

situations that might indicate anxiety about the mathematics currently taught within an

elementary classroom (Hadley, 2005). This section included one question stem

containing nine related items with a range of scores from 9, indicating no anxiety about

teaching mathematics, to a score of 45, indicating very high anxiety about teaching

mathematics. Items on the ATM scale were responded to using a 5-point Likert-type

scale, ranging from 1 (low anxiety) to 5 (high anxiety). The total score represented a

summation of all nine items. Examples of the type of items included as part of the ATM

scale were teaching students how to interpret tables, graphs, and charts" and "preparing

to teach students a new concept that will be challenging to them".

Hadley (2005) used a panel of 10 mathematics education researchers and

educators to evaluate the content validity of the items. Analysis was done using the

results of 14 teachers who were respondents in the pilot testing of the questionnaire. The

results of the pilot study indicated that internal consistency ($\alpha = .90$) and test-retest

reliability ($r = .83$) of the measure were strong.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The third section, Part III, of the Mathematics Anxiety and Teaching Efficacy

Survey was comprised of items from the Mathematics Teaching Efficacy Beliefs

Instrument (MTEBI) (Enochs, Smith, & Huinker, 2000). Permission to use this scale was

obtained from Dr. Larry Enochs of Oregon State University (Appendix C). The MTEBI

was designed to measure teaching self-efficacy and outcome expectancy. This

instrument originally included 21 items, and was altered for the purposes of this study.

Item 18 on the original MTEBI instrument, "Given a choice, I will not invite the principal

to evaluate my mathematics teaching" (Enochs et al., p. 201) was removed from this

section because it was the only item in the questionnaire related to teacher evaluation. This section, therefore, contained two question stems with 20 Likert scaled items. The total scores for this section ranged from 20 indicating very negative beliefs about mathematics teaching efficacy, to 100, indicating very positive beliefs about mathematics teaching efficacy. Items on the MTEBI instrument were responded to using a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Items 3, 6, 8, 15, 17, 18 and 20 on the Mathematics Anxiety and Teaching Efficacy Survey, such as "Even if I try very hard, I do not teach mathematics as well as I teach most subjects", were scored in reverse to produce consistent values between positively and negatively worded items. The total score for mathematics teaching efficacy was determined by summing the 20 items in questions 5 and 6.

There were two subscales included in the MTEBI, the Personal Mathematics Teaching Efficacy (PMTE) subscale, and the Mathematics Teaching Outcome Expectancy (MTOE) subscale. There were 12 items included on the PMTE subscale and eight items on the MTOE. Examples of the type of items included as part of the PMTE subscale were "I will continually find better ways to teach mathematics" and "I know how to teach mathematics concepts effectively". Examples of items included as part of the MTOE scale were "When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort" and "If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching".

Enochs et al. (2000) conducted a study to establish construct validity of the instrument. The factor structure of the MTEBI was examined through a confirmatory

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factor analysis. The original MTEBI instrument consisted of 21 Likert scale items, 13 on

the Personal Mathematics Teaching Efficacy (PMTE) subscale and 8 on the Mathematics

Teaching Outcome Expectance (MTOE) subscale (Enochs et al.). There were 324 pre-

service teachers (58 male and 266 female) from college and university settings in

Wisconsin, California, South Carolina, and Michigan included in the sample. Reliability

analysis produced an alpha level of .88 for the PMTE subscale and an alpha level of .77

for the MTOE subscale. A confirmatory analysis was conducted and indicated that the

two subscales were independent, thus adding to the construct validity of the MTEBI with

the attainment of excellent goodness-of-fit values (χ^2 = 346.70, 184 *df)*.

Demographic Information

The fourth section of the instrument included six demographic questions. Survey

items were constructed as multiple choice and open-ended. These items ascertained

information regarding gender, grade level taught, years of experience teaching

mathematics, highest degree earned, and ethnicity. Excluding the informed consent

question and the screening question to determine eligibility, there were a total of 38 items

on the Mathematics Anxiety and Teaching Efficacy Survey and 6 demographic questions.

According to Darling and Hammond (2000); Hawkins, Stancavage, and Dossey

(1998); and Murnane and Phillips (1981), student achievement is enhanced when teachers

have more than a few years of experience. Teachers were asked to indicate the number

of years of teaching experience they had in the area of mathematics. Based on previous

research, the results for years of teaching experience were later grouped into three categories, 1-3 years, 4-19 years, and 20 or more years.

Data Screening

Submitted surveys were examined by the researcher to ensure that each participant entered their survey code accurately, responded to all of the survey questions, and filled out items related to demographic information. The results were downloaded from www.surveymonkey.com and were imported into a spreadsheet using the Statistical Package for Social Sciences, Version 16.0 (SPSS).

Student achievement data from the 2009 Mathematics FCAT were collected for each third, fourth, and fifth-grade teacher in the school district for the 2008-2009 school year. The data included the class averages for the percentage of students scoring at levels 3-5 on the mathematics portion of the FCAT. The achievement test data were matched to each participating teacher's completed survey using the assigned teacher survey code.

Data Analysis for Question 1

Research Question 1 asked, "To what extent, if any, is there a relationship among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?" To answer Research Question 1, a Pearson's product moment correlation was calculated.

Data Analysis for Question 2

Research Question 2 asked, "To what extent if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?" Teachers' perceived mathematics anxiety was measured by the Mathematics Anxiety and Teaching Efficacy Survey. In order to answer Research Question 2, a factorial Analysis of Variance (ANOVA) was conducted. The dependent variable was elementary teachers' perceived mathematics anxiety (AMAS) score. The independent variables were: (a) gender, (b) grade level taught (3 categories including third, fourth, and fifth), (c) years of experience (3 categories including 1-3 years, 4-19 years, and 20 or more years), (d) highest degree earned (2 categories including bachelor's degree and master's degree), and (e) ethnicity (2 categories including white and non-white).

Data Analysis for Question 3

Research Question 3 asked, "To what extent, if any, is there a mean difference in elementary teachers' perceived anxiety about teaching mathematics based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?" Anxiety about teaching mathematics was measured by the Mathematics Anxiety and Teaching Efficacy Survey. To answer Research Question 3, a factorial Analysis of Variance (ANOVA) was conducted. The dependent variable was elementary teachers' perceived anxiety about teaching mathematics (ATM) score. The independent variables were: (a) gender, (b) grade level taught (3 categories including third, fourth, and

fifth), (c) years of experience (3 categories including 1-3 years, 4-19 years, and 20 or more years), (d) highest degree earned (2 categories including bachelor's degree and master's degree), and (e) ethnicity (2 categories including white and non-white).

Data Analysis for Question 4

Research Question 4 asked, "To what extent, if any, is there a mean difference in mathematics teaching efficacy based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?" Mathematics teaching efficacy was measured by the Mathematics Anxiety and Teaching Efficacy Survey. In order to answer Research Question 4, a factorial Analysis of Variance (ANOVA) was conducted. The dependent variable was the mathematics teaching efficacy (MTEBI) score. The independent variables were: (a) gender, (b) grade level taught (3 categories including third, fourth, and fifth), (c) years of experience (3 categories including 1-3 years, 4-19 years, and 20 or more years), (d) highest degree earned (2 categories including bachelor's degree and master's degree), and (e) ethnicity (2 categories including white and non-white).

Data Analysis for Question 5

Research Question 5 asked, "To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predicts the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest

when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?" To answer Research Question 5, the analysis included a multiple regression to determine if students scoring proficient or above could be predicted. The dependent variable was the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. The independent variables were: (a) elementary teachers' perceived mathematics anxiety (AMAS), (b) anxiety about teaching mathematics (ATM), and (c) mathematics teaching efficacy (MTEBI).

Summary

This chapter detailed the methodology and procedures utilized in analyzing the perceived mathematics anxiety and teaching efficacy of elementary teachers in a west central Florida school district and how these factors were related to student mathematics achievement as measured by students scoring proficient or above on the Mathematics FCAT. The analysis described in this chapter served to establish how certain demographic variables related to mathematics anxiety, mathematics teaching efficacy, and student achievement. The instrumentation used to conduct the study was detailed, and the data collection and analysis techniques were described. Chapter 4 highlights the analysis of data for the participating schools and presents a summary of the analysis of the data for the five research questions used to guide this study.

CHAPTER 4
ANALYSIS OF THE DATA

<u>Introduction</u>

Teachers' perceived anxiety about mathematics, their anxiety about the mathematics they teach, mathematics teaching efficacy beliefs, and their students' mathematics achievement were examined. The results contribute to the existing research on mathematics anxiety and teaching efficacy and the influence these factors have on student achievement. This study was guided by the following five questions:

1. To what extent, if any, is there a relationship among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?

2. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

3. To what extent, if any, is there a mean difference in elementary teachers' perceived anxiety about teaching mathematics based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

4. To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

5. To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity?

Chapter 4 is organized into seven sections. The first section provides a review of the reliability analysis of the survey instrument. Section two depicts an overview of the research population and describes the demographic characteristics revealed through the descriptive analysis. A thorough data analysis for each of the five research questions can be found in sections three through seven.

Reliability Analysis of Survey Instrument

The Mathematics Anxiety and Teaching Efficacy Survey was designed to measure mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy beliefs. The survey instrument was created using three developed scales that were previously tested for reliability and validity.

Abbreviated Math Anxiety Scale (AMAS)

Evidence for construct validity of the nine items of the AMAS was tested using exploratory factor analysis. The first step in determining the factorability of the nine items on the AMAS section was to review the communalities. Communalities were reviewed to ensure that no value exceeded 1.0. Based on this review, there were no items removed for the analysis.

The initial factorability of the nine items was examined using common criteria, including: (a) a review of item correlation, (b) Kaiser-Meyer-Olkin measure of sampling adequacy (overall and individual), (c) Bartlett's test of sphericity, and (d) communalities.

First, all items correlated significantly with all other items ($p < .05$), with 28 of 36 items correlating at least .30 with at least one other item. This relationship is demonstrated in Table 2. Second, the overall Kaiser-Meyer-Olkin measure of sampling adequacy was .84, larger than the recommended value of .50. Additionally, all of the measures of sampling adequacy values for individual values were .77 or above which was larger than the recommended value of .50. Third Bartlett's test of sphericity was statistically significant [$\chi^2(36) = 530.91$, $p < .01$]. It is also desirable to have communalities of .30 or above to provide evidence of shared variance among items. Table 3 indicates that one of the nine items did not meet this criterion point, but given that the other criteria for factorability were met, factor structure analysis was acceptable for proceeding.

Table 2

Correlation Matrix for Abbreviated Math Anxiety Scale (AMAS) Items (N = 115)

Item	1	2	3	4	5	6	7	8	9
2	.26**	—							
3	.36**	.39**	—						
4	.24**	.84**	.47**	—					
5	.28**	.59**	.42**	.56**	—				
6	.37**	.32**	.65**	.36**	.42**	—			
7	.37**	.18*	.45**	.24**	.27**	.65**	—		
8	.26**	.72**	.43**	.71**	.63**	.36**	.17*	—	
9	.45**	.41**	.41**	.36**	.45**	.46**	.40**	.43**	—

*$p > .05$. **$p > .01$.

Table 3

Factor Loadings and Communalities Based on Maximum Likelihood Analysis for Math Anxiety Scale (AMAS) Items (N = 115)

Item	Factor 1	Factor 2	Communality
1. Using tables in back of book	**.98**	-.10	.23
2. Thinking about upcoming math test	**.91**	-.02	.86
3. Watching teacher work algebraic equation on board	**.78**	.04	.54
4. Taking a math exam	**.56**	.22	.81
5. Being given a difficult math assignment due the next class meeting	-.04	**.90**	.48
6. Listening to lecture in a math class	-.15	**.79**	.77
7. Listening to another student explain a math formula	.18	**.62**	.53
8. Being given a math "pop" quiz	.24	**.44**	.64
9. Starting a new chapter in a math book	.09	**.43**	.36

The maximum likelihood estimation procedure with promax rotation was utilized

to extract factors from the data. Initial eigenvalues indicated the first two factors

explained 50% and 17% of the variance, respectively. The remaining factors did not have eigenvalues greater than one. Therefore, solutions for more than two factors were not examined. The two-factor solution, which represented 58% of the variance explained when extracted, was preferred due to theoretical support, review of the scree plot, and difficulty in interpreting solutions with three or more factors. The correlation between the two extracted factors was .51.

All items contributed to a simple factor structure with a primary factor loading of .43 or above which was above the recommended value of .30. Each item fell clearly into one of the two factors. Table 3 provides the factor loading pattern matrix for the final solution. The first factor was named Mathematics Assessment Anxiety, as these four items addressed teachers' perceptions of being tested or quizzed on mathematics. The second factor was named Learning Process Anxiety, as it addressed any issues with anxiety related to learning mathematics. These two groupings were supported by internal structure validity evidence addressing measurements of these specific topics. These two factors did not include the same items as previously reported by the original authors.

Internal consistency for these subscales was examined using Cronbach's alpha. These values were .89 for Mathematics Assessment Anxiety and .83 for Learning Process Anxiety. A substantial increase in Cronbach's alpha would not be achieved by deleting any items from the scales.

Composite scores were created for the two factors by computing the means for each of the factors. Higher scores indicated a greater degree of anxiety in learning mathematics. Descriptive statistics for these scales are provided in Table 4.

Table 4

Descriptive Statistics for Math Anxiety Scale (AMAS) Items (N = 115)

Item	Mathematics Assessment Anxiety (n = 4)	Learning Process Anxiety (n = 5)
Mean	3.06	1.04
Standard Deviation	1.85	0.78
Cronbach's Alpha	.89	.83

Anxiety About Teaching Math (ATM) Scale

Evidence for construct validity of the nine items was tested using exploratory

factor analysis. The first step in determining the factorability of the nine items on the

ATM section was to review the communalities. Communalities were reviewed to ensure

that no value exceeded 1.0. Based on this review, there were no items removed prior to

the analysis.

The initial factorability of the nine items was examined using common criteria,

including: (a) a review of item correlation, (b) Kaiser-Meyer-Olkin measure of sampling

adequacy (overall and individual), (c) Bartlett's test of sphericity, and (d) communalities.

In examining the factor extraction, which utilized maximum likelihood estimation

with promax rotation, initial eigenvalues indicated that two explaining 49% and 14% of

the variance respectively, should be extracted. However, in examining the scree plot,

only one factor was apparent. Combined with the theoretical support that the ATM was

designed to measure one major construct, the decision was made to re-run the factor

analysis as a single factor.

First, all items correlated significantly with all other items ($p < .05$), with 29 of 36 items correlating at least .30 with at least one other item. This relationship is demonstrated in Table 5. The overall Kaiser-Meyer-Olkin measure of sampling adequacy was .85, larger than the recommended value of .50. Additionally, the measure of sampling adequacy values for individual values were all .76 or above, larger than the recommended value of .50. Bartlett's test of sphericity was statistically significant [$\chi^2(36) = 432.05, p < .01$]. An additional criterion commonly used to determine factorability is that communalities should be recommended above the value of .30. When this occurs, it provides evidence of shared variance among items. Table 6 indicates that two of the nine items did not meet this criterion value, but given that the other criteria for factorability were met, factor structure analysis was acceptable for proceeding.

Table 5
Correlation Matrix for Anxiety about Teaching Math (ATM) Items (N = 117)

Item	1	2	3	4	5	6	7	8	9
2	.30**	—							
3	.40**	.28**	—						
4	.33**	.48**	.36**	—					
5	.40**	.56**	.53**	.49**	—				
6	.40**	.46**	.42**	.60**	.61**	—			
7	.50**	.21*	.60**	.29**	.39**	.30**	—		
8	.25**	.38**	.54**	.37**	.57**	.42**	.52**	—	
9	.24**	.59**	.25**	.50**	.47**	.47**	.21*	.38**	—

*$p > .05$. **$p > .01$.*

Table 6

Factor Loadings and Communalities Based on Maximum Likelihood Analysis for Anxiety about Teaching Math (ATM) Items (N = 117)

Item	Factor 1	Communality
1. Teaching students how to interpret tables, graphs, charts	.81	.26
2. Preparing students for year-end math test	.73	.42
3. Working out math equations on board in front of class of students	.67	.40
4. Preparing presentation for parents about math curriculum taught	.66	.44
5. Preparing to teach students challenging new concept	.65	.65
6. Explaining rationale for math curriculum to parent	.63	.53
7. Talking to student who wanted to solve math problem differently	.61	.29
8. Writing a lesson plan for teaching a new math concept	.54	.44
9. Waiting for end-of-year math test results	.52	.37

The maximum likelihood estimation procedure with promax rotation was utilized to extract the factors from the data. Initial eigenvalues indicated that the first factor explained 49% of the variance. This solution, which represented 42% of the variance explained when extracted, was preferred due to theoretical support, review of the scree plot, and difficulty in interpreting solutions with multiple factors.

All items contributed to a simple factor structure with a primary factor loading of .52 or above which was above the recommended value of .30. Only one factor was ultimately extracted, indicating that all items contributed to a description of anxiety about teaching mathematics. This single group was supported by internal structure validity evidence addressing a singular measurement on this given topic.

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Internal consistency for this scale was examined using Cronbach's alpha. This value was .86. A substantial increase in Cronbach's alpha would not be achieved by deleting any items from the scale. A composite score was created for the factor by computing the mean for all items. Higher scores indicate a greater degree of anxiety in teaching mathematics. Descriptive statistics for this scale are provided in Table 7.

Table 7
Descriptive Statistics for Anxiety about Teaching Math *(ATM) Items (N = 117)*

Items ($n = 9$)	Numeric Value
Mean	1.93
Standard Deviation	0.65
Cronbach's Alpha	.86

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

Evidence for construct validity of the 20 items in Part III, questions 5 and 6, of the MTEBI section on the Mathematics Anxiety and Teaching Efficacy Survey, was tested using exploratory factor analysis. The first step in determining the factorability of the 20 items on the MTEBI section was a review of the communalities. Communalities were reviewed to ensure that no value exceeded 1.0. Based on this review, there were two items, 4 and 15, with values of .999 that were removed. Though the factor analysis still reported communalities of above .999 after the removal of these two items, no more items showed excessively high values. This occurrence eventually led to a decision to limit the number of extractable factors to two, through a combination of scree plot

examination, eigenvalues, theoretical support, and usability of factor sizes. Forcing the extraction of only two factors eliminated any warnings of communalities exceeding 1.0.

The initial factorability of the remaining 18 items was examined using common criteria, including: (a) a review of item correlation, (b) Kaiser-Meyer-Olkin measure of sampling adequacy (overall and individual), (c) Bartlett's test of sphericity, and (d) communalities.

First, all items correlated significantly with all other items ($p < .05$), with 53 of 153 items correlating at least .30 with at least one other item. This relationship is demonstrated in the correlation matrix for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) items displayed in Appendix F. The overall Kaiser-Meyer-Olkin measure of sampling adequacy was .89, larger than the recommended value of .50. Additionally, the measure of sampling adequacy values for individual items were all .66 or above, larger than the recommended value of .50. Bartlett's test of sphericity was statistically significant [$\chi^2(153) = 640.83$, $p < .01$]. It is also desirable to have communalities of .30 or above to provide evidence of shared variance among items. Table 8 indicates that 7 of 18 items did not meet this criterion point, but given that the other criteria for factorability were met, factor structure analysis was acceptable for proceeding.

Table 8

Factor Loadings and Communalities Based on Maximum Likelihood Analysis for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) Items (N = 114)

Item	Factor 1	Factor 2	Communality
1. Students do better in math because I exerted extra effort	**.81**	-.03	.15
2. I find better ways to teach math	**.73**	.17	.22
3. Even when trying hard I do not teach math as well as most other subjects	**.71**	.02	.39
5. I know how to teach math concepts effectively	**.69**	-.03	.48
6. I am not effective in monitoring math activities	**.68**	.03	.20
7. Students underachieve in math due to ineffective math teaching	**.62**	.05	.31
8. I generally teach math ineffectively	**.61**	.06	.45
9. Inadequacy of students' math background can be overcome by good teaching	**.61**	.03	.17
10. Low-achieving students progressing in math is due to my extra attention	**.56**	.08	.13
11. I understand math concepts well enough to be effective in teaching	**.48**	-.01	.67
12. I am generally responsible for student math achievement	**.47**	-.06	.18
13. Student math achievement is directly related to my effectiveness in teaching	**.25**	.17	.47
14. If parents comment about student's increased interest in math it is probably due to my performance	.02	**.68**	.22
16. I am typically able to answer student math questions	-.44	**.55**	.41
17. I wonder if I have the necessary skills to teach math	.11	**.41**	.63
18. When a student has difficulty in understanding a math concept I struggle to help student understand it	.07	**.38**	.41
19. When teaching math I usually welcome student questions	.15	**.35**	.52
20. I do not know how to develop student interest and motivation to learn math	.16	**.30**	.36

Maximum likelihood estimation with promax rotation was utilized to extract the factors from the data. Initial eigenvalues indicated that the first two factors explained 33% and 10% of the variance, respectively. The remaining factors did not have eigenvalues greater than one. Therefore, solutions for more than two factors were not examined. The two-factor solution, which represented 35% of the variance explained when extracted, was preferred due to theoretical support, review of the scree plot, and difficulty in interpreting solutions with three or more factors. The correlation between the two extracted factors was .40.

All items contributed to a simple factor structure with a primary factor loading of .25 or above with only this lowest item below the recommended value of .30. Each item fell clearly into one of the two factors. The first factor was named Understanding and Effectiveness, as these 12 items addressed teachers' perceptions of their understanding of mathematics or their effectiveness in communicating it to students. The second factor was named Student Achievement, as it addressed their perceived importance on student achievement levels in mathematics. These two groupings were supported by internal structure validity evidence addressing measurements on these specific topics. The items included on these two subscales were different than previously reported and identified by the original authors.

Internal consistency for these subscales was examined using Cronbach's alpha. Values were .88 for Understanding and Effectiveness and .56 for Student Achievement. A substantial increase in Cronbach's alpha would not be achieved by deleting any items

from the scales. Although the achievement factor had a Cronbach's alpha that was slightly less desirable, it was sufficiently strong.

Composite scores were created for the two factors by computing the means which loaded most strongly on each of the factors. Higher scores indicated a greater degree of perceived efficacy in teaching mathematics. Descriptive statistics for these scales are provided in Table 9.

Table 9
Descriptive Statistics for MTEBI Items (N = 114)

Item	Understanding and Effectiveness ($n = 12$)	Student Achievement ($n = 6$)
Mean	4.18	3.60
Standard Deviation	0.49	0.43
Cronbach's Alpha	.87	.55

Population

The population of this study included all third, fourth, and fifth grade teachers employed by a west central Florida school district during the 2008-2009 school year. This population consisted of 128 teachers in 11 elementary schools across the county. Of the teachers invited to participate, 119 (93.0%) from the 11 elementary schools completed a survey.

Of the 119 teachers who participated in the study, 7.6% ($n = 9$) were male and 92.4% ($n = 110$) were female. Approximately 41.2% ($n = 49$) taught third grade, 31.9% ($n = 38$) taught fourth grade, and 26.9% ($n = 32$) taught fifth grade during the 2008-2009

school year. Years of experience teaching elementary mathematics for the respondents ranged from one to 21 years or more. There were 16.8% ($n = 20$) of the teachers had 1-3 years of experience, 61.3% ($n = 73$) who had 4-19 years of experience, and 21.8% ($n = 26$) who had 20 or more years of experience. The results indicated that there were 63% ($n = 75$) of the participants who indicated that a bachelor's degree was the highest degree earned and 37% ($n = 44$) who had earned a master's degree. Ethnicity was not fairly distributed across the categories, with 95% ($n = 113$) of respondents reporting their ethnicity as white, and the remaining 5% ($n = 6$) of respondents selected a minority classification. Based on the unequal group size, the categories were narrowed into white and non-white by the researcher.

<div align="center">Creation of Composite Subscores</div>

The researcher arrived at the composite score for teachers' perceived mathematics anxiety, as measured by the Abbreviated Math Anxiety Scale (AMAS), by summing the responses to the nine items in Part I, question 3 on the Mathematics Anxiety and Teaching Efficacy Survey. This sum was calculated based on information from the 5-point Likert-type scale, ranging from 1 to 5 (1 = low anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = quite a bit of anxiety, and 5 = high anxiety) for each item.

The researcher arrived at the composite score for anxiety about teaching mathematics, as measured by the Anxiety about Teaching Mathematics scale (ATM), by summing the responses to the nine items in question 4 on the Mathematics Anxiety and Teaching Efficacy Survey. This sum was calculated based on information from the 5-

point Likert-type scale, ranging from 1 to 5 (1 = low anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = quite a bit of anxiety, and 5 = high anxiety) for each item.

Similarly, the composite score for mathematics teaching efficacy, as measured by the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), was determined by summing the responses to the 20 items in questions 5 and 6 on the Mathematics Anxiety and Teaching Efficacy Survey. This sum was calculated based on information from the 5-point Likert-type scale, ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree, and 5 = strongly agree) for each item. Reverse coding was used for several of the items to account for positively and negatively worded phrasing. A mean score for each scale was then determined by dividing the composite subscore by the number of items within the scale. This mean score was used to interpret results based on the descriptions provided within the Likert scales.

Research Question 1

To what extent, if any, is there a relationship between elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?

A Pearson's product moment correlation was generated to determine to what extent, if any, were there relationships between the three components of the Mathematics Anxiety and Teaching Efficacy Survey (teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy) and student achievement as measured by the percentage of students for each teacher scoring proficient or above on

the 2009 FCAT mathematics subtest. An alpha level of .05 was used to conduct the correlation analyses.

Review of the scatterplot of the variables suggested that linear relationships between the variables were feasible, and thus the researcher proceeded with conducting the correlation procedure. Although some of the scatterplots suggested that there was only a slight linear relationship, there was no evidence of a curvilinear or other non-linear relationship. The results of the Pearson's product moment correlation between the three components (teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy) and student achievement are found in Table 10.

The correlation calculations for each of the three components of the Mathematics Anxiety and Teaching Efficacy Survey (teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy) and student achievement were as follows: teachers' perceived mathematics anxiety ($r = .04$, $r^2 = .002$, $p = .656$), anxiety about teaching mathematics ($r = -.09$, $r^2 = .008$, $p = .320$), and mathematics teaching efficacy ($r = .21$, $r^2 = .044$, $p = .026$). The anxiety-related variables (teachers' perceived mathematics anxiety, $r = .04$, $r^2 = .002$, $p = .656$, and anxiety about teaching mathematics, $r = -.09$, $r^2 = .008$, $p = .320$), were not significantly correlated with the percentage of students in the classroom scoring proficient or above. Shared variance between the variables of teachers' perceived mathematics anxiety and the percentage of students in the classroom scoring proficient or above on the 2009 Mathematics FCAT was approximately 0.2%, generally interpreted to be a small effect (Cohen, 1988).

Similarly, the shared variance between the variables of anxiety about teaching

mathematics and the percentage of students scoring proficient or above was

approximately 0.8%, which is also interpreted to be a small effect (Cohen).

Table 10

Pearson Product-Moment Correlations Between Teachers' Perceived Mathematics
Anxiety, Anxiety about Teaching Mathematics, and Mathematics Teaching Efficacy and
the Percentage of Students Scoring Proficient or Above (N = 119)

Variable	2	3	4
1. Percentage of students scoring proficient or above	.04	-.09	.21*
2. Perceived mathematics anxiety	--	.30**	-.09
3. Anxiety about teaching mathematics		--	-.39**
4. Mathematics teaching efficacy			--

Note. All correlations with Anxiety about Teaching Mathematics utilized ($N = 118$).
* $p < .05$. ** $p < .01$.

Mathematics teaching efficacy, however, was significantly correlated in a positive

direction with the percentage of students scoring proficient or above on 2009 Florida

Comprehensive Assessment Test (FCAT) mathematics subtest ($r = .21$, $r^2 = .044$, $p =$

.026). In other words, as mathematics teaching efficacy rose, so did the percentage of

students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test

(FCAT) mathematics subtest. Shared variance between mathematics teaching efficacy

and the percentage of students scoring proficient or above was approximately 4%,

generally interpreted to be a small to moderate effect (Cohen, 1988).

There was also a statistically significant positive correlation between teachers'

perceived mathematics anxiety and anxiety about teaching mathematics ($r = .30$, $r^2 =$

0.09, $p = .001$). As perceived mathematics anxiety rose, so did anxiety about teaching mathematics. Shared variance between these was approximately 9%, generally interpreted to be a moderate effect (Cohen, 1988).

Likewise, there was a statistically significant negative correlation between anxiety about teaching mathematics and mathematics teaching efficacy ($r = -.39$, $r^2 = 0.15$, $p = .000$). As teachers cited increased anxiety about teaching mathematics, their efficacy of teaching mathematics decreased. Shared variance between anxiety about teaching mathematics and mathematics teaching efficacy was approximately 15%, generally interpreted to be a large effect (Cohen, 1988). Perceived mathematics anxiety and mathematics teaching efficacy did not, however, share a statistically significant relationship ($r = -.09$, $r^2 = 0.008$, $p = .313$).

Research Question 2

To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

To answer Research Question 2, descriptive statistics were explored for the five demographic variables included in the survey in order to determine if there was a difference in elementary teachers' perceived mathematics anxiety based on teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity. In order to further investigate differences not explained through descriptive statistics, the researcher initially set out to conduct a factorial Analysis of Variance (ANOVA).

Gender and Ethnicity

There was very little variability in the gender and ethnicity for the respondents who completed the Mathematics Anxiety and Teaching Efficacy Survey. Of the 119 respondents, 91.6% ($n = 109$) completed all items within the AMAS section of the survey instrument. Of those included, 92.7% ($n = 101$) were female and 7.3% ($n = 8$) were male. Of those who responded to all items on the AMAS section, 96.3% ($n = 105$) were white and 3.7% ($n = 4$) were non-white. Gender and ethnicity were not included in the factorial ANOVA model due to minimal variability and thus only descriptive statistics were reported for these variables.

When considering the AMAS factor, Mathematics Assessment Anxiety, male participants had a slightly lower mean score ($M = 2.66$, $SD = 1.15$, $n = 8$) as compared to the females ($M = 3.06$, $SD = 1.05$, $n = 101$). The effect size, d, was calculated to be 0.36 using the pooled standard deviation, and is interpreted to be a small to moderate effect size (Cohen, 1988). No statistical tests were performed, but the evidence revealed that males indicated similar anxiety levels about assessment related to mathematics as their female counterparts.

Reviewing the AMAS factor, Learning Process Anxiety, male participants had a slightly higher mean score ($M = 1.90$, $SD = .80$, $n = 8$) as compared to the females ($M = 1.81$, $SD = .72$, $n = 101$). The effect size, d, was calculated to be 0.11 using the pooled standard deviation, and is interpreted to be a small effect size (Cohen, 1988). No statistical tests followed, but the evidence showed that males exhibited relatively similar anxiety levels about the process of learning mathematics as females.

Review of the results for the category of ethnicity indicated that white participants had a slightly lower mean score for the factor of Mathematics Assessment Anxiety ($M = 3.03$, $SD = 1.05$, $n = 105$) as compared to non-white participants ($M = 3.13$, $SD = 1.56$, $n = 4$). The effect size, d, was calculated to be -0.08 using the pooled standard deviation, and is interpreted to be a small effect size (Cohen, 1988). No statistical tests followed, but the evidence showed that white respondents exhibited relatively similar anxiety levels about the assessment of mathematics as non-white respondents.

Investigation of the AMAS factor, Learning Process Anxiety, indicated that white participants had a lower mean score ($M = 1.81$, $SD = .72$, $n = 105$) than did non-white participants ($M = 2.1$, $SD = .81$, $n = 4$). The effect size, d, was calculated to be -0.38 using the pooled standard deviation and was interpreted to be a small to moderate effect size (Cohen, 1988). No statistical tests were conducted, but the evidence showed that white respondents exhibited relatively similar anxiety levels about the process of learning mathematics as non-white respondents.

Grade Level Taught, Years of Experience, and Highest Degree

The objective was to determine any mean differences in AMAS scores when demographic factors, including gender, grade level taught, years of experience in teaching mathematics, highest degree attained, and ethnicity, were considered. Initially the desired analytical procedure was a five-way factorial ANOVA. Due to unequal group size based on gender and ethnicity, the researcher addressed these variables on a strictly descriptive basis. Also, when using the literature-recommended grouping for years of

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experience, it became apparent that there would be a violation of cell sizes. Many cells contained only one individual or none at all. Instead of conducting several one-way ANOVAs, the researcher conducted a pair of two-way ANOVAs in order to examine the interactions between the variables.

Therefore, two separate two-way ANOVA tests were conducted for each of the two AMAS factors (Mathematics Assessment Anxiety and Learning Process Anxiety). The first set of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable, elementary teachers' perceived mathematics anxiety, based on grade level taught (three levels) and years of experience (three levels). The second set of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable, elementary teachers' perceived mathematics anxiety, based on grade taught (three levels) and highest degree earned (two levels). Although some slight duplication occurred by including grade level twice, the focal point in the second analysis was whether there were any significant differences in the dependent variable when accounting for the interaction, something that could not be attained by running a one-way ANOVA.

To control for the increased probability of making a Type I error since two factorial ANOVAs were conducted, the Bonferroni adjustment was applied. Results were examined using an alpha of .025.

AMAS Mathematics Assessment Anxiety, Grade Level, and Years of Experience

Assumptions for the two-way ANOVA between grade level taught and years of experience in determining mathematics assessment related anxiety in learning mathematics were tested and residuals were reviewed prior to conducting the ANOVA. Boxplots did not indicate any potential outliers, so no removals were necessary. Other assumptions of the test were reviewed and met. Skewness (-.20) and kurtosis (-.94) values, the histogram, and Q-Q plots suggested approximate normality. Although the Kolmogorov-Smirnov test of normality ($D = .10$, $df = 117$, $p = .01$) suggested formally that normality may not have been present, the researcher made the determination, based on other evidence and indices, that normality was still a reasonable assumption.

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(8, 108) = .46$, $p = .881$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that suggested a violation of independence. Based on the dot plot, there were no observable trends.

The F ratio is not statistically significant for either main effect. It is also not statistically significant for the interaction. The ANOVA indicated no statistically significant main effect for grade level taught, $F(2,108) = 1.50$, $p = .23$, eta squared = .03. Additionally, there was no statistically significant main effect for years of experience, $F(2,108) = .81$, $p = .45$, eta squared = .02. Lastly, there was no statistically significant interaction between grade level taught and years of experience $F(4, 108) = .82$, $p = .51$, eta squared = .03. At most, eta squared indicated that the proportion of AMAS

mathematics assessment anxiety accounted for by the main effects or interaction was approximately 3%.

Because the omnibus F test was not statistically significant, post-hoc comparisons were not performed. The results of the analysis indicated that there was no difference in the degree of anxiety reported by teachers related to assessment, on average, based on grade level taught, years of experience, or the interaction between these two variables. The means and standard errors for all levels of the independent variables are displayed in Tables 11 and 12.

Table 11
Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Mathematics Assessment Anxiety by Grade Level Taught and Years of Experience: Main Effects (N = 117)

	Grade Taught			Years of Experience		
Statistic	Third	Fourth	Fifth	1-3	4-19	20+
M	3.20	3.33	2.85	3.25	2.95	3.18
SE	0.18	0.22	0.20	0.24	0.13	0.21
n	49	36	32	20	71	26

Table 12

Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Mathematics
Assessment Anxiety by Grade Level Taught and Years of Experience: Interaction
(N = 117)

	Grade Taught		
Experience	Third	Fourth	Fifth
1-3 Years			
M	3.41	3.80	2.54
SE	0.37	0.47	0.40
n	8	5	7
4-19 Years			
M	3.02	3.05	2.78
SE	0.19	0.21	0.27
n	31	25	15
20+ Years			
M	3.18	3.13	3.23
SE	0.33	0.43	0.33
n	10	6	10

AMAS Learning Process Anxiety, Grade Level, and Years of Experience

Assumptions for the two-way ANOVA between grade level taught and years of

experience in determining learning process related anxiety were tested prior to

conducting the ANOVA. One potential outlier was identified by the boxplots. This

observation was removed and subsequent results reflected the absence of this outlier.

According to Levene's test of equality of variances, the variances could not be

assumed to be homogeneous $F(8,107) = 2.68$, $p = .01$. Therefore, the spread versus level

plots were checked for possible actions. Since there was a linear relationship between the

standard deviation and mean; and all raw data values were positive, a log transformation was taken of all the AMAS factor data points.

Assumption testing was conducted and residuals were reviewed for the transformed values. Skewness (.45) and kurtosis (-.75) values, the histogram, and Q-Q plots suggested approximate normality, as well as the Kolmogorov-Smirnov formal test of normality ($D = .07$, $df = 116$, $p = .20$).

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous $F(8,107) = 1.42$, $p = .20$. Since the groups were not randomly assigned, independence cannot be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that may suggest a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA indicated no statistically significant main effect for grade level taught $F(2,107) = 0.05$, $p = .95$, eta squared = .001. There was, however, a statistically significant effect for years of experience, $F(2,107) = 5.38$, $p < .01$, eta squared = .09. Lastly, there was no statistically significant interaction between grade level taught and years of experience, $F(4,107) = 0.51$, $p = .73$, eta squared = .02. Eta squared indicated that the proportion of AMAS learning process related anxiety behavior based on the log transformations scores accounted for by years of experience was approximately 9%.

Because the omnibus F test for years of experience was significant, and because neither the test for significant effect of grade level taught nor the test for significant interaction effects were significant, only a post-hoc comparison for years of experience was conducted. Keeping in mind that these values are logs of the original values, teachers

with 1-3 years of experience were significantly less anxious about the log transformed

mathematics learning process ($M = 1.39$, $SE = 0.09$) than were the teachers with 20 or

more years of experience ($M = 2.01$, $SE = 0.08$). For the post-hoc analysis, this difference

was significant at $p < .01$.

The results of this analysis indicated that there was no difference in the log

transformed degree of anxiety reported by teachers when learning mathematics, on

average, based on grade level taught, or based on the interaction between grade level

taught and years of experience. However, less experienced teachers were less anxious

than their highly experienced counterparts when learning mathematics. The means and

standard errors for all levels of the independent variables are displayed in Tables 13 and

14.

Table 13
Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Learning Process
Anxiety by Grade Level Taught and Years of Experience: Main Effects, Log-Transformed
(N = 116)

Statistic	Grade Taught			Years of Experience		
	Third	Fourth	Fifth	1-3	4-19	20+
M	1.68	1.63	1.68	1.39	1.67	2.01
SE	0.06	0.08	0.07	0.09	0.05	0.07
n	48	36	32	19	71	26

Table 14

Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Learning Process Anxiety by Grade Level Taught and Years of Experience: Interaction, Log-Transformed (N = 116)

	Grade Taught		
Experience	Third	Fourth	Fifth
1-3 Years			
M	1.46	1.35	1.35
SE	0.13	0.18	0.14
n	8	4	7
4-19 Years			
M	1.79	1.58	1.62
SE	0.07	0.07	0.09
n	30	26	15
20+ Years			
M	1.84	2.03	2.16
SE	0.12	0.15	0.12
n	10	6	10

AMAS Mathematics Assessment Anxiety, Grade Level, and Highest Degree

Assumptions for the two-way ANOVA between grade level taught and highest degree earned in determining mathematics assessment related anxiety were tested prior to conducting the ANOVA. Boxplots did not indicate any potential outliers, so no removals were necessary. Other assumptions of the test were reviewed and met. Skewness (-.11) and kurtosis (-.93) values, the histogram, and Q-Q plots suggested approximate normality. The results of the Kolmogorov-Smirnov test of normality ($D = .08$, $df = 117$, $p = .05$) suggested that normality was a reasonable assumption.

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(5, 111) = .67$, $p = .65$. Since the groups were not randomly assigned,

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independence cannot be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that may suggest a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA verified that there was no statistically significant main effect for grade level taught, $F(2,111) = 0.64$, $p = .53$, eta squared = .01. Additionally, there was no statistically significant main effect for highest degree earned, $F(1,111) = 0.44$, $p = .51$, eta squared = .004. Lastly, there was no statistically significant interaction between grade level taught and highest degree earned, $F(2, 111) = 0.52$, $p = .60$, eta squared = .01. At most, eta squared indicated that the proportion of AMAS mathematics assessment anxiety accounted for by the main effects or interaction was only 1%.

Because the omnibus F test was not statistically significant, post-hoc comparisons were not conducted. The means and standard errors for all levels of the independent variables are displayed in Tables 15 and 16, indicated that there was not a significant difference in the degree of anxiety reported by teachers related to assessment, on average, based on grade level taught, highest degree earned, or the interaction between these two variables.

Table 15

Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Mathematics
Assessment Anxiety by Grade Level Taught and Highest Degree Level: Main Effects
(N = 117)

Statistic	Grade Taught			Degree Earned	
	Third	Fourth	Fifth	Bachelor	Master
M	3.12	3.10	2.86	3.09	2.96
SE	0.15	0.19	0.19	0.13	0.16
n	49	36	32	73	44

Table 16

Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Mathematics
Assessment Anxiety by Grade Level Taught and Highest Degree Level: Interaction
(N = 117)

	Grade Taught		
Degree	Third	Fourth	Fifth
Bachelor			
M	3.08	3.30	2.90
SE	0.20	0.22	0.24
n	29	24	20
Master			
M	3.16	2.90	2.81
SE	0.24	0.30	0.30
n	20	12	12

AMAS Learning Process Anxiety, Grade Level, and Highest Degree

Assumptions for the two-way ANOVA between grade level taught and highest

degree earned in determining learning process related anxiety were tested prior to

conducting the ANOVA. Two potential outliers were identified in the boxplots. These

observations were removed and subsequent results reflect the absence of these outliers.

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According to Levene's test of equality of variances, the variances could not be assumed to be homogeneous $F(5,109) = 2.73$, $p = .02$. Therefore the spread versus level plots were checked for possible actions. Since there was a linear relationship between the standard deviation and mean and all raw data values were positive, a log transformation was taken of all the data points.

Assumption testing was conducted for the transformed values. Skewness (.17) and kurtosis (-.86) values, the histogram, and Q-Q plots suggested approximate normality. Although the Kolmogorov-Smirnov formal test of normality ($D = .09$, $df = 115$, $p = .04$) suggested normality may not have been present, the researcher made the determination based upon the other evidence that normality was still a reasonable assumption.

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous $F(5,109) = 1.55$, $p = .18$. Since the groups were not randomly assigned, independence cannot be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that may suggest a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA indicated no statistically significant main effect for grade level taught $F(2,109) = 0.12$, $p = .89$, eta squared = .002. Additionally, there was no statistically significant main effect for highest degree earned $F(2,109) = 3.80$, $p = .05$, eta squared = .03. Lastly, there was no statistically significant interaction between grade level taught and highest degree earned, $F(2,109) = 0.06$, $p = .60$, eta squared = .001. At

most, eta squared indicated that the proportion of AMAS learning process related anxiety

behavior accounted for the main effects or interaction was 3%.

Because the omnibus *F* test was not statistically significant, post-hoc comparisons

were not conducted. The means and standard errors for all levels of the independent

variables are displayed in Tables 17 and 18, indicated that there was not a difference in

AMAS scores measuring learning process anxiety, on average, based on grade level

taught, highest degree earned, or the interaction between these two variables.

Table 17
Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Learning Process Anxiety by Grade Level Taught and Highest Degree Level: Main Effects, Log-Transformed (N = 115)

Statistic	Grade Taught			Degree Earned	
	Third	Fourth	Fifth	Bachelor	Master
M	1.73	1.67	1.72	1.60	1.84
SE	0.05	0.07	0.07	0.04	0.06
n	47	36	32	71	44

Table 18

Descriptive Statistics for Abbreviated Math Anxiety Scale (AMAS) Learning Process
Anxiety by Grade Level Taught and Highest Degree Level: Interaction, Log-Transformed
(N = 115)

	Grade Taught		
Degree	Third	Fourth	Fifth
Bachelor			
M	1.60	1.55	1.63
SE	0.07	0.08	0.08
n	27	24	20
Master			
M	1.88	1.80	1.82
SE	0.08	0.11	0.11
n	20	12	12

Research Question 3

To what extent, if any, is there a mean difference in elementary teachers'
perceived anxiety about teaching mathematics based on teacher (a) gender; (b) grade
level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

To answer Research Question 3, descriptive statistics were explored for the five

demographic variables included in the Mathematics Anxiety and Teaching Efficacy

Survey in order to determine if there was a statistically significant difference in

elementary teachers' perceived anxiety about teaching mathematics based on teacher (a)

gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e)

ethnicity. In order to further investigate differences not explained through descriptive

statistics, the researcher initially set out to conduct a factorial Analysis of Variance

(ANOVA).

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Gender and Ethnicity

There was very little variability in gender and ethnicity for the respondents who completed the Mathematics Anxiety and Teaching Efficacy Survey. Of the 119 respondents, 91.6% ($n = 109$) of them completed all items within the ATM section of the survey instrument. Of those included, 92.7% ($n = 101$) were female and 7.3% ($n = 8$) were male. Of those who responded to all items on the ATM section, 96.3% ($n = 105$) were white and 3.7% ($n = 4$) were non-white. Gender and ethnicity were not included in the factorial ANOVA model due to minimal variability, and only descriptive statistics were reported for these variables.

Male participants had a slightly lower anxiety about teaching mathematics (ATM) mean score ($M = 1.68$, $SD = 0.83$, $n = 8$) as compared to the female respondents ($M = 1.93$, $SD = 0.65$, $n = 101$). The effect size, d, was calculated to be -0.33 using the pooled standard deviation. This has generally been interpreted to be a small to moderate effect (Cohen, 1988). No statistical tests were run, but the evidence showed that males reported similar levels of anxiety about their teaching of mathematics as females.

The non-white respondents had a higher anxiety about teaching mathematics (ATM) mean score ($M = 2.02$, $SD = 1.15$, $n = 4$) compared to the white respondents ($M = 1.91$, $SD = 1.15$, $n = 105$). The effect size, d, was calculated to be -0.12 using the pooled standard deviation which has generally been interpreted to be a small effect (Cohen, 1988). No statistical tests were conducted, but the evidence showed that non-white teachers exhibit generally similar anxiety levels about their teaching of mathematics as white teachers.

Grade Level Taught, Years of Experience, and Highest Degree

The goal was to determine any significant difference in ATM score when demographic factors, including grade level taught, years of experience in teaching mathematics, and highest degree earned, were considered. Initially, the desired analytical procedure was a three-way factorial ANOVA. Due to unequal group size based on gender and ethnicity, the researcher addressed these variables on a strictly descriptive basis. Also, when using the literature-recommended grouping for years of experience, it became apparent that there would be a violation of cell sizes, with many cells containing only one individual or none at all. Instead of conducting several one-way ANOVAs, the researcher conducted a pair of two-way ANOVAs in order to examine the interactions between the variables.

Therefore, two separate two-way ANOVA tests were performed for the ATM factor. The first test involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught (three levels) and years of experience (three levels). The second test involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught (three levels) and highest degree earned (two levels). Although some slight duplication occured by including grade level twice, the focal point in the second analysis was the determination of significant differences in the dependent variable when accounting for the interaction, something that could not be attained by performing a one-way ANOVA.

ATM, Grade Level, and Years of Experience

Assumptions for the two-way ANOVA between grade level taught and years of experience in determining anxiety in teaching mathematics were tested prior to conducting the ANOVA. An initial examination of boxplots displayed four outliers which were removed prior to testing. All subsequent results reflected the smaller sample size. Other assumptions of the test were reviewed. Skewness (-.59) and kurtosis (-.10) values, the histogram, and Q-Q plots suggested approximate normality, as well as the Kolmogorov-Smirnov test of normality ($D = .06$, $df = 113$, $p = .20$).

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(8, 104) = 1.39$, $p = .21$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that suggested a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA indicated no statistically significant main effect for grade level taught, $F(2, 104) = 0.70$, $p = .50$, eta squared = .03. Additionally, there was no statistically significant main effect for years of experience, $F(2, 104) = 1.02$, $p = .37$, eta squared = .02. Lastly, there was no statistically significant interaction between grade level taught and years of experience, $F(4, 104) = 0.59$, $p = .67$, eta squared = .02. At most, eta squared indicated that the proportion of ATM accounted for by the main effects or interaction was approximately 2%.

Because the omnibus F test was not statistically significant, post-hoc comparisons were not conducted. The means and standard errors for all levels of the independent

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variables are displayed in Tables 19 and 20, and indicate that there was no difference, on

average, in the degree of anxiety reported by teachers when teaching mathematics based

on grade level taught, years of experience, or the interaction between these two variables.

Table 19
Descriptive Statistics for Anxiety About Teaching Math (ATM) Scale by Grade Level Taught and Years of Experience: Main Effects (N = 113)

	Grade Taught			Years of Experience		
Statistic	Third	Fourth	Fifth	1-3	4-19	20+
M	1.85	1.95	1.75	1.95	1.89	1.71
SE	0.10	0.13	0.11	0.13	0.07	0.12
n	48	37	28	19	71	23

Table 20
Descriptive Statistics for Anxiety About Teaching Math (ATM) Scale by Grade Level Taught and Years of Experience: Interaction (N = 113)

	Grade Taught		
Experience	Third	Fourth	Fifth
1-3 Years			
M	1.82	2.24	1.80
SE	0.20	0.26	0.23
n	8	5	6
4-19 Years			
M	1.89	2.01	1.76
SE	0.10	0.11	0.15
n	30	27	14
20+ Years			
M	1.84	1.60	1.69
SE	0.18	0.26	0.20
n	10	5	8

ATM, Grade Level, and Highest Degree

The assumptions of the test were reviewed for the two-way ANOVA between grade level taught and highest degree earned and met prior to conducting the ANOVA. An initial examination of boxplots displayed three outliers which were removed prior to testing. All subsequent results reflected the smaller sample size. Other assumptions of the test were reviewed. Skewness (.57) and kurtosis (.00) values, the histogram, and Q-Q plots suggested approximate normality as well as the Kolmogorov-Smirnov test of normality ($D = .08$, $df = 114$, $p = .07$).

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(5, 108) = 1.61$, $p = .16$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that suggested a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA verified a lack of main effect for grade level taught, $F(2, 108) = 0.40$, $p = .67$, eta squared = .01. However, there was a statistically significant main effect for highest degree earned, $F(1, 108) = 12.73$, $p < .01$, eta squared = .10. Lastly, there was a statistically significant interaction between grade level taught and highest degree earned, $F(2, 108) = 4.20$, $p = .02$, eta squared = .07. The proportions accounted for by ATM, as indicated by the eta squared values were important to note as a result of highest degree earned. The main effect alone accounted for 10% of the variance and the interaction between grade level and highest degree earned accounted for 7% of the variance.

Because the omnibus *F* was statistically significant, post-hoc comparisons were conducted for this combination of variables. The means and standard errors for all levels of the independent variables are displayed in Tables 21 and 22, and indicate that across all grades, those whose highest degree earned was the bachelor's degrees had a higher level of anxiety when teaching mathematics. The largest discrepancy occurred among those who taught fourth grade.

Table 21
Descriptive Statistics for Anxiety About Teaching Math (ATM) by Grade Level Taught and Highest Degree Level: Main Effects (N = 114)

| Statistic | Grade Taught | | | Degree Earned | |
	Third	Fourth	Fifth	Bachelor	Master
M	1.86	1.85	1.75	2.00	1.63
SE	0.08	0.09	0.10	0.06	0.08
n	48	37	29	71	43

Table 22
Descriptive Statistics for Anxiety About Teaching Math (ATM) by Grade Level Taught and Highest Degree Level: Interaction (N = 114)

| Degree | Grade Taught | | |
	Third	Fourth	Fifth
Bachelor			
M	1.92	2.24	1.85
SE	0.10	0.11	0.12
n	28	25	18
Master			
M	1.79	1.45	1.65
SE	0.12	0.15	0.16
n	20	12	11

Research Question 4

To what extent, if any, is there a mean difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

To answer Research Question 4, descriptive statistics were explored for the five demographic variables included in the survey in order to determine if there was a difference in elementary teachers' perceived mathematics teaching efficacy based on teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity. In order to further investigate differences not explained through descriptive statistics, the researcher initially set out to conduct a factorial Analysis of Variance (ANOVA).

Gender and Ethnicity

There was very little variability in gender and ethnicity for the respondents who completed the Mathematics Anxiety and Teaching Efficacy Survey. Of the 119 respondents, 91.6% ($n = 109$) of them completed all items within the MTEBI section of the survey instrument. Of those included, 92.7% ($n = 101$) were female and 7.3% ($n = 8$) were male. Of those who responded to all items on the MTEBI section, 96.3% ($n = 105$) were white and 3.7% ($n = 4$) were non-white. Gender and ethnicity were not included in the factorial ANOVA model due to minimal variability and thus only descriptive statistics will be reported for these variables.

When considering the MTEBI subscale, Understanding and Effectiveness, male participants had a slightly higher mean teaching efficacy (MTEBI) score ($M = 4.41$, $SD = $

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0.39, $n = 8$) compared to female respondents ($M = 4.16$, $SD = 0.51$, $n = 101$). The effect size, d, was calculated to be 0.56 using the pooled standard deviation. This has generally been interpreted to be a moderate effect (Cohen, 1988). No statistical tests were run, but the evidence showed that males may feel slightly more efficacious when addressing understanding and effectiveness than females.

Reviewing the MTEBI subscale, Student Achievement, male participants had a slightly higher mean teaching efficacy (MTEBI) score ($M = 3.67$, $SD = 0.18$, $n = 8$) on Part III of the survey compared to female respondents ($M = 3.61$, $SD = 0.42$, $n = 101$). The effect size, d, was calculated to be 0.19 using the pooled standard deviation and has generally been interpreted to be a small effect (Cohen, 1988). No statistical tests were run, but the evidence showed that males generally have similar feelings of teaching efficacy in addressing student achievement as females.

Review of the results for the category of ethnicity indicated that non-white respondents had a higher mean teaching efficacy (MTEBI) for Understanding and Effectiveness ($M = 4.38$, $SD = 0.40$, $n = 4$) than did the white respondents ($M = 4.17$, $SD = 0.50$, $n = 105$). The effect size, d, was calculated to be -0.47 using the pooled standard deviation and has generally been interpreted to be a moderate effect (Cohen, 1988). No statistical tests were conducted, but the evidence indicated that non-white teachers reported slightly higher levels of teaching efficacy when addressing understanding and effectiveness as white teachers.

Investigation of the MTEBI subscale, Student Achievement, indicated that non-white respondents had a higher mean efficacy score ($M = 3.75$, $SD = 0.52$, $n = 4$) than did

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the white respondents ($M = 3.60$, $SD = 0.41$, $n = 105$). The effect size, *d,* was calculated

to be -0.32 using the pooled standard deviation and has generally been interpreted to be a

small to moderate effect (Cohen, 1988). No statistical tests were conducted, but the

evidence indicated that non-white participants reported similar levels of teaching efficacy

when addressing student achievement as white participants.

Grade Level Taught, Years of Experience, and Highest Degree

The objective was to determine any significant difference in MTEBI score when

demographic factors, including grade level taught, years of experience in teaching

mathematics, and highest degree earned, were taken into account. Initially, the desired

analytical procedure was a three-way factorial ANOVA. Due to unequal group size

based on gender and ethnicity, the researcher addressed these variables on a strictly

descriptive basis. Also, when using the literature-recommended grouping for years of

experience, it became apparent that there would be a violation of cell sizes, with many

cells containing only one individual or none at all. Instead of conducting several one-

way ANOVAs, the researcher conducted a pair of two-way ANOVAs in order to examine

the interactions between the variables.

Therefore, two separate two-way ANOVA tests were performed for each of the

two MTEBI factors, Understanding and Effectiveness and Student Achievement. The

first set of tests involved conducting a two-factor ANOVA to determine mean differences

in the given dependent variable based on grade level taught (three levels) and years of

experience (three levels). The second set of tests involved conducting a two-factor

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ANOVA to determine mean differences in the given dependent variable based on grade level taught (three levels) and highest degree attained (two levels). Although some slight duplication occured by including grade level twice, the focal point in the second analysis was whether there were any significant differences in the dependent variable when accounting for the interaction, something that could not be attained by running a one-way ANOVA.

MTEBI Understanding and Effectiveness, Grade Level, and Years of Experience

Assumptions for the two-way ANOVA, between grade level taught and years of experience in predicting perceived effectiveness in mathematics related to understanding and effectiveness, were tested prior to conducting the ANOVA. Seven observations were identified as outliers via boxplot examination and were removed. Thus, all subsequent analyses did not contain these observations. An additional observation was removed as its residual was identified as an outlier in an examination of normality plots. After these removals, other assumptions of the test were reviewed. Skewness (.02) and kurtosis (-.68) values, the histogram, and Q-Q plots suggested approximate normality as did the Kolmogorov-Smirnov test of normality ($D = .08$, $df = 108$, $p = .07$).

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(8, 99) = 0.63$, $p = .75$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that suggested a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA indicated no statistically significant main effects for grade level taught, $F(2, 99) = 1.49$, $p = .23$, eta squared = .03. There was, however, a statistically significant main effect for years of experience, $F(2, 99) = 6.02$, $p = .003$, eta squared = .10. Lastly, there was no statistically significant interaction between grade taught and years of experience, $F(4,99) = 0.58$, $p = .68$, eta squared = .02. Approximately 10% of the variance in teacher perception of understanding and effectiveness in beliefs was accounted for by years of experience.

Because the omnibus F test for years of experience was significant, and because neither the test for significant effect of grade level taught, nor the test for significant interaction effects was significant, only a post-hoc comparison for years of experience was conducted. Teachers with 1-3 years of experience noted feeling significantly less effective in their mathematics teaching when related to perception of understanding and effectiveness ($M = 4.12$, $SE = .09$) than did the teachers with 20 or more years of experience ($M = 4.53$, $SE = .09$). For post-hoc analysis, this difference was significant at $p = .01$.

The means and standard errors for all levels of the independent variables displayed in Tables 23 and 24, indicated that there was no difference in the perception of mathematics teaching efficacy related to understanding and effectiveness, on average, based on grade level taught and the interaction between grade level taught and years of experience. However, less experienced teachers felt less efficacious than did their highly experienced counterparts when addressing understanding and effectiveness.

Table 23

Descriptive Statistics for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)
Understanding and Effectiveness by Grade Level Taught and Years of Experience: Main
Effects (N = 108)

	Grade Taught			Years of Experience		
Statistic	Third	Fourth	Fifth	1-3	4-19	20+
M	4.29	4.40	4.19	4.12	4.23	4.53
SE	0.07	0.09	0.07	0.09	0.05	0.09
n	44	34	30	18	68	22

Table 24

Descriptive Statistics for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)
Understanding and Effectiveness by Grade Level Taught and Years of Experience:
Interaction (N = 108)

	Grade Taught		
Experience	Third	Fourth	Fifth
1-3 Years			
M	4.16	4.23	3.99
SE	0.14	0.19	0.16
n	8	4	6
4-19 Years			
M	4.21	4.23	4.23
SE	0.07	0.08	0.10
n	28	26	14
20+ Years			
M	4.49	4.73	4.37
SE	0.14	0.19	0.12
n	8	4	10

<u>MTEBI Student Achievement, Grade Level, and Years of Experience</u>

Assumptions for the two-way ANOVA between grade level taught and years of experience in determining perceived effectiveness in mathematics related to student achievement were tested prior to conducting the ANOVA. Four observations were identified as outliers via boxplot examination and were removed. Thus, all subsequent analyses did not contain these observations.

After these removals, other assumptions of the test were reviewed. Skewness (.12) and kurtosis (-.39) values, the histogram, and Q-Q plots suggested approximate normality as did the Kolmogorov-Smirnov test of normality ($D = .07$, $df = 113$, $p = .20$).

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(8, 104) = 2.05$, $p = .05$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that may suggested a violation of independence. Based on the dot plot, there were no observable trends.

The ANOVA indicated no statistically significant main effect for grade taught, $F(2, 104) = 0.15$, $p = .87$, eta squared = .01. There was also no statistically significant main effect for years of experience, $F(2, 104) = 2.84$, $p = .06$, eta squared = .05. Lastly, there was no statistically significant interaction between grade taught and years of experience, $F(4, 104) = 0.33$, $p = .86$, eta squared = .01. Despite the lack of significance, 5% of the variance, generally interpreted to be a small effect, in teacher perception of student achievement while teaching could be accounted for by years of experience.

Because the omnibus *F* test was not statistically significant, post-hoc comparisons

were not conducted. The means and standard errors for all levels of the independent

variables displayed in Tables 25 and 26, indicated that there was no difference, on

average, in teacher perception of efficacy in teaching mathematics related to student

achievement based on grade level taught, years of experience, or the interaction between

these two variables.

Table 25
Descriptive Statistics for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)
Student Achievement by Grade Level Taught and Years of Experience: Main Effects
(N = 113)

Statistic	Grade Taught			Years of Experience		
	Third	Fourth	Fifth	1-3	4-19	20+
M	3.64	3.58	3.63	3.48	3.60	3.77
SE	0.07	0.09	0.07	0.09	0.05	0.09
n	48	33	32	19	70	24

Table 26

Descriptive Statistics for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)
Student Achievement by Grade Level Taught and Years of Experience: Interaction
(N = 113)

	Grade Taught		
Experience	Third	Fourth	Fifth
1-3 Years			
M	3.52	3.33	3.57
SE	0.14	0.19	0.15
n	8	4	7
4-19 Years			
M	3.58	3.61	3.61
SE	0.07	0.08	0.10
n	30	25	15
20+ Years			
M	3.80	3.79	3.72
SE	0.12	0.19	0.12
n	10	4	10

MTEBI Understanding and Effectiveness, Grade Level, and Highest Degree

Assumptions for the two-way ANOVA between grade level taught and highest

degree in determining perceived effectiveness in mathematics related to Understanding

and Effectiveness were tested prior to conducting the ANOVA. Nine observations were

identified as outliers via boxplot examination and were removed.

However, in examining Levene's test of equality of variances, the variances could

not be assumed to be homogeneous, $F(5, 101) = 3.61$, $p < .01$. Furthermore, spread of

standard deviation or variance versus level did not suggest linear patterns. This would

have allowed for log or square root transformations. Keeping in mind that the intent of

the analysis was to examine highest degree and grade level, the determination was made

to attempt the analysis as a one-way ANOVA using highest degree as the two-level independent factor. With only two groups, it was acceptable to run an independent *t*-test.

The original 117 observations were analyzed, and two outliers were removed after boxplot examination prior to running the *t*-test. The two levels of the residuals were examined for outliers. For those with the highest degree as bachelor's degree, skewness (.20) and kurtosis (-.59) values, the histogram, and Q-Q plots all suggested approximate normality as did the Kolmogorov-Smirnov test of normality ($D = .08$, $df = 65$, $p = .20$). The same held true for the master's degree group. Skewness (-.51) and kurtosis (-.21) values, the histogram, and Q-Q plots all suggested approximate normality as did the Kolmogorov-Smirnov test of normality ($D = .10$, $df = 42$, $p = .20$).

Based on Levene's test of equality of variances, the variances could not be assumed homogeneous, $F = 5.24$, $p = .02$. Therefore, when running the *t*-test, the adjusted test statistic was used to account for this fact.

The independent *t*-test, $t(67.71) = -1.15$, $p = .26$, indicated that there was no significant difference for highest degree earned between teachers that earned bachelor's and master's degrees in their perceived efficacy in the area of understanding and effectiveness when teaching mathematics. Those with master's degrees, on average, believed that they were slightly more efficacious ($M = 4.27$, $SD = 0.53$, $n = 42$) than those who had indicated highest degree as bachelor's degrees ($M = 4.16$, $SD = 0.39$, $n = 72$), but this difference was not significant.

<u>MTEBI Student Achievement, Grade Level, and Highest Degree</u>

Assumptions for the two-way ANOVA between grade level taught and highest degree in predicting perceived effectiveness in mathematics related to student achievement were tested prior to conducting the ANOVA. Twelve observations were identified as outliers via boxplot examination and were removed.

However, in examining Levene's test of equality of variances, the variances could not be assumed to be homogeneous, $F(5, 99) = 3.58$, $p < .01$. Furthermore, spread of standard deviation or variance versus level did not suggest linear patterns, which would have allowed for log or square root transformations. Keeping in mind that the intent of the analysis was to examine highest degree and grade level, the determination was made to attempt the analysis as a one-way ANOVA using highest degree as the two-level independent factor. With only two groups, it was acceptable to run an independent t-test.

The original variable without observations removed was used to test assumptions for the one-way ANOVA using highest degree earned to determine perceived effectiveness in mathematics related to student achievement. Three observations were identified as outliers via boxplot examination and were removed. Thus, all the subsequent analyses did not contain these observations.

After these removals, other assumptions of the test were reviewed. Skewness (.07) and kurtosis (-.07) values, the histogram, and Q-Q plots suggested approximate normality. Although the Kolmogorov-Smirnov test of normality ($D = .09$, $df = 114$, $p = .01$) suggested formally that normality may not have been present, the researcher made

the determination based on other evidence that normality was still a reasonable assumption.

Based on Levene's test of equality of variances, the variances were assumed to be homogeneous, $F(8, 104) = 2.05$, $p = .05$. Since the groups were not randomly assigned, independence could not be assumed. However, a dot plot of unstandardized residual values by group was created to determine if there were patterns to the data that would suggest a violation of independence. Based on the dot plot, there were no observable trends.

The original 117 observations were analyzed, and three outliers were removed after boxplot examination prior to running the t-test. The two levels of the residuals were examined for outliers. For bachelor's degree, skewness (.14), kurtosis (-.12), the histogram, and Q-Q plots suggested approximate normality. The Kolmogorov-Smirnov formal test of normality ($D = .11$, $df = 71$, $p = .04$) did show discrepancies, but based upon the graphic evidence it was determined acceptable to assume normality. Normality was also shown for the master's degree group. Skewness (-.03), kurtosis (.12), the histogram, and Q-Q plots suggested approximate normality, as did the Kolmogorov-Smirnov test of normality ($D = .12$, $df = 43$, $p = .14$). Based on Levene's test of equality of variances, the variances could be assumed to be homogeneous, $F = 0.79$, $p = .78$.

The independent t-test, $t(112) = -0.34$, $p = .73$, indicated that there was no significant difference between teachers with bachelor's and master's degrees in their perceived efficacy in the area of student achievement when teaching mathematics. Those with master's degrees, on average, felt that they were slightly more efficacious ($M = 3.62$,

SD = 0.40, *n* = 43) than those with bachelor's degrees (*M* = 3.60, *SD* = 0.38, *n* = 71), but

this difference was not significant.

<div align="center">Research Question 5</div>

To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

A hierarchical multiple linear regression analysis was conducted to examine the

relationship between the variables of elementary teachers' perceived mathematics anxiety

(AMAS), anxiety about teaching mathematics (ATM), and mathematics teaching efficacy

(MTEBI) and student achievement in mathematics. The goal was to determine if student

proficiency in mathematics could be predicted by their teachers' AMAS, ATM, and

MTEBI scores while controlling for the demographic factors of grade level taught, years

of experience, highest degree earned, and ethnicity.

<div align="center">Assumptions</div>

Prior to interpreting the results, assumptions for multiple linear regression

analysis were tested and met. An initial review of Cook's distance, centered leverage

values, and scatterplots suggested that there were no outliers. However, when

unstandardized predicted values were reviewed for normality, Shapiro-Wilk's formal test

of normality indicated that this distribution was not normal (*W* = .96, *df* = 109, *p* < .01).

Additionally, there was one observation indicated as an outlier on the boxplot of

unstandardized residuals and a different observation indicated as an outlier on the boxplot of unstandardized predicted values. Both of these observations were removed and the tests were re-run.

The removal of the two observations improved the normality statistics. For the unstandardized residuals, skewness (-.36) and kurtosis (-.15) indicated normality, as did a non-significant Shapiro-Wilks test ($W = .98$, $df = 107$, $p = .17$). No outliers were present in the boxplot. The Q-Q plot and histogram showed slight normality, but with the evidence of the other statistics this was acceptable.

The unstandardized predicted values showed similar normality. Skewness (-.47) and kurtosis (-.23) statistics indicated normality, as did a non-significant Shapiro-Wilks test ($W = .98$, $df = 107$, $p = .05$). No outliers were present in the boxplot. The Q-Q plot and histogram showed slight normality, but the evidence of the other statistics was acceptable.

Linearity was tested as well. The scatterplots for the dependent and independent variables indicated linear relationships. Scatterplots of standardized residuals to predicted values and to each independent variable also confirmed linearity, as almost all values were located between a band of -2 and 2.

Studentized residuals were plotted against all independent variables to determine independence. The assumption of independence was supported since no patterns were apparent. The same held true for a plot of studentized residuals to the unstandardized predicted dependent value and to case numbers. The plot of studentized residuals to

unstandardized predicted values suggested homogeneity of variance as well, since predicted values did not increase or decrease with increased residual values.

Multicollinearity was the final assumption subjected to testing. Since this was a hierarchical multiple regression, each model had different sets of tolerance statistics, but in each case these values were well above .10, with most between .60 and .80. Likewise, variance inflation factors were much less than 10 with most between 1.2 and 1.8. In most iterations of the model, there were no multiple eigenvalues close to zero, nor were any indices greater than 15. However, in the model including all demographics and all independent variables, two indices were above 30 (33.24 and 45.44). Despite the possible assumption violation, the variance between proportions for the factors with high condition indices were checked. These values measure how much of the variability in a regression coefficient can be associated with a component. No regression coefficient had two or more regression coefficients highly associated with a component with a high condition index (greater than 0.5), so the multicollinearity issue was deemed acceptable for the nature of this study.

Results

The variables were entered in block format to determine the added effect of each independent variable of interest (AMAS, ATM, or MTEBI) in predicting the percentage of students showing proficiency on the mathematics FCAT.

Block 1 contained demographic information of grade level taught, years of experience, and highest degree earned. Grade level taught was converted into a dummy

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variables since it was categorical in nature. Years of experience was continuous, whereas degree was naturally dichotomous. Information was then entered based on the order of survey items. Block 2 contained the addition of elementary teachers' perceived mathematics anxiety (AMAS) including both the Mathematics Evaluation Anxiety (MEA) variable and the Learning Mathematics Anxiety (LMA) variable. Block 3 contained the addition of anxiety about teaching mathematics (ATM) comprised of a single factor. Lastly, Block 4 contained the addition of mathematics teaching efficacy (MTEBI), which included the Understanding and Effecitivenss variable and Student Achievement variable.

The model as of Block 1 was considered the baseline model. Since the premise was not to find best model fit, but rather to determine significance of predictors, no independent variables were removed after each step. Neither gender nor ethnicity was used due to the lack of variability in these factors. The results of the hierarchical multiple regression are displayed in Table 27.

Table 27 *Summary of Hierarchical Regression Analysis for Variables Predicting Florida Comprehensive Assessment Test (FCAT) Mathematics Proficiency (N = 117)*

Variable	Model 1			Model 2			Model 3			Model 4		
	B	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Constant	68.38	3.17		69.05	4.62		69.52	5.22		25.18	15.02	
Grade Taught												
Grade 3	11.26	2.84	.44**	11.62	2.88	.46**	11.65	2.90	.46**	11.77	2.80	.46**
Grade 4	11.89	3.09	.43**	12.53	3.16	.45**	12.57	3.18	.46**	11.90	3.06	.43**
Experience	0.19	0.20	.10	0.16	0.21	.08	0.16	0.22	.08	0.01	0.21	.01
Bachelor	2.45	2.71	.10	2.09	2.75	.08	1.92	2.88	.07	2.96	2.79	.11
R^2		.18										
F for Δ in R^2		5.54**										
Abbreviated Math Anxiety Scale (AMAS)												
Mathematics Assessment Anxiety				-1.31	1.36	-.11	-1.23	1.43	-.10	-1.22	1.38	-.10
Learning Process Anxiety				1.88	2.00	.11	1.89	2.01	.11	1.78	1.95	.10
Anxiety about Teaching Math (ATM)							-0.40	2.01	-.02	2.82	2.18	.14
Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)												
Understanding and Effectiveness										8.39	2.94	.31**
Student Achievement										1.13	3.04	.04
R^2					.19			.19			.27	
F for Δ in R^2					0.57			0.04			5.25*	

*p < .05. **p < .01.

The demographics of grade level taught, years of experience, and highest degree earned in Block 1 of the baseline model were good predictors of proficiency on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest, $F(4, 102) = 5.54$, $p < .01$. Although this is the baseline model, it is important to note that this initial model is significant. The regression equation for predicting FCAT math proficiency as a function of these variables is:

Percent Proficient = 68.38 + 11.26(Grade 3) + 11.89(Grade 4) + 0.19(Years of Experience) + 2.45(Bachelor's Degree). Accuracy in predicting mathematics proficiency was strong, with a multiple correlation coefficient of .42. Approximately 18% ($R^2 = .18$) of the variability in proficiency on the 2009 FCAT mathematics subtest was accounted for by the regression model.

The second step for Block 2 added the two factors of the score for elementary teachers' perceived mathematics anxiety (AMAS), Mathematics Evaluation Anxiety (MEA) and Learning Mathematics Anxiety (LMA). When holding the demographic variables constant, these factors were not good predictors of mathematics achievement and were not statistically significant, $\Delta F(2, 100) = 0.57$, $p = .57$. The regression equation for the total model predicting FCAT mathematics proficiency as a function of these variables is: Percent Proficient = 69.05 + 11.62(Grade 3) + 12.53(Grade 4) + 0.16(Years of Experience) + 2.09(Bachelor's Degree) − 1.31(MEA) + 1.88(LMA). Accuracy in predicting mathematics proficiency barely increased, with a change in multiple correlation coefficient of .01. Only one extra percentage point ($\Delta R^2 = .01$) of the variance

of mathematics proficiency was accounted for by the regression model above the prior model.

The third step added the score for anxiety about teaching mathematics (ATM). The factor was not a good predictor of mathematics achievement and was not significant when holding all previous demographic factors and AMAS constant as measured by F change, $F(1, 99) = 0.04$, $p = .85$. The regression equation for the total model predicting FCAT mathematics proficiency as a function of these variables is: Percent Proficient = 69.52 + 11.65(Grade 3) + 12.57(Grade 4) + 0.16(Years of Experience) + 1.92(Bachelor's Degree) − 1.23(MEA) + 1.89(LMA) − 0.40(ATM). Accuracy in predicting mathematics proficiency did not increase beyond the previous multiple correlation coefficient of .43. The percentage of variance of mathematics proficiency accounted for by the regression model remained at 19% ($R^2 = .19$).

The fourth and final step added the two factor scores for mathematics teaching efficacy (MTEBI), the Understanding and Effectiveness factor and the Student Achievement factor. When holding the demographic variables of AMAS, and ATM constant, this set of factors was a good predictor of mathematics achievement, $\varDelta F(2, 97) = 5.25$, $p < .01$. The regression equation for the total model predicting FCAT mathematics proficiency as a function of these variables is: Percent Proficient = 25.18 + 11.77(Grade 3) + 11.90(Grade 4) + 0.01(Years of Experience) + 2.96 (Bachelor's Degree) − 1.22(MEA) + 1.78(LMA) + 2.82(ATM) + 8.39(Understanding and Effectiveness) + 1.13(Student Achievement). Accuracy in predicting mathematics proficiency increased, with a change in multiple correlation coefficient of .09. An

additional 8% of the variance in mathematics proficiency was accounted for by the regression model above the prior model ($\Delta R^2 = .08$).

Summary

This chapter presented the analysis of data and the demographic information collected from the population's responses on the Mathematics Anxiety and Teaching Efficacy Survey compared to student achievement data obtained from elementary students in a west central Florida school district that took the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. The analysis of data was guided by five research questions to determine what, if any, relationships existed between teachers' perceived anxiety about mathematics, their anxiety about the mathematics they teach, mathematics teaching efficacy beliefs, and their students' mathematics achievement. A summary and discussion of the findings, conclusions, implications for practice, and future research are presented in Chapter 5.

CHAPTER 5
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

<u>Introduction</u>

This chapter contains a summary and discussion of the findings organized around the five research questions which guided the study. Conclusions, implications for practice, and recommendations for future research are presented. Specifically, this chapter contains a discussion of the research analysis concerning the relationship between teachers' perceived anxiety about mathematics, their anxiety about the mathematics they teach, mathematics teaching efficacy beliefs, and their students' mathematics achievement. Implications and conclusions for this study were drawn by the researcher based on the analysis of data and the research available on the topics of mathematics anxiety, teaching efficacy, and student achievement. Recommendations for future research are included to provide guidance to researchers interested in learning more about how mathematics anxiety, teaching efficacy, and student achievement may be related.

This chapter is organized into six sections. A restatement of the purpose can be found in section one. Section two provides a review of the methodology used for this study. Section three includes the summary findings and discussion of the five research questions. Discussion and conclusions are located in section four. Implications for practice are in section five and recommendations for future research on the relationship between teachers' perceived anxiety about mathematics, their anxiety about the mathematics they teach, mathematics teaching efficacy beliefs, and their students' mathematics achievement are in included in section six.

Purpose of the Study

The purpose of the study was to determine to what extent there were relationships among elementary teacher anxiety about learning mathematics, their anxiety about the mathematics they teach, their mathematics teaching efficacy beliefs, and their students' mathematics achievement. The researcher also investigated potential intervening variables such as gender, grade level taught, level of college degree, and years of teaching experience, that may influence these relationships.

Hadley (2005), in her dissertation, was unable to identify statistically significant relationships between either mathematics anxiety or anxiety about teaching mathematics, and student achievement in mathematics. This finding did not support the notion that mathematics anxiety, as well as anxiety about teaching mathematics, related to student achievement. Thus, the need to investigate the relationship between these factors was reinforced.

Methodology

Population

The target population of this study included all third, fourth, and fifth grade teachers employed by a west central Florida school district during the 2008-2009 school year. This population consisted of 128 teachers in 11 elementary schools across the county. Of the teachers invited to participate, surveys were completed by 119 (93.0%) teachers from all of the 11 elementary schools.

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Instrumentation

Data regarding mathematics anxiety, anxiety about teaching mathematics, and teaching efficacy were collected from the Mathematics Anxiety and Teaching Efficacy Survey (Appendix A). The survey instrument consisted of 12 questions with 46 items in total and was comprised of four separate sections. These four sections included: (a) the Abbreviated Math Anxiety Scale (AMAS), (b) the Anxiety about Teaching Math (ATM) scale, (c) the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), and (d) demographic information.

Data Collection

The researcher requested student achievement data from the district's Research and Accountability Department. The researcher requested a list of teachers who taught mathematics in third, fourth, and fifth grades during the 2008-2009 school year. During a school visit, teachers met in a computer lab to complete the survey instrument. A verbal description of the study was presented by the researcher to the group of teachers at each school site, and teachers were asked to complete the survey electronically. Following the initial school visits, the researcher monitored the status of participation of each elementary school.

Data Analysis

For this study, descriptive statistical analysis was conducted for each composite scale that comprised the Mathematics Anxiety and Teaching Efficacy Survey. Data

analysis for Research Question 1 focused on the extent to which there was a relationship between teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. Data analysis for Research Questions 2, 3, and 4 focused on the extent to which there was a mean difference in teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy based on teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity. Teachers' perceived mathematics anxiety was measured by the Mathematics Anxiety and Teaching Efficacy Survey. Data for Research Question 5 were analyzed to determine to what extent teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predicted the percentage of students in their classes scoring proficient or above on the 2009 Mathematics Florida Comprehensive Assessment Test (FCAT) when controlling for teacher (a) gender, (b) grade level taught, (c) years of experience, (d) highest degree earned, and (e) ethnicity.

<div align="center">Summary and Discussion of Findings</div>

This study was guided by five research questions. The following section contains the summary, analysis, and discussion of findings obtained from the data for each of the questions.

To what extent, if any, is there a relationship between elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest?

This question was framed to reveal any relationship between teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the percentage of students scoring proficient or above on the 2009 Mathematics Florida Comprehensive Assessment Test (FCAT). The scores for teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy were collected from data provided in Parts I, II, and III of the Mathematics Anxiety and Teaching Efficacy Survey. The percentages of students scoring proficient or above were gathered from the school district's Research and Accountability Department.

A Pearson's product moment correlation was conducted in order to determine to what extent, if any, were there relationships between the three components of the Mathematics Anxiety and Teaching Efficacy Survey (teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy) and student achievement. The results of the correlation indicated that no statistically significant relationship existed between teachers' perceived mathematics anxiety and student achievement. The correlation calculations also indicated that there was no statistically significant relationship between anxiety about teaching mathematics and student achievement. Mathematics teaching efficacy, however, was significantly correlated in a positive direction with the percentage of students scoring proficient or

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above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics

subtest. The effect size is small and thus has little practical significance. As mathematics

teaching efficacy scores increased, so did the percentage of students scoring proficient or

above on 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest.

The outcomes of this data analysis were not what had been expected based on the

results of several other research studies. Throughout the literature and research on the

relationships between mathematics anxiety and student achievement, various researchers

have identified studies that indicated strong correlations between these two variables

noting that higher levels of mathematics anxiety were related to lower mathematics

achievement (Betz, 1978; Clute, 1984; Cooper & Robinson, 1991; Hafner, 2008;

Hembree, 1990; Sherman & Wither, 2003; Wigfield & Meece, 1998). The results in the

present study aligned with more recent studies indicating there were no relationships

between teacher anxiety about mathematics, or anxiety about teaching mathematics, and

mathematics achievement (Ashcraft, 2002; Hadley, 2005; Hadley 2009). Although

causal relationships could not be determined from the data, there are several possible

explanations presented in the following paragraphs.

A review of the composite scores for teachers' perceived mathematics anxiety, as

measured by the Abbreviated Math Anxiety Scale (AMAS), indicated that the mean

composite score for teachers perceived mathematics anxiety was 21.50 ($SD = 6.97$).

There were nine items used to measure teachers perceived mathematics anxiety. Thus, if

one examines the mean based on the number of items (9), a mean score of 2.39 is

calculated. The scale for calculation ranges from 1 to 5 (1 = low anxiety, 2 = some

anxiety, 3 = moderate anxiety, 4 = quite a bit of anxiety, and 5 = high anxiety). Although this score takes several variables into account based on the items included on the survey instrument, one could interpret this information to indicate that the perceived mathematics anxiety of the group was on the lower end of the scale between the categories of some to moderate anxiety.

Reviewing the scores for teachers' anxiety about teaching mathematics, as measured by the Anxiety about Teaching Mathematics scale (ATM), indicated that the mean composite score for teachers' anxiety about teaching mathematics was 17.14 ($SD =$ 5.36). Following the same procedure for dividing the mean by nine based on the number of items, a mean score of 1.90 is calculated. The scale for this calculation also has a range from 1 to 5 (1 = low anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = quite a bit of anxiety, and 5 = high anxiety). This score takes several variables into account based on the number of items included on the survey instrument. This information can be interpreted to indicate that the anxiety about teaching mathematics of the group was on the lower end of the scale between the categories of low to some anxiety.

There was a significant correlation between mathematics teaching efficacy and the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. As scores for mathematics teaching efficacy increased, so did the percentage of students scoring proficient or above. This finding is similar to the finding in a 1995 study conducted by Enon (as cited in Swars, 2004) which indicated that highly efficacious teachers were more effective mathematics teachers. According to Hall and Ponton (2005) and

Swackhamer (2009), teachers with higher levels of teaching efficacy produce higher achieving students. The mean score for mathematics teaching efficacy, as measured by the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), was 79.49 ($SD = 7.70$). The scale for this instrument ranges from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree, and 5 = strongly agree). Dividing the mean by the 20-items used to measure anxiety about teaching mathematics results in a mean score of 3.97. This score takes several variables into account based on the number of items included on the MTEBI survey. This information can be interpreted to indicate that the mathematics teaching efficacy score of the group was on the upper end of the scale between the categories of uncertain to agree.

A review of the student achievement data for the county of interest in the study supported its high achieving status. When reviewing the research data, the mean percentage of students in third, fourth, and fifth grade scoring 3-5 on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest for this population was 79.43 ($SD = 13.86$). This average was higher than the 72.67% of students across the state of Florida who scored at levels 3 and above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. It was also higher than the mean of 74% of students who scored levels 3 and above for the entire west central Florida school district used in the study (FLDOE, 2009a).

Further review of the data analysis indicated that there was also a statistically significant positive correlation between teachers' perceived mathematics anxiety and anxiety about teaching mathematics. Although effect size was small, as scores for

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perceived mathematics anxiety increased, so did anxiety about teaching mathematics. Likewise, there was a statistically significant negative correlation between anxiety about teaching mathematics and mathematics teaching efficacy. There was however only a small effect size. As teachers indicated increased anxiety about teaching mathematics, their efficacy of teaching mathematics decreased. Perceived mathematics anxiety and mathematics teaching efficacy did not, however, share a statistically significant relationship. Teachers who were anxious about teaching mathematics did however have lower teaching efficacy beliefs.

These results supported the findings in other research studies which indicated that mathematics anxiety was related to anxiety about teaching mathematics (Hadley, 2005, 2009). Additionally, the analysis differed from other studies that had indicated a significant relationship between perceived mathematics anxiety and mathematics teaching efficacy (Cooper & Robinson, 1991; Hadley, 2005, 2009; Hafner, 2008; Pajares & Kranzler, 1985; Swackhamer, 2009; Swars, 2005; Swars , Daane, & Giesen, 2006). According to Swars et al., teachers with lower mathematics anxiety commonly had higher mathematics teaching efficacy, and those with higher mathematics anxiety usually had lower mathematics teaching efficacy. Anxiety about teaching mathematics was also negatively related to mathematics teaching efficacy in previous research by Hadley (2009).

Research Question 2

To what extent, if any, is there a mean difference in elementary teachers'
perceived mathematics anxiety based on teacher (a) gender; (b) grade level taught; (c)
years of experience; (d) highest degree earned; and (e) ethnicity?

This research question sought to determine the experiential and demographic

differences among responding elementary teachers based on perceived mathematics

anxiety. Descriptive analyses were calculated for each of the following variables: gender,

grade level taught, years of experience, highest degree earned, and ethnicity. To ensure

that differences which may not have been observed in the descriptive analysis could be

further explained, the researcher planned to conduct a factorial Analysis of Variance

(ANOVA) including all of the demographic variables. Due to unequal group size based

on gender and ethnicity, these variables were addressed on a strictly descriptive basis.

Also, when using the literature-recommended grouping for years of experience, it became

apparent that there would be a violation of cell sizes, with many cells containing only one

individual or none at all. Therefore, rather than conducting several one-way ANOVAs,

the researcher conducted a pair of two-way ANOVAs in order to examine the interactions

between the variables.

Gender

When considering the AMAS factor, Mathematics Assessment Anxiety, male

participants had a slightly lower mean score as compared to females. No statistical tests

were run, but the evidence showed that males had similar levels of anxiety about

assessment related to mathematics as females. This was consistent with previous research

indicating that males had only slightly lower levels of mathematics anxiety (Betz, 1978; Eccles and Jacobs, 1986; Hadley, 2005; Hunt, 1985; Malinsky, Ross, Pannells, & McJunkin, 2006). This anxiety experienced by females towards assessment could have begun during adolescence, the time when males begin to outperform females in mathematics.

In contrast, review of the second AMAS factor, Learning Process Anxiety, indicated that male participants had a slightly higher mean score ($M = 1.90$, $SD = .80$, $n = 8$) as compared to the females ($M = 1.81$, $SD = .72$, $n = 101$). No statistical tests followed, but the evidence showed that females exhibited similar anxiety about the learning process of mathematics as males. This finding was consistent with recent research on mathematics performance between males and females. Although it has been previously reported that males outperform females in mathematics, Alkhateeb (2001) claimed that more recent studies have indicated that the gap between performance levels based on gender was decreasing.

Ethnicity

Review of the results for ethnicity indicated that white participants had a slightly lower mean score for the factor of Mathematics Assessment Anxiety as compared to non-white participants. No statistical tests followed, but the evidence showed that white respondents exhibited similar anxiety about the assessment of mathematics as non-white respondents. Investigation of the AMAS factor, Learning Process Anxiety, indicated that white participants had a lower mean score than did the non-white participants. White

respondents exhibited similar anxiety about the process of learning mathematics when compared to the non-white respondents based on the results of this research. According to X. Ma (1999), there have been few studies comparing the relationship between mathematics anxiety and mathematics achievement among ethnic groups.

Grade Level Taught, Years of Experience, Highest Degree Earned

Two separate two-way ANOVA tests were also conducted for each of the two AMAS factors (Mathematics Assessment Anxiety and Learning Process Anxiety). The first set of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable, elementary teachers' perceived mathematics anxiety based on grade level taught and years of experience. The second set of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable, elementary teachers' perceived mathematics anxiety, based on grade taught and highest degree earned.

AMAS Assessment Anxiety, Grade Level, and Years of Experience

The ANOVA indicated no statistically significant main effect for grade level taught. Additionally, there was no statistically significant main effect for years of experience. Lastly, there was no statistically significant interaction between grade level taught and years of experience. The results of the analysis indicated that there was not a difference, on average, in the degree of anxiety reported by teachers related to assessment

based on grade level taught, years of experience, or the interaction between these two variables.

AMAS Learning Process Anxiety, Grade Level, and Years of Experience

The ANOVA indicated no statistically significant main effect for grade level taught. There was, however, a statistically significant effect for years of experience. Lastly, there was no statistically significant interaction between grade level taught and years of experience. Teachers with 1-3 years of experience were significantly less anxious about the mathematics learning process than were teachers with 20 or more years of experience. The results of this analysis indicated that there was no difference, on average, in the degree of anxiety reported by teachers when learning mathematics based on grade level taught or based on the interaction between grade level taught and years of experience. However, less experienced teachers were less anxious than were their highly experienced counterparts when learning mathematics.

AMAS Mathematics Assessment Anxiety, Grade Level, and Highest Degree

The ANOVA verified that there was no statistically significant main effect for grade level taught. Additionally, there was no statistically significant main effect for highest degree earned. Lastly, there was no statistically significant interaction between grade level taught and highest degree earned. There was no significant difference, on average, in the degree of anxiety reported by teachers related to assessment based on grade level taught, highest degree earned, or the interaction between these two variables.

AMAS Learning Process Anxiety, Grade Level, and Highest Degree

The ANOVA indicated no statistically significant main effect for grade level taught. Additionally, there was no statistically significant main effect for highest degree earned. Lastly, there was no statistically significant interaction between grade level taught and highest degree earned. There was no difference in AMAS scores for learning process anxiety, on average, based on grade level taught, highest degree earned, or the interaction between these two variables.

There were almost twice as many teachers who reported holding a bachelor's degree ($n = 75$) as the highest degree earned than those who had earned a master's degree ($n = 44$) as the highest degree earned. None of the participants in the survey reported having an education specialist or a doctoral degree. Teachers with a bachelor's degree as the highest degree earned had only a slightly lower mean composite score on teachers' perceived mathematics anxiety than did teachers with a master's degree.

The fifth grade teachers had the lowest mean perceived mathematics anxiety composite score, third grade teachers were in the middle range, and fourth grade teachers had the highest mean anxiety level. This finding slightly aligned with results of a previous study (Hadley, 2005) illustrating that teachers of upper elementary grades had less anxiety about mathematics. This was attributed to differences in curriculum in different grades, the emphasis on use of manipulatives in lower grades, and longer attention spans of students in the upper grades.

Research Question 3

To what extent, if any, is there a mean difference in elementary teachers'
perceived anxiety about teaching mathematics based on teacher (a) gender; (b) grade
level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

This research question was aimed at determining any significant difference among

participants based on anxiety about teaching mathematics (ATM) when experiential and

demographic factors, including grade level taught, years of experience in teaching

mathematics, and highest degree earned, were considered. Descriptive analyses were

calculated and initially, the desired analytical procedure was a factorial ANOVA.

However, when using the literature-recommended grouping for years of experience, it

became apparent that there would be a violation of cell sizes, with many cells only

containing one individual or none at all. The combination of highest degree earned with

years of experience was the major interaction yielding this result, but it was still desirable

to examine the interactions between other variables.

Gender

There was slight variability in the gender and ethnicity demographics for

respondents who completed the Mathematics Anxiety and Teaching Efficacy Survey.

The nine male participants had a slightly lower mean score on perceived anxiety about

teaching mathematics (ATM) than did the 101 female respondents. No statistical tests

were performed, but the evidence revealed that males may feel slightly have similar

anxiety about teaching of mathematics as females. Similar to the results in Research

Question 2, this finding was also consistent with previous research indicating that male

teachers had only slightly lower levels of mathematics anxiety towards teaching the subject (Hadley, 2005).

Ethnicity

The results for ethnicity indicated that the 105 white respondents had a lower mean score on perceived anxiety about teaching mathematics (ATM), than did the four non-white respondents. No statistical tests were conducted, but the evidence showed that non-white teachers may have similar levels of anxiety about teaching mathematics as white teachers.

Grade Level Taught, Years of Experience, Highest Degree Earned

Two separate two-way ANOVA tests were run for the ATM factor. The first test involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught and years of experience. The second test involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught and highest degree earned. Although some slight duplication occurred by including grade level twice, the focal point in the second analysis was whether there were any significant differences in the dependent variable when accounting for the interaction, something that could not be attained by running a one-way ANOVA.

<u>ATM, Grade Level, and Years of Experience</u>

The ANOVA indicated no statistically significant main effect for grade level taught. Additionally, there was no statistically significant main effect for years of experience. Lastly, there was no statistically significant interaction between grade level taught and years of experience. The results of the analysis indicated that there was no difference, on average, in the degree of anxiety reported by teachers when teaching math based on grade level taught, years of experience, or the interaction between these two variables.

<u>ATM, Grade Level, and Highest Degree</u>

The ANOVA verified a lack of main effect for grade level taught. However, there was a statistically significant main effect for highest degree earned. Lastly, there was a statistically significant interaction between grade level taught and highest degree earned. The results of the analysis indicated that across all grades, those with bachelor's degrees had a higher level of anxiety when teaching mathematics, but the largest discrepancy occurred among those who taught fourth grade.

There were almost twice as many teachers who reported they held a bachelor's degree ($n = 74$) than teachers who earned a master's degree ($n = 44$). None of the participants in the survey reported having an education specialist or a doctoral degree. Teachers with a bachelor's degree as the highest degree earned had a much higher mean composite score on elementary teachers' perceived anxiety about teaching mathematics than did teachers with a master's degree as the highest degree earned.

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Research Question 4

To what extent, if any, is there a mean difference in elementary teachers'
perceived mathematics teaching efficacy based on teacher (a) gender; (b) grade level
taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

This research question was aimed at determining the experiential and

demographic differences among responding elementary teachers based on perceived

mathematics teaching efficacy. Descriptive analyses were performed for each of the

following variables: gender, grade level taught, years of experience, highest degree

earned, and ethnicity. To ensure that differences which may not have been observed, the

researcher planned to conduct a factorial Analysis of Variance (ANOVA) for each of the

experiential and demographic variables. However, when using the literature-

recommended grouping for years of experience, it became apparent that there would be a

violation of cell sizes with many cells containing only one individual or none at all. The

combination of highest degree earned with years of experience was the major interaction

yielding this result, but it was still desirable to examine the interactions between other

variables.

Gender

When considering the MTEBI factor, Understanding and Effectiveness, male

participants had a slightly higher mean teaching efficacy (MTEBI) score than did female

respondents. No statistical tests were run, but the evidence showed that males reported

slightly higher levels of teaching efficacy when addressing understanding and

effectiveness when compared to females.

Reviewing the MTEBI factor, Student Achievement, male participants had a slightly higher mean teaching efficacy (MTEBI) score compared to female respondents. Again, no statistical tests were run, but the evidence showed that males may have felt similar levels of teaching efficacy when addressing student achievement as females.

Ethnicity

Non-white respondents had a higher mean teaching efficacy (MTEBI) score for the factor of Understanding and Effectiveness than did the white respondents. No statistical tests were conducted, but the evidence showed that non-white teachers reported slightly higher levels of teaching efficacy when addressing understanding and effectiveness when compared to white teachers.

Investigation of the MTEBI factor, Student Achievement, indicated that non-white respondents had a higher mean efficacy score than did the white respondents. The evidence indicated that non-white participants may have felt similar levels of teaching efficacy when addressing student achievement as white participants.

Grade Level Taught, Years of Experience, Highest Degree Earned

Two separate two-way ANOVA tests were performed for each of the two MTEBI factors, Understanding and Effectiveness and Student Achievement. The first set of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught and years of experience. The second set

of tests involved conducting a two-factor ANOVA to determine mean differences in the given dependent variable based on grade level taught and highest degree attained.

MTEBI Understanding and Effectiveness, Grade Level, and Years of Experience

The ANOVA indicated no statistically significant main effects for grade level taught. There was, however, a statistically significant main effect for years of experience. Lastly, there was no statistically significant interaction between grade taught and years of experience. Teachers with 1-3 years of experience reported feeling significantly less effective in their mathematics teaching when related to perception of understanding and effectiveness than did the teachers with 20 or more years of experience.

The results of the analysis indicated that there was no difference in the perception of mathematics teaching efficacy related to understanding and effectiveness, on average, based on grade level taught or based on the interaction between grade level taught and years of experience. However, less experienced teachers felt less efficacious than did their highly experienced counterparts when addressing understanding and effectiveness.

MTEBI Student Achievement, Grade Level, and Years of Experience

The ANOVA indicated no statistically significant main effect for grade taught. There was also no statistically significant main effect for years of experience. Lastly, there was no statistically significant interaction between grade taught and years of experience. The results of the analysis illustrated that there was no difference, on

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average, in teacher perception of efficacy in teaching mathematics related to student achievement based on grade level taught, years of experience, or the interaction between these two variables.

MTEBI Understanding and Effectiveness, Grade Level, and Highest Degree

An independent t-test was conducted which indicated that there was no significant difference between highest degree earned for teachers with bachelor's and master's degrees in their perceived efficacy in the area of understanding and effectiveness when teaching mathematics. Those with master's degrees, on average, felt that they were slightly more efficacious than those who indicated highest degree earned as bachelor's degrees, but this difference was not significant.

MTEBI Student Achievement, Grade Level, and Highest Degree

The results of an independent t-test indicated that there was no significant difference in highest degree earned between teachers with bachelor's and master's degrees in their perceived efficacy in the area of student achievement when teaching mathematics. Those with master's degrees, on average, felt that they were slightly more efficacious than did those who indicated highest degree earned as bachelor's degrees, but this difference was not significant.

Research Question 5

To what extent, if any, do elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest when controlling for teacher (a) gender; (b) grade level taught; (c) years of experience; (d) highest degree earned; and (e) ethnicity?

A hierarchical multiple linear regression analysis was conducted to examine the relationship between elementary teachers' perceived mathematics anxiety (AMAS), anxiety about teaching mathematics (ATM), and mathematics teaching efficacy (MTEBI) and student achievement in mathematics. The goal was to determine if student proficiency in mathematics could be predicted by AMAS, ATM, and MTEBI scores while controlling for the demographic factors of grade level taught, years of experience, highest degree earned, and ethnicity.

The demographics of grade level taught, years of experience, and highest degree earned included in the baseline model were good predictors of proficiency on the 2009 FCAT mathematics subtest. Although this was the baseline model, it is important to note that this initial model was significant. Accuracy in predicting mathematics proficiency was strong with a multiple correlation coefficient of .42. The second step added the two factors of the score for elementary teachers' perceived mathematics anxiety (AMAS), Mathematics Evaluation Anxiety (MEA) and Learning Mathematics Anxiety (LMA). When holding the demographic variables constant, these factors were not good predictors of mathematics achievement and were not significant. Accuracy in predicting mathematics proficiency barely increased, with a change multiple correlation coefficient

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of .01. Only one extra percentage point of the variance of mathematics proficiency was accounted for by the regression model above the prior model.

Anxiety about teaching mathematics (ATM) was not a good predictor of mathematics achievement and was not significant when holding all previous demographic factors and AMAS constant. Accuracy in predicting mathematics proficiency did not increase beyond the previous multiple correlation coefficient of .43.

Lastly, the two factor scores for mathematics teaching efficacy (MTEBI), the Understanding and Effectiveness factor and the Student Achievement factor were considered. When holding the demographic variables, AMAS, and ATM constant, this set of factors was a good predictor of mathematics achievement.

The findings of this study are in contrast to the results of several studies which indicated that teachers' level of mathematics anxiety could significantly predict students' mathematics performance (Fennema & Sherman, 1977; Hendel, 1980; Rounds & Hendel, 1980; Wigfield & Meece, 1988). The findings, however, supported previous research conducted by Enon in 1995 (as cited in Swars, 2004) indicating that teaching efficacy may be a significant predictor of teacher effectiveness in the area of mathematics.

Conclusions

The findings of this study expanded the work in the area of mathematics anxiety, mathematics teaching efficacy, and student achievement. This study sought to determine: (a) if there were relationships among elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy and the

percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest in 2009; (b) if there were mean differences in elementary teachers' perceived mathematics anxiety based on teacher gender, grade level taught, years of experience, highest degree earned, and ethnicity; (c) if there were mean differences in elementary teachers' perceived anxiety about teaching mathematics based on teacher gender, grade level taught, years of experience, highest degree earned, and ethnicity; (d) if there were mean differences in elementary teachers' perceived mathematics teaching efficacy based on teacher gender, grade level taught, years of experience, highest degree earned, and ethnicity; and (e) the extent to which elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy predicted the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest.

The relationship between the three components of the Mathematics Anxiety and Teaching Efficacy Survey (teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy) and student achievement as measured by the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest was not found to be statistically significant. Specifically, there was no statistically significant relationship between perceived mathematics anxiety and student achievement. Likewise, there was also no significant relationship between anxiety about teaching mathematics and student achievement. Mathematics teaching efficacy was however significantly correlated in a

positive direction with the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest.

It was found that there was a statistically significant correlation between mathematics teaching efficacy and the percentage of students scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest. Further review of the data indicated that there was also a statistically significant positive correlation between teachers' perceived mathematics anxiety and anxiety about teaching mathematics. Additionally there was a significant negative correlation between anxiety about teaching mathematics and mathematics teaching efficacy. Perceived mathematics anxiety and mathematics teaching efficacy did not, however, share a statistically significant relationship.

It was found that males may have felt slightly less anxious about their learning of mathematics than females. Results also indicated that non-white teachers may have felt less anxious about their learning of mathematics when compared to white teachers. There was also no significant difference between the mean score for teachers' perceived mathematics anxiety among bachelor's degree or master's degree recipients, although based on descriptive statistics, teachers with a bachelor's degree had only a slightly lower mean score on teachers' perceived mathematics anxiety.

The results of the study indicated that males may have felt slightly less anxious about their teaching of mathematics than females. The research also illustrated that non-white teachers may have felt less anxious about their teaching of mathematics when compared to the white teachers. The results of the independent t-test for highest degree

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earned indicated that there was a statistically significant difference between the mean score for teachers' perceived anxiety about teaching mathematics among bachelor's degree or master's degree recipients. Teachers with a bachelor's degree had a much higher mean score on Part II of the survey measuring elementary teachers' perceived anxiety about teaching mathematics than did teachers with a master's degree.

When examining differences, if any, in elementary teachers' perceived mathematics teaching efficacy, the researcher noted that the male participants had a slightly higher mean score on Part III of the survey measuring perceived mathematics teaching efficacy (MTEBI), than the female respondents. No statistical tests were run, but the evidence showed that males may have had slightly lower teaching efficacy scores than females. When looking at ethnicity, non-white respondents had a higher mathematics teaching efficacy mean score than did the white respondents. The results of the independent *t*-test for highest degree earned indicated that there was no statistically significant difference between the mean score for mathematics teaching efficacy among bachelor's degree or master's degree recipients.

When determining the extent to which elementary teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy could predict the percentage of students in their class scoring proficient or above on the 2009 Florida Comprehensive Assessment Test (FCAT) mathematics subtest, the researcher conducted a hierarchical multiple linear regression analysis. The initial model included the demographics of grade level taught, years of experience, and highest degree earned and was significant. The variables were good predictors of proficiency in

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mathematics. When holding the demographic variables constant in the second step of the model, the scores for perceived mathematics anxiety factors were not good predictors of mathematics achievement, were not significant, and accuracy in predicting mathematics proficiency barely increased. The addition of the score for anxiety about teaching mathematics (ATM) to the model was not significant when holding all previous demographic factors and AMAS constant. The last two factor scores for mathematics teaching efficacy (MTEBI), the Understanding and Effectiveness factor and the Student Achievement factor, were good predictors of mathematics achievement and accuracy in predicting mathematics proficiency increased.

The findings of this study are in contrast to the results of several studies which indicated that the level of mathematics anxiety can significantly predict mathematics performance (Fennema & Sherman, 1977; Hendel, 1980; Rounds & Hendel, 1980; Wigfield & Meece, 1988). The findings also support previous research conducted by Enon in 1995 (as cited in Swars, 2004) indicating that teaching efficacy is a significant predictor of teacher effectiveness in the area of mathematics. Based on these findings, future research should be focused more on how to improve teacher efficacy rather than just on decreasing mathematics anxiety because it is strongly related to student performance.

Implications for Practice

Because of the No Child Left Behind (NCLB) Act of 2001 and high stakes accountability, educators have the inherent responsibility to increase student achievement

and success in mathematics (NCLB, 2002). NCLB required states to use assessments to measure school accountability which placed greater emphasis on determining a teacher's ability to teach mathematics effectively. In recent reports from the National Mathematics Advisory Panel (2008) and the National Council on Teacher Quality (2007), an ambitious vision for mathematics education was set forth encompassing the goal of excellence for all students. This vision was accompanied with the argument that teachers would be the primary agents for change and that the quality of mathematics teachers could significantly impact student achievement.

The National Mathematics Advisory Panel (2008) indicated that anxiety about mathematics was related to low mathematics grades and poor scores on standardized tests of mathematics achievement. In the report, the panel recommended that researchers assess potential risk factors for mathematics anxiety and developing promising interventions for reducing serious mathematics anxiety. The literature presented in this study illustrated that elementary teachers with high levels of mathematics anxiety, coupled with low mathematics teaching efficacy, have the potential to transmit their anxiety and beliefs to their students, thus raising concern as an inhibitor of mathematics attainment and success for students. Because of increased accountability, this has implications for educational leaders.

The findings of this study, in relationship to educational reform, have extensive implications for educators within the educational system. Several connections between teachers and their role in a student's mathematics performance were identified in this study. Educational leaders and stakeholders should find the relationships of mathematics

anxiety and teaching efficacy as they related to mathematics student achievement useful in making decisions that may result in a number of changes in current practices.

In order to improve student achievement in the area of mathematics, school administrators must understand the influence that teachers' mathematics anxiety and mathematics teaching efficacy have on students' ability to learn mathematics adequately and appropriately. Past research examining the relationship between teachers' mathematics anxiety and student achievement yielded results indicating a strong relationship between these two factors (Betz, 1978; Clute, 1984; Cooper & Robinson, 1991; Hafner, 2008; Hembree, 1990; Sherman & Wither, 2003; Wigfield & Meece, 1998). In particular, these studies illustrated that higher levels of teachers' mathematics anxiety would result in lower student achievement. School administrators may need to attend professional development trainings on how to improve students' ability to learn mathematics by addressing both the mathematics anxiety and mathematics teaching efficacy of teachers. School level administrators should also take these results into account and consider a teacher's anxiety level towards mathematics when assigning teachers to certain grade levels. Additionally, studies have also included results to support the research regarding the influence of teachers with higher levels of teaching efficacy on student achievement (Hall & Ponton, 2005; Swackhamer, 2009).

The findings of this study did not support the aforementioned results on the relationship between teachers' mathematics anxiety and student achievement; however, the results were in agreement with the research on the positive relationship between teaching efficacy and increased performance in mathematics. As reported, the data

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collected from this study did not reveal any statistically significant relationships between elementary teachers' anxiety about mathematics, their anxiety about the mathematics they teach, their mathematics teaching efficacy beliefs, and their students' mathematics achievement.

The findings revealed in this study suggested that mathematics teaching efficacy was strongly related to student achievement, as well as anxiety about teaching mathematics. More research should be conducted in the area of teaching efficacy in order for educational leaders to develop it in elementary teachers. School based administrators must therefore understand current research on teaching efficacy and how efforts should be focused on improving teachers' beliefs in their skills and abilities as effective mathematics teachers. According to the National Council of Supervisors of Mathematics (2008), a leader in mathematics education must ensure that teachers are experiencing continuous growth in their understanding and comfort of the subject. Based on the connection between teaching efficacy and student achievement, school administrators should provide teachers with professional development opportunities and training focused on improving productive dispositions towards mathematics and promoting research-informed teaching practices and effective instructional strategies. Teachers will need the training necessary to remain current in mathematics education research and maintain a comfort with using the knowledge so that they can provide a high level of learning for all students.

This implication also requires that teachers understand how to effectively help students interact with new knowledge and deepen their understanding of that content.

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School administrators could assist by establishing collaborative teams of teachers to work together in order to develop effective lessons aimed at improving student achievement. According to the National Council of Supervisors of Mathematics (2008), when teachers engage regularly in joint work focused on common learning goals, their collaboration pays off in the form of increased teacher confidence and remarkable gains in student achievement. Administrators can provide the necessary professional development so that teacher teams can develop and use an array of instructional strategies with which they may not have been previously comfortable. Fauth and Jacobs (1980) indicated that educational leaders needed to go beyond the identification of teachers with mathematics anxiety. They needed to provide staff development programs designed to help mathematically anxious teachers overcome their fears. Common planning time and support should also be provided to teachers so that they can improve their content and pedagogical knowledge by learning skills and acquiring abilities to be effective mathematics teachers through reflective practice.

In order to improve the mathematics teaching efficacy, Gabriele and Joram (2007) stated that it was necessary to provide teachers with opportunities that fostered the value of investigating student thinking in mathematics. Additionally, administrators needed to focus on teachers' comfort level because it was viewed as an essential developmental aspect of improving mathematics teaching efficacy. These authors believed that it was imperative that teachers were comfortable with exploring and solving mathematical content and with the delivery of classroom instruction (Gabriele & Joram). J. Smith (1996) remarked that teachers could incorporate several different components of

mathematics instruction in order to establish and improve their efficacy beliefs. Educational leaders could assist teachers by encouraging them to choose problems that required students to engage with significant mathematical content, predict student reasoning when problem solving, generate and direct discourse as opposed to being the only authority on mathematics in the classroom, and allow for the incisive portrayal of mathematical content, rules, or procedures (J. Smith, 1996).

Allowing teachers to reflect on past experiences, and the feelings associated with those experiences, has been predicted to assist in the improvement of teaching efficacy in the area of mathematics (J. Smith, 1996; Swars, 2005; Swars et al., 2006). Once teachers have established an awareness of those feelings, it has been beneficial to provide them with learning experiences in which they were successful (Ross & Bruce, 2007; Swars, 2005; Swars et al., 2006). Tschannen-Moran et al. (1998) indicated that educational leaders can also help improve teaching efficacy by providing staff development in which the teaching task has been analyzed prior to implementation of professional development. When professional development is provided related to mathematics content for elementary teachers, it should incorporate scaffolding of reform-oriented mathematics activities. Ball (1990) posited that to effectively create professional development that reduced mathematics anxiety, and concurrently improve mathematics teaching efficacy, the current measure of elementary teachers' mathematical understanding needed to be considered.

Administrators can also help reduce anxiety levels and increase mathematics teaching efficacy by providing the commitment of resources, dedicating time within the

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school day for teacher collaboration, and offering support through contextual and ongoing professional development (National Council of Supervisors of Mathematics, 2008). Principals need to advocate for teachers to model positive dispositions towards mathematics. Educational leaders must ensure that students have access to effective mathematics teachers who foster high levels of achievement for every student.

<u>Recommendations for Future Research</u>

As a result of the findings of this study, the following recommendations are offered for future research:

1. This study could be replicated using a larger sample size with larger school districts, or with state and national populations in order to cross-validate the results.

2. Further research could be conducted using a population of teachers in grades K-2 and 6-12 within the same school district or in different districts and/or states in order to substantiate the results. A different measure of student achievement in the area of mathematics would need to be used for a study conducted in grades K-2, 6-8, and 9-12.

3. The relationships between teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy could be further examined using different populations, such as middle school and high school teachers, in order to corroborate the findings of this research.

4. The study could be replicated using a different measure of student achievement such as report card grades as an additional variable.

5. Instead of examining highest degree earned, further research could investigate teachers' major in college, specifically looking for mathematics related degrees.

6. This study could be repeated in a school district that has more diversity and higher variability in ethnicity, gender, and student achievement to determine if the same results would be found.

7. A study could be conducted to determine if there is a difference in the percentage of students scoring proficient or above on a mathematics test for different AYP subgroups based on teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy.

8. This study could be conducted as a longitudinal study looking at student achievement gains over a period of years and the relationship to mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy beliefs.

9. This study could be extended to include interviews of teachers that completed the survey instrument in order to further explain relationships.

10. The relationships between teachers' perceived mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy could be further examined using student achievement results from the same school year.

11. Research could be conducted on the causes of mathematics anxiety among teachers in order to decrease the impact it may have on student achievement.

12. Additional research could focus on observations of teachers in their classrooms in order to view how their mathematics anxiety and teaching efficacy are related to the implementation of effective teaching strategies in the area of mathematics.

APPENDIX A
TEACHER MATHEMATICS ANXIETY AND TEACHING EFFICACY SURVEY

Mathematics Anxiety and Teaching Efficacy Survey

Survey Instructions

Thank you for agreeing to complete this survey regarding mathematics anxiety and teaching efficacy. The following items are intended to measure teacher mathematics anxiety and what type of activities and teaching practices are related to mathematics anxiety. All responses to this survey are confidential and participation is voluntary.

Please answer the following questions as truthfully as possible so that the data collected will be useful and reliable.

1. Please enter your teacher survey code provided.

By entering this teacher survey code, you are providing your consent to participate in the research study as explained in your email. You may exit this survey at anytime and withdraw your participation from the research study without consequence.

Mathematics Anxiety and Teaching Efficacy Survey

2. Did you teach 3rd, 4th, or 5th grade mathematics in Citrus County during the 2008 - 2009 school year?

◯ Yes

◯ No

Mathematics Anxiety and Teaching Efficacy Survey

Part I: Abbreviated Math Anxiety Scale (AMAS)

3. Think about a mathematics class where you were the STUDENT. Please rate each item related to how anxious you would feel during the event specified.

	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
Having to use the tables in the back of a mathematics book.	◯	◯	◯	◯	◯
Thinking about an upcoming mathematics test one day before.	◯	◯	◯	◯	◯
Watching a teacher work an algebraic equation on the board.	◯	◯	◯	◯	◯
Taking an examination in a mathematics course.	◯	◯	◯	◯	◯
Being given a homework assignment of many difficult problems which is due the next class meeting.	◯	◯	◯	◯	◯
Listening to a lecture in a mathematics class.	◯	◯	◯	◯	◯
Listening to another student explain a mathematics formula.	◯	◯	◯	◯	◯
Being given a "pop" quiz in a mathematics class.	◯	◯	◯	◯	◯
Starting a new chapter in a mathematics book.	◯	◯	◯	◯	◯

Mathematics Anxiety and Teaching Efficacy Survey

Part II: Anxiety about Teaching Mathematics (ATM)

4. The items in this section refer to things and experiences that may cause anxiety or apprehension to you as a classroom TEACHER. Please rate each item related to how anxious you currently are about the event specified in your classroom.

	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
Teaching students how to interpret tables, graphs, and charts.	○	○	○	○	○
Preparing students for the upcoming year-end mathematics test.	○	○	○	○	○
Working out mathematics equations on the board in front of a class of students.	○	○	○	○	○
Preparing a presentation for parents about the mathematics curriculum you teach.	○	○	○	○	○
Preparing to teach students a new concept that will be challenging to them.	○	○	○	○	○
Explaining your rationale for the mathematics curriculum to a parent who stopped by your classroom after school.	○	○	○	○	○
Talking to a student who wanted to use a different way to solve a mathematics problem than the way taught in class.	○	○	○	○	○
Writing a lesson plan for teaching a new mathematics concept.	○	○	○	○	○
Waiting for the results of your students' year-end mathematics tests.	○	○	○	○	○

Mathematics Anxiety and Teaching Efficacy Survey

Part III: Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

5. Please indicate the degree to which you agree or disagree with each of the following statements.

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
When one of my students does better than usual in mathematics, it is often because I exerted a little extra effort.	○	○	○	○	○
I continually find better ways to teach mathematics.	○	○	○	○	○
Even if I try very hard, I do not teach mathematics as well as I teach most subjects.	○	○	○	○	○
When the mathematics grades of students improve, it is often due to my having found a more effective teaching approach.	○	○	○	○	○
I know how to teach mathematics concepts effectively.	○	○	○	○	○
I am not very effective in monitoring mathematics activities.	○	○	○	○	○
If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	○	○	○	○	○
I generally teach mathematics ineffectively.	○	○	○	○	○
The inadequacy of a student's mathematics background can be overcome by good teaching.	○	○	○	○	○
When a low-achieving student progresses in mathematics, it is usually due to extra attention given by me.	○	○	○	○	○

Mathematics Anxiety and Teaching Efficacy Survey

Part III: Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

6. Please indicate the degree to which you agree or disagree with each of the following statements.

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
I understand mathematics concepts well enough to be effective in teaching elementary mathematics.	○	○	○	○	○
I am generally responsible for the achievement of my students in mathematics.	○	○	○	○	○
Students' achievement in mathematics is directly related to my effectiveness in mathematics teaching.	○	○	○	○	○
If parents comment that their child is showing more interest in mathematics at school, it is probably due to my performance.	○	○	○	○	○
I find it difficult to use manipulatives to explain to students why mathematics work.	○	○	○	○	○
I am typically able to answer students' mathematics questions.	○	○	○	○	○
I wonder if I have the necessary skills to teach mathematics.	○	○	○	○	○
When a student has difficulty in understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.	○	○	○	○	○
When teaching mathematics, I usually welcome student questions.	○	○	○	○	○
I do not know how to develop student interest and motivation to learn mathematics.	○	○	○	○	○

Mathematics Anxiety and Teaching Efficacy Survey

Part IV: Demographics

7. What is your gender?

◯ Female

◯ Male

8. What is the grade level in which you taught mathematics during the 2008-2009 school year?

◯ 3rd

◯ 4th

◯ 5th

9. What is the grade level that you are currently teaching during the 2009-2010 school year?

◯ 3rd

◯ 4th

◯ 5th

Other (please specify)

[   ]

10. How many years have you taught elementary mathematics?

[   ]

11. What is the highest degree that you have earned?

◯ Bachelor's Degree (B.A., B.S., etc.)

◯ Master's Degree (M.A., M.B.A., M.Ed., M.S., etc.)

◯ Education specialist or professional diploma (Ed.S.)

◯ Doctorate or first professional degree (Ph.D., Ed.D., etc.)

Mathematics Anxiety and Teaching Efficacy Survey

12. What is your ethnicity?

- ◯ White
- ◯ Black or African-American
- ◯ Hispanic
- ◯ Asian
- ◯ Multiracial

Other (please specify)

[   ]

Mathematics Anxiety and Teaching Efficacy Survey

Mathematics Anxiety and Teaching Efficacy Survey

Thank you for your willingness to complete this survey. The research being conducted is based on the relationships among mathematics anxiety, anxiety about teaching mathematics, and mathematics teaching efficacy of elementary teachers. Your responses are valuable and are important to the field of research on mathematics anxiety of elementary teachers and its effect on student mathematics achievement.

Thank you for your time.

APPENDIX B
APPROVAL OF EXEMPT HUMAN RESEARCH

University of
**Central
Florida**

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**

To: **Jennifer Sasser**

Date: **November 12, 2009**

Dear Researcher:

On 11/12/2009, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	PERCEIVED MATHEMATICS ANXIETY AND TEACHING EFFICACY OF ELEMENTARY TEACHERS IN RELATIONSHIP TO STUDENT MATHEMATICS ACHIEVEMENT
Investigator:	Jennifer Sasser
IRB Number:	SBE-09-06519
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 11/12/2009 08:32:10 AM EST

IRB Coordinator

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APPENDIX C
PERMISSION TO USE SURVEY INSTRUMENTS

AMAS Permission

2 messages

Jennifer Sasser <sasserj@gmail.com>   Thu, Jul 23, 2009 at 2:16 AM
To: dhopko@utk.edu

Dear Dr. Derek Hopko,

Hello. My name is Jennifer Sasser and I am a doctoral student at the University of Central Florida. I am currently working on the proposal for my dissertation regarding mathematics anxiety and teaching efficacy of elementary teachers. I am writing to request permission to be able to use and slightly modify the 9-variable, Abbreviated Math Anxiety Scale (AMAS) developed by you and your colleagues, as part of my survey. I plan on making slight modifications to the instrument, such as changing the word 'math' to 'mathematics' in several of the items. I would greatly appreciate your support. Please feel free to contact me if you have any questions.

Thank you in advance for your consideration.

Sincerely,
Jennifer Sasser

Email: sasserj@gmail.com

Hopko, Derek R <dhopko@utk.edu>   Thu, Jul 23, 2009 at 7:36 AM
To: Jennifer Sasser <sasserj@gmail.com>

That's fine Jennifer, you have my permission. Good luck with your research!
Dr. Hopko

Derek R. Hopko, Ph.D.
Associate Professor and Associate Department Head
The University of Tennessee
Department of Psychology
307 Austin Peay Building
Knoxville, TN 37996-0900
PH: (865) 974-3368
FAX: (865) 974-3330

MTEBI Permission

2 messages

Jennifer Sasser <sasserj@gmail.com>   Thu, Jul 23, 2009 at 2:23 AM
To: enochsl@onid.oregonstate.edu

Dear Dr. Larry Enochs,

Hello. My name is Jennifer Sasser and I am a doctoral student at the University of Central Florida. I am currently working on the proposal for my dissertation regarding mathematics anxiety and teaching efficacy of elementary teachers. I am writing to request permission to be able to use and slightly modify the Mathematics Teaching Efficacy Belief Instrument (MTEBI) developed by you and your colleagues, as part of my survey. I plan on making slight modifications to the instrument, such as changing the word 'math' to 'mathematics' in one of the items. I would also like to remove one item from the instrument (# 18 - Given a choice, I will not invite the principal to evaluate my mathematics teaching). I would greatly appreciate your support. Please feel free to contact me if you have any questions.

Thank you in advance for your consideration.

Sincerely,
Jennifer Sasser

Email: sasserj@gmail.com

LARRYENOCHS <enochsl@onid.orst.edu>   Thu, Jul 23, 2009 at 3:38 PM
To: Jennifer Sasser <sasserj@gmail.com>

You certainly have permission to use the MTEBI. Removing an item requires an explanation.
[Quoted text hidden]
Larry G Enochs
Professor
Science and Mathematics Education
237 Weniger Hall
Oregon State University
Corvallis, OR 97331
541-737-1305
http://smed.science.oregonstate.edu/node/42

"Students should continue to learn and use their learning in more effective problem solving for the rest of their lives. When one takes life-long learning and thinking as the major goal of education, knowledge becomes a means rather than an end, and other formerly implicit goals become more explicit." (McKeachie et al, 1986, p1.)

Anxiety about Teaching Mathematics Permission

Kristin HADLEY <KristinHadley@weber.edu>   Tue, Jun 16, 2009 at 4:50 PM
To: Jennifer Sasser <sasserj@gmail.com>

Dear Jennifer,

You have my permission to use the Elementary Teachers Mathematics Anxiety and Teaching Practices survey instrument in your study. Additionally, you may want to use the attached updated survey instrument. Feel free to adapt it as needed for your setting. Good luck with your study.

Kristin M. Hadley, Ph.D.
Weber State University
Department of Teacher Education
1304 University Circle
Ogden, UT 84408-1304
801 626-8653

APPENDIX D
INFORMED CONSENT LETTER TO PARTICIPANTS

Dear (County Name) Elementary School Teacher:

You are invited to participate in a confidential study because you taught mathematics in grades 3 – 5 during the 2008 – 2009 school year for (County Name) Schools. The purpose of my research is to identify the relationships between mathematics anxiety, anxiety about teaching mathematics, mathematics teaching efficacy and student mathematics achievement as measured by the Florida Comprehensive Assessment Test (FCAT). I would appreciate your participation in this research for assessing the influence that mathematics anxiety and teaching efficacy beliefs have on student achievement.

This electronic survey should take approximately 15 minutes to complete. If you choose to participate, I ask that you please attend the afternoon session on <u>(date)</u> at <u>(time)</u>. I plan on meeting with the teachers in <u>(location)</u> so that I can provide you with all the specific information necessary to complete the survey and answer any questions that you may have.

Your completion of the survey is voluntary. You can decline to participate in this survey without repercussions. There are no anticipated professional or financial risks. To help ensure the confidentiality of your identity, you will be assigned a numeric code. This teacher survey code, as well as all the information gathered through the use of the survey instrument, will be held confidential and discarded upon completion of the research. This teacher survey code will be used for tracking purposes only in order to match student achievement data to the information collected for analysis purposes through the completed survey. Your privacy and research records will be kept confidential to the extent of the law. The results of this study may be published. The published results will not include your name or any other information that would personally identify you or your school in any way.

If you have any questions about this survey or would like additional information about this study, please contact me at sasserj@gmail.com My faculty advisor, Dr. Rosemarye Taylor, may be contacted at (407) 823-1469 or by email at rtaylor@mail.ucf.edu Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed to UCF Institutional Review Board Office at the University of Central Florida, Office of Research and Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The phone numbers are (407) 823-2901 or (407) 882-2276.

The submission of the online survey will indicate your consent to volunteer to participate in this study. Thank you in advance for your assistance with this research.

Sincerely,
Jennifer Ann Sasser
Doctoral Candidate, University of Central Florida
Assistant Principal, Citrus Springs Middle School

APPENDIX E
ADMINISTRATOR COVER LETTER/PERMISSION FORM

Dear (County Name) Elementary School Principal:

Thank you for taking the time to explore the components of this study and for considering participation by your school. This study will assist in identifying the relationships between mathematics anxiety, anxiety about teaching mathematics, mathematics teaching efficacy, and student mathematics achievement as measured by the Florida Comprehensive Assessment Test (FCAT). Teachers will be asked to complete a survey instrument that includes a mathematics anxiety scale, a teaching mathematics anxiety scale, and a teaching efficacy scale. The 2009 Mathematics FCAT results, specifically the percentage of students scoring proficient or above, for teachers who taught third, fourth, and fifth grade during the 2008 – 2009 school year will be requested from the school district.

Permission is needed for access to your teachers during December of 2009. I would like to spend about 30 minutes after school with the teachers in a computer lab setting in order to administer the survey instrument electronically. You will have the opportunity to select the date that would work best for both you and your staff.

The published research will not contain any teacher nor school names, other than to note that all participating schools were schools in a west central Florida school district.

Please send me an email indicating whether or not you are willing to grant permission for your teachers to complete the survey instruments should they choose.

Upon completion of this study, you will have the opportunity to receive a copy of the published results, as well as a copy of the results of the data collected for the county.

Questions about this study can be directed to myself by email at sasserj@gmail.com My faculty advisor, Dr. Rosemarye Taylor, may be contacted at (407) 823-1469 or by email at rtaylor@mail.ucf.edu

Your time and effort in helping me gather information is greatly appreciated and will ultimately assist educational professionals to improve student achievement in the area of mathematics.

Sincerely,

Jennifer Ann Sasser
Doctoral Candidate, University of Central Florida
Assistant Principal, Citrus Springs Middle School

APPENDIX F
CORRELATION MATRIX FOR MATHEMATICS TEACHING EFFICACY BELIEFS
INSTRUMENT (MTEBI) ITEMS

Correlation Matrix for Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) Items (N = 114)

Item	1	2	3	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20
1	—																	
2	.19*	—																
3	.15	.33**	—															
5	.29**	.31**	.43**	—														
6	-.02	.30**	.37**	.28**	—													
7	.08	-.09	-.13	-.10	-.19*	—												
8	.24**	.28**	.39**	.47**	.36	-.19*	—											
9	-.04	.09	.15	.13	.17*	.22**	.13	—										
10	.26**	.23**	.21*	.33**	.22*	.04	.26**	.07	—									
11	.25**	.28**	.46**	.54**	.33**	-.11	.55**	.28**	.18*	—								
12	.14	.03	.09	.12	.10	.04*	.20*	.19*	.04	.42**	—							
13	.31**	.14	.25**	.17*	.15	.21*	.21*	.27**	.23**	.33**	.31**	—						
14	.18*	.16*	.18*	.26**	.13	.18*	.10*	.18*	.18*	.20*	.18*	.32**	—					
16	.25**	.29**	.36**	.51**	.14	-.13	.41**	.16*	.20*	.56**	.15	.21*	.21*	—				
17	.19*	.36**	.51**	.56**	.36**	-.18*	.56**	.15	.29**	.65**	.25**	.17*	.27**	.48**	—			
18	.20*	.31**	.36**	.43**	.24**	-.13	.41**	.22**	.15	.52**	.19*	.21*	.17*	.39**	.54**	—		
19	.14	.42**	.43**	.49**	.30**	-.17*	.44**	.17*	.20*	.61**	.20*	.21*	.23**	.49**	.52**	.50**	—	
20	.18*	.37**	.51**	.39**	.28**	-.06	.39**	.18*	.14	.47**	.10	.21*	.25**	.37**	.42**	.36**	.46**	—

*p > .05. **p > .01.*

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