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THE RELATIONSHIP AMONG MATHEMATICS ANXIETY, MATHEMATICAL
SELF-EFFICACY, MATHEMATICAL TEACHING SELF-EFFICACY, AND
THE INSTRUCTIONAL PRACTICES OF ELEMENTARY SCHOOL TEACHERS

by

Lydia Joan Smith

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

December 2010

ABSTRACT

THE RELATIONSHIP AMONG MATHEMATICS ANXIETY, MATHEMATICAL SELF-EFFICACY, MATHEMATICAL TEACHING SELF-EFFICACY, AND THE INSTRUCTIONAL PRACTICES OF ELEMENTARY SCHOOL TEACHERS

by Lydia Joan Smith

December 2010

The purpose of this quantitative, correlational study was to explore the relationships among the variables of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practice of elementary school teachers. The study included 320 practicing elementary teachers who teach mathematics to students in kindergarten through eighth grade. These teachers completed the Abbreviated Mathematics Anxiety Scale, the Mathematics Teaching and Mathematics Self-Efficacy survey, and the Patterns of Adaptive Learning Survey. Quantitative data analysis methods included descriptive statistics and multiple regression analysis. Results indicated a statistically significant relationship between mathematical teaching self-efficacy (efficacy) and mastery approaches to instruction, as well as a significant relationship between mathematical teaching self-efficacy (content) and performance-based instruction. The contradiction found within the data suggested an inconsistency among teachers regarding how their mathematical teaching self-efficacy influences their instructional practices. Additionally, results indicated that when teaching mathematics as it relates to mathematics content, teachers are confident in their abilities to provide performance - based instruction. This study offers findings to mathematics teacher educators and elementary mathematics teachers about the importance of identifying and

resolving the internal conflict found within the subscales of mathematical teaching self-efficacy because of its relationship to elementary teachers' instructional practices.

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A Dissertation
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December 2010

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Now glory be to God! By his mighty power at work within us, he is able to accomplish infinitely more than we would ever dare to ask or hope. Ephesians 3:20

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CHAPTER I

INTRODUCTION

Mathematics has not been widely known for its popularity among Americans throughout generations, and it has become even less favored according to recent reports and statistics (Anderson, 2010; Manigault, 1997; National Science Board, 2006; Polya, 1957; Wallace, 2005). It has been suggested that the United States has lost its competitive edge in the global economy because of poor precollege mathematics and science preparation. The majority of college graduates choose not to take advanced mathematics courses because of limited or poor mathematics preparation at the elementary level (National Science Board, 2006; Wallace, 2005). Although the standards for what has been identified as effective mathematics instruction have been outlined and defined by the National Council of Teachers of Mathematics (NCTM, 2000), the implementation of these effective practices are still not consistently found among elementary classrooms in teachers' instructional practices. Compounding the problem, teachers' mathematics anxiety and poor mathematical self-efficacies have been found to negatively influence some students' performances and perceptions in the content area (Beilock, Guderson, Ramirez, & Levine, 2010; Kahle, 2008).

Despite the attention given to the articulation of standards for mathematics, American students continue to experience poor outcomes in the content area (National Science Board, 2006; Wallace, 2005). Additionally, concerns with elementary teachers' mathematics anxiety (Beilock et al., 2010; Furner & Berman, 2003; Jackson & Leffingwell, 1999) and the influences of mathematical self-efficacy and mathematical teaching self-efficacy on teachers' instructional practices (Bandura, 1997; Kahle, 2008;

Midgley, Feldlaufer, & Eccles, 1989), suggest that these components, separate or collective, may have more influence on teachers' instructional practices than established standards. While necessary, the national standards are used as a foundational structure and provide a basis for instruction, but do not necessarily eliminate or alleviate teachers' individual issues and concerns with mathematics (Kahle, 2008). The mathematics anxiety elementary teachers may exhibit, or their low sense of mathematical self-efficacy or mathematical teaching self-efficacy, may make them more reluctant to implement those mathematical instructional practices deemed necessary for student mastery. There is a lack of research examining the impact of these influences on teaching behaviors that are, nonetheless, shown to have strong influence over teachers' attitudes towards mathematics. By recognizing the factors that negatively influence teachers' instructional practices in mathematics, efforts can be extended towards alleviating and eliminating some of the negative influences.

The position of the National Council of Teachers of Mathematics (NCTM) is that students must be taught how to problem-solve and work through strategies in order to derive a rational, reasonable plan for resolving mathematical issues, and it is directly aligned with the theoretical base of constructivism. The process of creating mathematical-literate students is done by allowing students to communicate in discourse, collaborate, extend, explain, and explore mathematical concepts, which are all supportive and aligned with constructive learning (NCTM, 2000; Van de Walle, 2004). Without such experiences, students are not given the opportunity to effectively problem-solve because mathematical ideas and understanding cannot be effectively conveyed to passive learners. Rather, students must be mentally engaged and actively learning

through working with new ideas, connecting new thoughts to existing networks, and challenging their personal ideas as well as those of others (Van de Walle, 2004).

Research has shown that teachers who suffer from mathematics anxiety and fail to have mathematical security tend to monopolize mathematics instruction and fail to offer students the opportunity to engage in constructivist learning (Bush, 1989; Fiore, 1999; Furner & Duffy, 2002; Jackson & Leffingwell, 1999; Karp, 1991). It is critical that steps are taken to help teachers overcome their own mathematical anxieties and low mathematical self-efficacies so that learning opportunities for students can be extended. By learning the foundational beliefs of effective mathematics instructional practices, teachers can break down the barriers that created their own mathematics anxieties, fears, and insecurities. The NCTM focuses heavily on the theoretical base of constructivism as the most influential instructional style that promotes active, invested mathematical learning among students (NCTM, 2000; Van de Walle, 2004). The council specifically emphasizes the importance of constructivism during the preliminary years when conceptual understanding is being established. By establishing these stronger foundational experiences in the elementary classroom, teachers can help advance mathematics instruction and overcome their own mathematical weaknesses and fears. It is necessary to understand not only the critical elements of high quality mathematics instruction, but also the underlying affective elements that influence instructional practices and student outcomes as well.

Theoretical Framework

The theoretical framework underlying this research study is grounded in constructivist learning theory. Understanding the foundation for effective mathematics

instruction is critical in educating teachers on how to better prepare students in the content area as well as help alleviate some of their own anxieties or concerns regarding mathematics instruction. The constructivist approach to mathematics has shown itself to create the strong foundation for mathematics learning as well as align with the standards of the National Council of Teachers of Mathematics (NCTM, 2000; Van de Walle, 2004). Constructivism has established the expectation that student learning is an interdependent process in which only the learner can actively construct personal meaning of the knowledge being acquired based on his or her cognitive developmental stages and his or her socio-cultural experiences (NCTM, 2000; Piaget, 1971; Vygotsky, 1978). Strictly following directions without reflective thought provides little to no construction of understanding; learning becomes limited because of the barriers of rules and procedures, especially in mathematics (Van de Walle, 2004).

According to Marlow and Page (2005), the construction of knowledge is the focus of the learning process, not how the information is received. The researchers also communicated that the massive amount of information presented in classrooms is unmanageable when the traditionally stated *teacher instruction-learner listening* method is used for instruction. Educators must demonstrate the thinking process regarding mathematics because students have to be taught how to think through the information and use logical judgment to determine how to solve problems. They must also be provided an opportunity to construct personal knowledge from the information and material presented (Marlow & Page, 2005; NCTM, 2000; Van de Walle, 2004). As communicated by Vygotsky (1978), every function of a child's development first appears on a social level and then on an individual level. In the theorist's assertions, he claims that the higher

functions of individuals occur through relationships with other individuals. Without the invested efforts of students learning in the construction of their knowledge, through individualized exploration and interactive communication, a limited amount of ownership and understanding of the mathematics content takes place (Van de Walle, 2004).

Supporting Research

Campbell and Johnson (1995) conducted a case study involving fourth grade students in an urban school setting where the constructivist approach to instruction and learning was consistently practiced within the classroom. After observing the instruction, the researchers focused on two students who used personally constructed knowledge to model their understanding of the calculations and place-value concepts in one word problem. Although the two students were able to calculate one aspect of the problem mentally, each student used different cognitive tools to solve the second half of the presented problem. In solving the problem, both students used an approach that was easily available to their knowledge base and then worked through the concept of the calculation. The students constructed ideas about the computation that had meaning to them, although each student used an individualized approach. The students demonstrated confidence, understanding, and a belief that they could solve the presented problem. The students reasoned logically and rationally to show mastery of the concept (Campbell & Johnson, 2005; Van de Walle, 2004).

In an additional study, Schifter and Fosnot (1993) compared and contrasted the problem solving approaches of third grade students, in two separate classrooms, as they aligned with the constructivist approach to instruction and learning. In one classroom where the teacher used a more open, constructivist approach to instruction, a group of

students discussed the best way to divide 90 by four. The students decided to use base-ten blocks to work through and solve the problem together. Rather than the teacher telling the students how to solve the problem, the students explored the meaning to find a reasonable answer. Because the problem had a remainder, the students discussed the use of the remainder depended on the meaning within the problem, and that there may be more than one way to interpret the meaning of a remainder. In the second, more traditional classroom, a student working individually on long division computed the quotient of a problem. The calculated solution to the problem contained a remainder, as did the problem observed in the first classroom. However, when the student was asked the meaning of the remainder and if she, the student, could solve the problem and explain the concept of the remainder with a base-ten block, the student said it was not possible and opted out of an explanation for the understanding the remainder's meaning. As noted by the researchers, the student could compute the numbers; however, she had no concept as to the meaning of the problem she solved. The researchers concluded that the first observed classroom that exhibited more of a constructivist approach to instruction and learning was the more effective environment for student learning and mastery of mathematics content (Schifter & Fosnot, 1993). Because of the demonstration of a deeper understanding for learning mathematics concepts exhibited through research studies, the constructivist approach to learning has continued to be the supported and encouraged theory base for instruction promoted by the National Council of Teachers of Mathematics so that students can experience continued success in their mathematics learning (NCTM, 2000; Van de Walle, 2004).

Constructivism

According to Marlow and Page (2005), there are four ways to describe constructivist learning in order to contrast it with traditional learning. First, constructivist learning is based on constructing individual knowledge, not being told the information or receiving the knowledge. This allows for assimilation of the information into existing schemata. Secondly, constructivist learning is not about recall, rather it is practiced understanding and application of knowledge and information. Thirdly, constructivist learning requires thinking and analyzing, not just memorizing and accumulating. It accentuates the thinking process rather than the quantity a learner memorizes. Fourthly, constructivist learning is considered active, not passive. Learners become more effective when they discover their own answers, concepts, solutions, and when they create interpretations and reflection about their own learning (Marlow & Page, 2005; Van de Walle, 2004). Ultimately, educators that consider themselves constructivists believe students can construct their own knowledge from information, learn new information by constructing from an old base of information, and learn through discussion of their thinking with classmates and teacher. Unfortunately, the constructivist method of instruction in mathematics is rarely practiced in elementary classrooms; rather, teachers focus on rote memory, recitation of facts, and procedural instruction of algorithms found to be more aligned with behaviorism (Burrill, 1997; Manigault, 1997; Van de Walle, 2004).

The theoretical base and conceptual framework of the majority of mathematical research and mathematical instructional standards are based on the constructivist theory of learning as defined by Jean Piaget and Lev Vygotsky. Fogarty (1999) cited these

theorists as being “master architects” (p. 76) in the design of human learning. Piaget’s research on the epistemological stages of development, or cognitive constructivism, and Vygotsky’s role of social interaction in the learning process, or social constructivism, are critical in understanding the human mind and the building process of cognitive knowledge (Piaget & Inhelder, 1969; Vygotsky, 1978). As identified by Cawelti (2003), the founding theories of these two constructivists allow for deeper understanding of students’ learning experiences. Low test scores and ineffective teaching practices in our schools have led educators and leaders to focus on students’ learning and the construction of knowledge (Brooks & Brooks, 1999). However, many elementary teachers are now focused on performance driven instruction rather than mastery driven instruction because of testing mandates required by No Child Left Behind (Darling-Hammond, 2004; Midgley et al., 2000).

Piaget and cognitive constructivism. Piaget was a Swiss researcher who formulated the theory of genetic epistemology of learning by conducting extensive clinical and case studies that emphasized the individual learner and the process of cognitive development (Huitt & Hummel, 2003). As learners manipulated objects to solve problems, Piaget analyzed the learner’s assumptions and actions (Fogarty, 1999). Through the observations and documentation, Piaget established structural changes that took place in the construction of knowledge and beliefs. Through this process, Piaget established four main stages of learning during a learner’s development: (a) the sensorimotor stage in infancy, (b) the preoperational stage of toddlers and young children, (c) the concrete operational stage of elementary and preadolescent children, and (d) the formal operational period of adolescence students and adulthood (Piaget & Inhelder,

1969). The studies represented generalized patterns and characteristics that were not thought to be interchangeable. Through the development of schemata or cognitive schemas, Piaget claimed that children could integrate new knowledge or accommodate new knowledge due to the action of cognitive dissonance. Piaget and Inhelder defined this process as *assimilation* and *accommodation*. Assimilation allows students the use of existing schema to give meaning to experiences, and accommodation is the process of altering existing ways of viewing things or ideas that contradict or do not fit into their existing schema (Van de Walle, 2004). The process of assimilation and accommodation created equilibrium and a greater foundation for learning (Piaget, 1971). Piaget believed that students should play an active role in their learning processes and that cognitive growth was created when construction and reconstruction of knowledge related to previous experiences and environments (“Math Education,” 1995). Piaget’s cognitive theories are used as the foundation for discovery learning so students can build their own understanding with the teacher playing a limited role (Chen, n.d.).

Among the integrated networks, or cognitive schemas, identified by Piaget, the construction of knowledge and the tools to construct new knowledge are created. As students learn, networks within the brain are rearranged, added to, changed, or modified through reflective, purposeful thought so that individuals can supplement their current understanding (Van de Walle, 2004). Piaget’s theories helped define the current constructivist view of learning through his view of cognitive constructivism by defining the thought processes that occur behind thinking, processing, and understanding (Cawelti, 2003; Fogarty, 1999).

Vygotsky and social constructivism. Vygotsky's works began in the 1920s and 1930s and contributed to and complemented the beliefs of Piaget (Cawelti, 2003). Although Piaget's works focused more directly on cognitive constructivism and suggested that teachers should play a limited role in students' learning, Vygotsky's works, published after his death, affirmed the significance of social interaction during the cognitive learning process. Vygotsky's theory, often called social constructivism or socio-cultural constructivism, provides room for an active, involved teacher or peer during the learning process (Chen, n.d.). Interaction among the students and teacher provides students with cognitive tools necessary for development, and the quality and type of tools provided determine students' patterns and rates of development. As written by Vygotsky (1978), "humans are active, vigorous participants in their own existence and that at each stage of development children acquire the means by which they can competently affect their world and themselves" (p.123). Vygotsky believed that children's play was a significant factor of concept knowledge and that, while playing with others, children emulated adult activities and roles that developed skills for future roles. Vygotsky proposed that children's play in the educational setting did not disappear, rather surfaced during other learning, and created the foundation for the construction of future knowledge and beliefs.

As part of this development, Vygotsky (1978) emphasized the importance of communication and speech. "Speech not only facilitates the child's effective manipulation of objects but also controls the child's own behavior" (Vygotsky, p. 26). This allowed children the ability to form relationships through communication. According to Dangel and Guyton (2004), schools must be models of interactive

classrooms that encourage discourse and collaboration. Children's development depends upon the opportunities to interact, collaborate and communicate, so cooperative learning environments must encourage social discourse with others so that ideas and thoughts were shared, justified, and respected (Henson, 2003).

Vygotsky's (1978) "zone of proximal development (ZPD)" (p. 86) was established on the belief learners maintain an area within their brain for future learning. According to Vygotsky, a child can become independent with a skill once she has been guided and instructed through the process prior to her independence. The ZPD theory emphasizes the need for a mentor during the learning process, especially as students learn a new process or concept. This helps students advance to their personal zone of learning because they are challenged to think by a more advanced peer (Davydov, 1995). The social constructivist approach to Vygotsky's ZPD supports the foundational learning beliefs that students need social interaction, scaffolded instruction, and an opportunity to work with a more developed learner. Through this social constructivist approach to learning, educators could scaffold instruction and learning to promote collaborative processes that enhance and support students' cognitive development. Through collaborative efforts and communication, a wide range of useful mathematical connections are made so that students are capable of making profitable connections and constructions within their mathematical learning (Van de Walle, 2004). As students learn within their ZPD, the students create a process of cognitive, social, and emotional interchange because of the connections made through their cognitive assimilations and accommodations (Hausfather, 1996; Piaget, 1971).

Current research on constructivism. Morrone, Harkness, D'Ambrosio, and Caulfield (2004) expressed that social constructivism encourages students to master goals more thoroughly than other instructional practices. The use of communication and discourse in the classroom promotes higher order thinking skills and focuses on the depth of knowledge required for mastering mathematics, and they are a highly encouraged practices supported by the National Council of Teachers of Mathematics (NCTM, 2000).

Moore (2005) determined the extent that constructivist learning had on students' mathematics achievement, self-efficacy, intrinsic motivation and attitude regarding group work. Students worked through a geometry unit where scaffolding activities, hands-on tools, and real-world problems were used. Students took tests and surveys to collect data, and they participated in group discussions, interviews and observations. Throughout the unit, students indicated that learning geometry was fun and enjoyable because of the creativity involved, the problem-solving opportunities, and the collaboration with peers. The researcher concluded that the constructivist style of teaching is beneficial because students take on more personal responsibility, ask more in-depth questions, stay on academic tasks, follow directions, and set goals. Additionally, the academic achievement of the students extends to both high- and low-achieving students. The researcher concluded that lower achievers experience growth because of increased perceptions regarding personal abilities and grades. The higher achievers also grow because of challenging experiences with the curriculum that allow the students to extend their thinking. According to Moore's research, both groups positively benefit from the constructivist classroom.

Lane (2007) found that most of the certified preservice programs for future elementary school teachers taught constructivism as the most effective strategy for teaching, especially in mathematics. Additionally, Lane stated that practicing K-12 teachers implement the constructivist style during their instruction to model for preservice teachers. However, Lane also contended that the majority of college and university faculty teaching mathematics are apprehensive to apply constructivist practices in their teaching. Regardless, Lane concluded that preservice teachers would use constructivist teaching methods during mathematics instruction if they receive appropriate training and modeling during their learning. Additionally, once preservice teachers become practicing teachers, they need sustained support to encourage their constructivist efforts.

Mathematical Practices of Mastery Instruction vs Performance Instruction

Manigault (1997) stated that for nearly 70 years, teaching methods have focused on learning-by-rote, which aligns more with the behaviorist model of learning. Rather than learning for mastery, students have been required to learn for memorization and short-term understanding. This left an impression on many American students that mathematics was unrewarding, boring, and dull, and that their learning had to be motivated by external means (Manigault, 1997; Van de Walle, 2004). Rather than learning by internal motivation, many students attached the value of their learning to performance driven factors such as test scores, fear of failure, or some type of tangible reward (Van de Walle, 2004). Additionally, many teachers focused on the demands placed on them by the No Child Left Behind Act of 2001 (Darling-Hammond, 2004). Instead of focusing on mastery instruction for an increase in student learning, standards

were lowered to meet the requirements of a mandated state test and mastery learning was overlooked. Performance driven instruction influenced students to become performance driven learners (Darling-Hammond, 2004). However, due to undesirable test results and the struggling students that resulted from the paradigm shift, the National Council of Teachers of Mathematics started investing numerous hours into the study of how mathematics should be taught (NCTM, 2000).

The benefits of relational understanding and mastery learning are extensive when connected to learning in the elementary mathematics classroom. Through mastery instruction, students become more intrinsically rewarded and personal memory is enhanced. Mastery instruction aligns itself with constructivist learning, both cognitive and social, because of its focus on the understanding and developmental stages of the students (Meece, Anderman, & Anderman, 2006). Mastery instruction allows students more freedom to interact and communicate through problem solving and discourse, which directly supports the social constructivist approach to instruction (Ames, 1992; Dweck, 2000). Also, students have less to memorize, and they are more likely to learn new connections and procedures for unfamiliar mathematical concepts. Students' problem-solving abilities increase, as do their positive attitudes and beliefs regarding mathematics. Relational understanding and mastery instruction produces a self-generative regard to mathematics in that the pleasurable experiences of the learning process encourages students to seek or invent new ideas independently, primarily when confronting problem-based situations (Skemp, 1978; Van de Walle, 2004).

The National Council of Teachers of Mathematics (NCTM, 2000) focuses on the concept of mastery instruction, based heavily on the cognitive and social constructivist

theories, in the Learning Principle presented in the standards. The Learning Principle conveys that learning with understanding is essential for the mastery of mathematics. Primarily, all students can and must learn mathematics with understanding and mastery (NCTM, 2000; Van de Walle, 2004). This can be accomplished by allowing students to learn from their instructional base in order to grow their knowledge and understanding. However, students would not be isolated in the process; rather, students would work with teachers and peers to establish a communication base that would extend their current base of knowledge (NCTM, 2000). Due to the unpredictability of problems that students will have to solve in the future, learning through mastery instruction and mastery understanding is the resource students will have to successfully approach these future problems as reinforced through the Learning Principle of the NCTM.

Influential mathematicians. A number of mathematicians contributed to the modern day perspective and approach to mathematics teaching and learning. Polya (1945) asserted in the forward of his book *How to Solve It*:

A great discovery solves a great problem but there is a grain of discovery in the solution of any problem. Your problem may be modest; but if it challenges your curiosity and brings into play your inventive faculties, and if you solve it by your own means, you may experience the tension and enjoy the triumph of discovery.

(p. v)

Polya's belief supported that students experience greater learning when their curiosity is challenged by the teacher. By drilling and practicing students repeatedly with routine operations, students' interests are killed, intellectual developments are hampered, and learning opportunities are misused. Polya shared in the reprinting of his second

addition of *How to Solve It* (1957) a study conducted by Educational Testing Service of Princeton, New Jersey that appeared in *Time* magazine (June 18, 1956). The article asserted mathematics has “the dubious honor of being the least popular subject in the curriculum...Future teachers pass through the elementary schools learning to detest mathematics...They return to the elementary school to teach a new generation to detest it” (Polya, 1957, p. ix).

Polya’s solution was to simplify the thought processes behind solving mathematical problems by creating steps about how to solve math problems. Polya’s steps include (a) *understand the problem* which identifies the problem must be understood before it can be solved; (b) *devise a plan* which includes connecting the data to the unknown and work through a process; (c) *carry out the plan* which allows the processes of working the problem according to the plan; and (d) *look back* which includes checking the problem and analyzing the answer obtained (1957, pp. xvi-xvii).

Resnick also contributed to mathematical advancement with research studies invested in the nature of intelligence, the process of education and thought, cognitive research, and socially shared cognition (Resnick, 1976; 1987; Resnick & Kolpfer, 1989; Resnick, Levine & Teasley 1991). Through Resnick’s noted research, the premise of understanding the cognitive thought process of individuals impacts approaches to mathematical instruction. More specifically, often rote procedures of learning mathematical facts interfere with students’ abilities to invent meaningful solutions to mathematical algorithms. The critical component for building on informal knowledge can construct meaningful algorithms for students (Resnick, Nesher, Leonard, Magone, Omanson, & Peled; 1989).

Bruner (1960) supported *discovery learning* in mathematics education. He affirmed that thinking through problem solving and finding out solutions through exploration and experimentation is the most beneficial way for students to learn mathematics. Bruner's three stages of representation of ideas are enactive, iconic, and symbolic. Students work with what they know and do not know, then attach meaning to the problem and work through it, and once again attach deeper meaning to the problem solving through the evolution of the process. According to Bruner (1966), curiosity is an intrinsic motive for learning; however, the drive to achieve competence is also a key motivator. For curiosity to be channeled into more powerful intellectual pursuits, the transition from the passive, receptive, episodic form of learning must be transformed to the sustained and active form, which can only be fostered through effective instructional practices (Bruner, 1966).

The need for improvement in teaching and learning mathematics continues with researchers, educators, professional organizations, and governmental agencies calling for increased performance among America's students (Anderson, 2010). The National Council of Teachers of Mathematics (NCTM, 2000) is the current leading supporter of the efforts to increase the quality of mathematics teaching and learning. According to the NCTM, teachers are the primary contributors who make the connection between effective instructional practices and established standards, and it is vital that teachers are knowledgeable, willing, and informed professionals who are eager to overcome personal anxieties regarding mathematics and increase self-efficacies about mathematics. It is not only through the study of the quality standards set in place by the NCTM, but also

understanding the affective domain of both students and their teachers, that American students will experience effective instruction in the content area of mathematics.

If students are to become successful, literate mathematics students, elementary teachers must demonstrate positive attitudes toward mathematics, overcome personal anxiety in the subject, have confidence in their abilities to teach mathematics, and implement effective mathematical instructional practices throughout all elementary grade levels (Van de Walle, 2004). Student learning will be extended throughout their high school courses, and the benefits of strong foundational learning will promote students taking higher mathematics at the college level. This, in turn, will strengthen students as global competitors (Anderson, 2010; Van de Walle, 2004).

Statement of the Problem

While extensive research on mathematics anxiety and self-efficacy has been conducted, not enough is known about the impact of mathematics anxiety and self-efficacy on the mathematical instructional practices of elementary school teachers. Specifically, the research conducted on mathematical self-efficacy and mathematical teaching self-efficacy has been limited (Hackett & Betz, 1989; Kahle, 2008; Pajares & Miller, 1995), with no studies of the two efficacies along with mathematics anxiety in relation to elementary school teachers' instructional practices being explored.

The constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices of elementary school teachers are not new concepts. These concepts have been investigated separately beginning with the work of Richardson and Suinn (1972). Research on mathematics anxiety is often aligned with beliefs, behaviors, and attitudes, and has often focused on the relationship of that

anxiety to individuals' past mathematical experiences (Jackson & Leffingwell, 1999). Much of the mathematics anxiety research focuses on differences in genders (Woodard, 2004). However, there is also data documenting that mathematics anxiety can stem from poor teacher preparation (Kleckler, 1999) and often results in teacher frustration (Cornell, 1999). Furthermore, within the larger study of general teaching efficacy which has long been a focus of educational researchers, there is an emerging body of research focusing specifically on mathematical self-efficacy and mathematical teaching self-efficacy (Kahle, 2008).

The literature on individual's mathematics anxiety is plentiful throughout mathematics research regarding gender, course selection, and career choice (Ashcraft & Kirk, 2001; Hembree, 1990; Ma, 1999b), and some studies even identified teachers' instructional practices and classroom behaviors as being influential in contributing to individual's mathematics anxiety (Furner & Duffy, 2002; Jackson & Leffingwell, 1999). Additionally, teachers' self-efficacy has been thoroughly addressed (Bandura, 1977, 1997; Long, 2003; Midgley et al., 1989), and self-efficacy has been connected to teachers' instructional practices through teacher behaviors and attitudes (Mujis & Reynolds, 2002). The specific topics of mathematical self-efficacy and mathematical teaching self-efficacy were also researched (Ashton, Olejnik, Crocker, & McAuliffe, 1982; Kahle, 2008; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998); however, a direct connection to teachers' instructional practices has not been established with the constructs among experienced elementary school teachers.

Because science and mathematics are identified as being the content areas necessary for advancement in the competitive workforce, establishing a strong foundation

in these skilled areas at the elementary level is critically important (Wallace, 2005). A large number of preservice elementary teachers have been identified as having mathematics anxiety (Swars, Daane, & Giesen, 2006; Woolfolk & Hoy, 1990); because of the premise that many elementary teachers have an adverse reaction to mathematics (Austin, Wadlington, & Bitner, 1992), it is important to help alleviate some of the fears and negative attitudes towards the subject to prevent future generations from suffering from mathematics anxiety (Burns, 1998).

As supported by Darling-Hammond (2004) and Hidi (2001), the classroom teacher is the most influential factor impacting student achievement through the increase or decrease of students' intrinsic motivation. Highly efficacious teachers are aware that their words and behaviors are influential in increasing student learning, student self-efficacy, student motivation, student performance, and student academic achievement (Schunk, 1989). Additionally, teachers' efficacy influences their instructional practices because of the belief that they can impact student learning, and personal teaching practices change when personal beliefs are influenced (Hoy & Woolfolk, 1990; Thompson, 1992). Because of these research findings regarding the influence of teachers' efficacy in the classroom, the relationship between mathematical efficacies and elementary teachers' mathematics anxiety need to be explored collectively. Looking at these constructs in a cohesive study rather than in isolated parts will help align efforts in providing elementary teachers with the support necessary to advance their instructional practices in the elementary classroom. Although a great deal of research has been conducted on general self-efficacy (Bandura, 1977, 1986, 1997; Gibson & Dembo, 1984; Hoy & Woolfolk, 1990; Mujis & Reynolds, 2002), there has not been an extensive

amount of research done regarding mathematical self-efficacy and mathematical teaching self-efficacy (Kahle, 2008). Because mathematics anxiety is identified as an educational issue among elementary school teachers, specifically during their preservice years (Isiksal, Curran, Koc, & Askun, 2009; Liu, 2007), it is important to determine if mathematics anxiety is related to teachers' mathematical self-efficacy and mathematical teaching self-efficacy. Anxiety was found to negatively impact teachers' instructional practices (Burrill, 1997; Manigault, 1997), but the existing explored research does not identify the relationship between mathematics anxiety and mathematical self-efficacies. This leaves room for the assumption that mathematics anxiety could also negatively influence mathematical self-efficacies; however, no study has definitively explored the assumption or the relationship. While there are a few studies examining some of these individual constructs with experienced classroom teachers, an exhaustive search of the reported research revealed no studies that align or directly connect the constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary teachers.

Purpose of the Study

The purpose of the study was to investigate the mathematics instructional practices of elementary school teachers. More specifically, it explored any possible relationships among the constructs of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy to determine if these independent variables affected, in any manner, elementary school teachers' mathematical instructional practices. By identifying the relationship between or among any of the given constructs, the most effective mathematics practices among elementary school teachers can be

promoted by helping find ways to alleviate elementary teachers' mathematics anxiety, and increase mathematical self-efficacy and mathematical teaching self-efficacy among teachers in the elementary school classroom to prevent further influences of mathematics anxiety among students.

The study was designed to provide necessary data to determine the relationship among mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy, and the instructional practices of elementary school teachers represented by the selected school districts. It is hoped that the results of the study will expand upon the vast amount of mathematics anxiety research (Austin, Wadlington, & Bitner, 1992; Dutton, 1954; Dutton & Blum, 1968; Furner & Duffy, 2002; Hembree, 1990; Jackson & Leffingwell, 1999; Ma, 1999b; Plake & Parker, 1982; Richardson & Suinn, 1972) and provide connections among teachers' mathematical self-efficacy, mathematical teaching self-efficacy and teachers' instructional practices in the elementary mathematics classroom (Kahle, 2008; Mujis & Reynolds, 2002). Current research is deficient in directly aligning the relationship of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy with experienced elementary teachers' instructional practices. The completed study may help illuminate any relationships that exist among these constructs, thus better informing teacher preparation and enrich elementary school teachers' mathematics instruction.

Research Questions

The study examined the following research questions:

1. What are the mathematics anxieties, mathematical self-efficacies, mathematical

teaching self-efficacies, and instructional practices of certified elementary teachers?

2. For certified elementary school teachers (K-6), do mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy have an effect on their instructional practices in mathematics?

Hypotheses

This study evaluated the following null hypotheses:

H₁: There is no significant relationship between the dependent variable of elementary school teachers' mastery goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₂: There is no significant relationship between the dependent variable of elementary school teachers' performance goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₃: There is no significant relationship between the dependent variable of elementary school teachers' mastery approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₄: There is no significant relationship between the dependent variable of elementary school teachers' performance approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

Definition of Terms

The following is a list of terms with correlating definitions that are relevant to this study.

Cognitive constructivism - is the type of constructivism established by Jean Piaget through his study and analysis of the epistemological stages of learning and cognitive development (Huitt & Hummel, 2003). It focuses on changes within individuals during the construction of knowledge and beliefs. For the purposes of this study, it is one of the constructivist theories used to support the importance of constructive learning in mathematics. Mathematics activities must be reflective of previous interactive learning rather than following directions regarding earlier skills because developmental cognitive learning must be constructed (Van de Walle, 2004). The foundation for cognitive constructivism is also supported by the National Council of Teachers of Mathematics (NCTM, 2000) which supports the growth of the cognitive stages in children that accounts for developmentally appropriate strategies used when providing mathematics instruction for elementary students (NCTM, 2000).

Conceptual instruction – is a teacher’s method of classroom teaching where multiple ways are presented to model finding an answer, use numerous solution strategies, or instruct how to construct one’s own algorithm; a foundational understanding of the reasoning behind why a process works and how it is used in problem-solving situations (Heibert, 1986; National Council of Teachers of Mathematics, 2000).

Constructivism – is the theory base of this study; the learning process where students construct their own knowledge from provided information, learn new information by reflecting on previously learned information, and learn through

engagement and discussion of personal thinking with their classmates and teacher (Marlow & Page, 2005); it is aligned with the concept of mastery based instruction for the purposes of this study (Midgley et al., 2000).

Elementary school teacher – is a certified, licensed educator who practices education in a public school setting; he or she is currently working in a grade level within the kindergarten through sixth (K-6) grade range, and is deemed highly qualified according to the licensure standards of the state and the No Child Left Behind Act of 2001 (PL 107-110). These individuals are only required to be highly qualified at the elementary level and are not required to have a content focus or certification in the area of mathematics (Mississippi Department of Education, n.d.).

Instructional practices – teaching practices used by elementary school teachers who convey to students that learning is for the development of skill competence for either mastery of a skill, or to demonstrate knowledge of the skill on a performance based measure such as an assessment or graded piece of work (Midgley et al., 2000; Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998). For the purposes of this study, instructional practices will be measured by the Patterns of Adaptive Learning Scales (PALS) and will be broken into four subscales of mastery approaches to instruction, mastery goal structure for students, performance approaches to instruction, and performance goal structure for students (Midgley et al., 2000).

Learning mathematics anxiety – is a feeling of dread, fear, or anxiousness an individual experiences when he or she is required to participate in a math class, math activity, or math experience (Hopko, Mahadevan, Bare, & Hunt, 2003). For the purposes

of this study, learning mathematics anxiety (LMA) will be a subscale measured by the Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003).

Mastery approaches to instruction – are teaching strategies used that convey to students that the purpose of engaging in academic work is to develop skill competence, and include the practices of differentiated instruction, modification, and accommodation for effective learning within a classroom to provide students an opportunity for autonomy and responsibility, self-selected learning opportunities and assignment choices, and encouraging feedback based on student growth (Midgley et al., 2000; Turner et al., 1998). For the purposes of this study, mastery approaches to instruction will be aligned to the instructional practices associated with constructivism (National Council of Teachers of Mathematics, 2000; Van de Walle, 2004), and defined and measured by the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000).

Mastery goal structure for students – is the teachers' perceptions that the encompassing school communicates to the students that the purpose of engaging in academic work is to develop competence of skills and gain knowledge (Midgley et al., 2000). For the purposes of this study, the mastery goal structure will be aligned to the instructional practices associated with constructivism (National Council of Teachers of Mathematics, 2000; Van de Walle, 2004), and will focus around the principle that instruction encourages students to learn for the desire of gaining knowledge and for growing as a learner, as assessed by the Patterns of Adaptive Learning Scales instrument (PALS; Midgley et al., 2000).

Mathematics anxiety – is a tense feeling that interferes with the manipulation and understanding of how to work with numbers causing a negative attitude towards

mathematics, avoidance of mathematical thinking, limited career choices, lack of self-confidence, and fear of the content (Ashcraft, 2002; Richardson & Suinn, 1972). For the purposes of this study, mathematics anxiety will be broken down into two sub-constructs, or subscales, that include *learning mathematics anxiety* and *mathematics evaluation anxiety*. These two subscales are measured separately by the Abbreviated Math Anxiety Scale (AMAS) (Hopko et al., 2003). Because of the differences between the two subscales, each term is identified and defined separately.

Mathematics evaluation anxiety – is the negative feeling of panic and anxiousness an individual experiences when he or she anticipates a mathematics assessment, or some form of mathematical evaluation, is going to be administered (Hopko et al., 2003). Mathematics evaluation anxiety is a subscale of mathematics anxiety and will be measured as such by the Abbreviated Mathematics Anxiety Scale for the purposes of this study (AMAS; Hopko et al., 2003).

Mathematical instructional practices – are the manner in which teachers instruct mathematics based on their strengths rather than their weaknesses, and how teachers deliver instruction based on personal beliefs regarding learning (Midgley et al., 2000). Mathematical instructional practices will be addressed through subscales that include: (a) mastery goal structure for students, (b) performance goal structure for students, (c) mastery approaches, (d) performance approaches, and (e) personal teaching efficacy. The subscales are separated by the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). All subscales of the instrument will be assessed; however, the emphasis of the personal teaching efficacy construct will not be analyzed in this study using this instrument.

Mathematical self-efficacy – is an individual's perception of his or her personal mathematical ability in solving mathematical problems and completing mathematical tasks as derived by the Mathematics Teaching and Mathematics Self-Efficacy Scale (MTMSE; Kahle, 2008); it is divided into two separate sub-constructs, or subscales, of *mathematical self-efficacy in relation to problems* and *mathematical self-efficacy in relation to tasks* (Hackett & Betz, 1989; Kahle, 2008).

Mathematical self-efficacy in relation to problems – is an individual's personal perception that he or she could confidently answer a mathematics problem correctly without using a calculator; specifically, it is his or her ability to answer a mathematics problem presented within a context that is not limited to computation and skills in isolation but more aligned with word problems that included embedded problem solving, as measured by the Mathematics Teaching and Mathematics Self-Efficacy Scale (MTMSE; Kahle, 2008).

Mathematical self-efficacy in relation to tasks – is an individual's personal perception that he or she could successfully complete a basic mathematical skill required in daily life activities, as measured by the Mathematics Teaching and Mathematics Self-Efficacy Scale (MTMSE; Kahle, 2008).

Mathematical teaching self-efficacy (efficacy) – is a person's perception of his or her ability to effectively teach others mathematics, and promote student learning, in alignment with personal confidence and content knowledge (Bandura, 1986; Kahle, 2008; Woolfolk Hoy & Spero, 2005). It is divided into two separate sub-constructs, as determined by the Mathematics Teaching and Mathematics Self-Efficacy Scale (MTMSE), of mathematical teaching self-efficacy and mathematical teaching self-

efficacy regarding content (Kahle, 2008), and will be measured as such for the purposes of this study.

Mathematical teaching self-efficacy regarding content – is an individual's personal security with his or her knowledge of the skills and procedures required to successfully master mathematical content and effectively teach mathematical topics, as measured by a subscale of the Mathematics Teaching and Mathematics Self-Efficacy Scale (MTMSE; Kahle, 2008) for the purposes of this study.

Performance approaches to instruction – are teachers' strategies that communicate to students the purpose of engaging and being involved in academic school work is to demonstrate competence of required skills on measurable goals such as students' grades and test scores (Midgley et al., 2000). For the purposes of this study, performance approaches to instruction will be defined as establishing a standard of acceptable work to promote student motivation according to students' grades, test scores, and measurable academic performances, as assessed by the performance approaches subscale of the Patterns of Adaptive Learning Scales (PALS) instrument (Midgley et al., 2000).

Performance goal structure for students – is the teachers' perception that the encompassing school conveys to the students that the purpose of engaging in academic work is to demonstrate performance of required skills on mandated curriculum assessments (Dweck, 2000; Midgley et al., 2000; Midgley, Kaplan, & Middleton, 2001). For the purposes of this study, the performance goal structure for students will be defined as such and measured by the aligned subscale of the Patterns of Adaptive Learning Scales instrument (PALS; Midgley et al., 2000).

Procedural instruction – is the systematic, regimented method of content delivery that provides rules and guidelines for the successful completion of a mathematical algorithm by learning the steps to an algorithm, memorizing definitions, and practicing multiplication facts through rote memory (Dweck, 2000).

Self-efficacy - an individual's perceived ability that he or she is capable of accomplishing a task within a specific context (Bandura, 1977,1986, 1997).

Social constructivism – is the type of constructivism associated Lev S. Vygotsky, and additional supporting theorists, that affirms the importance of social interaction during the cognitive learning process. It creates the foundation for the construction of future knowledge and beliefs (Vygotsky, 1978). For the purposes of this study, social constructivism is used as a theoretical foundation because of its alignment with the standards of the National Council of Teachers of Mathematics (NCTM, 2000). Through social interaction, discourse, and collaboration students expand learning as they exchange pertinent information with their peers and make connections with their own cognitive learning during their developmental progression (Dangel & Guyton, 2004; NCTM, 2000).

Limitations

The limitations of this research included:

1. This study includes instructional practices as the dependent variable; the content of instructional practices survey may 'cue' the participant to select an answer that theoretically sounds more appropriate rather than select his/her personal instructional practice.

2. This study includes elementary school teachers who are licensed in grades K-6; however, teachers who are licensed to teach grades K-6 but do not teach mathematics, such as departmentalized language arts or reading teachers, are not included in the study.

Delimitations

1. The proposed study included teachers of grades kindergarten through sixth grade from selected school districts in the north, south, east, west, and central regions of the state of Mississippi that taught either self-contained or departmentalized subjects.
2. The proposed study included the school districts that responded as willing participants.
3. Only the variables of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and mathematical instructional practices of elementary school teachers as measured by the selected instruments were studied.

Assumptions

The study examined elementary teachers' instructional practices, grades K-6, in the mathematics classroom among the school districts of in the state of Mississippi. It is assumed that all participants that participate in this study will provide accurate and honest responses regarding their mathematics anxiety, mathematics self-efficacy, mathematics teaching self-efficacy, and instructional practices.

Summary

The research study sought to investigate the relationship among mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy, and instructional practices among elementary school teachers. The study is presented in five chapters. Chapter I provided an introduction and overview regarding the purpose of the study, and Chapter II includes an exhaustive review of the literature regarding mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices among elementary school teachers. Chapter III outlines the proposed research methodology using multiple regression research design. Chapter IV provides an analysis of the data regarding the research findings, and Chapter V offers the findings, conclusions, and implications of the research study.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The National Science Board reported in 2006 that American students were found to be the weakest performing group in the area of mathematics compared to their international counterparts. This poor performance is said to be primarily attributed to a poor mathematics foundation at the elementary level in United States (U.S.) schools (Wallace, 2005). Because of such limited preparation, America has steadily lost its edge as a global competitor in the most competitive career fields (Anderson, 2010; Wallace, 2005). The American struggle with mathematics is not a new phenomenon. Since the early 1970s there has been an explosion of research exploring both student-related and teacher-related factors contributing to this problem, including mathematics anxiety, personal beliefs about mathematics, and behaviors relating to teaching and learning mathematics (Beilock et al., 2010; Jackson & Leffingwell, 1999; Ma, 1999a, 1999b; Mujis & Reynolds, 2002; Richardson & Suinn, 1972). While these factors have been independently shown to negatively impact instructional practices, there were no studies found in this review of the literature exploring the inter-relatedness of these issues.

In order to understand these complex and inter-related constructs, one must first examine mathematics anxiety in general. While the studies reviewed connected teachers' sense of math anxiety to their students' math anxiety, experienced teachers were not the focuses of the majority of the studies (Hembree, 1990; Liu, 2007; Swars et al., 2006; Woolfolk & Hoy, 1990). The literature indicates that most research on mathematics anxiety involved students, elementary age through college, with less information

available for experienced teacher samples (Hembree, 1990; Isiksal et al., 2009; Levine, 1996; Liu, 2007; Ma, 1999a; Ukuktepe & Ozel, 2002).

There exists a large body of evidence showing that classroom teachers are the most influential factor impacting student achievement (Darling-Hammond, 2004; Hidi, 2001). There is also a great deal of literature showing that highly efficacious teachers are aware that their words, behaviors, and instructional practices influence student learning, student self-efficacy, student motivation, student performance, and student academic achievement and have great impact on their effectiveness as a teacher (Mujis & Reynolds, 2002; Schunk, 1989). However, very little of the reported research specifically connects teachers' math anxiety to teachers' self-efficacy, mathematical self-efficacy, or mathematical teaching self-efficacy, specifically as aligned constructs (Bush, 1989; Cornell, 1999; Jackson & Leffingwell, 1999; Karp, 1991; Swars et al., 2006). The early research regarding efficacy focused on generalized self-efficacy, and then extended to the differentiated topics of mathematical self-efficacy and mathematical teaching self-efficacy to establish the foundation for further research (Ashton & Webb, 1986; Bandura, 1977, 1986, 1997; Gibson & Dembo, 1984; Muijs, & Reynolds, 2002; Kahle, 2008; Pintrich & Schunk, 2002; Woolfolk & Hoy, 1990). Because the research indicates that the constructs of anxiety and self-efficacy, including mathematical self-efficacy and mathematical teaching self-efficacy, influence teachers' instructional practices as separate factors, further investigation took place regarding teachers' instructional practices (Alsup, 2003; Ashton & Webb, 1986; Brady & Bowd, 2005; Enochs, Smith & Huinker, 2000; Klein, 2004; Sparks, 1986; Starko & Schack, 1989; Woolfolk & Hoy, 1990). Collectively, these studies provide a solid base upon which to study the concept

of mathematics teaching and learning. Despite the depth of research reported in these areas, there is a lack of research studying the relationships among elementary teachers' mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices collectively.

In order to fully understand the connectedness of the constructs of anxiety and efficacy, and their impact on teaching practices, a review of the literature was conducted. After providing a foundation for the study of mathematics in America, this chapter presents findings from current research in the area of mathematics in elementary schools, particularly studies relating to math anxiety, math self-efficacy and math teaching self-efficacy. Although there was an overlap among the selected topics, this review of the literature was divided into three key areas: (a) Mathematics Anxiety, (b) Mathematical Instructional Practices of Elementary School Teachers and (c) Self-Efficacy (both Mathematical Self-Efficacy and Mathematical Teaching Self-Efficacy).

Mathematics in America

For many years, the U.S. was known as the economic and global leader of all of the nations. However, changes in the current global dynamics that require continuous technological advancements through mathematics and science have impacted the United States' reign as the global leader (Anderson, 2010; Wallace, 2005). For the U.S. to reemerge as a global leader and maintain its status as the top economically advantaged country, the nation must better prepare today's K–12 students to be the global leaders and productive citizens of tomorrow (Anderson, 2010; National Science Board, 2006).

A Nation at Risk and the National Council of Teachers of Mathematics

The National Commission on Excellence in Education published a document entitled *A Nation at Risk* in 1983. The document communicated that American schools ineffectively taught mathematics and that practicing educators and educational professors wanted to move toward more progressive approaches for teaching and learning the subject. The goal was for the United States to rank at the top of academic performance in mathematics by the year 2000.

In response, the National Council of Teachers of Mathematics (NCTM) developed the Curriculum and Evaluation Standards for School Mathematics in 1989; however, these standards were revised in 2000. The revised standards were fewer in number and carried more explanations and examples of specific problems (Herrera & Owens, 2001). The standards, still in place, require teachers to develop deep conceptual understandings of mathematics' topics by their students through working in groups and solving real-world problems using collaborative efforts and discourse (NCTM, 2000). Because mathematics instruction was identified as a content area that offered few equitable mathematics opportunities, non-engaging curriculums, limited student motivation, and poor teaching methods, the latter were identified as the causes of students' failure to reach their fullest academic potential in the subject area (Cai, 2001; Ferrini-Mundy & Schmidt, 2005). Therefore, the NCTM created five *Principles for School Mathematics* which provided the features of a "high-quality mathematics education" (p. 11).

1. The *Equity Principle* promotes meeting the needs of all students in mathematics. This requires that an established relevancy for the learner be

attached to the required task and/or skill and that the learning task be meaningful.

2. The *Curriculum Principle* emphasizes the importance of foundational ideas in mathematics. Concentration on major mathematic concepts allows students to build newer skills and knowledge based on previous mathematical processes. Consistency and coherency in curriculum allows students across grade-levels to invest in greater depths of knowledge.
3. The *Teaching Principle* focuses on the complexity of effective mathematical teaching practices. Knowledgeable teachers must not only know the content, but they must also understand pedagogical theories of learning and create learning environments that allow students to contribute to the classroom.
4. The *Learning Principle* recognizes the importance of actively constructing knowledge and building previous experiences. In mathematics, factual and procedural knowledge is the desired outcome. The Learning Principle is most directly aligned with the concepts and expectations of constructivist teaching and learning, and it focuses on the mastery approach to instruction and student understanding.
5. The *Assessment Principle* supports the careful integration of mathematical learning and classroom instructional decisions. Assessments have purpose and are used to guide instruction; in addition, they are an ongoing practice and are embedded in learning activities within the classroom experiences (National Council of Teachers of Mathematics).

Teachers' reactions and responses to A Nation at Risk. The pressures resulting from *A Nation at Risk* caused many teachers to experience frustration and a sense of unpreparedness for mathematics instruction (Loveless, 2001). Real-world problems have been identified as time consuming and take a great deal of explanation before they can be completed, and the concepts consolidated into single problems challenge teachers during instruction and tax the students (Wilson, 2003). According to Loveless, the engaging problems are often so complex that struggling students are allowed to bypass aspects of the problem where they lack proficiency. Research suggests that teachers cannot adequately plan spontaneous responses to student answers to guide them toward mathematical understanding and that reformed curricula expectations often overwhelm struggling students by asking too many abstract things at one time (Royer, 2003).

The “Math Wars” erupted in the 1990s and pitted mathematical educational leaders against classroom teachers who felt alienated in the reform process. The traditional practices of the mathematics classroom focus on checking homework, listening to teachers’ lectures, and practicing algorithms (Burrill, 1997). Five key problems were identified among such practices implemented within the traditional classroom including how teachers monopolize conversations, textbooks control the curriculum, isolated lower level skills are emphasized, reasoning skills are not valued, and schools operate on behaviorist ideology (Brooks & Brooks, 1999). The National Council of Teachers of Mathematics’ (NCTM) 2000 revision of the *Principles and Standards* was an attempt to solve these problems. The current goal of the NCTM is to emphasize the importance of teaching mathematics through a balanced approach, where procedural and conceptual knowledge are developed for a deeper understanding of

mathematical concepts and where mastery of problem solving is expected. However, the concern for better mathematical instructional practices and the issues addressed in the “Math Wars” of the 1990s has continued to affect the current day’s classrooms (Kahle, 2008).

Current advancement efforts. On January 6, 2010, President Barack Obama announced a \$250 million effort to support and enrich math and science education in American public schools (Anderson, 2010). These funds, in addition to the Science, Technology, Engineering and Mathematics (STEM) efforts previously established in November 2009 to improve public school education, increased funding for math and science to over \$500 million throughout the life of the project. With support from highly-technological businesses, public universities, and private foundations, the addition to the STEM efforts is believed to be possible (Anderson, 2010). The invested efforts are projected to prepare 10,000 or more new mathematics and science school teachers with five years of professional training and 100,000 established teachers with on-the-job training in science, technology, engineering, and mathematics (Anderson, 2010).

According to Anderson (2010), government leaders and businesses have shown increasing concern regarding the underperformance of K-12 students and have increased scrutiny of K-12 education in the areas of mathematics and science. Because of this, President Obama made improving mathematics and science in the K-12 setting a national cause. In the Race to the Top (RTTT) federal grant competition, which totals \$4 billion of available funds, proposals that were shown to emphasize mathematics and science instruction through the STEM efforts received bonus credits for their proposals. Additionally, private institutions including the Intel Corporation, the Intel Foundation,

and the Woodrow Wilson National Fellowship Foundation are projected to contribute \$240 million to train teachers in mathematics and science instruction. Primarily, Intel intends to provide an 80-hour mathematics course to help generalist elementary teachers extend their expertise in mathematics. Also, an additional \$13.5 million will be spent on universities that participate in the UTeach program that is intended to produce 10,000 mathematics and science teachers each year, an increase from the 2010 statistic of 7,500 per year. The UTeach program will also be supported by NASA and PBS (Public Broadcasting System) to advance the efforts of mathematics and science teaching so that American students can be better prepared to compete globally (Anderson, 2010).

The National Science Board (NSB, 2006) affirmed that the changing workforce requirements would require workers to have sophisticated skills in science, mathematics, engineering and technology. Recognition of these increased requirements were acknowledged and supported in the efforts made by President Obama through mathematics and science incentives designed to enhance America's global performance (Anderson, 2010). In fact, scientific and engineering occupations, which both incorporate mathematics, are expected to grow more rapidly than all other occupations (Wallace, 2005). This will continue the long-term growth that has greatly exceeded the annual growth of the general workforce by four times since the 1980s. The growth rate is projected at a 70 percent increase by 2012, growing from 15% to 26 % (NSB, 2006). Unfortunately for the United States, the disciplines that support and maintain the high-tech economy - mathematics, science and engineering – are not pursued by American students as future occupational goals. In the latest report, less than 6% of American high

school seniors planned to pursue engineering degrees, down 36% from a decade ago. These factors are thought to cause America to lose its global edge (Anderson; Wallace).

Over 25 years ago, the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology evaluated the condition of U.S. precollege education in the subject fields, specifically science and mathematics, and found it in desperate need of attention and repair (NSB, 2006). Since then, America has failed to increase U.S. student achievement to meet the goal established by the Commission. The goal was for American high school students to be the "best in the world by 1995" (NSB, 2006, p. 1); however, many other countries have surpassed the U.S. since that time. In 2000, 56% of China's undergraduate degrees were in hard sciences such as mathematics, chemistry, and engineering; only 17% of American college graduates were disciplined in these areas (Wallace, 2005). Not only were American students not first in science or mathematics achievement, but by the time they reached their senior year of high school, even the most advanced U.S. students performed at or near the bottom on international assessments (NSB, 2006). For American students to be successful as the emerging workforce, preparation needs to begin early in their education in order to develop mathematical and science skills for their future educational pursuits and career choices (Anderson, 2010; NSB, 2006; Wallace, 2005). The technological advancements in all fields will require students to acquire solid foundations in science and mathematics, even if students do not pursue careers in the technological field, in order for them to be productive and capable members of the American society (Anderson, 2010; Wallace, 2005). As a whole, the United States has done very little to properly educate and train the next generation of scientists, engineers, and mathematicians;

however, current efforts are emphasizing mathematics and science education due to its previous demise (Anderson, 2010; Wallace, 2005). Unfortunately, as other countries create jobs and advance their students' educational opportunities, the United States is losing ground with students who have potential to achieve more (Wallace, 2005).

The growing emphasis on mathematics and science achievement has placed a great deal of focus and scrutiny on K-12 instruction. For American students to increase their potential as global performers, mathematics and science must be emphasized in their educational experiences throughout their precollege education. Identifying why students have not received the appropriate level of mathematics and science instruction at the precollege level becomes the area of focus and interest. Research regarding elementary teachers' mathematics anxiety and mathematical self-efficacy establishes the foundation that leads to an explanation addressing the mathematics part of the issue.

Mathematics Anxiety

Mathematics anxiety is not a new concept and has been well documented through research since the 1950s (Dutton, 1954). The study of mathematics anxiety within the context of education has been reported as early as the 1970s (Richardson & Suinn, 1972). Researchers sought answers to identify the cause of mathematics anxiety; however, studies have indicated that there is no definitive, specific, isolated influence (Jackson & Leffingwell, 1999; Kazelskis, 1998; Morris, 1981). Some of the research suggests that mathematics anxiety in students can be influenced by elementary teachers' own personal mathematics anxiety (Beilock et al., 2010; Burns, 1998; Polya, 1957), beginning as early as third or fourth grade (Jackson & Leffingwell, 1999). The following sections present literature investigating the underlying constructs that influence mathematics anxiety.

The Mathematics Stigma

In the United States, mathematics traditionally carries a stigma, and people who are talented in math or enjoy math are often treated as though they are strange or abnormal (Manigault, 1997). However, in countries such as Russia and Germany, it is not considered appropriate or acceptable for a person to express a dislike or show ignorance of basic mathematics because it is deemed an essential part of literacy (Rendon & Hope, 1996). Manigault (1997) attributes the dislike of mathematics in America to the teaching style of the subject which presents the material in a lackluster and unrewarding manner. Manigault extends his thoughts by expressing that teachers' instructional methods rely heavily on the behaviorist approach to learning which focus on rote learning, memorization, and repetition. Although many teachers identify their personal beliefs as being aligned with other educational theories and strategies, the teachers' practices fail to reflect their claimed theory of belief (Levitt, 2001). To extend this, a common perception of mathematics among students, parents, and some teachers is that some people could work mathematics problems well and successfully, but most people could not (Tobias, 1987).

The majority of mathematics anxiety research reflects that individuals who have negative feelings and attitudes towards mathematics have more struggles and performance problems with mathematics content due to their anxiety. Richardson and Suinn (1972) stated, "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" (p.551). The anxiety results in mathematics avoidance, which causes a lesser mastery of the content skill and makes

individuals with mathematics anxiety less competent in mathematics (Ashcraft & Kirk, 2001).

Mathematics anxiety is identified as a serious problem for most students, including adult learners, with the majority having very few positive experiences in mathematics from kindergarten through college, leaving many students to avoid certain mathematics classes altogether (Jackson & Leffingwell, 1999; Ruben, 1998). Additional consequences identified for individuals with mathematics anxiety are negative attitudes toward mathematics, avoidance of mathematical thinking, limited career choices, lack of self-confidence, and fear (Ashcraft, 2002). Specifically for teachers who maintain higher levels of mathematics anxiety, classroom instruction is negatively influenced because the teachers are found to spend less time planning and implementing mathematics-related activities (Swetman, Munday, & Windham, 1993).

The Cycle of Mathematics Anxiety

Mathematics anxiety has been studied extensively in the field of education since the 1970s, and has influenced researchers' suggestions on how to resolve individual's mathematics apprehension (Kazelskis, 1998; Richardson & Suinn, 1972) and ultimately lead to increased mathematical competency among America's students. Various definitions of mathematics anxiety have been proposed (Ashcraft, 2002; Ghee & Khoury, 2008; Greenwood, 1984; Manigault, 1997; Richardson & Suinn, 1972; Tobias, 1987), and many precursors of mathematics anxiety have been identified (Fiore, 1999; Furner & Berman, 2003; Furner & Duffy, 2002; Hembree, 1990; Jackson & Leffingwell, 1999; Liu, 2007; Ma, 1999b); however, an explicit, definitive cause of mathematics anxiety has

not been established (Ashcraft & Kirk, 2001; Kazelskis, 1998; Manigault, 1997; Liu, 2007; Richardson & Suinn, 1972).

The literature reviewed established that mathematics anxiety, or a fear of mathematics, generally evolves during the elementary years of schooling and is influenced by teachers' instructional practices. Even more concerning is the evidence suggesting that this mathematics anxiety extends into their adult lives (Furner & Berman, 2003; Jackson & Leffingwell, 1999; Morris, 1981; Ruben, 1998). Mathematics anxiety often influences career choices and can result in individuals with a fear of math pursuing careers that do not require a great deal of mathematics training, particularly the field of elementary education (Hembree, 1990; Malzahn, 2002). Mathematics anxious teachers often exhibit the characteristics and behaviors in their instructional practices that caused their own mathematics anxiety, and the cycle of mathematics anxiety is extended to the next generation (Alsup, 2003; Beilock et al., 2010; Brady & Bowd, 2005; Burns, 1998; Polya, 1957). This is particularly troubling as it perpetuates the low mathematics achievement of multiple generations of students.

Foundations and Implications of Mathematics Anxiety

Mathematics anxiety was identified as a complex condition caused by a variety of factors, primarily developing during childhood through experiences in elementary school (Jackson & Leffingwell, 1999; Morris, 1981). Although a majority of the literature and studies regarding mathematics anxiety and mathematics education concentrate on high school and college mathematics (Hopko et al., 2003; Plake & Parker, 1982; Richardson & Suinn, 1972; Wigfield & Meece, 1988), the majority of students report their first experience with mathematics anxiety in the fourth grade, and the negative feelings that

resulted extended and persisted for more than 20 years (Jackson & Leffingwell, 1999). Due to the anxiety persistence, adults, whether parents or teachers, passed on negative attitudes and anxieties towards mathematics to students (Furner & Duffy, 2002). The reviewed literature highlights the findings of previous research regarding mathematics anxiety and various factors that contributed to understanding it.

The construct of mathematics anxiety has been included in a large number of studies throughout educational and psychological research (Dutton, 1954; Dutton & Blum, 1968; Hembree, 1990; Ma, 1999b). Hembree (1990) conducted a meta-analysis that included 151 studies that involved mathematics anxiety. As an initial emphasis, Hembree focused on the subconstructs of mathematics anxiety that included test anxiety and mathematics anxiety. The researcher's goal was to determine the relationship between mathematics anxiety and mathematics performance as well as identify if mathematics anxiety was more pronounced in females than in males. Because the theoretical foundation for mathematics anxiety was not established, the researcher emphasized the similarities of the two constructs by supporting the idea that mathematics anxiety was no more than subject-specific test anxiety regarding mathematics. Through a selection of 26 studies, Ma (1999b) intended to show more specifically the relationship between mathematics anxiety and mathematics achievement, and determine the variables that influence the two constructs. The study focused on the magnitude of the relationship between mathematics anxiety and mathematics achievement along with how gender, grade level, ethnicity, and anxiety-measuring instruments measure mathematics anxiety and mathematics achievement.

Hembree (1990) concluded that the performance correlation between mathematics anxiety and student performance was influenced by the student's Intelligence Quotient (I.Q.). He also concluded that students with higher mathematics anxiety consistently had lower mathematics performance. This was most commonly seen in males than in females among grades 5 -12. However, in the meta-analysis conducted by Ma (1999b), gender was not found to be an issue because the gender-related variable did not have appreciable effects on the magnitude of the relationships between mathematics anxiety and mathematics achievement. The attitude correlation between math anxiety and attitudinal constructs showed that positive attitudes about mathematics consistently related to lower mathematics anxiety (Hembree, 1990). Both Hembree and Ma agreed that students who enjoyed mathematics were reported to have higher self-confidence in the subject. In addition, students with high mathematics anxiety viewed their parents and teachers as being somewhat negative toward the subject of mathematics (Hembree, 1990).

Hembree (1990) affirmed the correlation showing that students with mathematics anxiety tended to avoid mathematics. In addition, highly-anxious mathematics students took, or anticipated taking, fewer high school and college mathematics courses, primarily the male students in their junior or senior year of high school. Conversely, Ma (1999b) reported that gender roles and grade level were both statistically insignificant when analyzing the relationship between mathematics anxiety and mathematics achievement. While Hembree emphasized that the relationships between the different types of anxieties (mathematics anxiety and test anxiety) were found to be directly related; however, Ma attributed Hembree's findings to a simplified picture of the relationship between the two constructs.

The comparisons among the differentials - ability level, gender, and ethnicity - were also reported in Hembree's (1990) study. Students with low or average ability in mathematics were found to have higher mathematics anxiety; however, the difference was not noticeable between the two identified groups. Females were found to have higher mathematics anxiety than males, especially in college; however, the results of their choices and coping skills reflected that the females must work through their anxiety more effectively because the anxious males made more reluctant choices regarding mathematics. Ma's (1999b) counters this argument by stating there is no statistical significance between males and females regarding the relationships between mathematics anxiety and mathematics achievement. In both studies, no differences were noticed between black and white students; however, Hembree noted that Hispanic students were found to be more anxious than other ethnic groups, but only in two research studies.

Hembree (1990) also found that mathematics anxiety levels increased throughout junior high school but peaked around grades 9-10. Ma (1999b) contributes these results to the limited number of elementary and secondary studies found in Hembree's study (seven elementary and secondary) compared to the number of studies involving colleges (58 college studies). Hembree reported that college courses reflected a leveled sense of mathematics anxiety; however, students in remedial courses and elementary education courses showed high levels of mathematics anxiety. All other majors, specifically mathematics and science majors were predictably low in the construct of mathematics anxiety (Hembree, 1990).

A focus of Hembree's study was also to determine the effects of treating mathematic anxiety to determine its effects on performance. Classroom interventions and

out-of-class psychological treatments were the emphasis of the mathematics anxiety treatments. Classroom interventions included curricular changes such as the use of calculators and small-group instruction; systematic desensitization and anxiety management training were the psychological treatments used. The classroom interventions were not found to be successful with highly anxious mathematics students; however, the combination of cognitive training and systematic desensitization caused a successful amount of reduced anxiety. This was also found in Ma's (1999b) study, and it was expressed that cognitive factors should be taken into account by instructors, teachers, and program developers to improve the effectiveness of various treatment programs when dealing with mathematics anxiety. In fact, students that experience a reduction in mathematics anxiety could experience improvement from the 50th to 71st percentile in mathematics achievement (Ma, 1999b).

Ma's (1999b) study included factors that were not included in Hembree's (1990) research. In regard to cognitive treatments for mathematics anxiety, Ma included suggestions for cognitive processes that would help reduce mathematics anxiety such as making the knowledge work for the learner, joining skill and content, linking motivation to cognition, and using social communities in learning. Additionally, the researcher included information about instruments that measure anxiety and identified the instruments as more effective than instruments that measured mathematics attitudes because anxiety was easier to operationally define. Emotion, belief, and attitude are elements of the affective domain in learning mathematics, and panic, fear, anxiety, and embarrassment are the emotional reactions to mathematics. According to Ma (1999b),

the domain that has the greatest relationship with mathematics anxiety and mathematics achievement has yet to be identified.

Both Hembree (1990) and Ma (1999b) agreed that mathematics anxiety and mathematics achievement were real factors that influenced students. Both researchers found that the negative associations between mathematics anxiety and mathematics achievement established a need for cognitively-based treatments to help students overcome mathematical anxiety and fears. Although the researchers did not agree on every aspect of how the constructs related, both studies sought to find the causing constructs that impact mathematics anxiety. By identifying the causing constructs, alleviation of the causes could assist mathematics students so they can find success in mathematics achievement.

Indicators that Influence Mathematics Anxiety

Teaching strategies, techniques, and policies throughout an individual's educational career have a considerable impact on developing and increasing math anxiety. Furner and Berman (2003) explained that one size fits all instruction, rote instruction, and the use of assignments as punishment contribute to creating mathematics anxiety. Additionally, teachers' hostility, gender bias, uncaring attitudes, embarrassment tactics in handling students, and lack of enthusiasm have all been shown to be contributing factors to mathematics anxiety (Furner & Duffy, 2002; Jackson & Leffingwell, 1999).

In Jackson and Leffingwell's 1999 study, the researchers searched for teacher behavior that caused or increased mathematical anxiety in students. They found that only seven percent of the study's participants had positive mathematical experiences from

kindergarten through college. In contrast, eighty-five percent of undergraduate college students experienced a certain degree of mathematics anxiety (Perry, 2004). From the research, Jackson and Leffingwell identified grade levels at which anxiety problems arose, suggesting that most appeared around the third and fourth grades at the elementary level, grades 9-11 at the high school level, and freshman year at the college level. According to the researchers, anxiety responses in students were caused by teachers' verbal and nonverbal remarks and teachers' covert, veiled, or implied behaviors such as ignoring a student's request for help. Teachers' instructional practices of assigning the same work for everyone, covering the textbook problem by problem, completing written work every day, focusing on one correct method for solving a problem, and assigning math homework as a punishment caused feelings of increased anxiety (Furner & Berman, 2003). More specifically, poor teaching practices and a lack of teacher enthusiasm contributed more to mathematics anxiety than the content or characteristics of the subject (Fiore, 1999; Jackson & Leffingwell, 1999).

In a study conducted by Cornell (1999), graduate students in a teacher certification program were surveyed to determine their feelings towards the subject of mathematics. Almost half of the participants expressed anxiousness or a dislike for mathematics. The causes of the teachers' frustrations reflected the same factors that impacted anxiety in previous studies (Bush, 1989; Pejouhy, 1990). These included obscure mathematical vocabulary, incomplete instruction, a lot of drill and practice, lagging behind, memorizing facts and procedures through rote memory, learning isolated facts and skills, and teachers' assumptions that the students would find the computations to be easy (Cornell, 1999; Kahle, 2008).

Throughout all of the studies, the consistent findings of teachers' instructional practices that caused mathematics anxiety among students included generalized instruction with no differentiation, assigned mathematics facts that required computation in isolation, and limited problem solving with only one perspective for finding the answer (Bush, 1989; Fiore, 1999; Furner & Berman, 2003; Jackson & Leffingwell, 1999; Pejouhy, 1990). Additionally, the consistent behavior found in teachers who caused a sense of mathematics anxiety was a lack of enthusiasm about the subject (Fiore, 1999; Furner & Duffy, 2002; Jackson & Leffingwell, 1999).

Mathematics Anxiety among Preservice Teachers

As identified in the meta-analysis studies of Hembree (1990) and Ma (1999b), the majority of mathematics anxiety studies were conducted in school-age students and college-age students, including college students that are preservice teachers. Because preservice teachers become practicing, experienced teachers, three later studies regarding mathematics anxiety were conducted after the two meta-analyses, and the studies are included in this review of literature.

Jackson and Leffingwell (1999) gathered responses from 157 senior-level elementary preservice teachers who were taking an elementary mathematics class required for their teaching certification. Data were collected through a written prompt that asked students to describe their worst or most challenging mathematics classroom experience from kindergarten through college. Of the 157 students, 146 expressed negative experiences that caused a sense of increased anxiety in the subject area of mathematics. According to the researchers, 16% of the students reported traumatic experiences as early as third or fourth grade, and students identified specific experiences

that made them not like mathematics. These experiences included the difficulty of the material, the hostile behavior of the teacher, gender bias expressed by the teacher, insensitivity and uncaring nature of the teacher, teacher anger, unrealistic expectations, poor quality of instruction, teacher comments and nonverbal behaviors, and being embarrassed in front of peers. The intent of the study was to find ways to create supportive, positive mathematical learning environments for students and to bring awareness to behaviors and indicators that teachers may sometimes overlook in their instructional and behavioral practices.

In more current studies conducted by Liu (2007) and Isiksal et al. (2009), the researchers focused on improving preservice teachers' classroom performance by focusing on methods of anxiety alleviation and improving mathematical self-concept. Liu's research focused on helping preservice teachers alleviate mathematics anxiety through online interactions with other preservice teachers who also reported having mathematics anxiety. The preservice teachers' online participation and communication regarding their anxiety towards teaching mathematics (ATTM) was considered a form of coping therapy. Through online discussions and communication regarding their ATTM, preservice teachers' anxiety considerably decreased among the 37 participants. As noted by the researcher, finding methods of anxiety alleviation for preservice teachers is critical, as the preservice teachers become practicing teachers, they take with them their anxieties that extend to their students if the anxiety is not addressed beforehand.

Isiksal and his colleagues (2009) also focused on identifying mathematics anxiety and mathematical self-concept beliefs among preservice teachers; however, in their study, negative correlations existed between mathematics anxiety and mathematics self-concept

among the 510 participating American and Turkish preservice early childhood and elementary teachers. Comparatively, American preservice teachers were found to have higher mathematics anxiety and lower mathematics self-concept, while the Turkish sample had higher mathematics self-concept and lower mathematics anxiety. It was established that the demanding entrance requirements to the Turkish universities require their students to be more prepared and educated in the content area of mathematics, where in contrast, the American university does not require students to be specialized in a content area for elementary instruction and the majority of students were general educators. In addition, the American students were only required to take a maximum of two to three mathematics classes at the college level due to acceptance of American culture of low mathematical skills (Isiksal et al., 2009). Thus, the majority of American preservice elementary teachers were projected to have anxiety issues upon entering the classroom. By comparing and contrasting the research studies of Liu (2007) and Isiksal et al. (2009), it is established that mathematics anxiety still exists among preservice teachers; however, through Liu's study it is indicated that strategies can be used to help alleviate and eliminate these mathematics anxieties so that the issue is not extended to the classroom. Through exploration of additional research, the influence of preservice teachers' mathematics anxiety was found to have a number of influences on classroom operations and instructional practices as they became practicing teachers.

Teachers and Mathematics Anxiety

The research reported thus far in this chapter has indicated that students' mathematics anxiety is cultivated and fostered, at least in part, through the classroom teachers' behaviors and instructional practices (Alsup, 2003; Brady & Bowd, 2005; Jackson & Leffingwell, 1999). Further, teachers share their math anxiety with students, and because math anxiety is learned, it is contagious (Austin et al., 1992). Several studies have identified specific practices and behaviors demonstrated by teachers who initiate mathematic anxiety within their students (Bush, 1989; Fiore, 1999; Furner & Duffy, 2002; Jackson & Leffingwell; Karp, 1991), and it had been found that many elementary teachers suffer from mathematics anxiety themselves (Austin et al., 1992). Because of the identified cycle of teachers' influence on students' mathematics anxiety, a further investigation of the literature regarding teachers and mathematics anxiety was conducted and reported.

Teachers' mathematics anxiety and gender influence. Although the meta-analysis research is conflicting in regard to mathematics anxiety being influenced by gender (Hembree, 1990; Ma, 1999b), researchers are still searching to find the differences between males and females in when working through mathematics anxiety. Beilock et al. (2010) more specifically diagnosed issues that arose when elementary school teachers exhibited mathematics anxiety. Although the researchers' work supported the concepts and findings of Bush (1989) and Karp (1991), their findings extended to address the influence female elementary teachers' mathematics anxiety had on female elementary students.

The literature researched found studies that focused on mathematics anxiety in college students and in preservice teachers with elementary education as their declared major (Brady & Bowd, 2005; Cornell, 1999; Cuff, 1993; Ellsworth & Buss, 2000; Malinsky, Ross, Pannells, & McJunkin, 2006; Sherman & Christian, 1999; Trujillo & Hadfield, 1999; Vinson, 2001). Among the studies, several reported that there is a higher mathematics anxiety demonstrated among the females majoring in elementary education than in the males and other college students majoring in different fields (Ashcraft, 2002; Brady & Bowd, 2005; Malkinsky et al., 2006; Ma, 1999b; Vinson, 2001). With the population of elementary school teachers being predominantly female (greater than 90%) it appears that there is limited preparation to teach mathematics at the elementary level (Kleckler, 1999; National Education Association, 2003).

Beilock et al. (2010) conducted a study that included 17 first- and second-grade female teachers and 52 boys and 65 girls from the teachers' classrooms. The teachers were assessed for mathematics anxiety, and the students were assessed for their academic achievement and beliefs about gender and academic success in mathematics. The testing took place both at the beginning and end of the school year, and a mediation analysis was used to depict a model of a causal chain of events. The researchers found that female students' end-of-the-school-year mathematics achievement was negatively affected by the way their teachers' mathematics anxieties influenced the girls' gender ability beliefs, although there was no difference found at the beginning of the school year with in the initial testing.

Beilock et al. (2010) conclude that the teachers' mathematics anxiety, due to gender and role influence, is the influencing factor of the girls' decreased confidence in

their own mathematical abilities, and the modeled anxiety leads to a decline in the girls' mathematical achievement. According to the National Education Association (2003), over 90% of practicing elementary school teachers are female, and elementary female students are found to be more sensitive to gender roles and same-gender teacher influence (Serbin & Sprafkin, 1986). Because of this, Beilock et al. concluded that mathematics anxiety demonstrated by elementary female students is fostered by the teachers' gender ability beliefs and anxieties regarding the subject of mathematics.

Mathematics anxiety and teacher preparation. It has been established that individual's anxiety about mathematics has often led to an avoidance of the subject altogether. Because of this, many college students, including preservice elementary teachers, choose to not take very many college mathematics courses. Research has indicated that elementary teachers' mathematical backgrounds are limited in content knowledge and mathematical experiences (Hembree, 1990; Malzahn, 2002), and therefore are not prepared to teach mathematics due to their backgrounds and personal anxieties regarding the subject matter (Hembree, 1990). Elementary educators are identified not only as having a limited knowledge of mathematics, but also a limited knowledge of research in mathematics education. Therefore, elementary teachers implemented only a limited number of methods and strategies for mathematical instruction (Schools in the Middle, 1998). The majority of the colleges and universities within the United States that were included in the study were shown to require very little mathematics for students majoring in elementary education (Malzahn, 2002). More specifically, elementary education majors were identified as a largely female population, and this population was found to have the highest level of mathematics anxiety and

mathematics avoidance behaviors of any college major (Hembree, 1990). As a result, students who had a tendency to avoid mathematics could successfully pursue a career as an elementary school teacher.

Effect on student performance. Students' educational experiences are dependent on what they learn in the classroom setting, and teachers are responsible for presenting the instruction and materials in a manner that conveys its importance in the educational process. Teachers' delivery and interest level regarding subject content has been established as a leading factor in influencing student achievement. According to the results of the Third International Mathematics and Science Study (TIMSS) published in 1996, American students were not prepared to take advanced mathematics between the ages of 9 and 13 in comparison to their international peers (Schools in the Middle, 1998). Ma (1999a) contributed American students' mathematical inability to the elementary and middle school teachers' lack of ability to articulate mathematical concepts clearly. The study found that a large majority of the teachers used misleading and discredited metaphors for mathematical operations like "borrowing" (Ma, 1999a, p. 22) for subtracting multi-digit numbers. Also, the United States teachers consistently explained the process of completing the problem rather than the meaning behind why the approach mathematically made sense. Ma called for American teachers to develop a profound understanding of fundamental mathematics so that classroom instruction could be improved.

Teachers' Mathematics Anxiety Extended through Instructional Practices

Because the research regarding mathematics anxiety has been studied separately from the constructs of mathematical self-efficacy and mathematical teaching self-efficacy, the impact mathematics anxiety has had on teachers' instructional practices has

also been explored separately (Hembree, 1990; Ma, 1999a; Schools in the Middle, 1998). The research explored communicates the previously found relationships among the isolated constructs of mathematics anxiety and teachers' instructional practices, and to reiterate what was found in the reviewed literature, the constructs are presented in the same related order.

As previously noted, mathematics anxiety has been explored and documented throughout a large number of populations (Aiken, 1974; Dutton, 1954; Hopko et al., 2003; Lee, 2009; Ma, 1999b; Plake & Parker, 1982; Richardson & Suinn, 1972; Sandman, 1980), including teachers (Austin et al., 1992; Beilock et al., 2010). However, extensive understanding of experienced teachers' mathematics anxiety has been insufficiently explored (Thompson, 1992). Anxiety has been identified as an influential factor in teachers' beliefs and behavior, both of which influence teachers' instructional practices (Brady & Bowd, 2005; Muijs & Reynolds, 2002; Swetman et al., 1993). A large number of preservice teachers have been identified as having a high level of mathematics anxiety, and the research has shown that they take their mathematics anxiety with them to their classrooms (Hembree, 1990; Levine, 1996; Liu, 2007; Swars et al., 2006; Woolfolk & Hoy, 1990); however, the research regarding experienced teachers' mathematics anxiety is currently evolving and the findings show that students, specifically girls, are impacted by the shared anxiety (Beilock et al., 2010).

Mathematics anxiety in itself was the foundation for teachers' resistance to change with personal instructional practices; however, many of the behaviors and teaching practices that influenced teachers' personal mathematics anxiety was carried through in their classroom practices (Manigault, 1997; Polya, 1957). Math anxious

teachers were more likely to adhere to traditional methods of teaching, and some would choose to avoid mathematics (Furner & Duffy, 2002; Pejouhy, 1990). Additional research supported that instructional practices of teachers were a large contributing factor to math anxiety in students and that the explain-practice-memorize paradigm was the “real source of the math-anxiety syndrome” (Greenwood, 1984, p. 663). Research indicated that a relationship between teachers’ level of mathematics anxiety and level of efficacy existed when measured among pre-service teachers (Swars et al., 2006), and students in these teachers’ classes would be conditioned by the teachers’ attitudes, beliefs, behaviors, and efficacies (Cornell, 1999).

A study regarding mathematics anxiety of upper elementary teachers was conducted by Bush in 1989. The researcher focused on how teachers’ mathematics anxiety related to (a) student anxiety and achievement, (b) teaching exercises, and (c) teacher characteristics. The results of the study indicated that mathematics anxious teachers tended to teach more traditionally, meaning their instruction (a) taught a great number of skills but addressed fewer concepts; (b) gave more seatwork and whole group instruction; (c) gave less time to homework correction; (d) conducted less small group instruction sessions; (e) involved students less in problem solving; and (f) used less interactive game activities while teaching. The teachers were insecure and failed to venture into activities that allowed students to take more mathematical risks (Bush).

In support of Bush’s research, Karp (1991) studied teachers’ mathematical attitudes and teaching behaviors. The research findings concluded that teachers who held negative attitudes towards mathematics typically had mathematics anxiety, and the instructional practices implemented by these teachers created a dependent atmosphere in

the mathematics classroom. Mathematics was demonstrated and explained as there being only one correct way to solve problems and students were not allowed much time to interact throughout the lesson. The teachers indicated that the mathematics instructor was the primary mathematical authority, and this left the students dependent on the teacher for acquiring information about the subject. The teachers' limited knowledge, anxiety, and negative attitudes toward mathematics became a limitation to student learning and to the use of effective teaching practices and methodology (Battista, 1986).

Both of the studies indicated the same classroom practices of teachers who demonstrated a sense of mathematics anxiety. Students in mathematics-anxious teachers' classrooms received a great deal of direct instruction and individualized seat work with little peer interaction, and students engaged in limited mathematical discussions. Additionally, teachers used teacher-focused methods of traditional instruction, and students became dependent on the classroom teacher as the mathematical authority (Bush, 1989; Karp, 1991). Because of the indications that mathematics anxiety originates with personal experiences in the classroom setting, further investigation regarding teachers' mathematical instructional practices was conducted to explore the factors that influence instructional practices.

Teachers' mathematical self-efficacies, both personal and teaching, were also found to influence teachers' instructional practices and were identified as contributors to student achievement because of the relationships shared among teachers' beliefs, self-efficacy, behavior and anxiety (Armor et al., 1976; Coleman, 2001; Hoy & Woolfolk, 1990; Muijs & Reynolds, 2002; Pintrich & Schunk, 2002; Swars et al., 2006). Teachers who exhibited high levels of mathematics anxiety were found to avoid teaching

mathematics as well as affect student performance in mathematics due to their anxiety (Hembree, 1990; Swars et al., 2006; Swetman et al., 1993). These studies indicated a connection between teachers' mathematics anxiety and instructional practices; however, the connection between mathematics anxiety and its relationship to mathematics teacher efficacy has yet to be established through the research (Swars et al., 2006).

Educational Concerns

Educators and researchers indicated that math anxiety was cyclical in nature (Alsup, 2003; Brady & Bowd, 2005; Vinson, 2001). Burns (1998) explained the phenomenon of the repetitive nature of math anxiety in her book *Math: Facing an American Phobia*. Burns stated that "the way we've traditionally been taught mathematics has created a recurring cycle of math phobia, generation to generation, that has been difficult to break" (p. x). According to Alsup, the teacher-centered lectures that emphasized rules, procedures, formulas, and solutions have been the indicators that established math anxiety were still used among preservice teachers.

Brady and Bowd (2005) conducted a study among 238 preservice teachers in Canada, and the findings were aligned with those of Alsup (2003). After administering the Mathematics Anxiety Rating Scale (MARS), the researchers concluded that the participants' math anxiety stemmed from previous formal instruction in the subject area; however, although the participants identified the source of their anxiety, the study indicated that the cycle of math anxiety in teachers and students would be continued through the future teachers' instructional practices (Brady & Bowd, 2005). The results of other studies concluded that teachers were an important factor in impacting students' attitudes towards mathematics (Jackson & Leffingwell, 1999; Nathan & Koedinger,

2000). However, Jackson and Leffingwell contend that teachers' behaviors were the detriment to students' attitudes, while Nathan and Koedinger expressed that it was teachers' beliefs that were more important. Conclusively, the teacher, in some manner, was considered the extending cause of mathematics anxiety.

Breaking the Cycle of Mathematics Anxiety through Instructional Practices

Although the cyclical nature of mathematics anxiety has been addressed through a great deal of research (Alsup, 2003; Brady & Bowd, 2005; Burns, 1998; Polya 1957), it was identified that mathematics anxiety was a learned behavior (Austin et al., 1992). Learned behaviors, as previously noted, can extend to create further mathematics anxiety, or the behaviors can be overcome through a teacher's sense of self-efficacy (Tschannen-Moran et al., 1998). By either over- or underestimating personal teaching capabilities, teachers can influence students' learning experiences through instructional practices. It was found that individuals that slightly overestimated their capabilities were able to make up for personal deficits and have effective performance outcomes (Bouffard-Bouchar, Parent, & Larivee, 1991). Individuals found to have high levels of personal teaching self-efficacy were found to be more persistent, active, and assured of their teaching efforts and would provide greater academic focus in the classroom by providing quality feedback to their students (Gibson & Dembo, 1984).

Self-Efficacy, Mathematical Self-Efficacy, and Mathematical Teaching Self-Efficacy

Self-efficacy is based on the concept that the teacher can have an influence on student learning and success through her belief that she is capable (Bandura, 1977). More specifically, mathematical self-efficacy is the teacher's belief that she can influence student success and learning in the area of mathematics (Kahle, 2008). As identified by

Bandura , teachers' beliefs influence how much effort they put forth toward a given task, how long they will persist when facing obstacles, how resilient they are when dealing with failures, and how much stress or depression they experience when coping with trying, demanding situations. These indicators of efficacy can be applied to all areas of self-efficacy and can be attached directly to mathematical self-efficacy.

Preliminary Understanding of Efficacy

Teachers have been identified as being one of the most influential factors impacting student achievement (Darling-Hammond, 2004). Research indicates that this is accomplished through creating classroom environments that promote intrinsic motivation among students (Hidi, 2001). Alderman (1999) suggested that it was in the domain of the teachers' responsibilities to establish a well-functioning learning environment where students (a) established a warm and respectful relationship with teachers and peers, (b) fostered social collaboration and peer support through cooperative learning, and (c) felt at liberty to make sufficient learning choices.

In addition to these components of an effective learning environment, communication has also been established as critical for teachers to establish with their students. Schunk (1989) indicated that when teachers became aware of the utility of their words, they were successful in increasing student learning, self-efficacy, motivation, performance, and academic achievement. Also, once teachers identified the communication factor as being influential, it also reflected itself as a manner to diminish student well-being and performance. Communicating with students by providing effective feedback was deemed efficacious in promoting positive student behaviors. Supporting research indicated the effects of teachers' praise and criticism in addition to

how both could be used effectively with students (Pintrich & Schunk, 2002). Students needed to understand teachers' support in order to be less fearful of making mistakes, more comfortable in taking academic and learning risks, and more likely to attempt new ideas in their learning. Also, it maintained a student's sense of self-worth (Turner, Meyer, Midgley, & Patrick, 2003).

Teachers' expectations of students are reflected in the teachers' instructional and academic approaches. Researchers identified numerous behaviors that demonstrate teachers' high and low expectations of students based on previous performances (Tom, Cooper, & McGraw, 1984). Moreover, students are shown to be able to identify when teachers hold lower expectations on their behalf according to how teachers approach their instruction (Coleman, 2001; Oakes, 1985). Students' abilities to perceive teachers' expectations are found to have profound effects on their performance and academic achievement (Rosenthal & Jacobson, 1968).

To create a link among the factors deemed representative of an effective teacher, Muijs and Reynolds (2002) conducted a study that incorporated the relationship between teacher behaviors, teacher beliefs, teacher subject knowledge, and teacher self-efficacy beliefs. In the study, it was found that teacher behaviors demonstrate the strongest relationship with academic achievement among students, while teacher beliefs and self-efficacy affect student achievement indirectly through their impact on student behaviors (Muijs & Reynolds, 2002).

Self-Efficacy

Self-efficacy is a term used to describe an individual's beliefs, or judgments, of their personal capacity to engage in certain actions. These beliefs are not necessarily

based on a person's actual competence to accomplish a task; rather, the beliefs are based on an individual's perceptions of their ability to accomplish a task (Bandura, 1977).

According to Bandura (1986), beliefs influence the amount of effort an individual invests in a task and the motivation to persist in times of difficulty. These self-efficacy beliefs impact a number of behaviors that include academic achievement, career choice, athletic performance, job performance, and recovery from an illness. Aligned with his own social-cognitive theory Bandura (1977) established that self-efficacy indicates an individual's future-oriented beliefs about the level of competence he or she can have in any given situation. Kahle (2008) emphasized that self-efficacy directs a person's choices regarding any personal skill ability, job success and attainment, and individual course selection for higher education because these things are directed by an individual's beliefs in his or her own abilities. Kahle continued by noting that self-efficacy constitutes a large part of the educational setting in that it influences academic goals, motivation, effort, interest, and self-concept of students and teachers.

Tschannen-Moran et al. (1998) confirm Kahle's (2008) findings by indicating that individuals who over- or underestimate their own capabilities may influence other people's use of the skills they possess. Because self-efficacy is deemed as a strong predictor of behavior (Bandura, 1997), an individual's capability is ruled only as well as its execution, and self-doubt can easily overrule the best skills. The established basis for self-efficacy beliefs support that it could contribute to successful performances that initiate individual' attempts at new tasks, new strategies, and efforts to succeed (Bandura, 1997), so researchers began narrowing down the construct of self-efficacy to reflect more extensively and reliably a measure of teaching self-efficacy (Gibson & Dembo, 1984).

Teacher Self-Efficacy

Numerous researchers studied self-efficacy, and several reported that teacher self-efficacy became the key focus of many educational studies. The relationship between teacher self-efficacy, rather low or high, and student achievement is evident (Pintrich & Schunk, 2002). According to Schunk (1991), low self-efficacy often results in avoiding tasks; however, high self-efficacy promotes conquering tasks with extended effort and persistence. In support of Pintrich and Schunk's (2002) findings, preliminary studies conducted by Armor and colleagues (1976) and Berman, McLaughlin, Bass, Pauly, & Zellman (1977) on behalf of the Rand Corporation introduced the teacher self-efficacy construct. In these studies, teacher self-efficacy was identified as "the extent to which teachers believe that they have the capacity to affect student performance" (Ashton, 1984, p. 28). It was the intent of the Rand Company to evaluate the educational programs funded by Title III of the Elementary and Secondary Education Act whose federal funding had been discontinued one to two years prior to the study (Armor et al., 1976; Berman et al., 1977).

The Rand study. Participants included 1072 teachers, and the surveys addressed questions regarding, (a) the nature of the Title III project in which the teacher was involved; (b) the effects of project implementation on both teachers and students; (c) the continuation of the project following elimination of federal funding; and (d) the school's characteristics and organizational climate. According to the results of the study, teachers' instructional styles and behaviors changed in favor of the project goals. Additionally, student performance improved which reflected that student reading achievement increased as the level of teacher self-efficacy increased. Gibson and Dembo (1984)

extended this study and created a 30-item measure of teacher self-efficacy which helped the researchers clarify that by indicating teachers' beliefs in personal abilities, the difference in teacher effectiveness could be explained, and that teacher self-efficacy possibly played an important role in teacher motivation and student achievement.

In contrast, teachers who believed students were incapable of learning were often accurate with their beliefs because of their instructional approach (Coleman, 2001). Teachers' attitudes and behaviors were different when low expectations were established because teachers were less persistent with implementing new teaching strategies and with using resource materials. These teachers also had a tendency to blame the student for his or her inability rather than focus on better teaching practices (Coleman, 2001).

Teacher self-efficacy is separated into two categories, general teaching efficacy and personal teaching efficacy (Gibson & Dembo, 1984). According to Hoy and Woolfolk (1990), a teacher's general teaching efficacy conveys a personal belief that the power of teaching influenced student learning. Teachers who held high teaching efficacy took responsibility for student learning. However, teachers who hold a low sense of general teaching efficacy feels powerless in helping challenging or incapable students. Low teaching efficacy teachers feel that motivation, ability level, and family influence are the key determinants in student progress rather than teacher influence (Ashton & Webb, 1986; Coleman, 2001).

Teachers' personal efficacy reflects teachers' beliefs regarding their individual abilities to teach, manage the classroom, and effectively instruct (Ashton, 1984). Teachers with high personal efficacy encourage student learning through support, academic challenges, and structured, warm environments (Muijs & Reynolds, 2002).

However, teachers with low personal efficacy avoid topics, subjects, and situations where they feel incompetent. Low personal efficacy teachers experience higher levels of stress that negatively impact classroom effectiveness (Ashton & Webb, 1986), whereas high self efficacy influence how much effort individuals put forth, how long they would persist when facing obstacles, how resilient they are in handling failures, and the amount of stress or depression they experience when dealing with demanding circumstances (Bandura, 1997).

Research suggests that teachers with high efficacy, either general or personal, are more likely to maintain a strong academic focus within the classroom and that efficacious teachers were more likely to engage in behaviors aligned with effective elementary instruction (Gibson & Dembo, 1984; Muijs & Reynolds, 2002). Efficacious teachers exude confidence, enthusiasm, and an expectation of success that elicit enthusiasm and motivated learning from their students, and they are less likely to criticize students that gave incorrect responses (Ashton 1984; Gibson & Dembo, 1984).

Determining Mathematical Self-Efficacy

Self-efficacy is shown to link teachers' behavior, beliefs, and instructional practices to how they influence students' learning (Gibson & Dembo, 1984; Muijs & Reynolds, 2002; Tom et al., 1984). It is identified as influential in determining an individual's method of approach when working toward a certain task, such as feeling secure and successful in a specific content area such as mathematics (Kahle, 2008). Tschannen-Moran et al. (1998) established that teacher self-efficacy is defined and identified as both context and subject-matter specific. Although a teacher may feel secure, competent, and capable in one area, either a subject or with a certain type of

student, this is not necessarily the case when working across various disciplines or among varying student populations. Specifically with mathematics, an individual's confidence and self-efficacy are deemed closely related in regard to his or her personal mathematical ability, as are individuals' attitudes and beliefs about mathematics (Kahle, 2008). The difference between mathematical self-efficacy and general self-efficacy is that mathematical self-efficacy is specific to a person's capabilities in the content area of mathematics. Mathematical self-efficacy defines an individual's beliefs that he or she is capable of performing mathematical tasks successfully (Kahle, 2008).

Measuring Mathematical Self-Efficacy. Hackett and Betz (1989) created the Mathematics Self-Efficacy Scale (MSES) to measure mathematics self-efficacy among completing math problems, addressing mathematical tasks, and selecting college courses. Mathematics self-efficacy was defined as "a situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular mathematics task or problem" (Hackett & Betz, 1989, p. 262). Prior to and since the creation of the MSES, many researchers examined the relationships between and among attitudes, anxiety, confidence, or fear of mathematics (Kahle, 2008; Pajares & Miller, 1995; Taylor & Brooks, 1986; Ufuktepe & Ozel, 2002).

Pajares and Miller (1995) conducted a mathematics self-efficacy study that related to college students and required them to make three types of mathematics self-efficacy judgments. Students were asked to report self-confidence about answering problems they were about to solve, express their confidence to perform in general on math-related tasks, and express their confidence to succeed in math-related courses (Pajares & Miller, 1995). The results from this study aided in the creation of the revised version of the Mathematics

Self-Efficacy Scale, or the MSES-R instrument (Kranzler & Pajares, 1997). After administering the MSES-R to 391 college undergraduates, the researchers found that the indicated outcomes reflected that students' confidence in answering problems was the most significant factor among the three indicated factors of the instrument (Kranzler & Pajares, 1997; Pajares & Miller, 1995).

Kahle (2008) modified the Mathematics Self-Efficacy Scale Revised (MSES-R) (Kranzler & Pajares, 1997) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) originally created by Enochs et al. (2000). The combination of the two instruments, created with the necessary changes and in alignment with the National Council of Teachers of Mathematics (NCTM) standards of 2000, resulted in the Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) (Kahle, 2008). The creation of the MTMSE established a reliable and valid instrument that can be used to measure experienced and practicing elementary teachers' mathematical self-efficacy and mathematical teaching self-efficacy.

Studies involving mathematical self-efficacy. Mathematical self-efficacy was derived from the original term of self-efficacy; however, it was attached to the specific content area of mathematics (Kahle, 2008). Bandura (1997) affirmed that self-efficacy is not necessarily uniform across all tasks that teachers perform or across all subject matters; therefore, by identifying self-efficacy in a specific content area, teachers can establish their own personal strengths and weaknesses. Dunn (2004) conducted a two-year qualitative study involving the Nambian educational system. The schools involved transitioned from a teacher-centered instructional approach to a student-centered, constructivist approach. The researcher's intent was to determine how self-concept and

teachers' beliefs influenced the implemented changes and how these changes were translated in the classroom. The self-concept of all of the teachers involved in the study influenced the teachers' instructional delivery. All of the participating teachers expressed low self-concept in teaching mathematics because of their academic preparation and personal schooling experiences (Dunn, 2004). The researcher concluded that teachers' preservice experiences negatively affected mathematics teaching and student learning. Toward the end of the study, Dunn advised that collaborative experiences and mentoring be used because of the benefits for both students and teachers. After time, the participating teachers recognized the importance of students initiating instruction, debating, and thinking through numerous methods of solving mathematical problems (Dunn, 2004).

In contrast to Dunn's study, students taught by highly efficacious mathematics teachers demonstrate higher expectations in their personal mathematics performances (Midgley et al., 1989). According to Long (2003), teachers' interest in subject areas can impact students' interests. The researcher investigated 112 high school students that were required to nominate a teacher who had inspired their learning within a specific subject area. Students were required to evaluate the teachers' effectiveness in the content area and indicate their own personal interest in the content area. The results of the study indicate that students' perceptions of teacher interest predict their own level of interest within the selected subject area (Long, 2003). Teachers' use of effective teaching practices, involvement with students, and innovative teaching strategies, as communicated by the students, establish a positive relationship between teacher efficacy and students' interests.

The combination of research indicates that highly efficacious teachers, specifically in the area of mathematics, demonstrate greater mastery of the content and share more effective instructional practices with their students (Long, 2003; Midgley et al., 1989). In contrast, experiences that fail to present collaborative, encouraging learning experiences are created by teachers who demonstrate low efficacy in teaching mathematics and cause students to experience negative feelings and beliefs towards the subject (Dunn, 2004). Because of this, teacher efficacy, which influences teachers' instructional practices, is found to impact students' appreciation and enjoyment for the content area (Long, 2003).

Mathematical Teaching Self-Efficacy

Mathematical teaching self-efficacy relates to an individual teacher's personal teaching efficacy (PTE) in that the trait reflects teachers' beliefs that they are making a statement regarding the efficacy of their own teaching, reflecting confidence that they are adequately trained to teach mathematics or they have enough experience to develop strategies for overcoming obstacles to student learning in the content area of mathematics (Ashton et al., 1982). Mathematical teaching self-efficacy is more specific and individualized than a belief about what teachers in general can accomplish because it is related not only to personal teaching beliefs, but also to a specified content area (Tschannen-Moran et al., 1998). Because of the importance found in the research regarding self-efficacy (Bandura, 1977, 1997; Kahle, 2008; Long, 2003; Midgley et al., 1989), specifically identifying mathematical teaching self-efficacy as an indicator for teachers' security in their instructional practices would benefit the advancement of

understanding how to increase student learning and achievement in the area of mathematics (Bandura, 1997; Midgley et al., 1989).

According to Kahle (2008), teachers' mathematical teaching self-efficacy was related to teacher knowledge, teacher preparation, student achievement, personal efficacy, and vicarious experiences. This concept of self-efficacy was in direct alignment with Bandura's (1986) social cognitive learning theory. As noted in previous studies related to general teacher self-efficacy, efficacious behaviors in teachers resulted in better discipline, effective classroom management, motivation among students, and increased student achievement (Pintrich & Schunk, 2002; Woolfolk & Hoy, 1990). According to Kahle, these same results occurred when applied to mathematical teaching self-efficacy.

Starko and Schack (1989) identified that teaching self-efficacy is increased through practicing skills or activities in real or simulated experiences. Although teachers are not likely to include thinking strategies that are unfamiliar to them in their lessons, they are capable of learning to become more efficacious so they can implement the strategies. By observing other teachers who model the desired instructional behaviors, teachers learn to improve their own instructional and teaching behaviors, which in turn raise teachers' mathematical teaching self-efficacy (Sparks, 1986). Teaching self-efficacy is identified as influential among teachers' instructional practices, classroom behaviors, and motivation among students (Pintrich & Schunk, 2002; Woolfolk & Hoy, 1990) and because of this mathematical teaching self-efficacy is found to have a positive, influential effect on the same factors within the mathematics classroom (Midgley et al., 1989). Although factors such as mathematics anxiety are shown to have negative effects on teachers' classroom behaviors and instructional practices (Jackson & Leffingwell, 1999),

the results of Starko and Schack's study indicate that strides can be taken to positively influence teachers' self-efficacy to counteract the negative influences.

Measuring mathematical teaching self-efficacy. Bursal and Paznokas (2006) conducted a study to determine the relationship between teachers' mathematics anxiety and their confidence levels to teach elementary mathematics and science. The researchers created the Revised-Mathematics Anxiety Survey (R-MANX) and gave the instrument measure to sixty-five preservice elementary school teachers. The R-MANX was given in combination with nine questions from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) by Enochs et al. (2000) and the Science Teaching Efficacy Beliefs Instrument (STEBI-B) by Riggs and Enochs (1990). The results of the study indicate a negative correlation between elementary preservice teachers' math anxiety and their confidence to teach elementary mathematics. Additionally, Bursal and Paznokas noted the preservice teachers who show high levels of math anxiety expressed their concerns that they are not capable of teaching mathematics effectively, especially if they are compared to their teaching peers. By addressing the need to increase elementary teachers' mathematical teaching self-efficacy, mathematics learning in the elementary classroom can only benefit to help American students become more competitive in global performance.

A Mathematical Instructional Model

Mathematical instructional practices have been presented with various supporting theories, numerous approaches, and considerable differences throughout the research. Because of the supporting information that indicates one particular learning theory providing the strongest mathematics foundation, as well as the studies that have

suggested the instructional approaches and practices found to be the most effective, further information was explored to present the findings of these studies.

Constructivism in Mathematics

The appropriate theoretical base supporting mathematics is often misunderstood because the majority of mathematics instruction observed in classrooms is based on the behaviorist theory of learning rather than the constructivist theory of learning (Manigault, 1997; Van de Walle, 2004). However, Schifter and Fosnot (1993) clarified the importance of constructivist learning in mathematics by declaring that creation of the conceptual networks that constitute individuals' understanding and sense of reality is the product of constructive and interpretive activity. Because of this reason, the researchers explained, "it follows that no matter how lucidly and patiently teachers explain to their students, they cannot understand for their students" (Schifter and Fosnot, 1993, p. 9). The importance of students thinking and engaging in active learning, both problem-centered and intensely interactive, communicating, reasoning, and developing conceptual understanding are all concepts consistent with constructivist learning; the concepts are also consistent with the standards and expectations for mathematics learning presented in the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (NCTM, 2000).

Supporting theorists. Although constructivism has branches of thought that support individualized views on constructivist learning, the foundational thought behind the theory is that children are the creators of their own knowledge, and they must be active participants in the development of their own understanding (Van de Walle, 2004). Constructivist thought is so closely related and interwoven, it is often a challenge to

separate the concepts behind the foundational theory (von Glasersfeld, 1981). In mathematics learning, the constructivist theories by Piaget and Vygotsky, as noted in Chapter I, are supportive of the practices found to be the most effective in mathematics instruction and learning and are the foundational theorists for this study. However, the supporting works of Ernst von Glasersfeld regarding radical constructivism have also been found to be influential in mathematics learning as he identified that constructing knowledge is an extremely active endeavor on the part of the learner (von Glasersfeld, 1990). Von Glasersfeld's noted his theory as being strongly connected to the foundational theories and beliefs of Piaget (von Glasersfeld, 1981).

Piaget's processes of assimilation and accommodation are the general principles of constructivism (Van de Walle, 2004). The process of assimilation refers to individuals using their existing schema to give meaning to experiences. Accommodation is the process of altering existing viewpoints that contradict or do not fit into existing schema. Through reflective thought and processing, people modify their existing schema to accommodate the ideas. Because children rarely give random answers or responses to explain their learning, research has indicated that their answers made sense to the students from their own personal perspective. In mathematics, if students' existing knowledge is incomplete, inaccurate, or non-existent, so students may construct their new knowledge inaccurately (Van de Walle, 2004; von Glasersfeld, 1981, 1990). In support of Piaget's theoretical belief, the more ways children are provided to think about and assess emerging ideas in their mathematics learning, the more likely they will correctly form ideas and integrate them into other ideas and a relational web of understanding (Van de Walle, 2004).

The theoretical beliefs of von Glasersfeld, radical constructivism, were notably founded upon the beliefs of Silvio Ceccato and Piaget (von Glasersfeld, 1981). Because of this reason, the theorist supports the belief that man alone is responsible for his thinking, his knowledge, and his accomplishments. Radical constructivism maintains that the means and operations by which individuals assemble the experiential world can be explored. Through the exploration, an awareness of how the world operates can be established and then improved upon because of invested thought and effort (von Glasersfeld, 1981). In radical constructivism, it is the individual's active operating that gives regularities and invariances in the experiential world. In applying these beliefs to mathematics, von Glasersfeld (1981) researched and theorized his perceptions of the most effective methods of mathematics instruction through radical constructivism. As a strong opponent against behaviorist instruction (von Glasersfeld, 1987), the theorist openly conveyed that knowledge was not a "transferable commodity" and that communication was "not a conveyance" (p. 41). In his beliefs, teachers' role was no longer to dispense truth for students to absorb, rather that teachers were to guide in conceptual organization of certain areas of experience. According to von Glasersfeld's radical constructivist theory regarding mathematics, mathematical knowledge could not be narrowed down to rote facts for recitation; however, mathematics incorporates an individual's ability to process and compute new results in the problem solving process (von Glasersfeld, 1987). Because of von Glasersfeld's theoretical alignment and association with Piaget (von Glaserfeld, 1981, 1987), Piaget's theoretical terms regarding cognitive constructivism appear in references to mathematics learning and processing. Mathematics is considered operative and not figurative, and problem solving is the product of reflection. The

application of von Glasersfeld's radical constructivism in mathematics requires that mathematics learning incorporates the concepts of knowing what to do in problem solving as well as why the process is being done. It incorporates reflective thought, operative knowledge, and teaching for progress and competence (von Glaserfeld, 1981).

Vygotsky's psychology and theoretical foundations were established by Marx's theories to learning that asserted man's social being determined their consciousness (Lerman, 2002; Marx, 1859). This foundation provided a framework for Vygotsky's sociocultural roots of thought. According to Vygotsky (1978), individual's higher functions originate through actual relationships between humans. As children grow and learn, their development appears twice. First, children's development occurs on a social level, between people; second, it occurs on an individual level. Through the social interaction and connection with other people, children advance in their learning because of the connectivity they find with personal levels of development. The socialization, or social constructivist approach to learning, is strongly supported and reinforced by the National Council of Teachers of Mathematics (NCTM, 2000). Specifically, the Teaching Principle supports the belief that teachers' instruction must encourage students to think, question, solve problems, and discuss their ideas, strategies, and solutions. Through the social process, students can learn mathematics with understanding and actively build new knowledge from personal experiences grounded in their prior knowledge (NCTM, 2000).

Through the professional literature, Vygotsky's theory is generally identified as social constructivism (Chen, n.d.; Van de Walle, 2004); however, it has also been identified as a theory of social cognition and sociocultural constructivism. The structures and meanings of mathematics and the insights of Vygotsky's constructivist psychology

provide sound theoretical fields for mathematics education (Lerman, 2002). Social constructivism affirms the significance of social interaction during the cognitive learning process. Because humans are active and involved beings, each stage of development is critical for children because they acquire the means that influence the world around them (Vygotsky, 1978). Children need opportunities to engage in cooperative learning and social discourse in order to expand their own thought and learning (Henson, 2003). Vygotsky's "zone of proximal development (1978, ZPD)" (p. 86) is specifically relevant to the instructional and learning process of mathematics. According to the ZPD theory, children gain independence with a more advanced skill once they are guided through the process by a more experienced peer. Before the independence is established, an experience mentor can successfully guide a child through the learning process through social interaction, open communication, collaboration, and discourse. When children are allowed to experience this social process in their mathematical learning, they experience a sense of justification and respect, and this promotes further learning (Henson, 2003).

Teaching Developmentally through Constructivism

There are four principles attached to concept of teaching developmentally as they relate to the constructivist theory. In order to teachers to use a developmental approach in their instruction that aligns to the theoretical beliefs of Piaget, Vygotsky, and von Glasersfeld, the following beliefs must be honored: (a) children construct their own knowledge and understanding; we cannot transmit ideas to passive learners; (b) knowledge and understanding are unique for each learner; (c) reflective thinking is the single most important ingredient for effective learning; and (d) effective teaching is a child-centered activity (Van de Walle, 2004). Because students are all unique in their

beliefs and ideas, their individuality has to be taken into consideration when teaching them new concepts and ideas. Students must be actively engaged in their learning process for the learning objective to have substantial meaning (Van de Walle, 2004; von Glasersfeld, 1990). As students interact and engage in proactive discourse, students learn from their peers and establish meaning to their own schema of knowledge. This allows students to form new ideas to expand their learning. Providing students the opportunity to engage in their work and share interrelated ideas allows them to connect their personal knowledge to the new learning task. Constructivism is focused on learning rather than teaching (Van de Walle, 2004). Because of this reason, students are given the responsibility and opportunity of learning while the teacher actively engages the students by posing good questions and problems, and by providing a learning environment that encourages sense making and exploration in learning.

Teaching Mathematics In-Depth

Teachers' approaches to mathematics instruction have varied throughout classrooms in various grade levels and in different cultures (Geist, 2001; Shaw, 1990; Yun-peng, Chi-chung, & Ngai-ying, 2006). Although some researchers identified a majority of classrooms that used a more systematic, behaviorist approach to instruction (Manigault, 1997; Van de Walle, 2004), additional researchers noted instructional approaches that were found to be more effective for students' learning. According to a study completed by Ma (1999a) comparing American and Chinese teachers, American elementary mathematics teachers do not need to take higher-level courses to be effective teachers. Rather, Ma addressed profound understanding as the critical component missing from American elementary school teachers' instructional practices. In

comparison, the Chinese elementary teachers were not required to take more extensive mathematics courses for educational preparation; however, they were more comfortable using more rigorous instructional practices. Chinese teachers learned and worked with teaching colleagues and developed mathematics lessons that guided students towards conceptual understanding and procedural agility, which are synonymous practices to constructivist learning. The Chinese teachers learned from others' experiences and precisely evaluated students' performances. This led to better lesson development and stronger teaching practices. The Chinese teachers' understanding related to their teaching pedagogy, because no teachers taught beyond their personal level of understanding. Through the examples demonstrated by the Chinese teachers, American elementary school teachers could learn to better prepare and deliver quality mathematics instruction by demonstrating a deeper understanding for the content and analyzing the depth of the students' understanding (Ma, 199a).

College and University Training in Mathematics

Klein (2004) investigated the differences between how teachers were trained and how they were required to teach in the actual classroom. According to Klein, outdated epistemological and ontological strategies were used for training because preservice teachers were expected to engage students in learning mathematics reflectively rather than through investigation. Klein emphasized how preservice teachers should not only learn content, but also to effectively learn how to teach the mathematics process. Preservice teachers must understand their personal history with mathematics because negative mathematics experiences could impact student learning and teacher quality. Teachers must be required to model the desired strategies and thinking processes for the

students in order for them to form a strong mathematical identity. Additionally, Klein supported the idea that universities must model evidence-based teaching styles, engage students in deep discourse regarding mathematical teaching methods, and engage preservice teachers in learning through mathematical investigations.

Teacher Perceptions about Teaching Mathematics

The majority of first year teachers expressed that they felt prepared to teach and could manage and discipline the class based on methods they had learned in college preparation courses (Coleman, 2001). However, after the first year of teaching, novice teachers began to realize that more than theory was required for success and mastery of teaching. Assessments of teaching styles and instructional methods through peer-evaluations and self-assessments were necessary for a broader perspective of better instructional practices. These types of evaluations were deemed especially helpful in teaching mathematics (Coleman, 2001). Teacher preparation was noted as being reflected in teachers' mathematical instructional practices. Therefore, proper and effective preparation of elementary teachers was necessary to avoid further teacher frustration and extended mathematics anxiety.

In studies conducted by Hembree (1990) and Levine (1996), the researchers concluded that preservice elementary teachers often showed strong signs of mathematics anxiety. Some researchers identified the problem as being a result of poor preparation from colleges and universities whose education departments placed little to no emphasis on mathematics training in their programs. Many colleges and universities had math courses for future elementary teachers; however, the classes were offered through math departments and gave little guidance on how to instruct in mathematics classes or address

mathematical anxiety (Paulos, 1988). The identified studies emphasized the importance of teacher preparation in the area of mathematics (Coleman, 2001; Hembree, 1990; Levine, 1996), and some mathematics anxiety could be prevented with better preparation (Coleman, 2001).

Mathematical Understanding and Instructional Practices

Teachers who feel secure in their content area and with the students they teach often do well with their teaching and instruction because of their personal and teaching self-efficacy (Tschannen-Moran et al., 1998); however, because of the findings of the study, the opposite side of the argument should also be presented. Ball (1990a) conducted research that concluded prospective teacher candidates bring a rule-bound and thin understanding of mathematics to their college courses, referring to the fact that these teachers also have a limited understanding of content for their classroom instruction.

The longitudinal study, which utilized interviews and questionnaires, included 250 prospective teacher candidates and included the participants' subject knowledge of mathematics, participants' mathematical ways of knowing, and participants' feelings toward mathematics. Prospective candidates answered questions about their feelings toward mathematics with some that regarded affective dimensions (e.g., sighs, giggles, etc.), and others addressed personal mathematical experiences. The results of the study indicate that only one-half of the prospective candidates enjoyed mathematics but more than one-third indicated they were not good at mathematics. According to the results of the study, teachers' mathematical understanding is interrelated with their personal feelings of mathematics and themselves (Ball, 1990a). When asked to represent a division problem, participants' responses were weak and affected by knowledge, ways of

thinking, beliefs, and self-confidence. As indicated by the study, teachers are the key instrument in developing students' self-confidence, and elementary teachers with negative attitudes and beliefs about mathematics have potential to negatively affect students (Ball, 1990b).

In a study conducted by Yun-peng et al. (2006), teacher development is deemed crucial for meeting students' academic needs. According to Yun-peng et al., rural and urban teachers in third grade, Chinese elementary schools make instructional decisions based on personal professional knowledge, educational beliefs, and examination pressures. The study indicates that urban teachers focus on higher standards of academic expectations and work above the national curriculum standards while rural teachers follow national standards, but the teachers' primary concern is getting students to pass the national tests (Yun-peng et al., 2006).

Additional research indicates that educating teachers about mathematical content may address curriculum issues identified through previous research (Lias, Krivak-Fowler, Holden, & Maxwell, 2006). Teachers who learn more about mathematics content could increase their personal self-concept about mathematics. According to Lias et al. (2006), the blend of content education and pedagogical skills provide teachers with deeper mathematical understanding. The way that teachers comprehend and implement curricula is influenced by their personal knowledge and beliefs about mathematics (Clark & Peterson, 1986).

Beliefs and instructional practices. Novice teachers often enter the classroom with a sense of accomplishment and achievement; however, they have not experienced the realities of what take place in the daily confounds of a classroom (Chester & Beaudin,

1996). After the first experiences in a school setting, new teachers', and even experienced teachers' in a new school setting, self-efficacies decrease due to lack of guidance and support regarding instructional choices. In a study conducted by Raymond (1997) over a ten month period, the researcher found discrepancies between beginning elementary school teachers' beliefs and actual teaching practices. Raymond's constructed model reflected how mathematical practices were more reflective of math content rather than math pedagogy. Raymond's model was described in the following manner:

This model relates how past school experiences, teacher education programs, social teaching norms, and the teacher's and students' lives outside school influence mathematics beliefs and mathematics teaching practices. Additionally, the model shows that early family experiences, the classroom situation, including the characteristics of the particular students, time constraints, current mathematics topic to teach, and teacher personality traits, including confidence, creativity, humor, and openness to change, influence mathematics beliefs and mathematics teaching practices. (p. 576)

According to the results of the study, past school experiences have the most significant influence on teachers' mathematics beliefs, and mathematics beliefs, classroom situation, and current mathematics teaching practices have the most influence on implemented mathematics teaching practices. Considering all of this, the researcher concluded that mathematical beliefs are not consistent with teachers' instructional practices (Raymond, 1997).

Research suggests for content and methodology in mathematics education to improve, teachers need to address their prior beliefs. Teachers change personal teaching

practices when personal beliefs are influenced (Thompson, 1992). Additionally, teachers who oppose the beliefs in mathematical reform and driving standards resist change unless their personal beliefs change (Weissglass, 1994). Many educators believe that elementary math teachers only need to know the material they are teaching and a broad idea of where the students are heading (Ball & Bass, 2000). However, the majority of math scholars disagree. Research suggests that depth of knowledge combined with the skill to communicate the concepts to learners in the classroom is an invaluable trait for an elementary educator (Ball & Bass, 2000; Hill, Schilling, & Ball, 2004).

Understanding the use of mathematics and providing ways to approach and think about a different solution method reflect good teaching practices (Ball & Bass, 2000; Hill, Schilling & Ball, 2004). Teachers must not only recognize students' mistakes, they must be able to understand the mistakes (Ball & Bass, 2000). Concrete and conceptual knowledge paired with strong pedagogical methods are required to be an effective math teacher. Didactic teaching environments do not produce students that are interested in the content of mathematics (Boaler & Greeno, 2000). Understanding and content retention are enhanced when students are afforded opportunities to learn by doing and this requires a change in instructional practices. To bring about these effective instructional practices, textbooks should be replaced by hands-on materials, and students should learn through an emphasis on thinking and metacognition rather than memorization and recitation (McBrien & Brandt, 1997). By recognizing that mathematical self-efficacy and mathematical teaching self-efficacy influence teachers' instructional practices, efforts can be extended to show that by using methods to increase teachers' efficacies in the content area, students would benefit from the gain through instructional practices.

Increasing Conceptual and Procedural Instruction

The efficacy research indicates that teachers who are more efficacious with their mathematical beliefs are more likely to use a more balanced, rational approach in their personal mathematics instruction. Mathematics education has had numerous theories encompassing different approaches to teaching mathematics and the type of student learning that should be deemed most important (Kahle, 2008). Traditionally, these theories have moved the focus of mathematics instruction from the rote process of the 1920s to practical mathematics in the 1940s; the New Math of the 1960s led America back to the basic in the 1970s. The National Council of Teachers of Mathematics (NCTM) changed things once again in the 1980s with the standards which triggered a reform movement in the 1990s. The NCTM Standards were revised in 2000, but in appearance it seemed as though America was returning to the original arguments regarding the instructional practices educators felt were the most beneficial for student learning (i.e., practical mathematics, New Mathematics, back to the basics mathematics) (Kahle, 2008). The revised NCTM Standards that were published in 2000 focused on the balance of procedural and conceptual knowledge; however, getting elementary school teachers comfortable enough to implement the balance of the standards is challenging as teachers do not agree on the best instructional approach (Kahle, 2008; NCTM, 2000).

Teachers' arguments are often based on personal, philosophical, theoretical, and pedagogical beliefs. Sowder (1998) asserts the differences between behaviorist and cognitivist approaches to learning mathematics is that individuals cannot agree on the order of learning. Educators cannot decide whether developing skills with symbols leads to conceptual understanding or if basic understanding should be established prior to

mathematical symbols and skill practice. Regardless, the majority of mathematics researchers find both procedural and conceptual skills to be necessary in the learning process (Kahle, 2008; NCTM, 2000). Even though the reform intended to advance mathematical instruction and many teachers have worked towards balancing their mathematical instruction, teaching practices viewed as effective by the NCTM continue to be linked to mathematics anxiety in teachers (Karp, 1991). By working with teachers to address their mathematics anxiety and increase their mathematical self-efficacies, the trauma of mathematics anxiety can be terminated and students can benefit from more influential, effective instructional practices.

Mathematical Instructional Practices

Teachers' instructional practices were identified as a key factor in effectively educating students because they were guided by individual teacher's personal beliefs, personal efficacies, and personal behaviors (Muijs & Reynolds, 2002). Nathan and Koedinger (2000) found that teacher beliefs about students' abilities and learning greatly influenced their instructional practices when working with those students. Teachers who espoused a student-centered constructivist approach to teaching still relied heavily on district mandated curriculum and assessment for instruction while failing to recognize the philosophical conflict (Levitt, 2001; Schraw & Olafson, 2002). Depending on an individual teacher's relationship with mathematics, selected instructional practices could advance or possibly limit student achievement. Specifically, teachers who exhibit a sense of mathematical anxiety convey that anxiety to students through their instructional practices, and the cycle of mathematics anxiety continues (Alsup, 2003; Beilock et al., 2010; Burns, 1998; Polya, 1957).

Influences on Instructional Practices

As discussed in a study by Yun-peng et al. (2006), teacher development was deemed crucial when meeting students' needs in the classroom. The study concluded that teachers made curriculum decisions based on personal professional knowledge, educational beliefs, and pressures of mandated examinations. Additionally, teacher development was deemed crucial when meeting students' needs in the classroom (Yun-peng et al., 2006).

The researchers (Yun-peng et al., 2006) investigated third grade classrooms in two Chinese elementary schools to determine how teachers influenced decision-making regarding the mathematics curriculum and mathematical instructional practices. National curricula and uniform materials were utilized by both participating schools because they aligned with the mandated national assessment that students took at the end of the school year. Textbooks were the primary resource that teachers used for creating instructional lessons. In addition to test preparation and instructional lessons, the teachers trained students for an extracurricular academic event, the Olympiad. The Olympiad was a mathematics competition that challenged students in the concepts of mathematics, and the preliminary preparation of the students was required of the teacher. Student success was a reflection of teacher success.

Yun-peng and colleagues (2006) identified that the preparation required of the teachers for students to be successful in the Olympiad and on the national assessment made the teachers more successful with their instruction. The study concluded that teachers made curriculum decisions based on personal professional knowledge, educational beliefs, and mandated national exam pressures; however, all of the teachers

were identified as teaching within the spectrum of their understanding and knowledge of mathematics content. All of the identified components created motivation, incentive, and pressure for both the students and teachers to achieve success.

Shaw (1990) conducted a qualitative study with three middle school teachers that determined the differences between teachers' *ideal beliefs* and *actual beliefs* about understanding and how these factors influenced teachers' instructional practices. Ideal beliefs represented what teachers preferred to teach in order for students to learn; actual beliefs were how the teachers actually taught based on contextual factors. The results indicated that teachers held a cluster of beliefs about understanding that were very different to their cluster of actual teaching beliefs and implemented classroom practices. Shaw concluded that several contextual factors attributed to the way teachers delineated from their beliefs such as how they learned mathematics, how they had taught mathematics, students' backgrounds, students' goals for learning mathematics, standardized tests, administrative demands, textbooks, and time.

To support Shaw's findings, Geist (2001) suggested reasons why these practices took place. First, teachers were not using standards to teach; rather, textbooks were the driving force behind instruction. Second, teachers had an extensive amount of curriculum to cover within a limited amount of time; therefore, directive instruction and passive learning allowed teachers to cover more material. The focus turned from teaching for learning to teaching for coverage. Both Shaw (1990) and Geist established that teachers' instructional practices were influenced by external factors such as textbooks, time, and coverage of objectives rather than teaching for the mastery of the mathematical skills and concepts.

These previous two studies contradict the findings of Yun-peng et al. (2006) who found the Chinese counterparts also used textbooks and mandated assessments to guide their instruction; however, Yun-peng and colleagues found that the teachers' instructional practices beneficially guided students' mastery of the mathematical skills and concepts because the number of required objectives were not as extensive and instruction allowed time for deeper understanding. The Chinese teachers were found to teach according to the security of their content knowledge, while the American teachers were required to teach a large, cumbersome number of objectives that often consumed time and extended beyond their mathematical security (Geist, 2001). All of the presented studies support that the teachers' instructional decisions impacted student learning and external factors, such as textbooks and mandated assessment pressures, influenced teachers' instructional practices (Geist, 2001; Shaw, 1990; Yun-peng et al., 2006). However, the manner in which the material and instruction was presented to the students varied.

Performance and Mastery Goals

Throughout the research, several factors have been identified as influential in determining students' goals and achievements (Ames, 1992; Dweck, 2000; Klein, 2004; Meece, 1991; Patrick, Turner, Meyer, & Midgley, 2003). According to Meece, students' personal goals were fostered and mediated by the classroom teachers' goals and the design of the classroom. The instructional practices of the teacher determined the outcome of student achievement, and achievement goals determined the underlying motivation behind student behavior and academic success (Meece et al., 2006). Achievement goals were identified as *performance goals* and *mastery goals*, with a marked difference between the two. Performance goals were founded on a student's

ability to demonstrate competence of certain skill or skills such as scores on standardized tests or course grades, which resulted in students selecting tasks that were less challenging so they could demonstrate a greater ability (Dweck, 2000). Mastery goals were more focused on improving as a learner and the learning process, which resulted in students desiring to advance in their skill competence, gain knowledge, and grow as a learner rather than focus on grades or test scores. Mastery goals drove students to seek more challenging work, learn adaptive strategies, and ask for assistance when needed (Ames), while performance goals led students to show more dependence on the teacher for content understanding (Dweck, 2000).

Performance and Mastery Instruction

Research supports that mastery instruction, or instruction based on teachers' ideal beliefs, is more beneficial for student learning rather than performance instruction that is led by external motivating factors (Ames, 1992; Dweck, 2000; Shaw, 1990). According to Owen (2010), the No Child Left Behind Act of 2001 (NCLB; PL 107-110) has had a great impact on teachers' instructional practices. Many teachers implement performance-driven instruction in many classrooms throughout America because of the pressures caused by testing mandates. Previous findings from Shaw (1990) support Owen's statement regarding performance-driven instruction, although the NCLB law was not established at the time of the 1990 study. As previously mentioned, Shaw's efforts reported that teachers were led by actual beliefs, rather than ideal beliefs, which were influenced by a number of causes. These causes included but were not limited to standardized tests, administrative demands, and time. Because of these types of mandates, students have experienced an increase in academic pressure that has led to an

increase in anxiety due to testing pressures, specifically mathematics anxiety (Owen, 2010). Collectively, the research indicates that the long-term effects of performance driven instruction causes a negative impact on student learning, and can ultimately contribute to anxiety in identified content areas, namely mathematics (Ames, 1992; Dweck, 2000; Meece et al., 2006; Owen, 2010; Shaw, 1990).

The classroom structure and instructional practices of the classroom teacher were identified as being influential in the development of student goals (Patrick et al., 2003). Teacher practices determined a learning environment that either (a) encouraged performance and avoidance tendencies or (b) encouraged mastery and approach tendencies. The classroom teachers established the learning environment, expectations, values and instructional tasks that influenced student motivation (Ames, 1992; Patrick, et al., 2003). Turner et al. (1998) identified teachers who did not clearly define consistent expectations for all students and did not show an appreciation for the content they were teaching were more likely to encourage students to use more avoidance strategies.

On the contrary, teachers perceived as mastery oriented were considered more successful with student learning. According to Turner et al. (2003), elementary students who held more performance goals and negative motivational patterns were in classroom environments where the teacher used highly controlling instructional practices and external motivators. However, teachers who used a mastery approach to instruction provided learning opportunities for students that allowed them to work toward increased knowledge and improved skills (Anderman & Midgley, 1997). Although current mandates of NCLB have indicated an influence on teachers' instructional practices in a negative direction toward performance-driven instruction (Owen, 2010), the mastery

approach to instruction has been identified as the most positive learning experience for students to help decrease anxiety and teacher dependence while increasing student inquiry and independent learning (Anderman & Midgley, 1997; National Council of Teachers of Mathematics, 2000; Patrick et al., 2003).

Teacher Confidence, Self-Efficacy, and Instructional Practices

Security and confidence with content and pedagogy have been shown to positively impact teachers' instructional practices (Dyrud, 1997; Newton & Newton, 2007; Yun-peng et al., 2006). To extend understanding of influences regarding teachers' mathematical instructional practices, Graven (2004) conducted an ethnographic qualitative study to determine the impact a mathematics leadership program had on teachers' self-confidence. The Program for Leader Educators in Senior-Phase Mathematics Education was used in the study to determine how self-confidence impacted instructional practices in teaching. The results of the study indicated that teachers who expressed more confidence in their classroom practices, primarily the presentation of information and asking of questions, better understood the curriculum and outcome based measures. Graven noted that once teacher confidence was established, teachers became more involved in school activities and started to prepare for future lessons in the subject of mathematics by seeking further training.

Additional research supported Graven's (2004) findings regarding mathematics confidence in teachers. Newton and Newton (2007) asserted the more confident teachers, who were capable of identifying cause and purpose goals, were skilled at deciphering and interpreting educational supplies such as textbooks and additional curriculum resources. This also supports the research findings of Yun-peng et al. (2006) who established that

the use of textbooks in the Chinese schools was done effectively. According to Dyrud (1997), teachers taught from their “strengths rather than their weaknesses, to capitalize on what they do well rather than trying to use strategies with which they are less comfortable and therefore less practiced and skilled” (p. 124).

Taken collectively, the research presented in this section indicates that secure, knowledgeable teachers who are skilled in their content areas are more effective with their instructional practices (Dyrud, 1997; Graven, 2004; Newton & Newton, 2007; Yun-peng et al., 2006). On the contrary, teachers who exhibited less confidence and a sense of anxiety in a content area, such as mathematics, invested less time and effort in planning and implementing lessons for that particular content area, notably the area of mathematics (Swetman et al., 1993). In order for teachers to be effective in their instructional practices, anxiety needs to be reduced and content security needs to be established so that students can benefit in their learning experiences.

Allinder (1994) also found that teachers’ professional teaching efficacy was connected to teachers’ willingness to seek more effective instructional practices, implement new and progressive instructional methods, and work with a variety of materials and approaches for greater student learning. Mathematics anxiety in students can be prevented by highly efficacious teachers, even if the teachers have math anxiety, because of the teachers’ beliefs that they can affect student learning regardless of external factors (Tschannen-Moran et al., 1998). As documented by the various researchers, highly efficacious teachers achieve this through their instructional practices (Allinder, 1994; Gibson & Dembo, 1984; Tschannen-Moran et al., 1998), and it has been established that highly efficacious teachers are more willing to work through challenging

situations, experiment with methods to better meet the needs of students, and plan and organize to assure quality instruction (Allinder, 1994; Tschannen-Moran et al., 1998).

Summary

Through reviewing the research regarding mathematics, it appears evident that the differing theories, behaviors, beliefs, attitudes, efficacies, and instructional beliefs of elementary educators impacted student learning throughout the years (Gibson & Dembo, 1984; Muijs & Reynolds, 2002; Tom et al., 1984). The relationships between and among mathematical anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices appear to be relevant as educators pursue moving forward with better, more efficient mathematical teaching practices. However, the endless cycle of these individual constructs impacting students' sense of anxiety, self-efficacy, and learning in a negative way need to be addressed further. None of the reported studies addressed these factors as a cohesive unit, and many of the studies indicated how these factors (as separate constructs) should have been used in comparison to teachers' instructional practices (Kahle, 2008). The intent of this review of literature was to establish a foundation for further research in identifying the relationships between and among mathematical anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers who teach mathematics.

Chapter I provided an introduction and overview of the proposed research study, and Chapter II offered an exhaustive review of the literature relating to mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices of elementary school teachers. The methodology used to study

these concepts is presented in Chapter III. An analysis of the conclusive data is presented in Chapter IV regarding the findings of the research study. Chapter V provides the findings of the study, conclusions that can be drawn from the information, and implications of the found data.

CHAPTER III

METHODOLOGY

Although there has been extensive research on mathematics anxiety and self-efficacy, a limited amount is known about the impact of mathematics anxiety and self-efficacy on the mathematical instructional practices of elementary school teachers. Specifically, the research conducted on mathematical self-efficacy and mathematical teaching self-efficacy has been limited mainly to post secondary students, including preservice teachers (Hackett & Betz, 1989; Pajares & Miller, 1995). None of the found studies investigated the two efficacies in combination with mathematics anxiety, specifically in relation to elementary school teachers' instructional practices.

Establishing a strong foundation in the content area of mathematics at the elementary level is critically important in order for American students to be competitive among other global competitors (Wallace, 2005). Meeting this challenge is made more difficult when considering the large number of preservice elementary teachers identified as having mathematics anxiety (Swars et al., 2006; Woolfolk & Hoy, 1990) and negative feelings about the subject of mathematics (Austin et al., 1992). The literature further suggests teachers' instructional practices and classroom behaviors are influential in contributing to their students' mathematics anxiety (Furner & Duffy, 2002; Jackson & Leffingwell, 1999) and ultimately poor performance (Swars et al., 2006). The classroom teacher is the most influential factor impacting student achievement through the increase of students' intrinsic motivation, and teachers' efficacy influences instructional practices because of the belief that teachers can impact student learning, and personal teaching practices change when personal beliefs are influenced (Darling-Hammond, 2004; Hidi,

2001; Hoy & Woolfolk, 1990; Thompson, 1992). Although anxiety was found to negatively impact teachers' instructional practices (Burrill, 1997; Manigault, 1997), the existing research thoroughly explored failed to identify the relationship between mathematics anxiety and mathematical self-efficacies.

The purpose of the study was to investigate elementary school teachers' mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy. Further, it sought to establish a relationship among these constructs and the instructional practices of teachers in grades K-6 in Mississippi. This chapter provides a description of the research design, participants, instrumentation, procedures, and treatment of the data for the study.

Research Questions

The study examined the following research questions:

1. What are the mathematics anxieties, mathematical self-efficacies, mathematical teaching self-efficacies, and instructional practices of certified elementary teachers?
2. For certified elementary school teachers (K-6), do mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy have an effect on their instructional practices in mathematics?

Hypotheses

This study evaluated the following null hypotheses:

H₁: There is no significant relationship between the dependent variable of elementary school teachers' mastery goal structure for students in their instructional

practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₂: There is no significant relationship between the dependent variable of elementary school teachers' performance goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₃: There is no significant relationship between the dependent variable of elementary school teachers' mastery approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H₄: There is no significant relationship between the dependent variable of elementary school teachers' performance approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

Research Design

To answer these questions and to test the hypotheses, the researcher used a quantitative, correlational multiple regression research design to explore the relationship among the variables of the study - mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy (as independent variables), and instructional practices (as the dependent variable). This design can establish that a set of independent variables explains a proportion of the variance in a dependent variable at a significant level, as well as establish the relative predictive importance of the independent variables (Creswell, 2008; Garson, 2009a). Multiple regression shares all the assumptions of

correlation such as the linearity of relationships, homoscedasticity (or the same level of relationship throughout the range of the independent variable), interval data, absence of outliers, and data whose range is not truncated (Garson, 2009a). The specification of the model being tested is critical, and the exclusion of important causal variables or the inclusion of extraneous variables can considerably change the beta weights (Creswell, 2008; Garson, 2009a). The change in beta weights can considerably influence and change the interpretation of the importance of the independent variables (Garson, 2009a), so anticipation of causal and extraneous variables will be accounted for in the design of the study. The self-report survey design of the study will provide relevant and insightful information about elementary mathematics teachers within a reasonable timeframe, and this can be beneficial in the research design (Creswell, 2008).

Participants

The participants for the study included practicing elementary school teachers, grades K-6, in five school districts from a southeastern state. In an attempt to ensure a representative sample, districts were identified for participation based on geographic location and congressional district. Next, school districts were selected to ensure diversity of socio-economic status of students. Based on these factors, 10 districts were invited to participate. When a district declined to participate, a geographically and socio-economically similar district was invited in its place. The five districts and 21 schools in the final sample represented each of the four congressional districts located in the state with one congressional district having two participating school districts. The socio-economic status (SES) of the school districts ranged from 38% to 82%, representing the percentages of students receiving free or reduced lunch (Mississippi Department of

Education, n.d.). The state's range of students receiving free or reduced lunch is 32% to 100%, and the representative sample of the study extended closely to the spectrum of the state's percentages. Although some of the schools with 100% free or reduced lunches were asked to participate, none responded to participate in the study. Title I schools, schools that receive federal funding because of their high poverty rate, were represented in four of the five participating districts. Although not every school in the four districts qualified for Title I funding, the balance of Title and non-Title schools in the study reflected the state's range of students receiving free and reduced lunch (Mississippi Department of Education, n.d.). The smallest school district that participated was a Title I district, and all of its schools qualify as Title I schools. The school district representing the congressional district four was the only district that did not receive Title I funding for any school. The school districts ranged in size from two schools within the district to 13 elementary schools within the district, representing a sample from one of the smallest to one of the largest of districts in the state. Although only four schools from the largest district participated, the remaining four districts included all of their schools that housed the required population of K-6 teachers.

Preliminary phone calls were been made and letters (Appendix A) mailed to superintendents requesting that their school districts participate in the study; e-mails were also sent to superintendents whose e-mail addresses were available. In addition, a cover letter was included (Appendix B) that included the protocol and procedural guidelines of the research study, and an example letter to teachers (Appendix C) was included to explain survey directions.

Data Collection

The five districts agreeing to participate received the survey packets for completion. A copy of protocol and questionnaire directions, a demographic questionnaire, the *Abbreviated Mathematics Anxiety Rating Scale*, the *Mathematical Teaching and Mathematical Self-Efficacy* survey, and the *Patterns of Adaptive Learning Survey*, were provided for each licensed teacher that taught mathematics in every participating school. Teachers who chose to participate in the study provided their consent to participate by submission of their completed survey. The survey packets were hand delivered to each district office representative or principal's office; the number of surveys distributed to each school was set by the number of K-6 licensed teachers who were housed in the school as accounted for by the district office. The survey packets were placed in a sealed return box which was placed in a location established by each district representative or school principal. The researcher picked up each return box on a date agreed upon by the district representative or school principal. Because of the security of the return box, neither district representatives nor school principals could see the information teachers provided on the surveys. The surveys were distributed to approximately 403 teachers within the 21 schools from the five school districts. A total of 320 complete surveys were returned.

Instrumentation

Three instruments were used to collect quantitative data in this research study, the *Abbreviated Mathematics Anxiety Rating Scale* (Hopko et al., 2003), the *Mathematical Teaching and Mathematical Self-Efficacy* survey (Kahle, 2008), and the *Patterns of Adaptive Learning Survey* (Midgley et al., 2000). All of the researchers were contacted,

and they granted permission to use their instruments. Each instrument was distributed in its original version and form.

Scales Measuring Mathematics Anxiety

Mathematics anxiety became a topic of interest in the 1950s when W.H. Dutton developed the *Dutton Scale*, which was the first instrument that measured individuals' emotional reactions toward mathematics (Dutton, 1954; Dutton & Blum, 1968). After that, the research interests extended to identify the symptoms of math anxiety (Aiken & Dreger, 1961; Gladstone, Deal, & Drevdahl, 1960), to measure a person's enjoyment and value of mathematics (Aiken, 1974), and to develop multidimensional attitude scales regarding mathematics (Michaels & Forsyth, 1977; Sandman, 1980). Not long after, researchers developed instruments that specifically investigated the topic of mathematics anxiety.

Measures of mathematics attitude and anxiety. As the curiosity and concern about mathematics anxiety grew, researchers began developing instruments that measured specific aspects of mathematics feelings and beliefs. The Mathematics Anxiety Rating Scale (MARS) was the first created by Richardson and Suinn (1972) to help individuals overcome math anxiety. It was followed by the Mathematics Anxiety Rating Scale revised (MARS-R) by Plake and Parker (1982), and the Abbreviated Math Anxiety Scale (AMAS) by Hopko et al. (2003). For the purposes of the proposed study, the AMAS will be used to measure teachers' mathematics anxiety; however, the following information about the other two mathematics anxiety instruments is provided as they were both instrumental in the development of the AMAS instrument.

The Mathematics Anxiety Rating Scale (MARS). The MARS was created as an anxiety measure to assess individual's responses to the manipulation of numbers and the use of mathematical concepts in practical situations (Richardson & Suinn, 1972). The

98-item inventory presented statements and descriptions of real-world and academic situations that could potentially stimulate mathematics anxiety within a person. The unidimensional measure of the MARS required participants to record responses on a 5-point Likert scale that ranged from 1 (*not at all*) to 5 (*very much*) in reporting their anxiety towards the presented situation. Summation of the values provided an overall score for each individual with high scores reflecting a high level of mathematics anxiety. The test-retest reliability of the MARS instrument was .78 and was found to be significant at $p < .001$, and a 7-week test-retest found the reliability to be .85 with an internal consistency (alpha) on the second sample of .97. Correlations between the MARS and the Differential Aptitude Test (DAT) were found to be negative, resulting in a -.35 correlation for the original testing, and -.32 for the second testing. This reflected that individuals with high mathematics anxiety performed poorly on the mathematics assessment. However, Richardson and Suinn concluded at the end of their study that individuals could be treated for mathematics anxiety because of the increase in scores among the 24 clients that participated and received treatment for mathematics anxiety.

Mathematics Anxiety Rating Scale-Revised (MARS-R). Plake and Parker (1982) created a shortened, revised version of the Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972). The new version of the MARS instrument, the MARS-R, included 24 Likert-type items that focused on situation-specific anxiety, general anxiety, and test anxiety. After assessing the instrument with 170 undergraduate students enrolled in mathematics courses, which included preservice teachers, two subscales were identified with the revised instrument: Learning Math Anxiety (LMA) and Mathematics Evaluation Anxiety (MEA). LMA was identified as the process of learning math and

statistics, and MEA was named as being the anxiety that develops when anticipating being tested on math or statistics.

Participants responded on the Likert-type questions that ranged from 1 (*low anxiety*) to 5 (*high anxiety*). The results ranged from 24 to 120 with the higher number reflecting individuals with higher mathematics anxiety. The instrument was tested for internal reliability with a reported alpha of .98; however, scores were not correlated with achievement anxiety. Rather, the MARS-R scores were correlated with the State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), math achievement, and the original 98-item MARS instrument. High correlations were found between the MARS and the MARS-R and were reported as .97. Although these high correlations were reported, the lack of test-retest data and the small sample size used to create the instrument (Plake & Parker, 1982), significant methodological limitations were noted as critical (Hopko et al., 2003). Because of the scrutiny regarding the reliability and validity of the MARS-R, researchers began assessing, modifying, and altering the instrument in order to create a more reliable measure (Hopko et al., 2003).

Abbreviated Mathematics Anxiety Rating Scale (AMAS). Researchers who previously used the MARS-R began to question the conceptual, self-report models of math anxiety and the lack of empirical scrutiny to validate the construct measures (Hopko et al., 2003). In addition, the researchers wanted to prove the emotional experiences of mathematics anxiety that were unaccounted for in previous measures threatened the internal and external validity of the studies, as proved in a confirmatory factor-analytic study (Hopko, 2003). According to the results of the factor analysis, the two-factor structure of the MARS-R proved to be a poor fit when used with a larger representative

sample. Because of this, researchers decided to create an abbreviated measure of math anxiety using a larger sample size.

The AMAS instrument was assessed and validated using 1,239 undergraduate, university students with a mean age of 19.6 years. The instrument, completed by a developmental sample (N = 815), was derived from the MARS-R after an exploratory factor analysis was completed to extract the principal components; the factor loadings, face validity of items, and scree-plot analysis were used to create the AMAS. A testing sample (N = 206) completed the AMAS as part of an assessment battery, and an exploratory analysis was once again conducted using principal components extraction with varimax rotation (Hopko et al., 2003). The test-retest process for the AMAS occurred two weeks after the battery assessment battery. An independent replication sample (N= 218) completed the AMAS, and a confirmatory factor analysis determined the adequacy of the factor structure. The two-factor exploratory analysis explained 52% of the variance, and factor loadings for the *Learning Math Anxiety* (LMA) ranged from .42 to .73 and for the *Math Evaluation Anxiety* (MEA) ranged from .26 to .88, identifying the two subconstructs that make up the 9-item anxiety AMAS assessment.

The AMAS instrument required respondents to answer on a 5-point Likert-type scale that ranged from 1 (*low anxiety*) to 5 (*high anxiety*), with the summation of the scores representing the nine items. The higher the summed score is for the individual, the higher the anxiety level. The internal consistency of the AMAS was found to be .90, as well as the internal consistency of the subscales. The Learning Math Anxiety (LMA) reliability reported an alpha of .78 and Math Evaluation Anxiety (MEA) reported an alpha value of .83. In the study, a gender effect was found to be significant because

females reported more mathematics anxiety than male students, and a moderate relationship regarding the number of high school mathematics courses and the grades earned in those courses was also identified. The study did not find a significant relationship between mathematics anxiety and race or mathematics anxiety and age (Hopko et al., 2003).

The overall purpose of the Hopko et al. study was to establish the psychometric properties of the AMAS instrument among university undergraduate students. Extensive information regarding the validity and reliability of the AMAS instrument is available (Hopko et al., 2003), and a summation of it was provided in this review of literature. The finding that gender plays a critical role in individual's mathematics anxiety was deemed a concerning issue with the reporting researchers. Additionally, the researchers suggested that early assessment of mathematics anxiety could serve as a useful purpose.

Measures of Mathematical Self-Efficacy and Mathematical Teaching Self-Efficacy

Kahle (2008) modified the Mathematics Self-Efficacy Scale Revised (MSES-R) (Kranzler & Pajares, 1997) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) originally created by Enochs et al. (2000). Kahle created the Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) by combining the MSES-R and MTEBI and ensuring changes were in alignment with the National Council of Teachers of Mathematics (NCTM) standards of 2000. The creation of the MTMSE established an instrument that produces reliable and valid scores that can be used to measure experienced and practicing elementary teachers' mathematical self-efficacy and mathematical teaching self-efficacy.

The Mathematics Teaching and Mathematics Self-Efficacy survey (MTMSE). The Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) survey was developed by Kahle (2008) to determine the mathematical self-efficacies among experienced elementary school teachers. The researcher based the instrument on the Mathematics Self-Efficacy Survey – Revised (MSES-R) by Kranzler and Pajares (1997) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) created by Enochs et al. (2000). The instrument has four subconstructs that account for the mathematical self-efficacy and mathematical teaching self-efficacy constructs specifically identified in the current study.

The subconstructs for mathematical self-efficacy were found to be *mathematics self-efficacy: problems*, with a reported Cronbach's alpha coefficient of internal reliability of 0.90, and *mathematics self-efficacy: tasks*, with a reported reliability of 0.862. The subconstructs for mathematical teaching self-efficacy were found to be *mathematics teaching self-efficacy: efficacy*, with a reported reliability of 0.855, and *mathematics teaching self-efficacy: content*, with a reported reliability of 0.880. The instrument also includes a fifth component of *conceptually or procedurally oriented teaching methods*; however, for the purposes of this study, it will not be included because it is irrelevant to the study's intent. The overall MTMSE instrument has a Cronbach's alpha coefficient of internal reliability of .942, but because the full instrument will not be used, the individual subconstruct reliability scores are emphasized.

The MTMSE instrument has 56 questions presented with a Likert-type scale that includes the range of one to six for the four separate sections of the instrument. The section of the instrument that assesses teachers' mathematical self-efficacy (section one)

requires teachers to read through mathematics questions presented in a multiple-choice format. The Likert-type scale for this section of the instrument is one (*not confident at all*) to six (*completely confident*). The teachers are required to determine how confident they feel about answering the questions without a calculator. The summation of the scores determines teachers' mathematical self-efficacy, with the higher scores representing teachers with high mathematical self-efficacy regarding solving mathematics problems and the lower scores representing teachers with a low mathematical self-efficacy regarding solving mathematics problems.

The second (section two) of the MTMSE instrument that measures teachers' mathematical teaching self-efficacy requires teachers to determine their agreement with statements presented about mathematics teaching. Teachers respond on a Likert-type scale of one (*strongly disagree*) to six (*strongly agree*). The summation of the scores determines teachers' mathematical teaching self-efficacy, with the higher scores representing teachers with high mathematical teaching self-efficacy and the lower scores representing teachers with low mathematical teaching self-efficacy.

The section (section three) of the MTMSE instrument that measures teachers' mathematical self-efficacy requires teachers to determine their confidence with completing mathematical tasks presented in daily life experiences. Teachers respond on a Likert-type scale of one (*not confident at all*) to six (*completely confident*). The summation of the scores determines teachers' mathematical self-efficacy regarding mathematics content, with the higher scores representing teachers with high mathematical self-efficacy regarding mathematics content and the lower scores representing teachers with low mathematical self-efficacy regarding mathematics content.

The section (section four) of the MTMSE instrument that measures teachers' mathematical teaching self-efficacy requires teachers to identify confidence in content strands of mathematics. Teachers respond on a Likert-type scale of one (*not confident at all*) to six (*completely confident*). The summation of the scores determines teachers' mathematical teaching self-efficacy regarding their confidence in teaching the content strands of mathematics, with the higher scores representing teachers with high mathematical teaching self-efficacy regarding their confidence in teaching the content strands of mathematics and the lower scores representing teachers with low mathematical teaching self-efficacy regarding their confidence in teaching the content strands of mathematics.

Measure of Instructional Practices

The Patterns of Adaptive Learning Scale (PALS) (Midgley et al., 2000) was created to identify two types of instructional practices demonstrated by elementary school teachers, performance instruction and mastery instruction. The instrument consists of different surveys for students and one survey for teachers. As identified by the researchers, the different PALS scales can be used together or individually. For the purposes of this study, the teacher scale will be used separately, and it will be the only scale discussed.

Patterns of Adaptive Learning Scales. The PALS instrument is broken down into five different subscales, each of which measure a different component of teachers' instructional practices according to if they provide performance-driven instruction or mastery-driven instruction. The instrument includes 29 Likert-type statements that range from one (*strongly disagree*) to five (*strongly agree*) with the summation of each

subscale representing the individual measure of that section. The first subscale measured is *Perceptions of the School Goal Structure for Students: Mastery Goal Structure for Students* with a reported alpha of 0.81. This subscale indicates the teachers' perceptions that the encompassing school communicates to the students that the purpose of engaging in academic work is to develop competence of skills. For example, "Students are told that making mistakes is OK as long as they are learning and improving," and "The emphasis is on really understanding schoolwork, not just memorizing it" (Midgley et al., 2000, p. 33). A high score on this section of the PALS instrument indicates that the teacher has a high sense of mastery goal structure for students and is a mastery-driven teacher with her instruction.

The second subscale measured is *Perceptions of the School Goal Structure for Students: Performance Goal Structure for Students* with a reported alpha of 0.70. This subscale indicates the teachers' perception that the encompassing school conveys to the students that the purpose of engaging in academic work is to demonstrate understanding of required skills through performance on tests; for example, "Students hear a lot about the importance of getting high test scores," and "Students are encouraged to compete with each other academically" (Midgley et al., 2000, p. 34). A high score on this section of the instrument indicates that the teacher has a high sense of performance goal structure for students and is a performance-driven teacher with her instruction.

The third subscale measured is *Approaches to Instruction: Mastery Approaches* with a reported alpha of 0.69; although the reported alpha did not reach the desired 0.70 alpha level, it was deemed acceptable for the purposes of this study. This subscale indicates the teaching strategies used that convey to students that the purpose of engaging

in academic work is to develop skill competence. For example, “During class, I often provide several different activities so that students can choose among them,” and “I give a wide range of assignments, matched to students’ needs and skill level” (Midgley et al., 2000, p. 35). A high score on this section of the instrument indicates the teacher uses mastery-driven instructional practices in her mathematical lessons.

The fourth subscale measured is *Approaches to Instruction: Performance Approaches* with a reported alpha of 0.69; although the reported alpha did not reach the desired 0.70 alpha level, it was also deemed acceptable for the purposes of this study. This subscale indicates teachers’ strategies that communicate to students the purpose of engaging and being involved in academic school work is to demonstrate competence of required skills on assessment and in contexts of comparison. For example, “I help students understand how their performance compares to others,” and “I encourage students to compete with each other” (Midgley et al., 2000, p. 36). A high score on this section of the instrument indicates the teacher uses performance-driven instructional practices in her mathematical lessons.

The fifth subscale measure is *Personal Teaching Efficacy* with a reported alpha of 0.74. Although the subscale will be included in assessment of teachers, the findings of the subscale will not be reported in this study. Rather, the Mathematical Teaching and Mathematical Self-Efficacy (MTMSE) survey will be used for the purposes of reporting the mathematical self-efficacies. The scores on this section of the PALS instrument will not be analyzed.

Procedures

The instruments for this study were distributed to teachers in May of 2010. Permission was obtained from the Institutional Review Board (Appendix D) at The University of Southern Mississippi and permission from each researcher (who holds legal and copyright laws of the instruments) was obtained in writing via e-mail correspondence and in letter form (Appendix E). Permission from superintendents of the participating school districts where instruments were distributed was granted in writing, and the researcher was allowed to distribute the research instruments to district office representatives and principals of each school within the participating school district. The researcher hand-delivered the instruments to the district offices and schools the week after the state assessment, which was the third week of May of the 2009-2010 school year. The district office representatives and school principals distributed the instruments to all teachers in the school that held grades K-6 licensure during staff development times. The instruments were placed by each participating teacher to the return box strategically placed in a central location by the district office representative or school principal. The instruments took approximately twenty-five to thirty minutes to complete. If unforeseen circumstances did not allow teachers to complete the instrument during the staff development time or if a teacher was absent, the principal placed the instruments in the absent teachers' school mailboxes for them to complete and return to the sealed return box located in the space designated by the district office representative or school principal. The researcher arranged a date within two weeks after the third week of May with the district office representatives and school principals for collecting the completed instruments.

Data Analysis

As stated earlier, a multiple linear regression procedure was used to test the hypothesis of the research study, and a significance level of 0.05 was used (Creswell, 2008). Data were entered into Microsoft Excel and then exported to SPSS, Version 17 for analysis to determine if there was a statistically significant relationship among any of the constructs.

Components of Instruments

Mathematics anxiety was measured using the Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003) including its two subscales, Learning Math Anxiety (LMA) and Math Evaluation Anxiety (MEA). Mathematical Self-Efficacy was measured using the Mathematical Teaching and Mathematical Self-Efficacy scales (MTMSE; Kahle, 2008) and was broken into two subscales, Mathematics Self-Efficacy (Problems) and Mathematics Self-Efficacy (Tasks), as was Mathematical Teaching Self-Efficacy, measured as Mathematics Teaching Self-Efficacy (Efficacy) and Mathematics Teaching Self-Efficacy (Content). All measures of mathematical self-efficacy and mathematical teaching self-efficacy were assessed by the Mathematics Teaching and Mathematics Self-Efficacy scale (MTMSE; Kahle, 2008). Multiple linear regression analysis was conducted to determine if the measures of the identified subscales had a significant relationship with the subscales of the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) to determine teachers' instructional practices. The subscales of the PALS instrument were identified as (1) Mastery Goal Structure for Students; (2) Performance Goal Structure for Students; (3) Mastery Approaches; (4) Performance Approaches; and (5) Personal Teaching Efficacy. The subscale Personal Teaching

Efficacy was assessed but not used in the analysis of this study because the efficacy construct was specifically measured by the MTMSE (Kahle, 2008) for the purposes of this research. Information regarding teacher characteristics was also collected through a demographic survey. This information included, but was not limited to, years of experience, number of mathematics courses taken at the college level, subject most confident to teach, and least confident strand of mathematics to teach. Although the data in the demographic survey were not used in the multiple regression linear analysis, the information collected was informative of the represented sample. Additionally, it provided pertinent information in the underlying results in regard to the data analysis.

Summary

The 21 schools housed participating elementary school teachers from the five school districts geographically dispersed throughout a southeastern state were the representative sample in the research study. Data from these participants were analyzed to explore the relationship among mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy and the instructional practices of participating elementary school teachers. After the return and collection of surveys, and following the guidelines and procedures established by the researcher and school districts and school principals, data was entered into Microsoft Excel and then exported to the SPSS statistical program for further analysis using a multiple linear regression. Through the regression analysis, the relationship, if any, among the identified constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy and instructional practices of elementary school teachers was identified. The following chapter presents the findings resulting from data analysis.

CHAPTER IV

RESULTS

The purpose of this quantitative, correlational study was to determine if a relationship existed among mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers. The research questions and hypotheses explored in the study were designed to help identify the specific relationships, if any, that existed among the named constructs to determine their influences on teachers' classroom instructional practices. Although research about mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy have all been explored as separate factors in their relationships to teachers' instructional practices in mathematics (Beilock et al., 2010; Jackson & Leffingwell, 1999; Mujis & Reynolds, 2002), the lack of studies incorporating all of the components established the basis for the study.

Organization of Data Analysis

The data presented in this chapter describe the relationships found among mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers participating in the study. In addition to collecting data describing the participants and their practices, the research design included a multiple linear regression analysis, showing the relationships found among constructs studied. Demographic characteristics of participants are provided via frequency tables showing the type of schools in which participants taught, as well as their gender, highest degree earned, college major, hours of college mathematics completed, years of teaching experience, and licensed areas (including highly qualified subject

areas). Following the demographic information, charts showing the means and standard deviations of scores from each instrument and subscale are presented along with relevant research question. The chapter continues with the results of the statistical analysis of the study's research questions and hypotheses regarding teachers' mathematical self-efficacies, anxieties, and instructional practices are presented, and the relationships found between the constructs are explained through the interpretations and analyses of the findings.

Research Questions and Associated Hypotheses

The research questions and hypotheses for this study are restated below. The results and analyses from testing these questions and hypotheses are discussed and presented in the next section. The research questions addressed in the study are:

1. What are the mathematics anxieties, mathematical self-efficacies, mathematical teaching self-efficacies, and instructional practices of certified elementary teachers?
2. For certified elementary school teachers (K-6), do mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy have an effect on their instructional practices in mathematics?

Hypotheses

This study evaluated the following null hypotheses:

H₁: There is no significant relationship between the dependent variable of elementary school teachers' mastery goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H2: There is no significant relationship between the dependent variable of elementary school teachers' performance goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H3: There is no significant relationship between the dependent variable of elementary school teachers' mastery approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

H4: There is no significant relationship between the dependent variable of elementary school teachers' performance approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy.

Analysis of Data

The following section provides in-depth information regarding analysis of data for this study. The section begins with reliability verification analysis which was conducted for each instrument prior to analysis of the hypotheses. Descriptive statistics are next provided for participant demographics, followed by statistical results related to testing each hypothesis.

Verification of Instrument Reliability

Prior to data analysis, reliability was tested to verify the strength of the instruments for the particular population studied in order to ensure that the instruments had adequate reliability as established in the original studies. The reliability of each instrument in the current study is found in Table 1 along with the original reliability

scores of each instrument. According to Garson (2009b), the Cronbach's alpha for social science research should be .70 or higher for a set of items to be considered reliable.

When an alpha level of .70 is set, the standard error of measurement will be over half (0.55) a standard deviation (Garson, 2009b). Because reliability is similar to percentage agreement with a desired 70% required agreement, the .70 alpha level is necessary to justify the reliability of the scale (Garson, 2009b).

While alpha levels in general for the population studied were lower than reported for the original instrument, all but two of the subscales were found to be reliable with an alpha value greater than .70. Reliability was confirmed for all subscales of the Abbreviated Mathematics Anxiety Scale (AMAS), the Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) scale, and the two subscales of Mastery Goal Structure for Students. The Performance Approaches subscale of the Patterns of Adaptive Learning Scales (PALS) was also confirmed, however, the remaining two subscales were found to fall below the .70 alpha level. The Performance Goals subscale had an alpha of only .62 (as compared to a .69 level reported by Midgley et al., 2000); and the Mastery Approaches subscale had an alpha of .541 (as opposed to a .69 level reported by Midgley et al., 2000). The two low reliability ratings were taken into account during the analysis of the data for the current research. Since these two subscales are below acceptable standards, additional care should be given when making conclusions using these subscale scores.

Table 1
Reliability Scores of the AMAS, MTMSE, and PALS

Instrument	Original α	Study α
Abbreviated Mathematics Anxiety Scale (AMAS)		
Learning Math Anxiety	.85	.83
Math Evaluation Anxiety	.88	.82
Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) survey		
Mathematics Self- Efficacy: Problems	.90	.94
Mathematics Self-Efficacy: Tasks	.86	.89
Mathematics Teaching Self-Efficacy: Efficacy	.86	.86
Mathematics Teaching Self-Efficacy: Content	.88	.93
Patterns of Adaptive Learning Survey (PALS)		
Mastery Goal Structure for Students	.81	.81
Performance Goal Structure for Students	.70	.62
Mastery Approaches	.69	.54
Performance Approaches	.69	.70

Demographic Characteristics of Respondents and Schools

Participants in the study were 320 K-6 teachers from 21 elementary schools (five districts) in one southeastern state. Surveys were hand delivered to representatives in the district offices of three of the school districts, and to school principals at each school in the remaining two districts. Either a district office representative or a school principal

distributed the surveys to participating K-6 elementary school teachers. Of the 403 surveys distributed, 320 usable surveys were returned (82%). Eleven returned surveys were discarded because of incomplete data on various parts of the instrument.

Demographic information was collected on teachers' educational and professional preparation prior to teaching. Additionally, data provided show a total of 91.9% of respondents from rural or suburban schools, which is consistent with the overall demographic makeup of the state. The majority of participants in the study were females reporting teaching as their first career. Most respondents reported their highest degree as a bachelor's degree (N=204), and nearly one-third (N=105) held master's degrees. Only 11 of the practicing classroom teachers held degrees higher than a master's degree. The frequencies and percentages of subjects by type of school, first career, gender, and highest earned degree are presented in Table 2.

Table 2
Frequencies and Percentages of Subjects by Type of School, First Career, Gender, and Highest Earned Degree

Variable	n	%
Type of School		
Urban	26	8.1
Suburban	116	36.3
Rural	178	55.6
Gender		
Male	11	3.4

Table 2 (continued)

Variable	n	%
Female	309	96.6
Highest Degree		
Bachelor's	204	63.8
Master's	105	32.8
Specialist	10	3.1
Doctoral	1	.3

The percentage of teachers who majored in elementary education was considerably larger than those that majored in other areas. There was a balanced representation of teachers who took a variety of hours in college mathematics in the sample. The percentages ranged from 6.3% to 27.4% with .6% being unaccounted for due to missing responses. The number of mathematics courses taken by teachers ranged from two – five (six to 15 credit hours). The frequencies and percentages of subjects by college major and hours of college mathematics courses completed in college are in

Table 3

*Frequencies and Percentages of Subjects by College Major and Hours of College**Mathematics*

Variable	n	%
College Major		
Elementary Education	280	87.5
Other	40	12.5
Hours of College Math		
0-3	20	6.3
4-6	35	10.9
7-9	61	19.1
10-12	87	27.2
13-15	52	16.3
16-18	25	7.8
18 +	38	11.9
No Response	2	.6

The remaining demographic information includes teachers' number of years teaching, licensed areas for teaching, and areas of highly qualified certification. Teachers who taught three to ten years represented 48.5% of the population sample, making it recognizable that almost half of the sampled teachers were in the early or preliminary phases of their teaching careers; however, the teachers had some teaching experience.

Information regarding number of years teaching is in Table 4. The majority of the sample indicated they held K-8 teaching licenses, with a very small percent holding a license to only teach in elementary grades 4-8 and grades 7-12. Percentages of teachers highly qualified in specific content areas were not evenly distributed, ranging from 1.3% to 47.8%, with 47.8% representing teachers who had no highly endorsed content areas beyond elementary education. Consequently, the content areas most represented by teachers who were highly qualified in content were 7-12 English and 7-12 Mathematics, respectively. The remaining percentages, 1.3% to 5.3%, reported themselves to be highly qualified in other content areas, and it represented a more balanced distribution. The results regarding licensed areas and highly qualified areas are presented in Table 5.

Table 4
Frequencies and Percentages of Subjects by Years Teaching

Variable	n	%
Years Teaching		
0-2	44	13.8
3-5	62	19.4
6-10	93	29.1
11-15	44	13.8
16-20	39	12.2
21-30	25	7.8
30+	12	3.8
No Response	1	.3

Table 5
Frequencies and Percentages of Subjects by Licensed Areas and Highly Qualified

Variable	n	%
Licensed Areas		
Pre-Kindergarten	5	1.6
K-4	43	13.4
4-8	21	6.6
K-8	250	78.1
7-12	1	.3
Highly Qualified		
7-12 Mathematics	38	11.9
7-12 English	57	17.8
7-12 Social Studies	17	5.3
7-12 Science	14	4.4
7-8 Endorsed Math	15	4.7
7-8 Endorsed English	15	4.7
7-8 Endorsed Social Studies	7	2.2
7-8 Endorsed Science	4	1.3
None	153	47.8

Mathematics Anxiety, Efficacy and Instructional Practices. Before conducting statistical procedures to determine relationships among the variables included in the study, simple reporting and examination of the constructs of mathematics anxieties,

mathematical self-efficacies, mathematical teaching self-efficacies, and instructional practices of certified elementary teachers were included in the study. Overall, participants reported higher math evaluation anxiety ($M = 3.32$; $SD = 1.02$) than learning math anxiety ($M = 2.23$; $SD = .89$); however, both scores remained on the lower end of the five point scale used showing that mathematics anxiety among the participating elementary teachers was not high. Statistics were generated to describe personal mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices of the participants are provided in the following sections.

Mathematics anxiety. The Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003) was used to measure this construct using a 5-point Likert-type scale with response options ranging from 1-5, with one representing *low anxiety*, three representing *neutral anxiety*, and five representing *high anxiety*. Analysis showed that teachers had a lower to neutral sense of mathematics anxiety, a high sense of mathematical self efficacy, and a high sense of mathematical teaching self-efficacy with each scale measured as individual subscales for means and standard deviations (see Table 6). Further analysis also indicated that teachers believed more strongly that their instructional practices aligned to mastery approaches to instruction ($M = 3.91$; $SD = .66$) rather than performance-based instruction ($M = 3.08$; $SD = .77$). Table 6 provides the mean and standard deviation for all scales and subscales measuring mathematics anxiety.

There are four items on the AMAS that measure math evaluation anxiety (items two, four, five, and eight) using the Likert-type scale described above. Since math evaluation anxiety was found to have a higher mean than learning math anxiety, data for the four items within the evaluation anxiety subscale are provided to give more

information on which statements prompted the highest sense of anxiety among the participating teachers. The highest mean found, 3.77, was in response to a question that questioned teachers about being given a pop-quiz in mathematics. The standard deviation was 1.196. The lowest mean, 2.73, references a question that required teachers to identify how they would feel about thinking about a mathematics test a day before the test is scheduled. The standard deviation was .89. Table 6 provides the mean and standard deviation scores that align with learning math anxiety and math evaluation anxiety scale of the Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003) as well as specific information on certain items that aligned directly to math evaluation anxiety. The specific items for math evaluation anxiety were included because of the difference found between the two subscales that showed teachers had a higher sense of anxiety regarding assessments rather than learning mathematics, indicating that testing in itself could cause more anxiety than the subject of mathematics.

Table 6
Descriptive Statistics for K-6 Teacher Sample on AMAS (N = 320)

	Mean	SD
Learning Math Anxiety	2.23	.89
Math Evaluation Anxiety	3.32	1.02
8. Being given a “pop” quiz in class.	3.77	1.20
5. Being given a homework assignment of many difficult problems that is due the next class meeting.	3.46	1.30
4. Taking an examination in a math course.	3.31	1.27

Table 6 (continued).

	Mean	SD
2. Thinking about an upcoming math test 1 day before.	2.73	1.28

Scale 1 = low, 5=high

Mathematics Self-Efficacy and Mathematics Teaching Self-Efficacy. Teachers' responses regarding mathematical self-efficacy and mathematical teaching self-efficacy on the Mathematics Teaching and Mathematics Self-Efficacy scale (MTMSE; Kahle, 2008) are reported in Table 7. Teachers reported relatively high levels of efficacy in both areas measured, with mathematical teaching self-efficacy (content) reflecting the highest mean score. In Table 7, based upon teachers' reports on personal mathematical self-efficacy and mathematical teaching self-efficacy, the mean and standard deviation are listed in four subscales: mathematical self-efficacy (problems), mathematical teaching self-efficacy (efficacy), mathematical self-efficacy (tasks), and mathematical teaching self-efficacy (content). The results suggest teachers in this sample have a high sense of mathematical self-efficacy and mathematical teaching self-efficacy with means ranging from 4.47 to 5.05 on a six point scale, and standard deviations ranging from 1.04 to .82.

Table 7

Descriptive Statistics for K-6 Teacher Sample on MTMSE (N = 320)

	Mean	SD
Math Self-Efficacy/ Problems	4.47	1.04
Math Teaching Self-Efficacy/Efficacy	4.90	.81
Math Self-Efficacy/Tasks	5.01	.78

Table 7 (continued).

	Mean	SD
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Math Teaching Self-Efficacy/Content	5.05	.82
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Scale 1=low, 6=high

Instructional practices. When responding to items on the Patterns of Adaptive Learning Surveys (PALS; Midgley et al., 2000), teachers reported instructional practices more in alignment with mastery goals for students and mastery approaches in regard to their instructional practices. As previously mentioned, it is important to note that the subscales of performance goals for students and mastery approaches were not found to have high reliability among the sample in this study and therefore must be viewed with caution. Table 8 shows data on reported instructional practices as measured by the PALS, including the mean and standard deviation on four subscales: mastery goals, performance goals, mastery approaches, and performance approaches. The fifth subscale of the original instrument was eliminated in the data report because its findings were not used for the purposes of this study. The means ranged from 2.83 to 3.99 on the five point scale suggesting teachers felt their instructional practices were reflective of mastery approaches to instruction rather than performance approaches to instruction, and the standard deviations ranged from .77 to .68.

Table 8

Descriptive Statistics for K-6 Teacher Sample on PALS (N = 320)

	Mean	SD
Mastery Goals	3.99	.68
Performance Goals	3.32	.67
Mastery Approaches	3.82	.66
Performance Approaches	2.83	.77

Scale 1= low, 5=high

Impact of Mathematics Anxiety, Mathematical Self-Efficacy, and Mathematical Teaching Self Efficacy on Instructional Practices

After determining the mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices of participating teachers, analyses of these data were conducted. More specifically, a multiple linear regression was conducted to determine if there were correlations among the constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers. Statistically significant relationships were found and are presented in the following sections.

A multiple linear regression analysis was conducted to determine if there was a significant relationship between the dependent variable of elementary school teachers' mastery goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy, as indicated in Hypothesis 1 (Table 9). The null hypothesis, which stated no significant relationship would be found, was rejected. A significant relationship was found between teachers' mathematical teaching self-efficacy (efficacy) and mastery goal

structure for students in reference to instructional practices. For every one unit increase in teachers' mathematical teaching self-efficacy (efficacy), there was a .125 increase in their mastery goal structure for students, controlling for all other independent variables. For every one standard deviation increase in teachers' mathematical teaching self-efficacy (efficacy), there was a .149 increase in mastery goal structure for students, controlling for all other independent variables in the model. The predicted value was found to be 2.821 when all independent variables in the model were understood to have a value of zero.

The predictor variable for mastery goal structure for students was found to be significant, $F(6, 313) = 2.28$, $p = .036$, $R^2 = .042$, with the independent variable of mathematical teaching self-efficacy (efficacy), being statistically significant. However, the remaining subscales of the independent variables regarding mathematics anxiety, mathematics self-efficacy, and mathematical teaching self-efficacy were not found to be statistically significant. Because the mastery goal structure for students was found to be significant in relation to teacher' mathematical teaching self-efficacy (efficacy), Hypothesis 1 was rejected, which indicates teachers' mathematical teaching self-efficacy (efficacy) was related to their mastery goal structure for students as it is associated with instructional practices.

Table 9
Coefficients for Independent Variables Regarding Mastery Goal Structure for Students

	B	β	<i>p</i>
Constant	2.821		
Learning Math Anxiety	.028	.037	.630
Math Evaluation Anxiety	.027	.040	.598
Math Self-Efficacy/ Problems	.032	.048	.551
Math Self-Efficacy/ Efficacy	.125	.149	.026*
Math Self-Efficacy/ Tasks	-.044	-.050	.523
Math Self-Efficacy/ Content	.097	.116	.147

Note N = 320. **p* < .05.

A multiple linear regression analysis was also conducted to determine if there was a significant relationship between the dependent variable of elementary school teachers' performance goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy as stated in Hypothesis 2 (Table 10). With the findings, the null hypothesis was rejected. A significant relationship was found with two of the subscales, mathematical teaching self-efficacy (efficacy) and mathematical teaching self-efficacy (content), in relation to the performance goal structure for students of instructional practices. In reference to mathematical teaching self-efficacy (efficacy), every one unit increase in mathematical teaching self-efficacy (efficacy) resulted in a .176 decrease in performance goal structure for students in regard to instructional practices, controlling for all other independent variables in the model. A one standard

deviation increase in mathematical teaching self-efficacy (efficacy) resulted in a .215 standard deviation decrease in performance goal structure for students in regard to instructional practices, controlling for all other variables. Mathematical teaching self-efficacy (content) indicated that every for every one unit increase, there was a .254 increase in performance goal structure for students. A one standard deviation increase in mathematical teaching self-efficacy (content) resulted in a .313 standard deviation increase, controlling for all other independent variables in the model. The predicted value was found to be 3.311 when all independent variables in the model had a value of zero.

The predictor variable for performance goal structure for students was found to be significant, $F(6, 313) = 4.54$, $p < .001$, $R^2 = .08$, with the independent variables of mathematical teaching self-efficacy (efficacy) and mathematical teaching self-efficacy (content), being statistically significant. However, the remaining subscales of the independent variables regarding mathematics anxiety, mathematics self-efficacy, and mathematical teaching self-efficacy were again found to have no statistical significance. Although the subscale of mathematical teaching self-efficacy (efficacy) and mathematical teaching self-efficacy (content) were found to be significant, the low reliability of the subscale ($\alpha = .62$) leaves room for speculation regarding the findings. However, because the performance goal structure for students was found to have significance with the two noted subscales, Hypothesis 2 was rejected.

Table 10

Coefficients for Independent Variables Regarding Performance Goal Structure for Students

	B	β	<i>p</i>
Constant	3.311		
Learning Math Anxiety	-.048	-.064	.398
Math Evaluation Anxiety	-.028	-.043	.560
Math Self-Efficacy/ Problems	-.044	-.069	.387
Math Self-Efficacy/ Efficacy	-.176	-.215	.001*
Math Self-Efficacy/ Tasks	-.002	-.003	.971
Math Self-Efficacy/ Content	.254	.313	<.001

Note N = 320. **p* < .05.

A multiple regression analysis was conducted to determine if there was a significant relationship between the dependent variable of elementary school teachers' mastery approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy as stated in Hypothesis 3 (Table 11). The predictor variable for mastery approaches was not found to be significant, $F(6, 313) = 1.038$, $p = .401$, $R^2 = .02$. None of the independent variables were found to have a statistically significant relationship with mastery approaches to instruction. In reference to the subscale of mastery approaches, it was not found to have high reliability within the study's sample ($\alpha = .541$); however, the findings did reflect that there is no significant relationship among or between the

variables. Because there was no significant relationship found, the researcher failed to reject Hypothesis 3.

Table 11

Coefficients for Independent Variables Regarding Mastery Approaches

	B	β	<i>p</i>
Constant	2.988		
Learning Math Anxiety	.037	.050	.516
Math Evaluation Anxiety	.051	.079	.301
Math Self-Efficacy/ Problems	-.036	-.057	.487
Math Self-Efficacy/ Efficacy	.009	.012	.863
Math Self-Efficacy/ Tasks	.047	.056	.481
Math Self-Efficacy/ Content	.092	.115	.157

Note N = 320. **p* < .05.

A multiple regression analysis was conducted to determine if there was a significant relationship between the dependent variable of elementary school teachers' performance approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy as stated in Hypothesis 4 (Table 12). This also provides information that helps address Research Question 2. According to the findings, the null hypothesis that stated no significant relationships would be found was rejected. Additional significant relationships were found between the subscales of mathematical teaching self-efficacy (efficacy), mathematical teaching self-efficacy (content), and performance approaches in regard to instructional practices. A one unit increase in mathematical teaching self-

efficacy (efficacy) resulted in a .15 decrease in performance approaches to instruction, controlling for all other variables. A one standard deviation increase in mathematical teaching self-efficacy (efficacy) resulted in a .158 standard deviation decrease in performance approaches to instruction, controlling for all other variables in the model. A one unit increase in mathematical teaching self-efficacy (content) resulted in a .213 increase in performance approaches to instruction, controlling for all other variables. A one standard deviation increase in mathematical teaching self-efficacy (content) resulted in a .226 standard deviation increase in performance approaches to instruction, when controlling for all other independent variables in the model.

The predictor variable for performance approaches was found to be significant, $F(6, 313) = 2.70$, $p = .014$, $R^2 = .049$, with the independent variables of mathematical teaching self-efficacy (efficacy) and mathematical teaching self-efficacy(content), being statistically significant. However, the remaining subscales of the independent variables regarding mathematics anxiety, mathematics self-efficacy, and mathematical teaching self-efficacy were again found to have no statistical significance. Because there was a significant relationship found with two of the independent variables, Hypothesis 4 was rejected.

Table 12
Coefficients for Independent Variables Regarding Performance Approaches

	B	β	p
Constant	3.563		
Learning Math Anxiety	.007	.008	.915
Math Evaluation Anxiety	-.026	-.034	.651

Table 12 (continued).

	B	β	<i>p</i>
Math Self-Efficacy/ Problems	-.058	-.077	.337
Math Self-Efficacy/ Efficacy	-.150	-.158	.018*
Math Self-Efficacy/ Tasks	-.148	-.149	.057
Math Self-Efficacy/ Content	.213	.226	.005*

Note N = 320. **p* < .05.

Summary

The evaluation of the relationships between mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers was completed through a multiple linear regression analysis. A total of 320 teachers from 21 schools in five districts in a southeastern state participated in the study. The results of the multiple linear regression indicated a relationship between elementary school teachers' mathematical teaching self-efficacy (efficacy) and mastery goal structure for students that supported the rejection of Hypothesis 1. The findings also found a statistically significant relationship between mathematical teaching self-efficacy (efficacy) and performance goal structure for students, as well as mathematical teaching self-efficacy (content) with performance goal structure for students. Although the findings were noted as significant, the reliability of the subscale performance goal structure for students was found to be deficient ($\alpha = .62$). Hypothesis 2 was also rejected. The final statistically significant relationships were found to be between mathematical teaching self –efficacy (efficacy) and performance approaches to instruction; additionally, mathematical teaching self-efficacy (content)

with performance approaches to instruction was also found to be significant which allowed for the rejection of Hypothesis 4. Hypothesis 3 was the only identified hypothesis in the study that failed to be rejected, and the measured subscale of the mastery approaches for this hypothesis was deemed unreliable ($\alpha = .541$). Chapter V will provide a summary of the study, give further insight into the findings, offer conclusions, and give implications regarding the research study. It will also provide ideas and suggestions for future research.

CHAPTER V

SUMMARY

Mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers are all topics that have been explored as individual constructs in the professional research literature (Ashcraft & Kirk, 2001; Beilock et al., 2010; Furner & Duffy, 2002; Hackett & Betz, 1989; Hembree, 1990; Jackson & Leffingwell, 1999; Manigault, 1997; Pajares & Miller, 1995). Previous findings supported that teachers' mathematics anxiety influences an increase in mathematics anxiety (possibly through instruction) among young, female students (Beilock et al., 2010), and that teachers who maintain a higher level of mathematics anxiety are found to spend less time planning and implementing mathematics-related activities which negatively influences mathematics instruction (Swetman et al., 1993).

Research indicated that a relationship exists between preservice teachers' level of mathematics anxiety and level of self-efficacy; however, the authors called for more research regarding the aligned constructs in regard to instructional practices (Swars et al., 2006). It was also found that teachers with a high sense of efficacy demonstrate stronger instructional practices (Mujis & Reynolds, 2002); however, teachers' instructional practices do not always align to their stated pedagogical beliefs because of external requirements such as time, required curriculums, and mandated assessments (Geist, 2001; Shaw, 1990). Because of the varied information found among the separate studies addressing the isolated constructs, the intention of this study was to determine the interrelatedness of all of the components to affirm or counter the previous research.

Summary of the Study

A thorough review of the literature revealed no study that addressed the constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers collectively. The purpose of this study was designed to determine the relationships among all of the constructs, and to establish if mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy influence teachers' instructional practices in mathematics. The study included 320 participants that taught from kindergarten through sixth grade within five school districts in a southeastern state. Data were collected for the study using three instruments: The Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003), the Mathematics Teaching and Mathematics Self-Efficacy scale (MTMSE; Kahle, 2008), and the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). The subscales from each instrument were individually assessed and analyzed so that specific components of each construct could be intently identified.

Findings

The findings that address the two research questions and the four hypotheses were presented in detail in Chapter IV and are summarized in this section. When the data were analyzed, trends among the data were found, with mathematical teaching self-efficacy (efficacy) having a significant relationship with three of the four PALS subscales, and mathematical teaching self-efficacy (content) having a significant relationship with two of the four subscales. Of the participating teachers, mathematics anxiety and mathematical self-efficacy were not found to have any relationships with teachers' instructional practices. Teachers' mathematical teaching-self efficacy, both mathematical

teaching self-efficacy (efficacy) and mathematical teaching self-efficacy (content) were found to have significant relationships with teachers' instructional practices, for both mastery and performance.

Conflicting results were found when analyzing the data. The conflict was found between the two subscales of the mathematical teaching self-efficacy scale and the two subscales of teachers' instructional practices. Teachers reported a high sense of general mathematical teaching self-efficacy (efficacy), which was said to increase their mastery goal structure for students. This was supported by their report that claimed an increase in the same self-efficacy caused a decrease in their performance goal structure for students. However, when teachers reported their mathematical teaching self-efficacy (content), its relationship to instructional practices was different and inconsistent with the previous findings. An increase in mathematical teaching self-efficacy (content) conveyed there was an increase in both performance goal structure for students and performance approaches to instruction, which contradicted the report on the teachers' general teaching self-efficacy. The two types of instructional practices are oppositional, not collaborative. Further analyses and interpretations of these findings are included in the following sections.

Discussion

The purpose of the current study was to explore relationships between the constructs of mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers. In doing so a collection of the Abbreviated Mathematics Anxiety Scale (AMAS), Mathematics Teaching and Mathematics Self-Efficacy (MTMSE) survey, and the Patterns of Adaptive

Learning Scale (PALS), were distributed to K-8 certified teachers who taught mathematics. Three hundred twenty (320) practicing elementary teachers participated in the completion of the surveys. This chapter summarizes the study, its findings, conclusions regarding the findings, implications for practice, and recommendations for further research.

Descriptive Information of Participating Teachers

The teachers who participated in the study had consistent demographic information that was expected for the population of elementary school teachers. The large majority (87.5%) of the teachers majored in elementary education for their primary degree, and there was a fairly high percentage (47.8%) of the teachers who held no highly qualified endorsements outside the area of elementary education. This was the expected finding for the research study because elementary education teachers are generally not required to be concentrated in a content area or content areas; rather, they are focused on the specialization of teaching at the elementary level where classes are often self-contained. It was not expected that a majority of the teachers would be highly qualified in the content area of mathematics, and the anticipation was accurate with only 11.9% certified to teach 7-12 mathematics and 4.7% endorsed to teach it in seventh and eighth grades. The significance of this finding supported the expected results because previous research indicated that mathematics was generally not the primary focus of individuals pursuing degrees in elementary education (Ashcraft & Kirk, 2001; Hembree, 1990; Ma, 1999b).

The sampled group represented the generalized dynamic of the southeastern state's teacher population that occupies the majority of elementary classrooms. The

findings reflected that the largest percentage (48.5%) of teachers were in the initial or early stages of their teaching careers, which represented three to ten years of teaching experience. This was not the anticipated finding of the study because of the assumption that a more balanced distribution of experience was going to be represented. However, it does support the anticipated finding that beginning teachers or teachers newly graduated from their educational programs initially espouse a student-centered approach to instruction; however, after time and mandated responsibilities are incorporated into their daily routines, their instructional practices are contradictory to their stated beliefs about their instructional styles (Levitt, 2001; Raymond, 1997; Schraw & Olafson, 2002).

The remaining descriptive information that reflects the sampled population was aligned to the expected findings of the study. The high percentage of female teachers (96.9%) and the uneven distribution among the number of hours of college mathematics teachers completed in college was anticipated because of the traditional dynamic of the elementary classroom and because of the range of teachers included in the study. Because seventh and eighth grade teachers were included, it was expected that they would have a higher number of mathematics courses because of the content preparation required for their endorsed areas of instruction (Mississippi Department of Education, n.d.). However, because the study focused on elementary teachers, it was not anticipated that many of the teachers would have an exhaustive number of mathematics courses because the majority of colleges and universities in the United States required very little mathematics for students majoring in elementary education (Malzahn, 2002). The study supported the variation of teachers' requirements through the distribution of results represented in the data. The remaining information found to be interesting among the

descriptives data was identified in the teachers' self-reports regarding their mathematics anxiety, their mathematical self-efficacies, and their instructional practices. The specifics of these findings are discussed in the section that follows.

Anxieties, Mathematical Self-Efficacies, and Instructional Practices of Teachers

When exploring the mathematics anxieties, mathematical self-efficacies, mathematical teaching self-efficacies, and instructional practices of certified elementary teachers, mathematics anxiety was not found to have a significant relationship with elementary teachers' instructional practices. This is contradictory to preliminary research that stated mathematics anxiety influences teachers' instructional practices, on some level, to have an impact on students' mathematics anxiety (Beilock et al., 2010).

However, previous research has supported that individuals who may have had a sense of mathematics anxiety were able to overcome it through communication and collaboration with peers (Liu, 2007). By discussing their personal anxiety toward teaching mathematics, the teachers' sense of mathematics anxiety decreased considerably, and they were able to share strategies for mathematics instruction.

After reflecting on the findings of the current study, the failure to find a relationship between mathematics anxiety and the instructional practices of teachers can possibly be explained by the security teachers find in utilizing their textbook series which are often said to be aligned to the state curricula for mathematics. Because teachers have been found to allow textbooks to be the driving force behind their mathematics instruction along with the extensive amount of curriculum they are required to cover (Geist, 2001), it is possible that a reliance on these resources helps eliminate the factor of mathematics anxiety. Generally mathematics textbook series include teacher manuals

that provide instructional ideas, scope and sequences of mathematics lessons, and answers to problems. By utilizing these resources, teachers do not have to rely heavily on their own independent thoughts or skills in regard to instructional planning, and they can find more confidence in their instructional lessons. As previously found, teachers who have more confidence in their classroom practices through presentation of information and questioning strategies (which often accompany textbook series) had a better understanding of curriculum and outcome based measures (Graven, 2004), and this leads to better instruction. Because of this reason, the failure to find a relationship between teachers' mathematics anxiety and their instructional practices can be justified.

There was a considerable difference between the two subscales measured by the AMAS instrument. Of the 320 participants, the mean score for teachers' math evaluation anxiety was considerably higher than their learning math anxiety, with math evaluation anxiety having a mean of 3.32 and learning math anxiety having a mean of 2.23. To further answer research question two, neither subscale was shown to have a relationship or correlation with elementary teachers' instructional practices. Because there was not a statistically significant relationship found between either of the subscales and the instructional practices of elementary teachers, the conclusion that supportive textbook series (often identified as being aligned to state curricula) provide enough security among teachers to eliminate mathematics anxiety as being an influential factor among their instructional practices. Although the reported scores between learning math anxiety and math evaluation anxiety shows a 1.09 difference, previous research established that mathematics anxiety was no more than subject-specific test anxiety

(Hembree, 1990), which would support the idea that the items addressing mathematics assessment would have the higher mean.

Overall, teachers had a high sense of self-efficacy in regard to their mathematical self-efficacy and mathematical teaching self-efficacy on the MTMSE. Teachers expressed the highest sense of self-efficacy in their mathematical teaching self-efficacy (content), with a mean score of 5.05, and their lowest sense of self-efficacy in their mathematical self-efficacy (problems) which reflected a mean score of 4.47. Because teachers were shown to have an overall reasonably high sense of mathematical self-efficacy among all of the subscales, it appears evident that they are secure in their abilities to teach mathematics. Perhaps this is because the items that measured their security with mathematical teaching self-efficacy (content) were one or two word items that were familiar to them through their mathematics strands in the state frameworks. It is possible the items appeared to be like a familiarity checklist rather than a measure that required them to think about the depth of skills connected to each strand. This would align with previous research conducted by Ball and Bass (2000) that suggested elementary math teachers generally only know the material they are teaching and a broad idea of where the students are heading rather than a more in-depth knowledge of mathematics. Teachers were not required to show mastery of the content, rather they reported their own securities. Because of this reason, there may be a limited perspective in regard to the teachers' self-efficacy with the mathematics content and what they know how to effectively teach through mastery instruction.

In reference to teachers' mathematical self-efficacy (problems) having the lowest, but still reasonably high sense of efficacy, it is important to recognize that teachers were

not required to work the third and fourth grade mathematics problems. Rather, they were required to report how they would feel answering those questions without a calculator. Teachers were not required to perform or show mastery of the content within the problems, which could provide a sense of security that may not exist if the latter were required. The self-report nature of the research was identified in the limitations of the study.

Teachers identified their instructional practices to be more aligned with mastery goals for students on the PALS, with a mean of 3.99, and mastery approaches, with a mean of 3.82. However, because the subscale of mastery approaches was found to have weak reliability ($\alpha = .541$), the indications of the findings must take the weak reliability into consideration. In previous studies, teachers have reported a high sense of self-efficacy that did not necessarily align to their instructional practices (Raymond, 1997). Although teachers believed their instructional practices were mastery driven, the implementation of their lessons indicated that they were not; rather, students were put into peer groups to complete work that was directly guided through procedural steps from the teacher for a performance based product (Van de Walle, 2004). Because of the disconnect found between teachers' ideal beliefs (what they think they are doing) and their actual beliefs (what they are actually doing), it seems reasonable to conclude that teachers could report their ideal beliefs about their instruction rather than their actual practices (Shaw, 1990).

The items that measured teachers' mastery goals for students and mastery approaches possibly appeared strong in theory and as effective for quality instructional practices, and teachers may have chosen to mark their ideal beliefs about instruction. The

study did not have an observational or evaluation component that could determine the teachers' actual instructional practices (as mentioned in the limitations of the study) outside of what the teachers self-reported. This leaves room to speculate that teachers reported their instructional practices as their ideal instructional practices rather than their actual instructional practices. The descriptive data of the three instruments helped provide generalized information regarding how elementary school teachers perceived their own mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices.

Effects on Instructional Practices

Research Question 2 asked, for certified elementary school teachers (grades K-6), do mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy have an effect on their instructional practices in mathematics? Using information found through the analyses of the four hypotheses of the study, there were no effects found with mathematics anxiety or mathematical self-efficacy; however, there were effects caused by mathematical teaching self-efficacy on the instructional practices of elementary school teachers. The nonsignificant relationships are addressed first, with further analyses of the significant relationships of the hypotheses that answer this research question provided in the sections that follow.

Nonsignificant Relationships Found with Instructional Practices

School districts generally adopt their textbook series according to the texts' content that is said to be aligned to the states' required curricula, so teachers may have a sense of security that they are teaching to the standards of the required frameworks because they utilize the provided resources. This is congruent with previous research that

concluded teachers organize and plan their instruction according to professional knowledge, educational beliefs, mandated examination pressure, administrative demands, textbooks, and time (Geist, 2001; Shaw, 1990; Yun-peng et al., 2006). Using the design of the textbook series helps in teachers' efforts to cover the cumbersome number of assessed objectives within a limited time-frame because the content is provided in an organized, prepackaged manner. When considering why a significant relationship was not found between mathematics anxiety or mathematical self-efficacy with teachers' instructional practices, it is important to remember the heavy reliance on textbook series and their supporting materials (Geist, 2001; Shaw, 1990). By relying on the sequence and structure of an organized mathematics lesson, teachers may have a sense of security and confidence in their abilities to implement the provided lessons which influenced these results. *Nonsignificant relationship with mathematics anxiety.* More confident teachers who are capable of identifying cause and purpose goals are capable of using and understanding their educational resources and curriculums to find the most effective outcomes (Newton & Newton, 2007), and this could help explain the insignificant relationship found between mathematics anxiety and teachers' instructional practices. For teachers who felt a sense of mathematics anxiety but had a strong sense of self-efficacy, it is possible that their self-efficacy helped them overcome their anxieties. Bouffard-Bouchar et al.(1991) report that teachers who were found to slightly overestimate their capabilities were able to make up for personal deficits and have effective outcomes. This study supports their finding, as participants' mathematics anxiety was not significantly related to their instructional practices.

It is also possible that some participants never had mathematics anxiety. In this case, an increasing or high sense of mathematics anxiety would not have a relationship with teachers' instructional practices because it would not exist in every individual teacher in the study. Mujis and Reynolds (2002) identified specific factors such as attitudes, beliefs, and personal experiences as external factors that influence teachers' instructional practices aside from mathematics anxiety. It is possible that participants in this study who expressed a low sense of mathematics anxiety experienced some of these constructs which were not measured in the present study, thus explaining this finding.

Non166significant relationship with mathematical self-efficacy. Ball and Bass (2000) claimed elementary math teachers believe they only need to know the material they are teaching and a broad idea of what the students eventually need to know rather than the specifics of the content (Ball & Bass, 2005). Because teachers are required to hold the minimum of a bachelor's degree from a college or university (Mississippi Department of Education, n.d.), their education level could help support a sense of security with the broad, generalized topics because the depths of what each item entails was not presented. The Mathematics Teaching and Mathematics Self-Efficacy (MTMSE; Kahle, 2008) scale presents the mathematics topics that are represented in the five strands of mathematics supported by the National Council of Teachers of Mathematics (NCTM, 2000) in the mathematics self-efficacy (content) subscale. These account for the generalized topics teachers are required to teach within their academic school year as mandated by the state frameworks. The lack of a significant relationship between teachers' mathematical self-efficacy and their instructional practices may also be understood by taking into account the education level of the population and the

requirements of the measuring instrument. The basic presentation of these topics could evoke a secure reaction from an educated person, specifically a teacher accountable for teaching the skills.

The problems presented on the mathematics self-efficacy (problems) subscale are written on a third and fourth grade level (Kahle, 2008). Because the sampled population included teachers certified to teach the mentioned grade levels, it is possible that some of the teachers felt they should know how to work all of the problems. Answers may have been provided on what some teachers felt they should be able to do rather than their actual security with what they could do (Shaw, 1990). Teachers were not required to show mastery of the content by working the problems.

Relationship Found with Mastery Goal Structure for Students

Hypothesis 1 stated: There is no significant relationship between the dependent variable of elementary school teachers' mastery goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy. This hypothesis was rejected, as a significant relationship was found between teachers' mathematical teaching self-efficacy (efficacy) and their mastery goal structure for students. As teachers' mathematical teaching self-efficacy (efficacy) increased, their mastery goal structure for students also increased.

This finding supports the importance of self-efficacy and its influences on instructional practices. By having a higher sense of mathematical teaching self-efficacy, teachers increase their mastery expectations for their students, which reflects a willingness to step outside of performance based expectations for students. As teachers

exhibit a strong sense of security and self-confidence with the content and teaching of mathematics, it is logical that they would provide students experiences to learn and master the subject as well. By providing learning experiences that incorporate a constructivist approach to learning, teachers can replace textbook instruction with hands-on materials, and emphasize thinking and metacognition rather than memorization and recitation (McBrien & Brandt, 1997). Highly efficacious teachers are more willing to work through challenging situations, experiment with methods to better meet the needs of the students, and plan and organize to assure quality instruction (Allinder, 1994; Tschannen-Moran et al., 1998). Teachers who were found to have a higher sense of security with content and pedagogy in mathematics extend students' learning experiences beyond teacher-centered lectures that focus on rules, procedures, formulas, and solutions (Alsup, 2003; Lias et al., 2006) and provide constructivist experiences with interactive, hands-on approaches to learning that allow students to explore, expand, and understand mathematics concepts for mastery learning (Van de Walle, 2004). The findings of this study support that a sense of mathematical teaching self-efficacy fosters and increases teachers' mastery goals for students through their instructional practices. Previous research indicated that by over- or under-estimating personal teaching capabilities, teachers can influence students' learning through their instructional practices (Tschannen-Moran et al., 1998), and this study is supportive of that finding.

However, previous research has also shown that teachers who espoused a student-centered constructivist approach to teaching still relied heavily on district-mandated curricula and assessments for classroom instruction while failing to realize their actual instruction was unaligned to their voiced philosophy (Levitt, 2001; Schraw & Olafson,

2002). Because the southeastern state that participated in this study is a recipient of the federal funding provided by the No Child Left Behind Act of 2001, mandatory assessments are a factor that need to be considered when referencing teachers' instructional practices. Many teachers implement performance-driven instruction in their classrooms because of the pressures caused by state mandates (Owen, 2010) even though the teachers express they may be doing otherwise (Raymond, 1997; Shaw, 1990). The findings of these previous studies can also be reiterated by the current study because teachers were not required to demonstrate their claims, although they were asked to give their initial, honest responses.

Relationships Found with Performance Goal Structure for Students

Hypothesis 2 stated: There is no significant relationship between the dependent variable of elementary school teachers' performance goal structure for students in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy. Although the uncertain reliability of the performance goal structure for students subscale was addressed in previous sections, analysis of the data found significant relationships. The results indicated that as teachers' mathematical teaching self-efficacy (efficacy) increased, their performance goal structure for students decreased.

As previous research has shown, teachers' professional teaching self-efficacy is connected to their willingness to seek more effective instructional practices, implement new and progressive instructional methods, and work with a variety of materials and instructional approaches for students to gain greater understanding (Allinder, 1994). It has also been found to cause teachers to maintain a strong academic focus within the

classroom and engage in behaviors aligned with effective elementary instruction (Gibson & Dembo, 1984; Muijs & Reynolds, 2002). Because performance based instruction and performance goals for students are aligned to less effective instructional practices (Dweck, 2000), the negative relationship between the subscales of teachers' instructional practices and teachers' mathematical teaching self-efficacies is significant because it shows that teachers have a proactive perception about quality instruction.

However, in the relationship found between teachers' mathematical teaching self-efficacy (content) and performance goal structure for students, an increase in their mathematical teaching self-efficacy (content) reflected an increase in the teachers' performance goal structure for students. As stated earlier, this finding contradicts the results regarding teachers' mathematical teaching self-efficacy (efficacy) as it relates to their instructional performance goal structure for students. This contradiction supports previous findings that showed a difference between elementary school teachers' beliefs about their instruction and their actual teaching practices (Raymond, 1997). Testing mandates, extensive curriculums, textbooks, and limited time are all factors that are influential to teachers' actual instructional practices (Geist, 2001; Owen, 2010), and these factors could also explain the discrepancies between the two types of instructional practices that are related to teachers' mathematical teaching self-efficacy. These findings show that there is a blend of teachers' mathematical teaching self-efficacy with two different, contradictory types of instructional practices. Because these findings are aligned with teachers' self-efficacy regarding content, it is possible that teachers who have a rule-bound and thin understanding of mathematics have a strong sense of confidence to teach mathematics in a rule-bound, procedural, and limited manner (Ball,

1990a). Although the teachers expressed their instructional approaches to be aligned to mastery approaches, the subscale of self-efficacy (content) has shown otherwise.

A more concerning educational issue arises in the finding that teachers' mathematical teaching self-efficacy (content) fosters performance based instruction because performance based instruction has been found to be the least effective instruction (Dweck, 2000). Because teachers reported their self-efficacy with teaching mathematics content being related to their performance based instruction, it is evident that teachers are secure in their abilities to provide limited mathematics instruction. Perhaps this is because teachers gain a sense of security and familiarity with their textbook series, and they fail to realize that the majority of texts contain skills in isolation rather than reaching to the requirements expected of students for the real mathematical challenge of problem solving. Rather than engrossing students in in-depth, complex problems that require thought provoking efforts, teachers assign numerous computation problems that only require students to practice the same mathematics operations repeatedly. Previous research established that elementary teachers implement only a limited number of methods and strategies in their mathematics instruction (Schools in the Middle, 1998), and this research study is supportive of the finding.

Geist (2001) established that elementary teachers find solace in using textbooks as the sole resource for their instruction because the series often offer organization that allows them to cover the topics of their curriculum within the limited timeframe they have to address the objectives. However, when teachers fail to realize that the textbooks do not offer the depths of required skills mandated by their state curriculum guides and only use strategies and approaches offered in the textbook series, they do not recognize

that the quality of what they are doing does not align with mastery approaches (Van de Walle, 2004). Teachers often assign mathematics problems to students in groups. However, all of the problems are typically the same, offer little to no variation of expectation, and are solved with step by step guidance usually provided by the teacher. Because of the failure to meet individual needs among the students and because teachers often misunderstand group work as differentiated instruction for mastery, it is evident that teachers may misunderstand their performance based instruction as mastery instruction. It is important that this misunderstanding be dispelled among elementary teachers so that they can expand their instruction to meet the learning needs of all students in mathematics. Mastery instruction requires teachers to expand beyond the comforts of their familiar resources and use multiple, constructivist approaches to instruction so that students become risk takers in regards to their problem solving (National Council of Teachers of Mathematics, 2000).

Because performance based instruction was identified as being aligned with testing mandates, performance based measures, and superficial, short-termed goals (Dweck, 2000) it is possible that teachers have a clearer understanding and sense of self-mastery with performance based instruction because of testing demands and mandates. Owens (2010) found teachers were driven by testing mandates rather than the needs or learning styles of their students. However, the long-term effects of performance driven instruction caused by these mandates is said to negatively impacts student learning, limits students' future learning, and creates a reliance on the teacher for content understanding (Dweck, 2000; Meece et al., 2006). Because students fail to establish a sense of self-reliance for successfully mastering mathematics concepts, ineffective teaching and

learning create a limitation in students' mastery of the mathematics content. To gain further insight regarding the mastery of mathematics through effective instructional practices, it is important to look further into the relationships found among mastery approaches to instructional practices.

Relationships Found with Mastery Approaches

Hypothesis 3 stated: There is no significant relationship between the dependent variable of elementary school teachers' mastery approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy. Again, while the uncertain reliability of the instructional subscale leaves room for speculation in the interpretation of the research; there were no significant relationships found among any of the subscales of the study. The failure to find reliability in the subscale could possibly be explained by a different interpretation of the items among the population sample in comparison to the original study. The insignificance of mastery approaches to instruction in relation to mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy is contradictory to previous findings regarding effective instructional practices. In previous studies, self-efficacy was found to have positive correlations with teachers' instructional practices (Graven, 2004; Newton & Newton, 2007; Tschannen-Moran et al., 1998), and effective instructional practices were found to be defined by mastery approaches to instruction (Dweck, 2000). Because of the failure to establish reliability with the subscale measure, it is possible that the teachers' responses were influenced by their interpretations of the items. This could have caused the failure to find significant relationships among the constructs.

Teachers' interpretations of the meaning of mastery instruction could possibly be a result of possible misconceptions about mastery approaches to instruction. Previous research identified that elementary teachers often misunderstand the difference between group work and differentiated instruction, with differentiated instruction often being aligned with mastery instruction (Van de Walle, 2004). Although many teachers provide group activities in their mathematics instructional lessons, the expectations of the students are all the same. Students work in groups or with partner pairs to discuss how to work a mathematics problem, but the problems are generally identical, with similar outcomes expected. Teachers generally guide students through the procedures for working the problems and then have students follow the same procedure for working their assigned group problems. Often these problems are isolated computation problems, and they do not require in-depth problem solving abilities, rather they are mathematical operations in isolation. This practice is contradictory to the constructivist approach to learning where students explore the meaning of the mathematics problems, draw from previous knowledge to establish meaning of the problem, and work through the problem solving process together to determine a reasonable answer without step-by-step instruction provided by the classroom teacher (NCTM, 2000; Van de Walle, 2004). Rather, in the construction of knowledge students demonstrate a conceptual knowledge of mathematics that consists of logical relationships constructed internally and exist in the mind as part of a network of ideas, and it is this learning opportunity that aligns itself to mastery instruction. Further insights regarding these findings will be addressed in the Conclusions section of the chapter.

Relationships Found with Performance Approaches

Hypothesis 4 stated: There is no significant relationship between the dependent variable of elementary school teachers' performance approaches in their instructional practices and the independent variables of mathematics anxiety, mathematical self-efficacy, and mathematical teaching self-efficacy. The results of the study indicated several relationships among teachers' performance approaches to instructional practices and the subscales of teachers' mathematical teaching self-efficacy. Teachers' mathematical teaching self-efficacy (efficacy) was found to have a significant relationship with teachers' performance approaches to instructional practices. As teachers' mathematical teaching self-efficacy (efficacy) increased, their performance approaches decreased.

These findings support the self-efficacy studies that conclude the value of a teachers' self-efficacy is influential in reference to their instruction. Teaching self-efficacy is aligned to teachers' willingness to learn and implement more effective instructional practices (Allinder, 1994; Tschannen-Moran et al., 1998), and it is found to be one of the most influential factors on student achievement (Darling-Hammond, 2004). Because performance based instruction is aligned to the less effective practices of teaching (Dweck, 2000), the subscales of teachers' instructional practices would reasonably not have a positive relationship with mathematical teaching self-efficacies that were found to align with mastery approaches to instruction. Teachers felt secure enough within their own self-efficacy to implement mastery approaches rather than performance approaches to instruction. However, as teachers' mathematical teaching self-efficacy (content) increased, their performance approaches to instruction also increased.

As discussed earlier, this finding contradicts the findings regarding teachers' mathematical teaching self-efficacy (efficacy) as it relates to their instructional performance goal structure for students, as well as their performance approaches to instruction. The findings of this study support previous research suggesting a difference between elementary school teachers' beliefs about their instruction and their actual teaching practices (Raymond, 1997). The same factors that were identified as being influential for impacting performance goals also apply to performance approaches. Influential factors such as testing mandates, extensive curriculums, textbooks, and limited time are all factors that determine teachers' actual instructional practices (Geist, 2001; Owen, 2010). These findings show that there is a blend of teachers' mathematical teaching self-efficacy with two contradicting types of instructional practices. Because performance based instruction has been found to be the least effective form of instruction (Dweck, 2000), it is alarming to find that teachers' mathematical teaching self-efficacy regarding content fosters this poor type of instruction. Although the teachers have a high sense of mathematical teaching self-efficacy, it was found to be related to the least effective instructional approach.

Conclusions

The explored relationship among teachers' mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of teachers resulted in findings there are relationships between the subscales of teachers' mathematical teaching self-efficacy and the subscales related to the instructional practices of elementary school teachers. Although the construct of mathematics anxiety was thought to be a related variable in the research study, the results of the analyzed data

indicated that mathematics anxiety had no significant relationship with any of the identified instructional practices of mastery goal structure for students, performance goal structure for students, mastery approaches, or performance approaches.

Mathematics Anxiety and Instructional Practices

Although mathematics anxiety has been found to cause a number of issues among its assessed and observed populations (Beilock et al., 2010; Cornell, 1999; Hembree, 1990; Jackson & Leffingwell, 1999), according to the findings of this research study it is not directly related to teachers' instructional practices. However, if mathematics anxiety were a factor in some of the participating elementary teachers, alternative methods for working through the anxiety were possibly found so that teachers' reported instructional practices were not influenced (Liu, 2007).

It was expected that mathematics anxiety would have a significant relationship with elementary teachers' instructional practices but because no significance was found, other explanations must account for its insignificance. An individual's sense of self-efficacy or their personal sense of self-regulation as a teacher could possibly help him/her overcome any insecurities or anxieties they may have in the content area of mathematics. Because people with a high sense of self-efficacy and personal confidence have been found to work through their insecurities (Graven, 2004), it is possible that the teachers who may have demonstrated mathematics anxiety were motivated to try harder with their mathematics instruction. Confident teachers, who are capable of identifying cause and purpose goals (although they may not be an expert in the content) are capable of identifying cause and purpose goals. They can successfully use educational supplies, textbooks, and curricula to determine the essential components for quality instruction

(Newton & Newton, 2007). Because of this reason, mathematics anxiety would be overcome by the teacher's sense of confidence. Regardless, teachers' instructional practices were uninfluenced by their mathematics anxieties.

Teachers were found to have a higher sense of mathematics test anxiety (as reflected by the higher mean of the Math Evaluation Anxiety [MEA] subscale) rather than an anxiety about mathematics content. While this finding suggests teachers' instructional practices were not influenced by their mathematics anxieties, it is important to recognize that elementary teachers are not expected to perform on mathematics assessments in their daily practices (to show personal mastery of the content on a mathematics test). Rather, teachers are required to teach the mathematics concepts on an elementary level. Because the MEA was possibly not directly aligned to a factor that causes an insecurity or threat among teachers in their daily instructional practices, it is a possible reason why mathematics anxiety was not found to have a significant relationship with teachers' instructional practices. Although the teachers' mathematics anxiety may collectively be strongly influenced by their mathematics test anxiety, it was insignificant in their daily instructional practices as a classroom teacher. By putting elementary teachers in another setting, possibly where a mathematics assessment would be given to hold them accountable for the content, the results may be different. However, this is not the case included in the daily responsibilities of school teachers, so it could account for the insignificance of the construct in the study.

Another reason mathematics anxiety may have been found to be insignificant in relation to teachers' instructional practices in mathematics could also be contributed to teachers' limited perceptions about the depths and content they are required to teach in

the elementary mathematics classroom (Ball & Bass, 2000). Because elementary mathematics is generally believed to be basic, introductory skills to mathematics learning, the majority of teachers probably do not feel threatened or anxious about the content. Supporting resources, such as textbooks and curriculum guides often provide enough stability (e.g., scope and sequence guides, answer keys, worksheets, enrichment pages, etc.) that elementary teachers' anxieties are relieved because they have enough content reassurance provided through their resources. The information that supports the insignificance of mathematics anxiety on elementary teachers' instructional practices may collectively be explained in the following manner: (a) teachers' high sense of self-efficacy helped them overcome their mathematics anxiety; (b) mathematics assessments, as measured in the subscale for mathematics anxiety, are irrelevant to teachers' daily practices; and (c) teachers' limited expectations of elementary mathematics content, along with their supporting resources help alleviate concerns with mathematics instruction.

Mathematical Self-Efficacy and Instructional Practices

Although no relationship was found between mathematical self-efficacy and the instructional practices of teachers, previous research indicated that security and confidence with content has been shown to positively impact teachers' instructional practices (Dyrud, 1997; Newton & Newton, 2007; Yun-peng et al., 2006). The failure to establish a relationship in this research study could possibly be contributed to the idea that teachers exhibited enough confidence in their abilities to complete the third and fourth grade-level problems presented on the Mathematical Teaching and Mathematical Self-Efficacy scale (MTMSE; Kahle, 2008), but that there was a disconnect between the

MTMSE and the prompts of the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) because of teachers' personal approaches to completing mathematics problems rather than generalized statements regarding their instruction. The lack of correlation between teachers' mathematical self-efficacy and their instructional practices could be connected to teachers' personal approach to solving the mathematics problems and analyzing mathematics content rather than their idealized beliefs on how mathematics should be taught (Dunn, 2004; Levitt, 2001; Manigault, 1997). The inability to establish a relationship between the two constructs in this study makes it important to examine teachers' personal approaches to solving specific mathematics problems in order to determine if a more direct relationship exists between mathematical self-efficacy and instructional practices. Because working through mathematics problems and demonstrating instructional practices were not a part of this study, it is important to acknowledge that a more specific measure of mathematics instructional practices may yield different results.

It was expected that a significant relationship would be established between the two constructs because the more secure teachers are with mathematics content, the more they would align their instructional practices with mastery instruction. However, this was not the result of this study. The information supporting the results of the study is the same as some of the information that supported the failure to find a significant relationship between mathematics anxiety and teachers' instructional practices. Teachers' security to successfully complete elementary mathematics problems according to the expectations they have regarding elementary mathematics content and the supporting texts and resources they have in place for mathematics instruction could possibly account for the

insignificant relationship between the two constructs. If teachers anticipate that elementary mathematics is not beyond their own personal capabilities in mathematics (Ball & Bass, 2000), and if they have resources that provide them guidance and direction for their mathematics instruction (Geist, 2001), it is reasonable to assume that their instructional practices in relation to their personal mathematical self-efficacies would not be influenced. External factors (i.e. – textbooks, curriculum guides, etc.) would have more influence on their instructional practices rather than their own mathematical abilities and securities.

Mathematical Teaching Self-Efficacy and Instructional Practices

The relationships found among mathematical teaching self-efficacy and the instructional practices of teachers throughout the majority of the tested hypotheses indicated that teachers' teaching self-efficacy plays a significant role in their instruction. This finding was supported in previous research that indicated teachers are the most influential factors impacting instruction and student achievement (Darling-Hammond, 2004; Kahle, 2008; Midgley et al., 1989; Schunk, 1989), and that teaching self-efficacy, in any subject, promoted better discipline, effective classroom management, motivation among students, and increased student achievement (Bandura, 1986; Mujis & Reynolds, 2002; Pintrich & Schunk, 2002; Woolfolk & Hoy, 1990). This study showed teachers' mathematical teaching self-efficacy (efficacy) is positively related to mastery instruction (the kind of instruction identified as being most effective); which supports previous research showing that highly efficacious teachers implement effective instructional practices. However, the positive relationship between teachers' mathematical teaching self-efficacy (content) and their instructional practices suggests another type of issue.

Because teachers reported having a high sense of efficacy to implement the poorest type of instruction, while feeling confident in their abilities to do so, is something crucial that should be addressed in professional developments and teacher training programs.

Perhaps this weak link is the issue causing the cyclical nature of poor mathematics performers rather than mathematics anxiety, as reported in previous studies (Alsup, 2003; Beilock et al., 2010; Brady & Bowd, 2005).

It was anticipated that teaching self-efficacy would have a significant relationship with teachers' instructional practices; however this was not found in the analysis of data in this study. Contradictory results were found between the two reported types of instructional practices implemented (as they related to the different types of self-efficacy). The interesting aspect of the contradiction was that teachers (in the general context of self-efficacy) thought they could effectively provide mastery instruction. But self-efficacy regarding content (specific to mathematics) showed that the teachers trust their content knowledge and efficacy to support performance based instruction, meaning they have a strong sense of security and assurance in their abilities to provide the poorest form of mathematics instruction. This relates back to teachers who use textbooks and curriculum guides to drive their mathematics instruction so that they can meet the required objective coverage mandated by the state assessments rather than focusing on the skills and abilities of the students within their classrooms (Geist, 2001; Levitt, 2001; Schraw & Olafson, 2002; Shaw, 1990; Van de Walle, 2004). Because the teachers who participated in the study are held accountable by a state assessment used for the guidelines of No Child Left Behind, and because the southeastern state uses test data to determine teachers' success or failure, it is strongly suggested through the results of this

study that teachers' instructional practices are negatively influenced by the demands of performance based measures. Additionally, it is strongly suggested that the relationship shows confusion amongst teachers' beliefs about the quality of their instructional practices in the content area of mathematics. Although their personal mathematical teaching self-efficacy shows a desire to provide mastery instruction, their self-efficacy with content does not align itself to the same practices. Rather, the demands of content (the teaching and learning of content) leave teachers offering performance based instruction to their students.

Because of this, a cause for teachers' sense of security underlying teaching self-efficacy (content) needs to be established to (a) successfully demonstrate an understanding of the concepts of mathematics through a demonstrated mastery of the skills or (b) identify mathematics instruction as a security in ability to adequately follow a pacing guide, textbook, or external resource that coaches the type of instruction teachers are encouraged to provide. The discrepancy between the two is considerable, and a clearer understanding of what causes the contradiction needs to be established in order to help teachers provide a higher quality, more in-depth form of mathematics instruction. It is strongly anticipated that the dependence on textbooks, curriculum guides, required curriculums, and mandated assessments are the primary cause of the conflicting information, just as these things were found to be influential among previous research (Geist, 2001; Raymond, 1997; Shaw, 1990).

Mathematical teaching self-efficacy (efficacy) and mastery goal structure for students.

The positive relationship found between these two construct implies that teachers who have a stronger sense of self-efficacy have a tendency to work toward a mastery goal

structure for students through their instructional practices. This finding supports Graven's (2004) research that concluded teachers who express more confidence in their classroom practices better understand the curriculum and outcome measures. Once teachers' confidence and strong sense of self-efficacy are established, teachers prepare ahead for future mathematics lessons by seeking additional training. Teachers who exhibit confidence are capable of identifying cause and purpose goals and can more successfully decipher and interpret educational supplies such as textbooks and additional curriculum resources to find what is relevant for instruction (Newton & Newton, 2007).

This was not a surprising finding in that highly efficacious teachers are found to seek more effective instructional practices, such as those associated with mastery goal structure for students, which was also aligned to teachers' professional teaching self-efficacy. Teachers with a higher sense of self-efficacy were found to practice the implementation of new and progressive instructional methods and work with a variety of materials and approaches for greater student learning (Allinder, 1994). Although observations of the teachers were not included in the current study, the intent was to find how teachers' self-reported mathematics self-efficacies related to their instructional practices. Because there were conflicting reports among the constructs and subscales of the constructs, the self-report nature of the study served its purpose. Teachers often have a sense of what they believe they are doing in the classroom that conflict with their actual practices. This finding supports previous research that affirmed the same results (Shaw, 1990).

According to the findings of this study, teachers with a high sense of mathematical teaching self-efficacy use mastery goal structure for students in their

instructional practices, which were shown to be more effective in teaching students how to be successful, independent, critical problem solvers that extend their learning into real-world experiences (Van de Walle, 2004). Because of previous research showing the influence of teachers' self-efficacy on their instructional practices, it was anticipated that these results would be found. However, the conflicting relationships found between the two identified teaching self-efficacies (as they related to teachers' instructional practices) and among the reported information were more aligned to the intent of the study. The concerns about the poor mathematics performance among American students reported earlier in this study (Anderson, 2010; Wallace, 2005) foreshadowed the anticipation that there would be a discrepancy between teachers' beliefs and practices in mathematics. There are many effective teachers who work diligently to provide quality educational experiences for their students; however, a disconnect between the teachers' intentions and their actual practices could be a cause for the unintended gap in mathematics skills among students. Because of the finding in this research study, efforts can be made on behalf of teachers to help them understand the depth of mathematics skills embedded in the strands of their mathematics content (according to the National Council of Teachers of Mathematics, 2000) so that they can consistently invest their efforts in more effective instructional practices for greater student mastery.

Mathematical teaching self-efficacy (efficacy) and performance goal structure for students. The results of this study indicated that teachers' mathematical teaching self-efficacy (efficacy) was negatively related to performance goal structure for students, with an increase in efficacy indicating a decrease in teachers' performance goal structure for students, which was supportive of the expected findings. This affirms the finding that

teachers' mathematical teaching self-efficacy (efficacy) is positively related their mastery goal structure for students because performance goals for students entail an opposing approach to instruction when compared to mastery goals. Overall, they are found to be less effective instructional practices.

These findings may be explained by the differences in the beliefs reported by the teachers. Teachers carry a set of ideal beliefs and actual beliefs regarding their instructional practices (Shaw, 1990). Ideal beliefs represent what teachers prefer to teach so that students will learn, and actual beliefs represent how the teacher actually teaches based on contextual factors. The possibility of teachers answering the questions on the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 2000) based on their ideal beliefs could influence the results in the relationship found. Contextual factors that have been found to strongly influence actual practices in classrooms are textbooks, time, and objective coverage rather than teaching for mastery (Geist, 2001). Although the PALS measured mastery-based instruction and performance-based instruction, it did not have these identified elements included in its measure. These additional factors could be important in getting a more accurate reading of teachers' daily instructional routines and practices.

Because the participating districts in the southeastern state are required to participate in mandatory accountability assessments for the No Child Left Behind Act of 2001, the teachers' ideal beliefs may not be what they actually implement in their classrooms because of testing pressures. The testing factor, as well as time and curriculum coverage aligned with testing requirements, could have more influence on teachers' instructional practices than the measure of instructional practices used for the

study. Although the findings of the study are consistent with what was expected, a critical speculation supports that teachers' mathematical teaching self-efficacy (efficacy) supports teachers' reflections about their ideal instruction rather than their actual instruction. They think they are doing what is right and effective with their instruction, when actually what they do in their daily practice is not.

Mathematical teaching self-efficacy (content) and performance goal structure for students. The relationship found between mathematical teaching self-efficacy (content) and performance goal structure for students indicated a positive correlation between the two constructs. This relationship was expected in the study because it required teachers to focus on their security with content along with their understanding the subject. Elementary teachers' limited training and preparation in mathematics (Malzahn, 2002; Schools in the Middle, 1998) suggests that content would have an impact on teachers' mathematics instructional practices. The conflicting results of this study could possibly be explained by teachers' general teaching self-efficacy regarding mathematics, mathematical teaching self-efficacy (efficacy), which provides the more idealistic view of teachers' instruction rather than the mathematical teaching self-efficacy that aligns with content, mathematical teaching self-efficacy (content). The findings strongly show teachers are implementing instructional practices that relate to their understanding of mathematics content, although many curricula require a more in-depth investigation of mathematics concepts. Many elementary teachers may still focus on a limited familiarity with the content, and they teach it in the same limited manner. The findings of this study support this assertion as anticipated.

This particular subscale of mathematical teaching self-efficacy indicates that it relates more directly to the teachers' actual beliefs about instruction because of the mathematics components teachers are required to teach (Shaw, 1990). In previous studies, it was found that teachers who espoused a more constructivist based, student centered, mastery approach to instruction continued to rely heavily on district mandated curriculum and assessments for instruction, and their instructional practices were unaligned to their stated beliefs (Levitt, 2001; Schraw & Olafson, 2002). This could also be a strong contributing factor and influence on the conflicting relationships between instructional practices found in the current study.

Additionally, the relationship found between teachers' mathematical teaching self-efficacy (content) and performance goal structure for students could be attributed to teachers' personal understanding related to their teaching pedagogy, as teachers do not generally instruct beyond their personal comfort level or level of understanding (Ma, 1999a). The teachers' sense of teaching self-efficacy regarding content provides them a confidence enough to teach students the materials and objectives on a performance-based level, and the teachers' expectations are possibly aligned to an end assessment that students are expected to pass. Perhaps teachers' insecurity with content, or a limited base of professional knowledge regarding mathematics instruction, along with their educational beliefs regarding the most effective method for providing mathematics instruction, contributes to the association between their mathematical teaching self-efficacy (content) and their performance goal structure for students.

The results of this study also confirm the relationship between teachers' fairly strong sense of mathematical self-efficacy (content) and the less effective instructional

practice of performance goal structure for students possibly originate from a source other than their personal confidence in teaching mathematics. As reflected in the findings, teachers have a confidence in their abilities to provide ineffective mathematics instruction. This sense of confidence could stem from teachers failing to use standards to teach, but rather using textbooks to drive their instruction. Also, it could originate with teachers having an extensive amount of curriculum to cover in a limited amount of time (Geist, 2001). Because of these factors and the findings of this study, it is possible that teachers become more focused on directive instruction and students' performance on assessments that they fail to realize their method of instruction has been found to be ineffective among the research.

Mastery approaches to instruction. Mastery approaches were identified as being the most effective instructional practices within elementary mathematics classrooms (Dweck, 2000). However, there were no significant relationships found with mastery approaches to instruction in the study possibly because of the reported weak reliability of the subscale among the study's sample. An analysis of the subscale was conducted to determine the possible cause of its unreliability. Although an exact causing factor was not researched or found, there were inconsistencies among the statements presented in the subscale to which teachers responded. Questions four and 13 appeared to relate more to teachers' recognition of academic differences among their students, and questions 11 and 26 related more to practicing differentiated instruction. The items in the subscale appeared to factor into two different categories, differentiated instruction and individual progress rather than one unified subscale; however, an exact reason for the difference was

not determined. This may explain why the reliability of the subscale is low and no relationships were found among any of the variables.

The failure to find significance was unexpected. It was anticipated that mastery approaches would have aligned with mathematical self-efficacy (both subscales) and mathematical teaching self-efficacy (both subscales) because of the previous research that supports their interrelatedness (Graven, 2004; Newton & Newton, 2007; Yun-peng et al., 2006). Because no relationships were found, it is difficult for the researcher to draw more specific conclusions on the analyzed data, primarily because of the unreliability of the subscale's measure, but also because it is difficult to conclude that there are relationships based on the results of the remaining subscales. By looking at the results associated with the results and relationships associated with the other subscales in the study, instructional trends of performance based instruction were identified even though no conclusive evidence was provided for mastery approaches to instruction because of the contradicting information regarding instructional practices found within the study's population.

Mathematical teaching self-efficacy (efficacy) and performance approaches to instruction. This study showed that as teachers' mathematical teaching self-efficacy (efficacy) increased, their performance approaches to instruction decreased. These findings are supported in the research that state teachers' sense of self-efficacy can either under- or overestimate their personal teaching abilities and instructional practices (Tschannen-Moran et al., 1998), and they were the expected results for the study. Even for teachers who expressed a general dislike or anxiety regarding mathematics could overcome their feelings by overestimating their capabilities, working through their

personal deficits, and producing effective performance outcomes (Bouffard-Bouchar et al., 1991). The confidence and high sense of teaching self-efficacy would apply to the individuals who expressed little to no dislike or anxiety toward mathematics as well. It was not unexpected that teachers would express confidence in their abilities to implement more effective instructional practices in their chosen profession because people generally want to be perceived as capable and competent in their professional careers.

With mathematics curricula, textbook series, and packaged programs becoming more conceptually based and inclusive of hands-on learning through interaction with manipulatives, it is possible that teachers believe themselves to be more capable of effective mastery approaches to their instruction. Because teachers' performance approaches to instruction decreased as their efficacy increased, it is speculated that teachers' may believe their instructional methods are more aligned to mastery approaches to instruction. However, because the subscale of mastery approaches unexpectedly found no relationships, and the subscale was found to be unreliable, this definitive conclusion based on the statistics could not be drawn. Although, it is possible that teachers misunderstand their interactive classroom practices to be in alignment with practices related to mastery instruction such as differentiated instruction, collaborative group work, and constructivist learning. Because teachers provide students the opportunity to work in groups or with partners, and because teachers sometimes allow students to use manipulatives, they often fail to recognize that they direct and guide students definitively through the steps on how they want them to solve the presented problems. This is counterproductive to the real foundation behind mastery learning, where students actively construct the meaning of the problem solving strategies according to the context of the

problem rather than what the teacher tells them to do. This one indiscretion could account for the inability to align teachers' efficacies with their instructional practices, particularly mastery approaches to instruction.

Mathematical teaching self-efficacy (content) and performance approaches to instruction. The study found a positive relationship between mathematical teaching self-efficacy (content) and performance approaches to instruction, meaning that as teachers' efficacy regarding content increased, their performance approaches to instruction also increased. This was a surprise finding within the research in that it supports the underlying belief that teachers inconsistently report their perceptions of their instructional practices in comparison to their actual instructional practices. Although, these findings contradict the teachers' reported mathematical self-efficacy's (efficacy) negative relationship with performance approaches. This could be because teachers had to respond to and analyze specific mathematics strands and scenarios on the Mathematics Teaching and Mathematics Self-Efficacy (MTMSE; Kahle, 2008) instrument.

With specific mathematics content involved, teachers' instructional practices may be more driven by assessment and performance driven mandates. Previous research has found that teachers make curriculum decisions based on pressures of mandated examinations and required district curriculums even though they express support for constructivist learning and exhibit a high sense of teaching self-efficacy (Levitt, 2001; Owen, 2010; Schraw & Olafson, 2002; Yun-peng et al., 2006). It is anticipated that teachers may also have a false perception about how to effectively teach the content of mathematics using the strategies that are supported by the research. Because teachers are often trained to teach using outdated epistemological and ontological strategies (Klein,

2004), teachers' perceptions of effective mathematics instruction specifically related to the skills and objectives associated with the content could be skewed. The results of this study provide supporting evidence that there is a conflict between teachers' reported instructional practices and that their actual self-efficacy related differently to the two opposing instructional practices.

Because a relationship was found indicating that teachers' mathematical teaching self-efficacy (content) was positively correlated with performance approaches to instruction, it is suggested that teachers have a high sense of self-efficacy in their abilities to provide a poor form of instruction, as was found in the relationship between teachers' mathematical self-efficacy (content) and performance goal structure for students. Teachers' generalized teaching self-efficacy (efficacy) indicates that teachers believe in their teaching capabilities using mastery instruction, with the exception of mastery approaches; however, the more specific mathematical teaching self-efficacy (content) implies that teachers have a confidence in their abilities to provide performance-based instruction. Because of this, it is critical to understand the possible reasons behind the contradictions. As identified in previous explanations regarding the inconsistencies found in the research, the inconsistencies among understanding the depth of the required mathematics content, a broad interpretation of mathematics skills, and a heavy reliance on textbooks for instruction are three possible reasons for the reported inconsistencies. By seeking further understanding to clarify the inconsistencies, efforts can be made to help teachers recognize practices that align to the most effective mathematics instruction that contribute to students' mastery learning.

Implications for Practice

The results of this study indicate that there is an inconsistency among teachers' mathematical teaching self-efficacies and the instructional practices they report. Because teachers' mathematical teaching self-efficacy regarding content shows that their instructional practices strongly align to performance based instruction, it is perplexing to determine how the teachers could also report that their generalized teaching self-efficacy would lend itself more to mastery based instruction. The contradiction in itself strongly suggests that there is an internal conflict among teachers in what they believe they are doing in their instructional practices and what they are actually doing in daily instruction. Because of the internal conflict, the inconsistencies found in the quality of mathematics instruction can be accounted for by realizing teachers need for additional support to eliminate the cause of the internal contradiction.

Strategies should be put in place to support teacher growth as they learn to establish a consistent foundation for effective, constructivist, research based instructional practices. By providing teachers with long-term, consistent professional development and support that guides teachers to better understand their curriculum and outcome based measures, as well as use more effective questioning strategies, teachers can find greater consistency with effective instructional practices (Graven, 2004). Proper professional development support, academic training, and learning experiences that demonstrate how to implement effective instructional practices have been identified as influential measures that helped teachers improve their instruction (Dunn, 2004). By working in professional learning communities where teachers plan and organize instruction cohesively and by

assigning mentors to teachers who need instructional support, more consistent communication regarding mathematics instruction will arise (Dunn, 2004; Graven, 2004).

When training pre-service teachers the same practices of support mentioned for practicing teachers should be provided. By instilling the most effective instructional practices in future teachers, possible frustrations and confusion could be avoided when the new teachers begin their careers in the classroom. Constructivist approaches to instruction should be demonstrated and modeled for preservice teachers so that they do not confuse guided group activities with appropriate, differentiated learning as found in many classrooms (Van de Walle, 2004). Once modeled, preservice teachers should be provided the opportunity to implement a mastery lesson to assure they have mastered the concept. Additionally, once the new teachers enter the classroom, instructional mentors and support teams should be in place to help novice teachers who may need suggestions or reinforcement. Previous research found that often new teachers enter classrooms only to find that there is no support to sustain them as professional learners (Chester & Beaudin, 1996). This should be avoided by offering professional learning communities, professional developments, and mentors to maintain a consistent foundation for learning in the field of education.

Providing teachers opportunities to practice mathematics skills, activities, or instruction in real or simulated experiences, among their professional peers is also a method that should be used to help teachers consistently align their efficacies with mastery approaches to instruction (Starko & Schack, 1989). Learning to work through the instructional process to recognize the effective methods, ineffective methods, and irrelevant methods can benefit teachers' perceptions and confidences in their abilities to

effectively convey the requirements of the content. These types of strides can be taken to positively benefit teachers' self-efficacy and counteract negative influences or insecurities with conceptual content (Starko & Schack, 1989).

Through the analysis of the inconsistencies regarding the subscales of mathematical teaching self efficacy, both efficacy and content, and teachers' instructional practices, it is important to identify that teachers need to use professional feedback and student data to judge their professional performances. Although a high sense of self-efficacy has been recognized as a critical component for quality teaching (Allinder, 1994; Bandura, 1986; Gibson & Dembo, 1984; Hidi, 2001; Tschannen-Moran et al., 1998), a high sense of self-efficacy should be focused on the most effective research based instructional practices that align with mastery instruction. Teachers' confidence and sense of self-efficacy focused on the wrong type of instruction leads to further issues among students within their own learning (Bouffard-Boucher et al., 1991); however, by properly training teachers how to use student data to determine the quality of previous instruction, teachers can gain insight on how to change or modify strategies that were ineffective. Additionally, they will have insight into what was beneficial for their students through their instruction. The training can be conducted the embedded and sustained professional developments or in professional peer groups (Dunn, 2004; Graven, 2004; Lee, 2007; Starko & Schack, 1989).

The concern associated with mandatory state assessments also needs to be addressed through training teachers about effective mathematics instruction. This can be done by teaching teachers the concept of back-loading their curriculum (English & Steffy, 2001) so that the assessment does not create a barrier that prevents effective

instruction. Through the concept of back-loading, teachers can realize that the accountability piece can gauge the instructional content, but it does not have to gauge the instructional quality. Effective, mastery lessons can be designed around the content students will be held accountable for knowing; but by beginning with the end in mind (Wiggins & McTighe, 2005), the guess work of determining how to teach the massive amounts of skills found in the curriculums should be taught is eliminated (Geist, 2001). In the process, teachers find more time, more succinct structure, and a purposeful focus for implementing quality, mastery instruction.

Recommendations for Future Research

There is a need for more research involving teachers' mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers. Because previous literature has suggested that personal and external factors relating to teachers' mathematics instructional practices should be further researched (Brown, 2005), the following recommendations are made: The current study should be replicated using the same quantitative measures; however, a qualitative component should be added that would include classroom observations and personal interviews with teachers. By directly observing the teachers' mathematics classroom instruction, the researcher could better judge teachers' instructional approaches to determine if the teachers use mastery based or performance based instruction. Interviews could help clarify the differences found between teachers' general mathematical teaching self-efficacy (efficacy) and their mathematical teaching self-efficacy (content). This added component could possibly help the researcher identify the

specific area of need to further help teachers increase the implementation of more effective instructional practices in the mathematics classroom.

Studies should be conducted that relate the components of teachers' mathematical self-efficacies, instructional practices, and student achievement. Because a considerable amount of the studied literature suggests that testing mandates influence teachers' instructional practices, which later influences student achievement (Muijs & Reynolds, 2002; Nathan & Koedinger, 2000; Owen, 2010), further research should explore these factors to determine if what teachers report regarding their self-efficacies and instructional practices align to their students' academic achievement. The importance of this added construct could help the researcher emphasize the importance of aligning instruction and assessments while helping diagnose what is needed to promote teachers' mathematical self-efficacies with effective and appropriate instructional practices.

The current study needs to be replicated using multiple states rather than a single southeastern state. Because not all states choose to participate in the mandated assessments required by No Child Left Behind (Darling-Hammond, 2004), a study involving teachers' mathematical self-efficacies and instructional practices should be compared and analyzed to determine if testing pressures have an influence on teachers' efficacy and instructional approaches, and if states that do not have testing pressures exhibit the same sense of efficacy or practice the same types of mathematical instruction.

Summary

The purpose of this study was to determine the relationships among mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and the instructional practices of elementary school teachers. Of the participating teachers from the southeastern state, mathematics anxiety and mathematical self-efficacy were not found to have any relationships with teachers' instructional practices. However, teachers' mathematical teaching-self efficacy, both mathematical teaching self-efficacy (efficacy) and mathematical teaching self-efficacy (content), were found to have significant relationships with teachers' instructional practices.

Conflicting results were found when analyzing the data generated via the two subscales of the mathematical teaching self-efficacy scale and the two subscales of teachers' instructional practices, mastery and performance. Teachers reported a high sense of general mathematical teaching self-efficacy (efficacy), which was said to increase their mastery goal structure for students. This was also supported by their report regarding an increase in the same self-efficacy causing a decrease in their performance goal structure for students. However, when teachers reported their mathematical teaching self-efficacy (content), its relationship to instructional practices was different. An increase in mathematical teaching self-efficacy (content) conveyed there was an increase in both performance goal structure for students and performance approaches to instruction, which contradicted the teachers' general teaching self-efficacy. The two types of instructional practices are oppositional, not collaborative.

Although the overall findings of the study indicated that teachers exhibit a reasonably high sense of mathematical teaching self-efficacy, the conflicting information

found through the study infers that teachers may have a strong sense of mathematical teaching self-efficacy with the poorer type of instructional practice, performance based instruction. A high sense of self-efficacy was found to create positive, productive, and beneficial learning environments for students (Darling-Hammond, 2004; Hidi, 2001; Mujis & Reynolds, 2002); however, teachers need to be taught and guided in the most appropriate, beneficial mathematics instructional practices so that their efficacies can be used for greater student mastery and gain in the content area. Future research is necessary to show the importance of the explored constructs among numerous elementary classrooms. By further diagnosing and aligning the positive aspects of the mathematics anxiety, mathematical self-efficacy, mathematical teaching self-efficacy, and instructional practices, specific strategies can be found or created to help teachers gain support in improving their mathematics instructional practices.

APPENDIX A

LETTERS TO SUPERINTENDENTS

*Researcher's Contact Information**Address**City, State, Zip Code**Email Address*

District Superintendent
XXX School District
Address
City, State, Zip Code

April 8, 2010

Dear Superintendent:

I am writing to ask for permission for your school district to participate in my dissertation study, *The Relationship among Elementary Teachers' Mathematics Anxiety, Mathematics Self-Efficacy, and Mathematics Teaching Self-Efficacy, and Instructional Practices*. It is with great anticipation that the results of this study can help in guiding elementary teachers with specialized professional developments and strategies regarding mathematics instruction at the elementary level. Your teachers and school district will be instrumental in helping give insight and direction toward improving mathematics instruction among elementary students within the public schools of Mississippi. The purpose of this research is to gain insight into elementary teachers' instructional practices regarding mathematics in relation to their mathematics anxiety (should it exist), mathematical self-efficacy, and mathematical teaching self-efficacy. Should it be discovered that elementary teachers suffer from mathematics anxiety and/or low mathematics self-efficacy and/or low mathematics teaching self-efficacy, efforts can be made on their behalf to help alleviate some of the issues associated with these topics.

The intent is to collect the self-report surveys from the elementary teachers the week after MCT2 testing. I certainly want to comply with the research guidelines of the district, so the distribution of the surveys would be conducted under the advisement of the district procedures.

As with all voluntary research, principals and teachers will be explicitly informed that their participation is not required, nor will they be penalized for nonparticipation. Teachers' informed consent will be understood and indicated by the completion and submission of a survey form, and their identity will remain anonymous. Because of the nature of the research, little to no risk will occur with participation in this study. The information will be used for proactive purposes and will not be associated with evaluations and/or plans of improvement for any teacher. Teachers who voluntarily participate in the study will be entered in a drawing for the chance to win one of ___ \$10 gift certificates to McAlister's Deli. Teachers will remove and keep a numbered ticket (that is randomly assigned) from the corner of their survey form. This ticket will be required for winning teachers to claim their prize because, as previously stated, names and identities will not be attached to completed survey forms. The surveys are a self-report document, and no student data and/or correlations regarding student data will be used in the study.

Once the study is complete, all participating individuals will have access to the results and findings of the study. Should any participant have further questions, he/she can contact the researcher using the information posted at the top of this letter. Again, thank you for your willingness to participate in this research study. With these types of collaborative efforts, the plans of action created on behalf of our teachers and students will help in our efforts to advance the educational experiences of all learners.

I have enclosed an example permission letter and a copy of the letter that will be attached to each teacher survey. Should you grant me permission, this information will be helpful in gaining IRB approval through The University of Southern Mississippi. Thank you for considering this request, and I look forward to hearing from you.

Sincerely,

L. Joan Smith

APPENDIX B

PROTOCOL AND CONSENT LETTER

*Researcher's Contact Information**Address**City, State, Zip Code**Email Address*

District Superintendent
XXX School District
Address
City, State, Zip Code

RE: Protocol and Consent Information for Research Study

April 8, 2010

Dear Superintendent:

Thank you for allowing your school district to participate in my dissertation study, *The Relationship among Elementary Teachers' Mathematics Anxiety, Mathematics Self-Efficacy, and Mathematics Teaching Self-Efficacy, and Instructional Practices*. It is with great anticipation that the results of this study can help in guiding elementary teachers with specialized professional developments and strategies regarding mathematics instruction at the elementary level. Your teachers and school district will be instrumental in helping give insight and direction toward improving mathematics instruction among elementary students within the public schools of Mississippi.

The purpose of this research is to gain insight into elementary teachers' instructional practices regarding mathematics in relation to their mathematics anxiety (should it exist), mathematical self-efficacy, and mathematical teaching self-efficacy. Should it be discovered that elementary teachers suffer from mathematics anxiety and/or low mathematics self-efficacy and/or low mathematics teaching self-efficacy, efforts can be made on their behalf to help alleviate some of the issues associated with these topics.

Unless directed otherwise, I will be contacting your elementary school principal(s) that house K-6 elementary school teachers. After communicating and consulting with each principal, I will follow his/her guidelines for delivering the surveys for each elementary school teacher in each school the week after MCT2 testing. Once an agreement is made with the school principal, distribution and collection of the surveys will occur according to the made agreement unless there is another plan established by your district regarding research studies.

As with all voluntary research, principals and teachers will be explicitly informed that their participation is not required, nor will they be penalized for nonparticipation. Teachers' informed consent will be understood and indicated by the completion and submission of a survey form, and their identity will remain anonymous. Because of the nature of the research, little to no risk will occur with participation in this study. The information will be used for proactive purposes and

will not be associated with evaluations and/or plans of improvement for any teacher. Teachers who voluntarily participate in the study will be entered in a drawing for a chance to win one of ___ \$10 gift certificates to McAlister's Deli. Teachers will remove and keep a numbered ticket (that is randomly assigned) from the corner of their survey form. This ticket will be required for winning teachers to claim their prize because, as previously stated, names and identities will not be attached to completed survey forms. The surveys are a self-report document, and no student data and/or correlations regarding student data will be used in the study.

Once the study is complete, all participating individuals will have access to the results and findings of the study. Should any participant have further questions, he/she can contact the researcher using the information posted at the top of this letter. Again, thank you for your willingness to participate in this research study. With these types of collaborative efforts, the plans of action created on behalf of our teachers and students will help in our efforts to advance the educational experiences of all learners.

Sincerely,

L. Joan Smith

APPENDIX C

LETTER TO TEACHERS

*Researcher's Contact Information**Address**City, State, Zip Code**Email Address*

Dear Elementary Education Teacher,

I am a student at The University of Southern Mississippi working on the completion of my Doctor of Philosophy degree (Ph.D.) in Curriculum, Instruction, and Special Education through the College of Education and Psychology. In partial fulfillment of my requirements, I am conducting a survey of elementary school teachers who are certified to teach in grades K-6 (rather K-4, 4-8, K-8, or K-6) to ascertain their personal perceptions of math anxiety, math self-efficacy, math teaching self-efficacy, and instructional practices.

Directions

1. Please do NOT write your name on the survey.
2. Please note that you are NOT required to participate and that you may choose to decline the opportunity to participate. There is no penalty for not participating, and your identity will not be revealed.
3. Please answer the demographic information on the front page of the survey.
4. Read each direction set carefully.
5. Many of the survey statements express feelings, attitudes, or beliefs about mathematics; however, some express beliefs and views regarding instructional practices. Please carefully read each statement and circle the number that corresponds with your answer. PLEASE NOTE: The scales of the surveys range from 1-6 and 1-5. The meanings of the scaled numbers are explicitly defined at the top of each number column.
6. All statements should have a response, please.
7. The survey should take between 20-30 minutes to complete.
8. When you have completed the survey, please deposit it in the identified, sealed box located in the designated spot assigned by your school administrator. Please detach the ticket that is stapled in the right-hand corner so that you can participate in the drawing for a chance to win one of __ \$10 gift certificates to McAlister's Deli. Once all of the surveys are collected, the winner(s) from your school district will be selected.

SPECIAL NOTE: Only the researcher will see the answers on your survey. The researcher will have no way to personally identify you. Your school administrator(s)

and/or school district personnel **not** see your survey answers. Please place the survey, face down, in the deposit box in your school.

Thank you for your help in participating in this important study. If you would like to know the final results of the study, please contact me at the email address posted above. Your time and input are greatly appreciated. Best wishes to you as you conclude the 2009-2010 school year!

Sincerely,

L. Joan Smith

APPENDIX D

IRB PERMISSION LETTER



THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

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

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

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

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

PROTOCOL NUMBER: **10042005**

PROJECT TITLE: **The Relationship Among Mathematics Anxiety, Mathematical Self Efficacy, Mathematical Teaching Self-Efficacy, and the Instructional Practices of Elementary School Teachers**

PROPOSED PROJECT DATES: **04/13/2010 to 12/31/2010**

PROJECT TYPE: **Dissertation or Thesis**

PRINCIPAL INVESTIGATORS: **Lydia Joan Smith**

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

DEPARTMENT: **Curriculum, Instruction, & Special Education**

FUNDING AGENCY: **N/A**

HSPRC COMMITTEE ACTION: **Expedited Review Approval**

PERIOD OF APPROVAL: **04/29/2010 to 04/28/2011**

Lawrence A. Hosman

 Lawrence A. Hosman, Ph.D.

4-30-2010

 Date

APPENDIX E

PERMISSION FOR INSTRUMENT USE



UNIVERSITY of NEW HAMPSHIRE

January 27, 2010

Lydia Joan Smith
118 College Drive #9510
Hattiesburg, MS 39406

Dear Ms. Smith,

Thank you for your interest in the Patterns of Adaptive Learning Survey (PALS). Our research group makes PALS available to researchers worldwide free of charge at our website www.umich.edu/~pals/pals. You have permission to use scales from the survey in your work and to adapt them to your particular context as needed.

I hope you find PALS useful in your research. Please let me know if I can provide additional information or answer any questions about PALS as you progress with your work.

Best regards,

A handwritten signature in blue ink that reads "Michael Middleton".

Michael Middleton
Associate Professor

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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

January 26, 2010

Lydia Joan Smith
118 College Drive #9510
Hattiesburg, MS 39406

Hi Joan:

You have my full permission to use the AMAS, and there is no need to contact the other authors.

Best of luck with your research!



Derek R. Hopko

Dr. Diane Kahle
4631 Coach Road
Columbus, Ohio 43220-2901

February 22, 2010

Lydia Joan Smith
118 College Drive #9510
Hattiesburg, MS 39406

Hello Joan,

Yes, I'm pleased that you will be able to use my survey for your study. All I ask is that you reference it properly as I'm sure you will. Good luck with your dissertation work. I did get your letter and I apologize for not getting back to you sooner. I'll look forward to seeing your results.

Sincerely,



Dr. Diane Kahle
UAHS Mathematics Teacher

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