The Impact of Professional Development in Mathematics on Elementary School Teachers' Mathematics Anxiety and Mathematics Efficacy Beliefs

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Abstract

Based on the design of the traditional elementary school, all classroom teachers are required to teach mathematics to their students; however, some teachers report they experience anxiety towards mathematics potentially impacting their students' learning. The purpose of this study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics anxiety, professional mathematics teaching anxiety, personal mathematics teaching efficacy, and their mathematics teaching outcome expectancy changed after the implementation of professional development in mathematical instructional practices. A quantitative, causal-comparative research design was utilized in this study. The independent variable for this study was participation in professional development in mathematics instructional practices. The four dependent variables measured were teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy and were measured using the McAnallen Anxiety in Mathematics Teaching Survey (MAMTS) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). The population included teachers in grades pre-kindergarten through sixth grade employed in one Midwestern public school district. Teachers in the sample participated in professional development opportunities provided by the district in mathematics instructional practices and completed the pre-and post-professional development surveys.

The results of this study indicated for primary elementary teachers, the mean perception of personal mathematics anxiety before the implementation of professional development in mathematics instructional practices was not different from the mean

perception of personal mathematics anxiety after the implementation of professional development in mathematics instructional practices. However, for primary elementary teachers, the mean perception of the three remaining dependent variables before the implementation was different from the mean perception after the implementation of professional development in mathematics instructional practices. For intermediate teachers, the mean perception of all four dependent variables before the implementation was different from the mean perception after the implementation of professional development in mathematics instructional practices. This study has implications that can be used by district leaders who are in school districts focusing on improving mathematics instructional practices in the classroom through professional development needs of its' certified elementary teachers.

Dedication

My family put me first on this adventure through their endless support. Thank you to my husband, Dan, for literally always taking care of everything at home while my work and my writing consumed our time. Your patience and encouragement are a testament to your character and strength as a husband and a father and a foundation of faith from your parents. For my father and mother, your devotion to the love of family, of support, and of the importance of a strong work ethic carries forward in the generations of our family. My understanding and appreciation for everything you have done for me have deepened, and I realize how blessed I am with the generations of our family. Returning home and seeing green, waving fields of corn reminds me of what hard work truly is and the sacrifices my ancestors made for our family's future. I hope I have made them proud. Finally, thank you to the planes, trains, and automobiles that safely carried me to destinations during this journey while my family members and in-laws patiently allowed me to write during our time together. You know you are loved when they support your writing as part of every family trip.

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Chapter 1

Introduction

Legislation from the federal government calling for improving student achievement places demands on elementary classroom teachers to become highly skilled in all core content areas. The enactment of the Elementary and Secondary Education Act (ESEA), commonly known as the No Child Left Behind Act (2001), included the assessment of students in reading and mathematics with progress requirements and the provision of teacher qualification criteria or highly qualified classification. Signed into law on December 10, 2015, the Every Student Succeeds Act (ESSA) reauthorized the ESEA. A critical provision in the ESSA included the requirement that all students in every school across the country be taught to high academic standards to prepare them to succeed in college and careers (U.S. Department of Education, 2016).

While secondary teachers through their licensure path specialize in one content area, the challenge exists for elementary teachers to become content knowledgeable and skilled instructors across all core content areas. In support of effective mathematics instruction, the National Council of Teachers of Mathematics (NCTM, 2000) identified the standards that elementary teachers should implement in their instructional practices and the Institute for Education Sciences (Loewus, 2016) supported more than 200 federally-funded studies about best practice for mathematics instruction. However, research has shown that teachers' mathematics anxiety and low mathematical self-efficacies have negatively influenced some students' academic performance in mathematics (Beilock, Gunderson, Ramirez, & Levine, 2010; Kahle, 2008). Consequently, while the national standards provide the basis for instruction, these standards do not necessarily eliminate or alleviate teachers' individual issues and concerns with mathematics (Kahle, 2008). Elementary teachers with mathematics anxiety, low sense of mathematical self-efficacy or mathematical teaching self-efficacy, may negatively affect their ability to implement mathematics instructional practices to support increased student achievement (Muijs & Reynolds, 2015).

Effective teaching also requires a challenging and supportive classroom learning environment for students as well as teachers continually seeking personal improvement in their teaching practice (Cooney, 1994; Graham & Fennell, 2001; NCTM, 2000, 2013, 2017). The use of professional development has been shown to be an effective method for improving teacher quality (Anderson & Olson, 2006; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Researchers at the National Research Council (NRC, 2001) supported providing professional development by stating, "If the United States is serious about improving students' mathematical learning, it has no choice but to invest in more effective and sustained opportunities for teachers to learn" (p. 12).

Because of increased legislative demands through ESEA that impact schools across America, it is important to study elementary teachers' perceptions of their mathematics anxiety. It is also important to study elementary teachers' self-efficacy in mathematics and mathematical teaching self-efficacy. Finally, professional development affects student achievement in three steps including enhancing classroom teachers' knowledge and skills. Subsequently, with better knowledge and skills teachers are able to improve classroom teaching and improved teaching in the classroom raises student achievement across the grade levels (Yoon et al., 2007). Because of this, it is important to study changes in teachers' perceptions of their mathematics self-efficacy, teaching efficacy, mathematical anxiety, and mathematics teaching outcome expectancy because if one area is weak then increased student learning cannot be expected.

Background

District A, a small Midwestern district of approximately 1,700 students, has been a part of the public school system since 1901. This school district is a public school system comprised entirely of federal property. The school district serves the military dependents of service men and women stationed at the military post, the National Cemetery, and the U.S. Penitentiary located on the military post, and the children of district staff. Students attend grades kindergarten through ninth grade, 92% of whom are dependents of active duty military soldiers and 8% are dependents of retired military or employees working on federal property (District A, 2016).

The student mobility rate within the district is a major educational challenge as it reaches nearly 50% each year. This high-level student transiency creates a unique opportunity for teachers and the school district overall. Though each student enters at different academic, social, and emotional levels, the district's focus is to help all students succeed, recognizing that they have been mobile for many years with minimum continuity in instruction. The district believes that it is imperative all students receive instruction matched to their learning needs to continue to master and develop their needed knowledge, skills, and abilities for postsecondary and career choices.

The district utilizes the STAR Assessment (Renaissance Learning, 2016) and the state assessment results as a measure of student achievement. Results from the 2015-2106 state assessments showed the district is above the overall state median in both English language arts (ELA) and mathematics; however, mathematics did not show the same level of gains as ELA. A review of data showed that across the assessed elementary grade levels of grades 4 through 6, 12.5% of the ELA tested content standards were at the highest score level of exceeds whereas 0% of the mathematics scores were at the exceeds level (Kansas State Department of Education, 2016).

Statement of the Problem

Some teachers initially choose elementary education because they expect few mathematics requirements; however, as they progress through their careers, they discover they do need to be knowledgeable about mathematics to teach children effectively (Tobias, 1978a). One example of an elementary teacher choosing to teach at a primary grade level is exemplified in a previous discussion the researcher had with elementary teachers about teaching core content. One teacher commented, "Math is not my thing. I'd rather teach reading" (district teacher, personal communication, August 12, 2011). In contrast, a second-year teacher with a non-traditional background of a retired military officer with education as a second career commented, "I enjoy teaching math" (district teacher, personal communication, November 6, 2015). Results from the current state assessment scores showed the second teacher's class performing at one of the highest achievement levels for that specific grade level across the district in mathematics.

Effective mathematics instruction requires teachers to consider how they think about mathematics, how they view students as learners, the environments of the classroom, and their roles as teachers (Reys, Reys, Barnes, Beem, & Papick, 1998). Research comparing Turkish and American preservice elementary teachers showed that Turkish university requirements include a nationwide entrance exam including mathematics and science questions, and completion of theoretical and practical courses in mathematics (Isiksal, Curran, Koc, & Aksum, 2009) as compared to no universally-required entrance exam at American universities and completion of a maximum of two to three mathematics classes at the college level (Isiksal et al., 2009) which limits the amount of preservice education supporting a high level of effective mathematics instructional background to implement into professional practice.

Researchers identified preservice elementary teachers as having mathematics anxiety (Swars, Daane, & Giesen, 2006). Specific beliefs communicated by most elementary teachers in a study by Austin, Wadlington, and Bitner (1992) included a statement of the reason for their anxiety, “Some people have a math mind and some don’t” (p. 391). Mathematics anxiety negatively affects professional teachers’ instructional practices (Burrill, 1997). Specifically, teachers who exhibit a sense of mathematical anxiety convey that anxiety to their students in the classroom through their instructional practices (Alsup, 2003; Beilock et al., 2010).

Teachers’ self-efficacy in a content area and instructional practices have been found to impact student achievement (Bandura, 1995; Brophy, 1986; Good & Brophy, 2003; Zimmerman, 1995). Improving student achievement led to the National Math Panel calling for a reform of mathematics education in the United States (U.S. Department of Education, 2008). Despite the adoption of the Common Core State Standards for Mathematics in 45 states beginning in 2006, questions continued to be raised nationwide about how to build teachers’ self-efficacy in mathematics content and instructional practices (Schmidt, 2012). Demonstrating the point of ongoing lack of guidance about building teachers’ self-efficacy, the state of Kansas provides the framework of the Common Core Standards, which establish academic expectations in mathematics that define the knowledge and skills all students should master by the end of each grade toward the goal of college and career readiness; however, these standards do not provide instructional best practices for teachers but rather academic grade-level expectations for all students (Kansas State Department of Education, 2017).

McCoach and Siegle (2007) established classroom teachers who personally received staff development on teaching strategies resulted in a positive impact on students' mathematics pre-and post-assessments as compared to students of teachers not participating in the professional learning. Research on mathematics anxiety (Ashcraft & Moore, 2009; Battista, 1986; Zettle & Raines, 2002), and self-efficacy in mathematics (Ball, 1991; Swars, 2005; and Harrell, 2009) has been conducted. Also, research on mathematical teaching efficacy has been conducted (Bandura, 1995; Tschannen-Moran & Woolfolk Hoy, 2007; Ware & Kitsantas, 2007). However, not enough is known about the concepts of teachers' perceptions of personal mathematics self-efficacy and anxiety, mathematics teaching self-efficacy and anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy and the relationship of these concepts with the introduction of professional development related to mathematics instructional practices.

Purpose of the Study

The purpose of this study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics anxiety changed after the implementation of professional development in mathematics instructional practices. The second purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their professional mathematics teaching anxiety changed after the implementation of professional development in mathematics instructional practices. The third purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy changed after the implementation of professional development in mathematics instructional practices. Finally, the fourth purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy changed after the implementation of professional development in mathematics instructional practices.

Significance of the Study

Because many elementary school teachers specifically express fears and anxiety toward the subject of mathematics (Buhlman & Young, 1982), it is important to investigate if there is a change in these fears and anxiety after the introduction of professional development in mathematics instructional practices. Additionally, for elementary teachers who perceive they have low self-efficacy in mathematics, it is important to investigate the change in their perceptions after the introduction of professional development. The results of the current study could contribute to the knowledge base related to primary and intermediate elementary teachers' perceptions of their personal mathematics self-efficacy and anxiety, mathematics teaching self-efficacy and anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy.

Because mathematics is a core content for all elementary students to learn, it is important to determine if the introduction of professional development changes teachers' personal mathematical anxiety, professional mathematics anxiety, teaching self-efficacy, and mathematical teaching outcomes to impact classroom instruction. Understanding these results could provide valuable information for K-12 administrators in determining intentional, targeted professional development in mathematics for elementary education teachers to positively impact student achievement. The results of the current study could also be of importance to faculty and administrators at universities that provide elementary education programs to determine needed program requirements for undergraduate students.

Delimitations

Delimitations, according to Lunenburg and Irby (2008) are “self-imposed boundaries set by the researcher on the purposes and scope of the study” (p. 134). Delimitations included elementary school teachers of kindergarten through sixth grade in one Midwestern school district participated in this study. The inclusion of only public-school teachers did not allow the perceptions of elementary school teachers in the private school setting to be included. One school district was used to conduct the research, which limited the access to the number of participants. Finally, only the variables of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the introduction of professional development of mathematics instructional practices as measured by selected instruments were investigated in the study.

Assumptions

Assumptions, as defined by Lunenburg and Irby (2008), are “postulates, premises, and propositions that are accepted as operational for the purposes of the research” (p.

135). Assumptions that influenced this research included results in which participants responded accurately and honestly in their responses resulting in valid data. Additionally, results from the sample of teachers surveyed were representative of the beliefs of elementary teachers across public schools throughout the Midwest. Finally, the instruments utilized to collect data were assumed to be accurately represented by the publishers for their reliability and validity.

Research Questions

The following research questions guided this study to determine elementary teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching self-efficacy, and mathematics teaching outcome expectancy after the introduction of professional development of mathematics instructional practices. Included in the research questions are the survey instruments. The first survey instrument, the McAnallen Anxiety in Mathematics Teaching Survey (MAMTS), measures teachers' perceptions of personal mathematics anxiety and professional mathematics teaching anxiety. The second survey, Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), measures teachers' perceptions of personal mathematics teaching efficacy and mathematics teaching outcome expectancy.

RQ1. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

RQ2. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

RQ3. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

RQ4. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

RQ5. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

RQ6. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

RQ7. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

RQ8. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

Definition of Terms

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

Mathematics anxiety. Cemen (1987) defined mathematics anxiety as a state of discomfort that occurs in response to situations involving mathematical tasks in which individuals can feel a lowered sense of self-esteem in their mathematical abilities.

Mathematics instructional practice. As defined by Midgley et al. (2000), mathematics instructional practice is the way teachers instruct mathematics based on their strengths rather than their weaknesses, and how teachers deliver instruction based on personal beliefs regarding learning.

Mathematical professional development. According to Jones, West, and Stevens (2006), mathematical professional development is teachers' learning on an individual basis that impacts school or district needs to support improved instruction for increased student outcomes.

Mathematical self-efficacy. Kahle (2008) defined mathematical self-efficacy as an individual's perception of personal mathematical ability in solving mathematical problems and completing mathematical tasks derived from the Mathematics Teaching and Mathematics Self-Efficacy Scale.

Mathematics teaching efficacy. According to researchers (Ashton & Webb, 1986; Enochs, Smith, & Huinker, 2000; Gibson & Dembo, 1984), mathematics teaching efficacy represents a teacher's belief in his or her skills and abilities to be an effective teacher of mathematics.

Mathematics teaching outcome expectancy. Defined by researchers (Ashton & Webb, 1986; Enochs et al., 2000; Gibson & Dembo, 1984), mathematics teaching outcome expectancy is a teacher's belief that effective mathematics teaching can result in students' mathematical achievement not impacted by outside factors including family involvement and community influences.

Organization of the Study

The introduction to the problem statement and design components of this study including background, significance, purpose statement, delimitations, assumptions, research questions, and the definition of terms were included in this chapter. A relevant review of the literature regarding the problem is presented in Chapter 2. Chapter 3 contains the presentation of methodology and procedures used for data collection and analysis. An analysis of the data is included in Chapter 4. In Chapter 5, a summary of the study, findings related to the literature, and the conclusions are presented.

Chapter 2

Review of the Literature

Chapter 1 provided an overview of the requirements of legislation from the federal government calling for improving student achievement and the demands placed on elementary classroom teachers to become highly skilled in all core content areas. Within the core content area of mathematics, a challenge exists for elementary teachers to become content knowledgeable both personally and professionally in mathematics, along with all other subjects. As mathematics instructors in the elementary classroom, some elementary teachers report mathematics anxiety or a low sense of mathematical self-efficacy. This chapter builds on the overview of the requirements of elementary classroom teachers in mathematics by synthesizing the literature relating to mathematics and student achievement, teachers' perceptions about mathematics anxiety, teachers' perceptions about mathematics self-efficacy and mathematical teaching self-efficacy, and mathematics professional development for teachers.

Mathematics and Student Achievement in the United States

With society's ongoing concentration on science, technology, engineering, and mathematics (STEM) to include the public's day-to-day reliance on technology in both professional and personal settings, educators across the United States must focus on mathematics education in kindergarten through twelfth-grade classrooms. "All students must receive preparation, beginning in prekindergarten, for algebra and other advanced mathematics topics" (Brown, 2009, p. 5). Students entering kindergarten are exposed to mathematics instruction to begin building mathematical concepts. In conjunction with mathematics instruction, assessment occurs. Standardized testing, designed to measure a student's aptitude and achievement and the quality and effectiveness of the instruction provided by each classroom teacher (Ashcraft & Moore, 2009), is one form of assessment to measure student growth. A call for standards-based instruction occurred to target instructional practice and assessment in order to standardize mathematics instructional practices across the country to prepare learners for post-secondary careers.

Despite the focus on standards-based reform in the United States, achievement gaps continue to be evident in mathematics across the country. In 1989, the NCTM outlined a set of comprehensive learning goals in the form of standards for mathematics at the national level that called for a broader view of mathematics and teaching, which highlighted traditional skill and content goals in addition to developing students' "mathematical power" (NCTM, 1989, p. 5) and subsequently published *Professional Standards for Teaching Mathematics* (NCTM, 1991) and *Assessment Standards for School Mathematics* (NCTM, 1995). In culmination, the NCTM (2000) published *Principles and Standards for School Mathematics*.

Despite published standards for teaching and assessing mathematics, the call for reform continued in 1999 when the National Science Board stated that deficiencies in mathematics and science were barriers to higher education and the 21st-century workplace. The National Science Board (1999) reported that during the 1980s national standards in mathematics began to be designed by the NCTM in consultation with all stakeholders in education serving students from ages four to graduate school. In 1994, the reauthorization of Title I of the Elementary and Secondary Education Act supported the standards movement by providing financial assistance to local agencies to improve outcomes for schools with large numbers of students from lower socio-economic families by “requiring states to develop challenging standards for performance and assessments that measure student performance against the standards” (Elmore & Rothman, 1999, p. 1). Additionally, a call for educational reform under three presidential administrations including *A Nation at Risk* (National Commission on Excellence in Education, 1983), *America 2000* (U.S. Department of Education, 1991), and *Goals 2000* (U.S. Department of Education, 1998), called for higher educational standards. President Reagan noted:

> The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur -- others are matching and surpassing our educational attainments. (National Commission on Excellence in Education (NCEE), 1983, para. 1)

Despite this work, in 2013, the achievement levels of eighth-grade students on the National Assessment of Educational Progress (NAEP) revealed 35% of all students scored proficient or above. Additionally, 26% of all students scored below basic on the same assessment. In 2015, fourth-and eighth-grade students’ scores resulted in lower average scores than in the previous assessment. This result was the first time that the average mathematics scores decreased from one administration to the next. Additionally, White students’ average mathematics scores were lower than their 2013 score average at fourth grade. Other races’ scores including Asian/Pacific Islander, Black, and Hispanic students did not increase from the 2013 scores (National Center for Educational Statistics, 2017).

In addition to the ethnic subgroups, in 2001 the achievement gaps continued to be evident in mathematics within other subgroups throughout the United States.

Specifically, mathematics achievement gaps continue to exist for students who are at risk for failure including those who are more mobile due to family circumstances and those with disabilities (Smrekar, Guthrie, Owens, & Sims, 2001). Many educators have argued that because these students have not consistently had the benefit of a standards-based curriculum, they historically have not performed as well as their peers on large-scale assessments in mathematics (Maccini & Gagnon, 2002). Research has shown that general education and special education teachers report a lack of materials and intervention methods as a barrier in teaching mathematics specifically for students at-risk and those with disabilities, which is “disconcerting for students who require manipulatives, multiple representations, and varied examples and non-examples as teachers’ progress through the concrete-semi-concrete-abstract phases of instruction” (Maccini & Gagnon, 2002, p. 339).

Closing achievement gaps could be considered a goal of all stakeholders in the United States educational system for students to compete in an increasingly global future economy. All students can be mathematically proficient (Kilpatrick, Swafford, & Findell, 2001) with the targeted focus on mathematical proficiency of five components. The authors identified the following:

> These components, or strands, include conceptual understanding of mathematical concepts, operations and relations; procedural fluency with accuracy and efficiency; strategic competence which includes the ability to compose and correctly solve mathematical problems; adaptive reasoning with the capacity for critical thought and rational justification; and productive disposition of naturally using mathematics in one’s daily life with ease as an effective tool to problem-

solve challenges requiring mathematics interaction. (Kilpatrick et al., 2001, p. 116)

In a comparative analysis of mathematics assessments administered to United States and Japanese students, eighth-graders demonstrated differences in testing format and expectations between the two groups. The assessment for eighth-grade Japanese students was composed entirely of multiple-choice items whereas the United States eighth-grade students' assessment contained both multiple-choice items and items on which students were required to provide a written response. In contrast, however, the Japanese exam contained fewer than half the questions and items that were longer, required more reasoning and analysis and resulted in much lower expectations for students in the United States (Dossey, 1997). In examining the differences between the Japanese assessment and the United States assessment, it was observed that within the design there was clearer coherence and focus in the Japanese materials. This observation led to recommendations including the Curriculum and Evaluation Standards for School Mathematics should contain grade level guidance about focus and activities specific to each grade level. According to Dossey (1997), "This step to achievement and delivery standards for school mathematics is circularly-achievable within the framework outlined by the NCTM content standards. Whether it is politically acceptable or systematically implementable are larger more volatile questions" (p. 40).

The 2015 Trends in International Mathematics and Science Study (TIMMS), evaluated mathematics and science achievement of United States students at fourth and eighth grade to students in the same grade levels in countries around the world. TIMMS compared mathematics data from 54 education systems (countries or portions of a country when the country was represented by multiple education systems) at fourth grade and 43 education systems at eighth grade. According to TIMMS, in average mathematics scores of fourth- and eighth-grade students, the United States ranked 14th and 10th, respectively. Education systems that scored above the United States in both grade levels included Singapore, the Republic of Korea, Chinese Taipei, Hong Kong, Japan, the Russian Federation, Kazakhstan, and Ireland (NCES, 2017). These statistics revealed the United States does not lead the world in mathematics achievement for either elementary or secondary students.

The National Mathematics Advisory Panel (2008) determined effective mathematics instruction matters, and it significantly impacts student learning**.** Research shows that classroom teachers are the most influential factor impacting student achievement (Darling-Hammond, 2004; Hidi, 2001). In the 1996 NAEP mathematics assessment, teachers of 81% of the eighth graders reported they were “certified to teach mathematics” (Hawkins, Stancavage, & Dossey, 1998, p. 19) and the number dropped to 32% of teachers of fourth-graders. Ball (1990, 1996) concluded that pre-service teachers do not have a deep understanding of mathematics but instead are fluent only in memorized facts and rules. Many of these same pre-service teachers have not experienced teaching practices from K-12 classroom educators that focused on multi-step, complex mathematical thought processes requiring logical, sequential mathematical reasoning in authentic scenarios. This lack of exposure to teaching methods continued into pre-service coursework. At the post-secondary level, Manouchehri (1997) observed teacher-led lectures was the standard mathematical instructional approach in many university and college classrooms rather than on approaches such as investigations, explorations, and multiple representations. Battista (1999) found that the majority of pre-service elementary teachers received their own mathematics instruction focused narrowly on procedures delivered in a lecture format. “Traditional mathematics teaching … is still the norm in our nation’s schools. For most students, school mathematics is an endless sequence of memorizing and forgetting facts and procedures that make little sense to them” (Battista, 1999, p. 426). Furthermore, Alsup (2003) established that because elementary teachers have often experienced math instruction narrowly focused on rules, formulas, and answers many pre-service elementary teachers experience mathematical anxiety about mathematics classes at the university level. Felton (2016) reported the National Center on Education and the Economy (NCEE) said elementary teachers can demonstrate to their students the steps to complete a long division problem but cannot explain how or why the process works.

Teachers’ Perceptions about Mathematics Anxiety

Individuals bring to their personal and professional settings their own perceptions and attitudes toward mathematics. Manigault (1997) stated, “There are probably millions of people who are math inhibited, math scared, or math scarred” (p. 1). Within a group of students, individual students report enjoying mathematics while others report negative thoughts and feelings about mathematics (Ashcraft, Kirk, & Hopko, 1998, Fennema & Sherman, 1978; Stodolsky, 1985). One challenge of negative attitudes can be that it produces anxiety, which results in mathematics anxiety continuing to rise over the course of educational careers (Brush, 1981) and into adulthood. Despite a desire to serve in the role of a professional educator, mathematics anxiety also impacts post-graduate students entering professional teaching roles (Kelly & Tomhave, 1985; Nisbet, 1991; Trujilo

Hadfield, 1999) including professional educators currently teaching in classrooms across the country. “One teacher in an adult group workshop reported that calculating the tip in a taxi was often so distressing that she preferred to walk, carrying heavy suitcases rather than experience such discomfort” (Donady and Tobias, 1977, p. 71). Mathematical anxiety may first be encountered by students from the instructional practices of their teachers, so teachers should first examine their own perceptions of their personal mathematics anxiety to determine if they may be the starting point of their students developing their own negative attitudes towards mathematics (Sovchik, 1996).

Mathematics anxiety has been defined in several ways. Early researchers defined it as a “fear of mathematics that usually stems from unpleasant experiences in mathematics either at school or home” (Richardson & Suinn, 1972, p. 552). Behaviors of nervousness and the inability to concentrate when faced with solving mathematical problems can be a result of mathematics anxiety (Tobias, 1978a). Hendel and Davis (1978) noted that when individuals with mathematics anxiety were faced with opportunities to learn mathematics, they instead “chose to avoid it which resulted in lower personal mathematics abilities ultimately impacting school and career decisions” (p. 433). Tobias and Weissbrod (1980) explained mathematics anxiety as “the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem” (p. 63). Austin and Wadlington, (1992) added to the research by stating that these individuals may also have negative math self-concepts as well. Tobias (1995) expanded on her earlier research and referred to mathematics anxiety as feelings of nervousness and tension for intellectually-capable individuals trying to solve mathematical problems in both academic and real-life scenarios.

Burns (1998) and Zettle and Raines (2002) defined mathematics anxiety as feelings of uncomfortableness resulting from being faced with mathematical problems perceived as challenging one's self-esteem potentially leading to negative thoughts toward mathematics. Bursal and Paznokas (2006) described mathematics anxiety as "a lack of applied understanding or an irrational dread of mathematics, which can often lead to an avoidance of the subject" (p. 173). Researchers distinguish mathematics anxiety as related only to mathematics instruction and activities that subsequently impact mathematics performance and reduces the opportunity for mathematical learning to occur (Burns, 1998; Bursal & Paznokas, 2006; Hembree, 1990; Tobias, 1998; Wood, 1988; Zettle & Raines, 2002). Burns (1998) and Jones (2001) found that 25% to 50% of Americans experience mathematics anxiety.

Robertson (1991) noted that mathematics anxiety begins mathematics avoidance, which leads to four potential phases incurred during mathematics anxiety. In the first phase, when a person faces a situation involving the expectation of interactions with mathematics, a negative reaction occurs. This negative reaction may have been a result of past negative experiences with mathematics. This first phase leads to the second phase of avoidance. In this phase, because of the negative reaction, the person chooses to evade mathematical situations. This circumventing of mathematical experiences leads to the third phase, which is reduced mathematics preparation, which finally results in the fourth phase of poor mathematical performance. When a person experiences all four phases, Robertson (1991) established that it manifested more negative experiences in mathematics and the cycle could be repeated. Each repetition of the cycle negatively reinforces to the person their inability to solve mathematics problems. Also, the results of Robertson's research showed that it is difficult for a person to break the cycle of repetition once they have entered it.

Mathematics anxiety has been described as an "I can't syndrome," a feeling of uncertainty, and of "causing an emotional static in the brain" (Tobias, 1978a, p. 48). Research by Preis and Biggs (2001) revealed "math myths" included statements such as: "I'm good at English – that's why I'm so bad at math; Women can't do math; Some people can do math, others can't; and My father/mother couldn't do math either" (p. 6). Perceptions as to the cause of mathematics anxiety included negative experiences as students in school encountering mathematics, lack of family support in learning mathematics, and mathematics test-taking anxiety (Trujillo & Hadfield, 1999). Preis and Biggs (2001) further revealed that they believe "it is more acceptable to say I'm not good at math than to say I can't read" (p. 6). Research by Swars (2004) revealed a pre-service teacher felt that teaching mathematics would take "a lot of energy and effort but reported that the use of mathematics in real-life situations was important in daily life" (p. 56). While important, researchers highlighted the difficulty in understanding mathematics when they established the brain required four stages of encoding, planning, solving, and responding to solve a mathematics problem successfully (Carey, 2016).

Mathematics anxiety has also been studied through biological research and manipulation of timing conditions specific to arithmetic task performance involving complex problems. Kellogg et al. (1999) studied 30 participants who were undergraduate psychology students attending Cleveland State University. These study participants included those with high mathematics anxiety who may have a “deficient inhibition mechanism which results in their working memory utilized by distractors irrelevant to the mathematics task” (p. 591). According to Hopko and Ashcraft (1999), the results of this deficiency were that tasks requiring conscious, long-term recollection of mathematics procedures were lower for individuals with elevated levels of anxiety as these individuals lacked processing efficiency. The working memory resources become consumed with anxiousness leaving fewer memory resources available for processing mathematical task completion requirements. In their study, Kellogg et al. (1999) hypothesized mathematics anxiety might be incurred through the factor of time resulting in performance deficits and “compared to individuals with low math anxiety, high math-anxious individuals exhibit performance deficits when engaging in arithmetic tasks” (p. 597). Ashcraft and Kirk (2001) found a difference in performance outcomes for individuals with high mathematics anxiety when solving more challenging mathematics problems. In subsequent research, Ashcraft and Moore (2009) investigated the cognitive consequences of mathematics anxiety when college students performed mathematical computations in a controlled setting of a laboratory. Within this setting, the researchers tested students at the University of Nevada, Las Vegas, on tasks that involved working memory on two-column addition problems consisting of with and without carrying ones to tens. This task was completed in combination with the exercise of letter recall, remembering either two or six letters of the alphabet while completing the addition problem and then correctly repeating back the letters, which cognitively impacted working memory. Results showed that carrying numbers in two-column addition impacted working memory as demonstrated by the higher number of errors in the letter recall task and it was highest among the study participants reporting the highest levels of mathematical anxiety. Ashcraft and Moore (2009) concluded that those participants were using portions of their working memory on their mathematics anxiety whenever they performed a mathematics task and if the requirement became more challenging they were "participating in a three-way competition for their limited memory resources: difficult math, letter retention and recall, and their own math anxiety … and their performance markedly dropped" (p. 202).

Interventions to reduce mathematics anxiety among college students, including graduate-level students, have shown a positive impact. In a study by Chapline (1980), pre-service elementary teachers reported a reduction in mathematical anxiety after the introduction of a mathematics methods course utilizing strategies to reduce anxiety. Teague and Austin-Martin (1981) studied pre-service elementary teachers enrolled in a mathematics methods course on teaching mathematics and learned the pre-service teachers' perceptions of their professional mathematics anxiety decreased after the introduction of mathematics instructional practices in their mathematics methods courses; however, the researchers did not find a significant change in the pre-service teachers' perceptions about mathematics. Results of research by Sovchik, Meconi, and Steiner (1981) on mathematics anxiety in pre-service teachers in Ohio were these study participants reported a reduction in their mathematical anxiety after participating in a mathematics methods course. In a study in Kentucky, Widmer and Chavez (1982) found elementary teachers' professional mathematical anxiety levels were significantly reduced when emphasis was placed on learning during professional development opportunities.

In research completed with 153 undergraduate students in New Zealand enrolled in a statistics and research methods course, Townsend, Moore, Tuck, and Wilton (1998) introduced mathematical instructional strategies including cooperative learning activities in coursework throughout an academic year and results showed that participants reported their self-concept in statistics increased but their mathematics anxiety did not decrease. Townsend, Lai, Lavery, Sutherlund, and Wilton (1999) found that there could be a positive impact in lowering mathematics anxiety when introducing additional variables. In their research, study participants were 141 undergraduate students in New Zealand with a compression of course session times including smaller laboratory groups taught by highly experienced tutors with specific instruction focused on collaborative small-group work, whole class discussions, and problem-solving approaches based on the principles of cooperative learning. Additional variables included change to a new textbook in the course and fewer assessments administered to participants throughout the semester. Townsend et al. (1999) found that in the course, general mathematical anxiety did decrease. Townsend et al. (1999) indicated that this result coincides with previous research (Anton & Klisch, 1995) to consider mathematics anxiety as both a state variable (temporary) and a trait variable (stable) to separate these from the apprehension of the fear of failure through test anxiety.

Tobias (1978b) indicated that some undergraduate students initially determined elementary education as their major in college in part because of the expectations of less mathematics coursework. Pre-service teachers revealed they have higher levels of negative feelings about mathematics than their college peers (Emenaker, 1996) and reported increased levels of mathematics anxiety as compared to other undergraduate students enrolled in other programs (Bursal & Paznokas, 2006; Harper & Daane, 1998; Hembree, 1990). Battista (1986) revealed increased perceptions of mathematics anxiety in elementary teachers stemming from their pre-service teachers' experiences as compared to their college peers enrolled in other academic courses of study. These pre-service teachers experiencing mathematics anxiety included female students who, in their personal education as students, received lower than originally anticipated grades in their earlier mathematics classes (Battista, 1986). Individuals with high anxiety toward mathematics also have negative attitudes toward mathematics, which can result in an avoidance of mathematics throughout their education career (Jameson, 2010).

Results of numerous studies have indicated practicing professional elementary teachers report high levels of mathematics anxiety (Gresham, 2007, Levine, 1996; McAnallen, 2010; Sloan, Daane, & Giesen, 2002; Vinson, 2001; Zettle & Raines, 2002). Brown, Westenskow, and Moyer-Packenham (2011) surveyed 53 elementary pre-service teachers in their senior year of college enrolled in mathematics methods classes and reported varying degrees of a relationship between personal mathematics anxiety and professional mathematics anxiety. The authors noted that this relationship is difficult to predict as "preservice teachers with low or no mathematics anxiety in their prior experiences can still possess mathematics teaching anxiety when teaching mathematics to students and vice versa for pre-service teachers with high levels of mathematics anxiety in their backgrounds" (p. 11).

Harper and Daane (1998) attributed the elementary classroom setting to be the first impactful location in creating mathematics anxiety for students. McAnallen (2010) surveyed elementary teachers from eight different school districts in seven states and found over a third of these elementary teachers reported mild or moderate personal mathematics anxiety and determined that mathematics anxiety begins with classroom instruction. Understanding how teachers' personal mathematics anxiety may affect their professional mathematics anxiety is important. It is also important to understand their perceived mathematical teaching self-efficacy to determine their frame of reference to find the best methods for improving their mathematics instructional practices in classroom instruction.

Teachers' Perceptions about Mathematics Self-Efficacy and Teaching Self-Efficacy

Teachers' perceptions about their capabilities in the classroom have led to teachers leaving the profession with self-efficacy beliefs lower than teachers who continue in the profession (Glickman & Tamashiro, 1982). In the United States, 25% of beginning teachers leave the profession after completing only their first or second year of teaching while almost 40% of teachers quit between their first and fifth year of teaching (Gold, 1996; Harris, 1993). Ma (1999) stated:

> One thing is to study whom you are teaching; the other thing is to study the knowledge you are teaching. If you can interweave the two things together nicely, you will succeed . . . Believe me, it seems to be simple when I talk about it, but when you really do it, it is very complicated, subtle, and takes a lot of time. It is easy to be an elementary school teacher, but it is difficult to be a good elementary school teacher. (p. 136)

Shulman (1987) purported that "teachers must possess three kinds of knowledge to teach mathematics to students: knowledge of mathematics, knowledge of students, and knowledge of instructional practices" (p. 2). Expanding upon this, Kilpatrick et al. (2001) offered that a perceived inability in any area can impact the effectiveness of a classroom teacher because personally understanding mathematics for oneself is different from teaching mathematics to students:

> Teachers certainly need to be able to understand concepts correctly and perform procedures accurately, but they also must be able to understand the conceptual foundations of that knowledge. In the course of their work as teachers, they must understand mathematics in ways that allow them to explain and unpack ideas in ways not needed in ordinary adult life. (Kilpatrick et al., p. 10)

An important aspect of teacher self-efficacy is the alignment of teacher roles with personal values, beliefs, attitudes, and norms of behavior (Tschannen-Moran et al., 1998). Elementary school teachers possess limited knowledge of mathematics, have not been provided with opportunities to learn mathematics in their preservice coursework, and can have difficulty solving or expanding on mathematical ideas (Ball, 1991; Ma, 1999). Teachers with a lower content knowledge of mathematics and a lower belief in their ability to accomplish mathematical tasks have subsequently provided incorrect instruction to students for mathematical problem-solving procedures (Leinhardt & Smith, 1985) and often could not provide a clear explanation to students in support of mathematical understanding (Borko et al., 1992).

Defined by Bandura (1997a), perceived self-efficacy is a belief in one's personal capabilities. People with high perceived self-efficacy "approach difficult tasks as challenges to be mastered rather than threats to be avoided … they concentrate on the task, not on themselves" (p. 4). In contrast, Bandura (1997a) stated "people with a low sense of self-efficacy avoid difficult tasks, dwell on obstacles, the consequences of failure, and their personal deficiencies … failure makes them lose faith in themselves because they blame their own inadequacies" (p. 4).

Early researchers in the educational field defined efficacy as "the extent to which the teacher believes he or she has the capacity to affect student performance" (McLaughlin & Marsh, 1978, p. 84). Additionally, McLaughlin and Marsh (1978) reported that "teachers' sense of efficacy was the most powerful teacher attribute in the Rand analysis" (p. 84). Brookover and Lezotte (1979) reported that when students achieved at higher levels, teachers felt higher perceptions of self-efficacy and responsibility in student learning with prior research reporting similar findings (Brophy & Evertson, 1977; Murray & Staebler, 1974; Porter & Cohen, 1977). Tschannen-Moran et al. (1998) described teacher efficacy as "the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (p. 233).

Success with an individual student results in a sense of pride and accomplishment for a teacher (Lorne, 1975). Gibson and Dembo (1984) noted that teachers might subscribe to the belief that certain instructional methods will positively impact student achievement but do not believe they personally can effectively put those teaching practices into place in their own classroom. Guskey (1986) reported that teachers' views of personal mathematics teaching efficacy were more directly impacted by the group of students as a whole rather than the results of individual students. Specifically, Guskey (1986) noted, "When poor performance was involved, teachers expressed less personal responsibility and efficacy for single students than for results from a group or entire class of students" (p. 18). Smylie (1988) reported that as teachers' beliefs of efficacy increased so did their willingness to practice new teaching methods and resulted in decreased stress. Tschannen-Moran et al. (1998) emphasized the power in the cyclical nature of teacher efficacy meaning greater efficacy encourages greater effort, leading to better teaching performance and, thus, greater efficacy. Guskey (1998) reported teachers' internal sense of efficacy increased in conjunction with their beliefs of the importance of the recommended mathematical teaching practices in new teaching methods and their ability to positively implement these in their classrooms.

Expectations of mathematics self-efficacy were found to be positively correlated with mathematics ability (Betz, 1978). Researchers have investigated the effects of a person's specific expectations about mathematics self-efficacy on choice and persistence in mathematics-oriented careers (Betz & Hackett, 1981; Hackett, 1985; Lent et al., 1984). Dew et al. (1984) established a relationship between mathematics self-efficacy and choice of mathematics courses in high school. Study participants included 23 male and 40 female undergraduate students whose math avoidance behavior was measured. Respondents with low self-confidence in their mathematical abilities led to course choices of non-technical electives resulting in less mathematics background contributing to lower expectations of mathematics self-efficacy. Hackett (1985) reported an individual's perceptions of mathematics self-efficacy was the most powerful predictor of career choice. According to Manger and Eikeland (1998), mathematics self-concept accounts for differences in Norwegian elementary female and male students' achievement levels in mathematics. Harrell (2009) noted the highest level of mathematics college coursework completion was a positive predictor of mathematics teaching self-efficacy.

To provide a valid and reliable measure of teacher self-efficacy of pre-service elementary science teachers, Enochs & Riggs (1990) modified Riggs' (1988) Science Teaching Efficacy Believe Instrument Form A (STEBI-A) to include Science Teaching Outcome Expectancy Instrument (STEBI-B). The STEBI-B was administered to 212 pre-service elementary teachers in California and Kansas and was established to be a valid and reliable measure of personal science teaching efficacy and science teaching outcome expectancy for pre-service elementary teachers. Modification of the STEBI-B resulted in the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) for pre-service elementary teachers in which Enochs et al. (2000), the developers, established factorial validity. In their study, the researchers surveyed 324 pre-service teachers in California, South Carolina, and Michigan enrolled in a mathematics methods course and asked the subjects to complete the instrument at the end of the course. Item analysis was conducted, and the outcome was the MTEBI appeared to be a valid and reliable assessment of mathematics teaching self-efficacy and outcome expectancy.

Cooper and Robinson (1991) studied 290 incoming university students who had selected mathematics-based college majors and investigated the relationships among mathematics coursework background, mathematics self-efficacy and performance, mathematics anxiety, and perceived support from parents and teachers. They noted respondents with a high level of mathematics anxiety also reported a negative attitude towards mathematics and low mathematics self-efficacy. Results of the study also provided additional validation supporting a relationship between mathematics self-efficacy and mathematics performance as the participants with a high perceived level of external support from their parents and teachers were either completely supportive or somewhat supportive of their choice in mathematics as a college major. Utley et al. (2005) investigated the change in pre-service teacher personal mathematics teaching efficacy and mathematics teaching outcome expectancy during their methods courses and student teaching and reported the pre-service teachers' personal mathematics teaching efficacies significantly increased during participation in methods courses and student teaching as did their mathematics teaching outcome expectancies. Bursal and Paznokas (2006) also reported that in a study in Minnesota, pre-service primary and intermediate elementary teachers' mathematics anxiety influenced their self-efficacy beliefs about teaching mathematics.

Self-efficacy in teachers is important because it affects the effort teachers invest in instruction (Ware & Kitsantas, 2007). According to Bandura (1997b), lower self-efficacy means weaker commitment toward teaching because these teachers invest less time in areas they perceive as a content in which they do not personally possess a depth of knowledge. The results of research conducted by Hoy (2000) established that less efficacious teachers tended to project their inefficacy on students and pre-service teachers with extensive and integrated fieldwork of a year-long internship caused challenges including students feeling overwhelmed and exhausted which undermined the school-based focus of learning. Utilizing the MTEBI, Bursal and Paznokas (2006) studied anxiety levels in 65 pre-service primary and intermediate elementary teachers to determine if mathematics anxiety influenced their self-efficacy beliefs about teaching mathematics and reported 48% of pre-service teachers with high mathematics anxiety level had low confidence in successfully teaching mathematics effectively.

Tschannen-Moran and Woolfolk Hoy (2007) studied self-efficacy beliefs among 255 teachers ranging in age from 21 to 57 years old with 1 to 29 years of professional teaching experience. In this research, Tschannen-Moran and Woolfolk Hoy (2007) noted a lower mean of self-efficacy beliefs among novice teachers as compared to more experienced teachers and determined “low teacher efficacy beliefs can contribute to low student efficacy and low academic achievement, which in turn may contribute to further declines in teacher efficacy” (p. 947). Also, students may be negatively impacted as teachers with lower self-efficacy may not apply themselves causing students fewer learning opportunities. According to Ware and Kitsantas (2007), this lack of learning opportunities is challenging especially in mathematics instruction since new concepts are introduced in almost every lesson.

An attribute of teachers with higher self-efficacy includes persistence in their teaching. They are highly innovative, trying new techniques in their instructional methods, and if the results are not successful, these teachers persist and try again (Smith, 2010; Tschannen-Moran & Woolfolk Hoy, 2001). In further research, Goddard et al. (2004) defined the sources of efficacy shaping as “mastery experience, vicarious experience, social persuasion, and affective state” (p. 3). The authors went on to define mastery experience as the perception of successful performance or increased expectations of being successful at future tasks; vicarious experiences occur when watching someone else perform a task successfully and then replicating the example; social persuasion is the specific evaluation of performance from colleagues, administrators, and mentors, and the affective state is the anxiety or excitement level experienced while participating in a task. Goddard et al. (2004) found evidence that suggests mastery experience and collective efficacy are the most powerful sources of influence on a teachers' sense of efficacy. According to these researchers, after controlling for socioeconomic status, collective efficacy explained student achievement regardless of minority student enrollment, socioeconomic status, and school size.

Ashton and Webb (1986), Moore and Esselman (1992), and Ross (1992) suggested that teacher efficacy can directly affect student achievement. In contrast, research by Davis-Langston (2012) did not support a relationship between elementary school teachers' self-efficacy and students' mathematics achievement levels. A teacher with strong self-efficacy can result in the continuation of practices and positively affects the performance of participating students (Berman et al., 1977). According to Gibson and Dembo (1984), teachers with high levels of self-efficacy and personal teaching efficiency were less critical of students, more frequently continued to work with failing students, and were more likely to use small group instruction.

Changing behavior is a challenging process, which impacts teacher efficacy (Tschannen-Moran et al., 1998). Teachers in the middle of a change process demonstrate a slowing inclining development of teacher efficacy moving toward positive growth (Ross, 1994; Stein & Wang, 1988) and while initially moving through the change process might have a negative impact on efficacy, new learning by teachers including new teaching strategies leads to an increase in efficacy, particularly as student learning improves. During this timeframe of the initial decline in efficacy, teachers benefit from encouragement, support, and feedback (Stein & Wang, 1988). Tschannen-Moran et al. (1998) added in general, "helping teachers feel a greater sense of control over their professional lives in schools will increase their sense of teacher efficacy and make for greater effort, persistence, and resilience" (p. 239). Smith (1996) and Stuart (2000) reiterated the importance of developing teacher efficacy with study results indicating mathematics anxiety develops from the way the subject is taught in school to children and may have been in the presentation to teachers when they were students in the classroom.

Swars (2005) continued self-efficacy research with four pre-service teachers located at a university in the Southeastern United States. After the teachers successfully completed a mathematics methods course, the researcher surveyed and interviewed the study participants. The results indicated teacher self-efficacy was a predictor of effective mathematics instruction in the classroom, and highly-efficacious teachers were more impactful in classroom instruction than teachers with low self-efficacy (Swars, 2005). Additionally, Swars found the pre-service teachers' personal experiences with mathematics as a student impacted the level of mathematics teacher efficacy perceptions, which directly led to levels of comfort with mathematics that resulted in positive teaching effectiveness.

Mathematical teaching self-efficacy resulted in providing an advantageous impact in the mathematics classroom (Midgley, Feldlaufer, & Eccles, 1989). Swars et al. (2006) utilized the MTEBI when they studied the relationship between mathematics anxiety and mathematics teacher efficacy among 28 pre-service teachers and found teachers with higher mathematics anxiety had lower mathematics teacher self-efficacy. The authors also noted these same teachers reported that effective teaching results in students' learning of mathematics. Swars et al. (2006) recommended that "providing a self-awareness of negative experiences with mathematics may be a building block towards reducing mathematics anxiety and increasing mathematics teaching efficacy" (p. 313).

Ross and Bruce (2007) designed professional development of standards-based mathematics teaching with the goal to increase teacher efficacy beliefs in upper elementary mathematics teachers in the areas of engagement, instructional strategies, and classroom management. The sample consisted of 106 sixth grade teachers in one school district. According to the researchers, while there were slight increases in the teachers' self-efficacy beliefs after the introduction of professional development in standards-based mathematics teaching, it was not statistically significant. In their study, the authors noted the only efficacy scores that were statistically significant were in teachers' perceptions of their classroom management efficacy. Research results from Ware and Kitsantas (2007) revealed teachers with high self-efficacy teaching mathematics in classrooms of young adolescents motivated students intrinsically, allowed open discourse in the classroom, and built a strong foundation for students to understand mathematics. These researchers found that the transition into a less supportive classroom negatively impacted a student's interest in the content taught, especially for students who were low-achieving.

According to Swars, Smith, Smith, and Hart (2009), pre-service elementary teachers' beliefs about their personal mathematics teaching efficacy and mathematics teaching outcome expectancy increased after completing their mathematics methods courses. The researchers administered the MTEBI four times to 24 pre-service elementary teachers at a university in the Southeastern United States completing their coursework and student teaching in preparation for teaching careers. Results indicated the pre-service teachers had significant increases in their personal abilities to teach mathematics after the introduction of professional learning through their mathematics methods courses. Additionally, the pre-service teachers also reported increases in their beliefs that the effective teaching of mathematics can positively impact student learning. In their findings, Swars et al. (2009) also reported the pre-service teachers' perception of their mathematics anxiety significantly decreased after the completion of their mathematics methods courses.

McAnallen (2010) studied 691 elementary teachers in rural, urban, and suburban communities from eight states and found the most-highly reported category contributing to the respondents' mathematics anxiety at 31% was interactions with parents about mathematics or teachers about mathematics and mathematics teaching practices indicating the need to increase teachers' personal mathematics teacher efficacy in mathematics instructional practices. Hadley and Dorward (2011) studied the relationship between elementary teachers' personal mathematics anxiety and personal mathematics teaching efficacy. Surveying 692 primary and intermediate elementary teachers in grades 1 to 6, the researchers reported a positive relationship between personal mathematics anxiety and personal mathematics teaching efficacy. Utilizing the MTEBI as one survey instrument, Bates, Latham, and Kim (2011) surveyed 89 early childhood pre-service pre-K to third-grade teachers at a university in the Midwest. The researchers studied the pre-service teachers' mathematics self-efficacy and personal mathematics teaching outcome expectancy and established that as pre-service teachers experienced more professional learning in mathematics instructional practices, they grew more confident in their teaching abilities with increased mathematical teaching outcome expectancy. In sum, increasing teacher efficacy leads to improved instruction and increased student outcomes (Tschannen-Moran et al., 1998).

Mathematics Professional Development for Teachers

Teachers must have the motivation, belief, and skill level to apply their mathematics professional development to classroom teaching to overcome barriers to mathematics instruction (Showers, Joyce, & Bennett, 1987). In their professional standards, the NCTM (1991) recommended teachers have appropriate mathematics coursework preparation through their undergraduate studies in addition to post-graduate professional development in mathematics content and teaching methods. Expanding on recommendations, national professional standards in mathematics includes a recommendation that educators decrease traditional teacher lecture format and ongoing surface-level instruction solely devoted to rote memorization of facts to instead engage students in active learning resulting in increased levels of understanding of mathematical concepts and develop and strengthen problem-solving and reasoning skills across mathematical concepts (NCTM, 1989, 1991).

Improvements in the knowledge, skills, and teaching practices must occur. According to Shulman (1987), along with a thorough understanding of mathematics content teachers must know and understand the curriculum standards that they will be responsible for teaching in the classroom as “teaching begins with a teacher’s understanding of what is to be learned” (p. 7) and educators must have extensive knowledge and understanding of mathematics if they hope to “transform the content knowledge they possess into forms that are pedagogically powerful and yet adaptive to the variation in ability and background presented by the students” (p. 15). In public education, the desired goal for mathematics professional development for teachers continues to be increased student achievement outcomes.

Goldin (1990) explained the significance of limited preparation and the impact of mathematical instruction in the classroom that “Some teachers, often (but not always) those with the least mathematical preparation, see mathematics only as such a set of rules and procedures” (p. 46) and that some teachers are insecure about their own ability in mathematics and look toward it only being implemented in a step-by-step procedure without any depth of foundational mathematical foundational. This lack of foundational knowledge has proven to be challenging. According to the NRC (2001):

> The kinds of knowledge that make a difference in teaching practice and in students’ learning are an elaborated, integrated knowledge of mathematics, a knowledge of how students’ mathematical understanding develops, and a repertoire of pedagogical practices that take into account the mathematics being taught and how students learn it. (p. 380)

Blank and Langesen (1999) surveyed fourth-grade and eighth-grade teachers of students who took the 1996 NAEP mathematics assessment to determine the amount of professional development in mathematics that the teachers had participated in over the last 12 calendar months. Nationally, an average of 28% of fourth-grade teachers reported receiving 16 or more hours of professional development in teaching mathematics. The hours of professional development increased to an average of 48% for eighth-grade teachers with the highest percentages of teachers in Kentucky at 69% and California receiving the most at 70% (Blank & Langesen, 1999). Highlighting an ongoing problem with lack of foundational mathematical knowledge, Maccini and Gagnon (2002) surveyed teachers on whether they knew the NCTM Standards. Results showed that “95% of general education teachers responded “Yes,” versus 55% of special educators …

[with] respondents who had never heard of the NCTM Standards were mostly high school special education teachers from rural school districts" (Maccini & Gagnon, 2002, p. 333).

Staff development in schools should be results-driven, which judges the success of education by what students demonstrate they know and as a result of what they are successfully able to apply after their education in school (Sparks & Hirsh, 1997). Professional development for teachers is a key component for improving classroom instruction (Ball & Cohen, 1999). In an analysis of professional development, Guskey (2003) reported: "the most frequently mentioned characteristic of effective professional development is enhancement of teachers' content and pedagogic knowledge" (p. 9). Despite the research indicating the need for strong background knowledge, many mathematics researchers claim that pre-service teachers as well as current teachers, particularly elementary school teachers, do not have the depth or breadth of content or instructional methods knowledge required to be effective mathematics teachers (Ball, Goffney, & Bass, 2005; Graham & Fennell, 2001; Ma 1999; Simon, 2000). According to the NRC (2001), one area in which there was consistent research evidence was in concerns with the inadequacy of U. S. students in the application of their mathematical skills and knowledge. The NRC (2001) stated, "The mathematics [that] students need to learn today is not the same mathematics that their parents and grandparents needed to learn … All young Americans must learn to think mathematically, and they must think mathematically to learn" (p. 3).

Focusing on the ability of professional educators to support students in attaining these goals, researchers at the NRC (2001) continued, "The preparation of U.S. preschool to middle school teachers often falls far short of equipping them with the knowledge they need for helping students develop mathematical proficiency" (p. 4). Additionally, the NRC (2001) advised that teacher professional development must be of high quality and focused on supporting all students attaining mathematical proficiency. "Improving students' learning depends on the capabilities of classroom teachers" (NRC, 2001, p. 14). Berry (2003) recommended, "We need to invest much more in teachers and teaching if we are going to dramatically improve public schooling in America" (p. 1).

To address the concerns in students' mathematical achievement, much research has been conducted on teacher quality (Borko, 2004; Darling-Hammond & Hammerness, 2005; Hezel Associates, 2007; Pagliaro, 1998; Smith & Gorard, 2007). Additional research has focused on the use of professional development to improve teacher quality (Anderson & Olsen, 2006; Kagan, 1992; Lee, 2005; Linder, 2009; Torff, Sessions, & Byrnes, 2005, Yoon et al., 2007). However, researchers have revealed elementary school teachers do not always participate or have limited participation in professional development in the core content area of mathematics. Usiskin and Dossey (2004) noted that 12% of fourth-grade teachers received 16 to 35 hours of professional development in mathematics and 7% participated in 36 hours or more in one school year. According to Boyle and Lamprianou (2006), only 10% of mathematics teachers in their study of models of professional development participated in professional development lasting two days or longer.

For school administrators considering the best ways in which to provide teachers with professional development in mathematics, research provides the required scope and components needed to support the work of the classroom teacher. Kellheller (2003) stated, “Often professional development programs become disconnected from a particular school or district goal and have no follow up, tend to amount to a series of disjointed experiences that do not necessarily have any observable effect on education” (p. 751). Desimone, Smith, and Ueno (2006) pointed to the need for professional development in mathematics to be ongoing and focused on mathematics teaching practice. Additionally, professional development in mathematics should be focused on the academics of mathematical content and improving students’ learning and thinking (Ball & Cohen, 1996; Loucks-Horsley, Hewson, Love, Mundry, & Stiles, 2003; NRC, 2001; Smith, 2001) and focused on mathematics teaching practice (Carpenter, Fennema, Franke, Levi, & Empson, 1999; NRC, 2001; Smith, 2001).

Sullivan and Leder (1992) studied the impact of primary-age elementary school teachers in Australia and reported that variables including culture in a school setting influenced teachers’ personal thoughts and actions. Specifically, Sullivan and Leder (1992) found new teachers completing their first year of teaching ranked factors including other teachers, materials and texts, and the behavior of other students as more important influences than mathematics curriculum. These new teachers who initially utilized current methods of teaching mathematics approaches and showed high levels of self-reflection reverted to less effective methods of mathematics instruction became more authoritarian in their instruction to maintain classroom discipline and “more concerned about students’ response to the work than the content itself” (p. 635).

In a qualitative study of 23 elementary teachers in Kansas, Ramey-Gassert, Shroyer, and Straver (1996) collected qualitative data from teachers who reported low personal efficacy beliefs in science, mathematics, and technology education. Results from the study established elementary teachers with the reported lowest teaching self-efficacy positively benefitted from extensive and ongoing successful teaching experiences including preservice and in-service activities. Efficacy levels of teachers have also been shown to change after professional development opportunities in mathematics. In a study that included 68 Houston, Texas, teachers ranging in teaching experience from one to 25 years, Roberts, Henson, Tharp, and Moreno (2000) utilized a training module over the course of 26 one-hour sessions and found the greatest impact on efficacy from their professional development was in teachers starting with the lowest efficacy beliefs at the initiation of the training.

To be effective, the practice of self-reflection requires explicit planning, teaching, and evaluation (Houston & Warner, 2000) and involves constantly framing questions in response, searching for the correct answers, and asking new questions from new learning. Professional learning in the design of college coursework containing new learning requiring searching for new answers and reflection can also impact future teachers. Vinson (2001) studied the changes in the perceptions of mathematics anxiety in 87 pre-service teachers enrolled in a mathematics methods course designed to increase the pre-service teachers' knowledge of conceptual mathematical knowledge and use of manipulatives. Results from the study showed that the overall mathematics anxiety of the participants was significantly reduced after participating in the professional learning. Rodgers (2002) categorized reflection into four components including reflection as a process of understanding one's personal experiences; that it must become a systematic way of disciplined and rigorous thinking; it occurs by collaboration with others because "when one is accountable to a group, one feels a responsibility toward others that is more compelling than the responsibility we feel only to ourselves" (p. 857); and it necessitates a mindset that wants intellectual growth.

Ticha and Hospesova (2006) showed the need for self-reflection in mathematics professional development for improvement in mathematics instruction in the classroom. They found that the quality of the instruction in students' mathematics classes subsequently depended on the teachers' own beliefs about the mathematics education; how the teachers were prepared in content, pedagogy, and methods of teaching mathematics; and how teachers utilized teaching activities in their instruction. Their research with four elementary school full-time teachers in Prague, Czechoslovakia, focused on the teachers' reflections of their growth and development in their own teaching. Results of the teachers' self-reflections of mathematics professional learning supported that educational improvement comes from self-reflection through more fully understanding one's own teaching "which can include mathematical content and different ways of its didactic elaboration, classroom discussion, and student-led discussions" (p. 129). Additionally, they noted that "joint reflection was crucial in collaboration and significantly influenced teachers" (p. 130). Muir and Beswick (2007) note that deep reflection will typically not occur among teachers unless there is an external voice that challenges what is currently in practice.

Gresham (2007) researched the level of mathematics anxiety in 246 early childhood/elementary pre-service teachers and whether their mathematics anxiety could be reduced after the introduction of a mathematics methods course that included the use of manipulatives. Results indicated a reduction in the pre-service teachers' anxiety. A call for more professional development came from the National Mathematics Advisory

Panel (2008) because teachers who are knowledgeable in multiple teaching methods in mathematics are the most effective teachers. Gellert (2008) expanded on this research by focusing on the impact of professional development for teachers to improve their mathematics teaching practice. In this study, Gellert (2008) interviewed 40 teachers across eight schools in Berlin, Germany, and established that routines for teaching mathematics are not cumulative, and it is challenging to change one's teaching practice. Additionally, Gellert (2008) recommended that teachers may benefit from collaboration with peers for support with mathematical instruction through continual peer involvement. According to Gellert (2008), "Change and development processes in themselves can become a matter of routine … This does not imply that instructional practices have to be changed every single week but … some routines could be scrutinized, questioned and, perhaps, modified or abandoned" (p. 106).

Reed (2014) surveyed 177 primary elementary teachers after the conclusion of a year-long mathematics course to determine if professional development reduced teacher personal or professional mathematics anxiety. Results indicated that teachers did not have less personal or professional mathematics anxiety after the introduction of professional development in mathematics instructional practices. In a four-year longitudinal survey study of 467 middle school mathematics teachers across 91 schools located in Missouri, Akiba and Liang (2016) found that teacher-led collaboration with the intent to discover more about mathematics instructional practices and research initiated by teachers with activities allowing for participation and presentation at professional conference resulted in overall increases in mathematics achievement for students. Their research specifically pointed to past funding sources, methods of professional development, and outcomes for teaching and learning.

Akiba and Lang (2016) cited the No Child Left Behind Act of 2001 and the Race to the Top Program, which mandated teachers receive high-quality professional development. Under No Child Left Behind (2001), five criteria were set to be considered high quality including a sustained, intensive focus on the content; aligned to state standards; improved teacher subject matter knowledge; advanced teachers' understanding of effective instructional strategies; and the professional development is regularly evaluated. According to Akiba and Lang (2016), significant cost was incurred when state departments of education and school districts worked with outside agencies to provide a type of one-size-fits-all program that did not allow for teachers to engage in meaningful conversations with their peers to impact student learning. "Through a collaborative and research-based learning process promoting in-depth discussions and reflections on specific teaching approaches and student learning, it is likely that these investments in promoting teachers' professional learning activities will result in improved student learning" (p. 107). A study of 15 kindergarten teachers in Ohio engaged in a mathematics professional development program for a year focused on strengthening teachers' competencies in standards-based instruction supporting the Common Core State Standards in mathematics. Results of the study indicated teachers' mathematical content knowledge increased, resulting in increased student achievement (Polly et al., 2017).

Summary

The review of the literature provided information for elementary teachers to become highly skilled in all core content areas, including mathematics instruction. This review documented elementary teachers reports of fears and anxiety toward mathematics, perceived low self-efficacy in mathematics, personal mathematics teaching efficacy, and mathematics teaching outcomes. Chapter 3 provides an in-depth description of the specific methods that were used to explore this topic.

Chapter 3

Methods

There were four purposes of this study. The first purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics anxiety changed after the implementation of professional development in mathematics instructional practices. The second purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their professional mathematics teaching anxiety changed after the implementation of professional development in mathematics instructional practices. The third purpose of this study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy changed after the implementation of professional development in mathematics instructional practices. Finally, the fourth purpose of this study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy changed after the implementation of professional development in mathematics instructional practices. The sections included in this chapter's explanation of the methods used to address the above purposes are the research design, selection of participants, measurement, data collection procedures, data analysis and hypothesis testing, and the limitations.

Research Design

A quantitative research design was utilized in this study. Specifically, a causal-comparative research method was employed to measure the changes in anxiety and self-efficacy after the introduction of professional development in mathematics instructional practices. Causal-comparative research does not manipulate the independent variable as it has already occurred (Lunenburg & Irby, 2008). The four dependent variables examined included teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the introduction of professional development of mathematics instructional practices. The independent variable examined was the time the survey was administered. The two categories were before the professional development implementation and after the professional development was completed.

Selection of Participants

The participants for this study included 79 elementary school teachers of pre-kindergarten through sixth grade students employed in one Midwestern public school district during the 2016-2107 school year. Teachers identified as having a range from one year of teaching experience to ten or more years of teaching experience from four elementary schools comprised the population. For this study, the researcher utilized a nonrandom sampling approach of purposive sampling. Lunenburg and Irby (2008) defined purposive sampling as it "involved selecting a sample based on the researcher's experience or knowledge of the group to be sampled" (p. 175). A teacher participated in the study if the following criteria were met:

1. The teacher was currently teaching at the pre-kindergarten through sixth-grade level.
2. The teacher held current Kansas teaching license credentials.

3. The teacher participated in professional development opportunities provided by the district in mathematics instructional practices and completed the pre- and post-professional development surveys.

Measurement

The independent variable for this study was participation in professional development in mathematics instructional practices. The four dependent variables measured were teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy. The dependent variables were measured using a revised version of the McAnallen Anxiety in Mathematics Teaching Survey (MAMTS) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI).

MAMTS. This survey measures teachers' perceptions of personal mathematics anxiety and professional mathematics teaching anxiety (Reed, 2014). The original MAMTS instrument began with 51 items that were subsequently reduced to 40 items in the 5-point Likert format (McAnallen, 2010). The personal mathematics anxiety factor of the MAMTS measures an individual teacher's personal feelings about mathematics by asking them to agree or disagree on a 5-point Likert scale *(strongly disagree* = 1 *to strongly agree* = 5) on items such as: "It makes me nervous to think about having to do any mathematics problems". For this factor, Cronbach alpha reliability coefficients were greater than .952 (McAnallen, 2010). The second factor of the MAMTS relating to professional mathematics anxiety includes items such as "I find it difficult to teach mathematical concepts to students." For this factor, Cronbach alpha reliability coefficients were greater than .953 (McAnallen, 2010). A copy of the MAMTS instrument is located in Appendix A and permission to use the MAMTS is in Appendix B.

The configuration of the survey that was used in the current study was a modification to the McAnallen survey, and reliability analyses were conducted. Thirteen items from the MAMTS were used to measure personal mathematics anxiety for the current study (see Table 1). Possible scores ranged between 13 and 65. After five items were reverse coded (see Table 1), responses to these items were summed. Twelve of the items from the MAMTS were used to measure professional mathematics anxiety for the current study. Possible scores ranged between 8 and 60. After seven items were reverse coded for the personal mathematics anxiety factor (see Table 1), responses to the items were summed to create the survey for the personal anxiety factor and the professional anxiety factor.

Table 1

Revised McAnallen Anxiety in Mathematics Teaching Survey (R-MAMTS)

Variable	Items
Personal mathematics anxiety	1[a], 2, 4[a], 7[a], 10, 12, 13[a], 14[a], 15, 16, 17, 20[a], 21[a]
Professional mathematics anxiety	3[a], 5[a], 6, 8, 9[a], 11, 18, 19, 22, 23[a], 24, 25[a]

Note. Adapted from *Examining Mathematics Anxiety in Elementary Classroom Teachers,* by R. R. McAnallen, 2010, pp. 25 – 27.

[a]Reverse coded items

Because of the modification to the original survey, reliability analyses using Cronbach's alpha were conducted for the personal mathematics anxiety subscale and the professional mathematics anxiety subscale. The Cronbach's alpha from the analyses ranged between 0.873 and 0.875 (see Table 2). These coefficients provide strong evidence for the reliability of the subscales.

Table 2

Reliability Coefficients for R-MAMTS

	Cronbach's α	*n*	*k*
Personal Anxiety Before	.873	78	13
Personal Anxiety After	.886	79	13
Professional Anxiety Before	.845	78	12
Professional Anxiety After	.869	78	12

Note. *n* = sample size, *k* = number of items

MTEBI. Developed by Enochs et al. (2000), the MTEBI measures teachers' perceptions of personal mathematics teaching efficacy and mathematics teaching outcome expectancy. The MTEBI contains 21 items, 13 on the personal mathematics teaching efficacy subscale and eight on the mathematics teaching outcome expectancy subscale (Enochs et al., 2000). Possible scores on the personal mathematics teaching efficacy scale range from 13 to 65 and possible scores on the mathematics teaching outcome expectancy scale range from 8 to 40. A copy of the MTEBI instrument is located in Appendix C and permission to use the MTEBI is in Appendix D.

The two subscales on the inventory are consistent with the two-dimensional aspect of teaching efficacy. A Cronbach's alpha of .88 for the personal mathematics teaching efficacy and .81 for the mathematics teaching outcome expectancy provide evidence for the reliability of the two subscales (Enochs et al., 2000). Additionally, it was established that the personal mathematics teaching efficacy and mathematics teaching outcomes expectancy scales are independent, which added to the construct validity of the MTEBI (Enochs et al., 2000).

The MTEBI resulted from a modification of the original Science Teaching Efficacy Belief Instrument (STEBI) (Enochs & Riggs, 1990). Items were changed on the MTEBI to reflect mathematics teaching beliefs. The personal mathematics teaching efficacy subscale addresses teachers' individual beliefs and capabilities to be effective in their teaching of mathematics. The subscale of the mathematics teaching outcome expectancy addresses teachers' individual beliefs that teaching of mathematics can be effective and enhance student learning outcomes. Respondents answer using a Likert-type scale with five response categories, ranging from *1 (Strongly Disagree)* to *5 (Strongly Agree).* Higher scores indicate greater teaching efficacy beliefs. After eight items are reverse coded on the personal mathematics teaching self-efficacy factor (see Table 3), responses to these items were summed.

Table 3

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

Variable	Items
Personal mathematics teaching efficacy	2, 3[a], 5, 6[a], 8[a], 11, 12, 15[a], 16, 17[a], 18[a], 19[a], 20, 21[a], 22, 23
Mathematics teaching outcome expectancy	1, 4, 7, 9, 10, 12, 13, 14

Note. Adapted from "Establishing Factorial Validity of the Mathematics Teaching Efficacy Beliefs Instrument," by L. G. Enochs, P. L. Smith, & D. Huinker, 2000, *School Science and Mathematics, 100*(4), p. 194-202.

[a]Reverse coded items

Data Collection Procedures

Permission was received on September 20, 2016, from the school district's Board of Education to conduct the archival data analysis (see Appendix E). A request to review the archival data for this study was made of the Baker University Institutional Review Board (IRB) (see Appendix F) on November 13, 2017. The IRB committee approved the study on November 15, 2017 (see Appendix G). Data review commenced after the IRB committee approval.

Teachers were asked to complete the MAMTS and the MTEBI surveys. A random number was assigned by a project director to each survey so that pre- and post-data could be disaggregated. The researcher collected the archived data and ensured that the data were kept secure and that all participants and schools remained unidentified. The data collected from the survey was stored on a password- and firewall-protected computer. No district, school, student, or teacher names appeared in any data, and no participant was personally identified.

Data Analysis and Hypothesis Testing

Archived quantitative data was used in this study. The data were compiled and organized into a Microsoft Excel worksheet and imported into the latest version of the IBM SPSS Statistics Faculty Pack 25 for Windows. Eight hypotheses were tested for statistically significant differences among primary (grades pre-kindergarten through 2) and intermediate (grades 3 through 6) teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the introduction of professional development of mathematics instructional practices.

RQ1. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H1. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H1. The two sample means, the before and after of primary elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

RQ2. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H2. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H2. The two sample means, the before and after of intermediate elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

RQ3. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H3. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H3. The two sample means, the before and after of primary elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

RQ4. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H4. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H4. The two sample means, the before and after of intermediate elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

RQ5. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H5. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H5. The two sample means, the before and after of primary elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, were compared. The level of significance was set at .05.

RQ6. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H6. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H6. The two sample means, the before and after of intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, were compared. The level of significance was set at .05.

RQ7. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H7. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H7. The two sample means, the before and after of primary elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, were compared. The level of significance was set at .05.

RQ8. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H8. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H8. The two sample means, the before and after of intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, were compared. The level of significance was set at .05.

Limitations

According to Lunenburg and Irby (2008, p. 133), "limitations are factors that may have an effect on the interpretation of the findings or on the generalizability of the results." Limitations of this study included:

1. The Midwestern public school district in which the study was conducted is a composed of approximately 1,700 students geographically located on a military post, and the results may not apply to other districts that are different in demographics and location.
2. Self-reported data from participants may be biased as individuals reported their own feelings or beliefs. Examples of self-report may include exaggeration or answers perceived to be more socially acceptable in the workplace.

Summary

In this chapter, the specific methodology and methods that were utilized to answer the eight research questions were addressed. The research design, data collection, and data analysis procedures used in this study were discussed. Also presented were the limitations associated with the research design. Although limitations did occur, no attempts to control for these limitations ensured the strength of this study. The descriptive data and the results of the data analysis are presented in Chapter 4.

Chapter 4

Results

Chapter 3 contained the methods used to examine the research questions of this study including the extent primary and intermediate elementary teachers' perceptions of their personal and professional mathematics anxiety, personal mathematics teaching efficacy, and their perceptions of their mathematics teaching outcome changed after the implementation of professional development in mathematics instructional practices. The research questions and hypotheses explored in this study were designed to help identify the specific relationships if any, that existed among the variables to determine the impact of primary and intermediate elementary teachers' perceptions of mathematical professional development's impact on classroom instructional practices. The results of this quantitative study follow including descriptive statistics and the hypothesis testing.

Descriptive Statistics

The data presented in this chapter was collected from primary and intermediate elementary school teachers. Represented in Table 4 are the demographic characteristics of teachers which included 42 primary teachers of grades pre-kindergarten through grade 2 and 37 intermediate teachers of grades 3 through 6. Within those groups, the gender of all 42 of the primary teachers was female. The gender of the intermediate teachers included 35 females and 2 males (see Table 4).

Table 4

Demographics of Teachers

	Primary	*Intermediate*
Number of Teachers	42	37
Female	42	35
Male	0	2

Additionally, years of teaching experience varied by group and are presented in Table 5. For the total group of 79 teachers, 32 participants had taught for one to five years accounting for 40.5% of the total surveyed, 32 participants had taught for six to fifteen years for 40.5% of the total surveyed, and 15 participants had 15 or more years of teaching experience for a total of 19% surveyed (see Table 5).

Table 5

Number of Years of Teaching Experience

	Number	*% of Total*
1-5 Years	32	40.5%
6-15 Years	32	40.5%
15 or More Years	15	19.0%

Finally, the degree level of the teachers ranged from bachelor's to education specialist with the results presented in Table 6. A total of 46 teachers (58.2%) held bachelor's degrees. Additionally, 31 teachers (39.2%) held master's degrees, and 2 teachers (2.5%) held an education specialist degree as their highest degree level of education (see Table 6).

Table 6

Degree Level of Participants

	Number	*% of Total*
Bachelor	46	58.2%
Master	31	39.2%
Education Specialist	2	2.5%

Hypothesis Testing

The research questions and hypotheses for the study are restated below and followed by the results and analysis from testing these hypotheses. The first four research questions were examined using the MAMTS and research questions five through eight were tested using the MTEBI data. Each research question was analyzed with a paired-samples *t* test, and the two sample means for each of the research questions and hypotheses were compared to determine the extent, if any, elementary teachers' perceptions changed for each research question and if there was a statistically significant difference.

RQ1. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H1. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H1. The two sample means, the before and after of primary elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was not statistically significant, t =.185, df = 40, p = .885. The mean of the primary elementary teachers' perceptions of their personal mathematics anxiety before the implementation was not different from the mean of the primary elementary teachers' perceptions of their personal mathematics anxiety after the implementation (see Table 7). H1 was not supported.

Table 7

Descriptive Statistics for the Hypothesis Test for H1

	M	*N*	*SD*
Personal Anxiety Before	36.098	41	8.642
Personal Anxiety After	35.976	41	9.251

RQ2. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H2. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H2. The two sample means, the before and after of intermediate elementary teachers' perceptions of their personal mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = 2.411$, $df = 36$, $p = .021$. The mean of the intermediate elementary teachers' perceptions of their personal mathematics anxiety before the implementation was different from the mean of the intermediate elementary teachers' perceptions of their personal mathematics anxiety after the implementation (see Table 8). H2 was supported.

Table 8

Descriptive Statistics for the Hypothesis Test for H2

	M	*N*	*SD*
Personal Anxiety Before	31.919	37	9.400
Personal Anxiety After	31.595	37	9.418

RQ3. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H3. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H3. The two sample means, the before and after of primary elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = 4.438$, $df = 41$, $p = .000$. The mean of the primary elementary teachers' perceptions of their professional mathematics anxiety before the implementation was different from the mean of the primary elementary teachers' perceptions of their professional mathematics anxiety after the implementation (see Table 9). H3 was supported.

Table 9

Descriptive Statistics for the Hypothesis Test for H3

	M	*N*	*SD*
Professional Anxiety Before	26.167	42	6.370
Professional Anxiety After	24.429	42	6.129

RQ4. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, change after the implementation of professional development in mathematics instructional practices?

H4. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H4. The two sample means, the before and after of intermediate elementary teachers' perceptions of their professional mathematics anxiety, as measured by the MAMTS, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = 3.494$, $df = 35$, $p = .001$. The mean of the intermediate elementary teachers' perceptions of their professional mathematics anxiety before the implementation was different from the mean of the intermediate elementary teachers' perceptions of their professional mathematics anxiety after the implementation (see Table 10). H4 was supported.

Table 10

Descriptive Statistics for the Hypothesis Test for H4

	M	*N*	*SD*
Professional Anxiety Before	25.056	36	7.294
Professional Anxiety After	24.139	36	7.216

RQ5. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H5. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H5. The two sample means, the before and after of primary elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = -3.233$, $df = 41$, $p = .002$. The mean of the primary elementary teachers' perceptions of their personal mathematics teaching efficacy before the implementation was different from the mean of the primary elementary teachers' perceptions of their personal mathematics teaching efficacy after the implementation (see Table 11). H5 was supported.

Table 11

Descriptive Statistics for the Hypothesis Test for H5

	M	*N*	*SD*
Personal Teaching Efficacy Before	54.310	42	8.065
Personal Teaching Efficacy After	55.071	42	7.233

RQ6. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H6. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H6. The two sample means, the before and after of intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy, as measured by the MTEBI, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = -2.471$, $df = 361$, $p = .002$. The mean of the intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy before the implementation was different from the mean of the intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy after the implementation (see Table 12). H6 was supported.

Table 12

Descriptive Statistics for the Hypothesis Test for H6

	M	*N*	*SD*
Personal Teaching Efficacy Before	56.000	37	7.016
Personal Teaching Efficacy After	56.703	37	5.962

RQ7. To what extent do primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H7. There is a statistically significant difference between primary (grades pre-kindergarten through 2) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H7. The two sample means, the before and after of primary elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = -5.194$, $df = 41$, $p = .000$. The mean of the primary elementary teachers' perceptions of their mathematics teaching outcome expectancy before the implementation was different from the mean of the primary elementary teachers' perceptions of their mathematics teaching outcome expectancy after the implementation (see Table 13). H7 was supported.

Table 13

Descriptive Statistics for the Hypothesis Test for H7

	M	*N*	*SD*
Teaching Outcome Expectancy Before	28.095	42	3.413
Teaching Outcome Expectancy After	29.286	42	3.330

RQ8. To what extent do intermediate (grades 3 through 6) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, change after the implementation of professional development in mathematics instructional practices?

H8. There is a statistically significant difference between intermediate (grades 3 through 6) elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, after the implementation of professional development in mathematics instructional practices.

A paired-samples *t* test was conducted to test H8. The two sample means, the before and after of intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy, as measured by the MTEBI, were compared. The level of significance was set at .05.

The results of the analysis indicated the difference between the two means was statistically significant, $t = -4.233$, $df = 36$, $p = .000$. The mean of the intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy before the implementation was different from the mean of the intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy after the implementation (see Table 14). H8 was supported.

Table 14

Descriptive Statistics for the Hypothesis Test for H8

	M	*N*	*SD*
Teaching Outcome Expectancy Before	29.243	37	4.153
Teaching Outcome Expectancy After	30.162	37	3.819

Summary

This chapter included both the descriptive statistics and results of the hypothesis testing. Descriptive statistics were presented including the number of primary and intermediate elementary teachers by grade level, gender, years of teaching experience, and highest educational degree level attained. Hypothesis testing results from each of the eight research questions utilizing the MAMTS for research questions one through four about personal and professional mathematics anxiety and the MTEBI for research questions five through eight about personal mathematics teaching efficacy and teaching outcome expectancy indicated all were statistically significant after the introduction of professional development in mathematics instructional practices with the exception of hypothesis one of the primary elementary teachers' perceptions of their personal mathematics anxiety which was not statistically significant as measured by the MAMTS. In the next chapter, a study summary, findings related to the literature, and the conclusions are presented.

Chapter 5

Interpretation and Recommendations

The objective of this study was to seek to develop an understanding of the extent to which there were differences in elementary school teachers' perceptions of their personal and professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after professional development in mathematics instructional practices. Included in this chapter is a study summary including an overview of the problem, purpose statement and research questions, review of methodology, and major findings. Findings related to the literature are presented as well as conclusions with implications for action, recommendations for future research, and concluding remarks.

Study Summary

The following section provides a summary of the current study. The summary contains an overview of the problem concerning elementary teachers' perceptions of their personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching self-efficacy, and mathematics teaching outcome expectancy and the change, if any, after the introduction of professional development in mathematics instructional practices. The next section provides a summary of the purpose of the study and research questions. The summary concludes with a review of the methodology and the study's major findings.

Overview of the problem. Historically, legislation from the federal government includes improving student achievement across all classrooms which requires elementary classroom teachers to become highly skilled in all core content areas. Most recently, in

December 2015, the ESSA reauthorized the ESEA and included the requirement that all students in every school across the country be taught to high academic standards to prepare them to succeed in college and careers (U.S. Department of Education, 2016). Because elementary-level teachers typically teach all core-content curriculum standards to all students, the challenge exists for elementary teachers to become content knowledgeable and highly effective instructors across multiple curricula. Research has shown, however, that teachers' mathematical anxiety and low mathematical self-efficacies have negatively influenced some students' performance in mathematics (Beilock et al., 2010; Kahle, 2008) despite national standards in mathematics that identified the standards that elementary teachers should implement in their instructional practices (NCTM, 2000). Additionally, elementary teachers with mathematics anxiety, low sense of mathematical self-efficacy or mathematical teaching self-efficacy, may negatively affect their ability to implement mathematics instructional practices to support increased student achievement (Muijs & Reynolds, 2015). An area to study is the use of professional development which has been shown to be an effective method for improving teacher quality (Anderson & Olson, 2006; Yoon et al., 2007) in teachers' increased knowledge and skills leading to better classroom instruction which positively affects student achievement (Yoon et al., 2007).

Purpose statement and research questions. The first purpose of this study was to determine the extent to which primary (grades pre-kindergarten through 2) and intermediate (grades 3 through 6) elementary teachers' perceptions of their personal mathematics anxiety changed after the implementation of professional development in mathematics instructional practices. The second purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their professional mathematics anxiety changed after the implementation of professional development in mathematics instructional practices. The third purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy changed after the implementation of professional development in mathematics instructional practices. Finally, the fourth purpose of the study was to determine the extent to which primary and intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy changed after the implementation of professional development in mathematics instructional practices. To guide this study, eight research questions were developed, and eight hypotheses were tested to address the purposes of the study.

Review of the methodology. The participants in this study included 79 primary and intermediate teachers in a small Midwestern district of approximately 1,700 students. A quantitative research design was utilized in this study with a causal-comparative research method to measure the relationships among the four dependent variables, which included teachers' perceptions of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the introduction of professional development of mathematics instructional practices. The independent variable was the time when the survey was administered pre- and post-professional development. The dependent variables were measured using the McAnallen Anxiety in Mathematics Teaching Survey (MAMTS) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). A paired-samples *t* test was conducted to test each hypothesis.

Major findings. The results of this study indicated the mean perception of personal mathematics anxiety before the implementation of professional development in mathematics instructional practices was not different from the mean perception of personal mathematics anxiety after the implementation of professional development in mathematics instructional practices for primary elementary teachers. However, for primary elementary teachers, the mean perception of professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy before the implementation increased from the mean perception of professional mathematics anxiety after the implementation of professional development in mathematics instructional practices. For intermediate teachers, the mean perception of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy before the implementation increased from the mean perception of personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the implementation of professional development in mathematics instructional practices.

Findings Related to the Literature

In this section, the current study findings are presented as they relate to the literature regarding the extent to which primary and intermediate elementary teachers' perceptions of their personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy changed after the implementation of professional development in mathematics instructional practices. The existing literature and results of the current study support similarities and differences in findings. The comparisons are presented in order of the research questions.

In the current study, findings were varied between the primary elementary teachers and the intermediate teachers regarding teachers' personal mathematics anxiety. Research ranged from 25 to 50% of Americans experience mathematics anxiety (Burns, 1998 and Jones, 2001) and McAnallen (2010) found over a third of elementary teachers reported mild or moderate personal mathematics anxiety. In the current study, the mean perception of personal mathematics anxiety of primary elementary teachers before the implementation of professional development was not different from the mean perception of personal mathematics anxiety after the implementation of professional development in mathematics instructional practices. However, the mean perception of personal mathematics anxiety before the implementation of professional development of intermediate elementary teachers was different from the mean perception of personal mathematics anxiety after the implementation of professional development in mathematics instructional practices. Findings in the literature also revealed mixed results when introducing variables to reduce undergraduate, graduate, and professional teachers' [personal mathematics anxiety. Chapline (1980), Sovchik et al. (1981), Harper and Daane (1998), Townsend et al. (1999), and Swars et al. (2009) studied personal mathematics anxiety in pre-service elementary teachers. The results for each study indicated a reduction in mathematical anxiety after the introduction of a mathematics methods course. The results of the current study differ from these results for the primary elementary teachers as the current study showed the mean perception of primary teachers' personal mathematics anxiety was not different; however, the current study supports the findings for intermediate elementary teachers as the mean perception of personal mathematics anxiety was different in the current study after the implementation of professional development in mathematics instructional practices. In contrast, the findings from the current study for primary elementary teachers' are consistent with Townsend et al. (1998) who found that introducing cooperative learning activities did not decrease participants self-report of mathematics anxiety; however, the current findings for intermediate elementary teachers' perceptions of personal mathematics anxiety do not support the findings of Townsend et al. (1998). Similarly, the findings of the current study support the research of Reed (2014) indicating that primary elementary teachers did not have less personal mathematics anxiety after the introduction of professional development in mathematics instructional practices.

Teacher perceptions for their professional mathematics anxiety were also gathered and analyzed. The current study revealed for both primary and intermediate elementary teachers the mean perception of professional mathematics anxiety before the implementation of professional development was different from the mean perception of professional mathematics anxiety after the implementation of professional development in mathematics instructional practices. This finding supports the research of Teague and Austin-Martin (1981), Widmer and Chavez (1982), Vinson (2001), Gresham (2007), and Brown et al. (2011) who reported that pre-service teachers' perceptions of their professional mathematical anxiety decreased after the introduction of professional learning in mathematics instructional practices in their methods courses. In contrast, the current study does not support the research of Reed (2014) that indicated primary elementary teachers did not have less professional mathematics anxiety after the introduction of professional development in mathematics instructional practices.

Self-efficacy in teachers is important because it affects the effort teachers invest in instruction (Ware & Kitsantas, 2007). In the current study, the mean perception of both primary and intermediate elementary teachers' perceptions of their personal mathematics teaching efficacy before the implementation of professional development in mathematics instructional practices was different from the mean perception of their personal mathematics teaching efficacy after the implementation of professional development in mathematics instructional practices. The current study supports Cooper and Robinson's (1991) findings that mathematics self-efficacy was positively affected by the level of mathematics professional learning. Additionally, the current study supports Ramey-Gassert et al. (1996) and Roberts et al.'s (2000) findings of increased personal mathematics teaching efficacy after the initiation of professional development experiences. The current findings support Utley et al. (2005) in which pre-service teachers' personal mathematics teaching efficacies significantly increased during participation in methods courses and student teaching. Additionally, results of the current study support Bursal and Paznokas (2006) who utilized the MTEBI to assess teachers' beliefs regarding mathematics and science instruction in elementary classrooms and noted after professional learning in mathematics content, personal beliefs in confidence to teach mathematics increased. In contrast, the current study findings for primary and intermediate elementary teachers' personal mathematics teaching efficacy do not support the research findings of Ross and Bruce (2007) in which the authors found only slight increases in sixth-grade teachers' self-efficacy beliefs after the introduction of mathematics professional development. However, Swars et al. (2009), reported a significant increase which is also supported in the findings of the current study. Similar to Bursal and Paznokas (2006) and the current study, Swars et al. utilized the MTEBI to assess for any change in pre-service teacher beliefs in their personal mathematics teaching efficacy after the introduction of mathematics methods and student teaching experiences study.

The final area researched in the current study was to what extent do primary and intermediate elementary teachers' perceptions of their mathematics teaching outcome expectancy change after the implementation of professional development in mathematics instructional practices. The findings in the current study support the research by Utley et al. (2005) in which pre-service teachers' mathematics teaching outcome expectancies significantly increased after participation in methods courses and student teaching as the mean perception of mathematics teaching outcome expectancy before the implementation of professional development for primary and intermediate teachers was different from the mean perception of the primary and intermediate teachers after the implementation of professional development in mathematics instructional practices. Similarly, the current study supports the findings of Swars et al. (2009) of increased pre-service elementary teachers' beliefs about their mathematics teaching outcome expectancy after completing their mathematics methods courses. Additionally, the current study supports Bates et al.'s (2011) study findings that as early childhood pre-service teachers experienced more professional learning in mathematics instructional practices, they grew more confident in their teaching abilities with increased mathematical teaching outcome expectancy.

Conclusions

This section provides conclusions drawn from the current study regarding the extent primary and intermediate teachers' percepts of their personal mathematics anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy changed after the implementation of professional development in mathematics instructional practices. Implications for action and recommendations for future research are included. This section ends with concluding remarks.

Implications for action. The results and conclusions from the current study can be used by District A leaders and school districts with similar demographics who are focusing on improving mathematics instructional practices in the elementary classroom. Understanding primary and intermediate elementary teachers may not have been prepared with a strong background in mathematics education to equip them to educate students to develop mathematical proficiency (NRC, 2001) may be the first step in determining needs for ongoing professional development. These needs may be met by providing teachers with opportunities to immerse themselves into ongoing positive opportunities in mathematics. Additionally, the knowledge that research revealed higher levels of mathematics anxiety for elementary teachers in their pre-service ungraduated coursework than other college students (Battista, 1986), may be another important step in determining needs for ongoing professional development. Research reveals that professional development in mathematics is critical to improving classroom instruction (Ball & Cohen, 1999). District A leaders can use the findings from the current study to understand the complexity of primary and intermediate elementary teachers' perceptions of their personal and professional mathematics anxiety as after the implementation of professional development in mathematics instructional practices the change was not statistically significant in decreased mathematics anxiety for primary elementary teachers' personal mathematics anxiety while it was statistically significant with decreased mathematics anxiety for intermediate elementary teachers. Results of this study can help District A with understanding that professional development in mathematics instructional practices can decrease professional mathematics anxiety for both primary and intermediate elementary teachers.

This study also has implications related to personal mathematics teaching efficacy and mathematics teaching outcome expectancy. Because the data analysis from this study showed a statistically significant difference between personal mathematics teaching efficacy and mathematics teaching outcome expectancy for both primary and intermediate elementary teachers after the introduction of mathematics professional development, District A may want to consider continuing to invest time and resources into ongoing professional development opportunities in mathematics for elementary teachers. This recommendation aligns with research results of teachers ranging in teaching experience from one to twenty-five years shown to improve their efficacy levels over the course of 26 one-hour sessions of professional development opportunities in mathematics with the greatest impact in teachers starting with the lowest efficacy beliefs at the initiation of the training (Roberts et al., 2000). Additionally, this recommendation aligns to the National Mathematics Advisory Panel (2008) belief for more professional development for teachers to become knowledgeable in a broad scope of teaching methods in mathematics. District A should continue to provide primary and intermediate elementary teachers professional development in mathematics instructional practices and may need to strategically look at how it was conducted during the time of the study to identify ways to improve future professional development in mathematics.

Pre-service mathematics coursework should focus on developing aspiring teachers' deep understanding of mathematical concepts and pedagogical methods to teach mathematics. Pre-service coursework could also include identifying future teachers' potential mathematics anxiety to develop awareness and to target specific needs. Addressing, educating, and evaluating the perceived level of mathematics anxiety throughout pre-service methods courses would enable these future teachers to reduce their own perceptions of their personal and professional mathematics anxiety prior to entering their first professional role.

Recommendations for future research. This study supports the body of research on primary and intermediate teachers' perceptions of the change of their personal and professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy after the implementation of professional development in mathematics instructional practices. The following recommendations were suggested for future researchers who are interested in completing studies surrounding primary and intermediate teachers' perceptions of their personal and professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcomes, especially in smaller school districts with a highly mobile student population.

1. Future research should extend the current study to determine whether there is a relationship between any one of the four variables of personal mathematics

anxiety, professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcomes and student academic performance on the state assessment. Future research could also consider extending the current study to include measures of student academic performance beyond the state assessment and track student growth over time (fall to spring) on an assessment such as the Measure of Academic Progress.

2. Future researchers should also consider replicating the current study but conduct it in a larger school district with fewer transient students and less turnover of teachers associated with the transient nature of the students.
3. Future research could replicate and extend the current study by lengthening the amount of professional development in mathematics instructional practices for both primary and intermediate elementary teachers.
4. Future research could extend the current study to compare the effectiveness of professional development in mathematics instructional practices in school districts with similar demographics across the nation including school districts serving students on a military installation.
5. Finally, a mixed-methods study would be helpful to capture qualitative data related to primary and intermediate teachers' perceptions of their personal and professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcome expectancy before and after the implementation of professional development in mathematics instructional practices. The qualitative aspect of a mixed-method study would be beneficial

to gain individual feedback and insight into teachers' perceptions while also studying the quantitative data from the study.

Concluding remarks. Primary and intermediate elementary teachers face ongoing challenges to educate all students in mathematics. Federal law mandates that all students be taught to high academic standards to prepare them to succeed in college and careers (U.S. Department of Education, 2016). While secondary teachers through their licensure path specialize in one content area, the challenge exists for elementary teachers to become content knowledgeable and highly-effective across all core content areas, including mathematics. Data from this study show that professional development in mathematics instructional practices is effective in supporting primary and intermediate elementary teachers' perceptions of a positive change in their professional mathematics anxiety, personal mathematics teaching efficacy, and mathematics teaching outcomes. Based on the study, there continues to be a need to focus on supporting a change in primary elementary teachers' perceptions of their personal mathematics anxiety as the change in their perception was not statistically significant. The findings are meaningful to all District A leaders and may help to determine a course of action for professional development in mathematics instructional practices and teacher professional development opportunities.

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Appendices

Appendix A: MAMTS

McAnallen Anxiety in Mathematics Teaching Survey (MAMTS)

Developed by Rachel McAnallen, PhD, (2010)

Please complete the following demographic information and then indicate the degree to which you agree or disagree with each statement that follows by circling the answer.

1. Current grade level(s) teaching PK K 1 2 3 4 5 6

2. Years of teaching experience (including this year) 1 2 3 4 5 6 7 8 9 10+

3. Highest Degree Bachelors Masters Educational Specialist Doctorate

****

Please circle the number that best describes your level of agreement with the statement.

		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1.	I was one of the best math students when I was in school.	1	2	3	4	5
2.	Having to work with fractions causes me discomfort.	1	2	3	4	5
3.	I feel confident in my ability to teach mathematics to students in the grade I teach.	1	2	3	4	5
4.	I am confident that I can learn advanced math concepts.	1	2	3	4	5
5.	When teaching mathematics, I welcome student questions.	1	2	3	4	5
6.	I have trouble finding alternative methods for teaching a mathematical concept when a student is confused.	1	2	3	4	5
7.	I can easily do arithmetic calculations in my head.	1	2	3	4	5
8.	I find it difficult to teach mathematical concepts to students.	1	2	3	4	5
9.	I feel confident using sources other than a mathematics textbook when I teach.	1	2	3	4	5
		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

10.	I don't have the math skills to differentiate instruction for the most talented students in my math classes.	1	2	3	4	5
11.	I dislike having to teach math every day.	1	2	3	4	5
12.	I avoid taking non-required math courses in college.	1	2	3	4	5
13.	I have a lot of self-confidence when it comes to mathematics.	1	2	3	4	5
14.	I am confident that I can solve math problems on my own.	1	2	3	4	5
15.	I become anxious when I have to compute percentages.	1	2	3	4	5
16.	I have math anxiety.	1	2	3	4	5
17.	It makes me nervous to think about having to do any math problem.	1	2	3	4	5
18.	On the average, other teachers are probably much more capable of teaching math than I am.	1	2	3	4	5
19.	I cringe when a student asks me a math question that I can't answer.	1	2	3	4	5
20.	I am comfortable working on a problem that involves algebra.	1	2	3	4	5
21.	I have a strong aptitude when it comes to math.	1	2	3	4	5
22.	I doubt that I will be able to improve my math teaching ability.	1	2	3	4	5
23.	If I don't know the answer to a student's mathematical question, I have the ability to find the answer.	1	2	3	4	5
24.	I become anxious when a student finds a way to solve a problem with which I am not familiar.	1	2	3	4	5
25.	I would welcome the chance to have my supervisor evaluate my math teaching.	1	2	3	4	5

26. I am ____ Male ____Female

27. Number of Years Mathematics Teaching Experience _______

28. Place a check mark in front of the following math classes you successfully completed in high school:

_____ Algebra I ______ Geometry ______ Algebra II

_____ Trigonometry/Precalculus ______ Calculus I ______ Calculus II

29. What is the highest level of math class that you passed in college? ________________________________

30. Compare yourself to other elementary math teachers in terms of your mathematical abilities:

01	02	03	04	05	06	**07**
One of the worst	Way below average	Below average	Average	Above average	Way above average	One of the best

31. Do you enjoy doing math? ____ Yes _____ No – Skip to Question 34

32. When did you first realize that you enjoyed mathematics?

___ Primary school (K-2) ___ Elementary (3-5) ___ Middle school (6-8)

___ High school (9-12) ___ College/Adulthood ___ Don't remember

33. Describe what you enjoy about mathematics:

34. Do you experience "math anxiety"? _____ Yes____No – Please continue to the end.

35. Rate the degree of your math anxiety. ____ 1 – Mild _____ 2- Moderate _____3-Severe

36. When did you first experience math anxiety?

___ Primary school (K-2) ___ Elementary (3-5) ___ Middle school (6-8)

___ High school (9-12) ___ College/Adulthood ___ Don't remember

37. Please describe the circumstances that led to your first experience with math anxiety:

Thank you for completing this survey.

Appendix B: MAMTS Approval

Re: Fw: Request permission to use the MAMTS

R
[redacted]

Reply|
Wed 11/2/2016, 10:16 AM
Grant, SuAnn
You replied on 11/2/2016 10:19 AM.

Action Items
Good Morning SuAnn,

Please forgive me for not answering sooner but I have been on the road traveling and I am not very good about e-mails when I am away from home.

Yes, of course, you may use the math anxiety scale that I developed during my doctoral work. You are welcome to change anything in it if you wish but then that would change any reliability of the original study.

Please let me know if there is any other information that you may need.

Thank you from Rachel aka Ms Math

Rachel R McAnallen PhD
[redacted]

Storrs, CT 06268
[redacted]
www.zoidandcompany.com

Math is a language to be spoken, an art to be seen, a music to be heard, and a dance to be performed.

In a message dated 11/2/2016 10:30:31 A.M. Eastern Daylight Time, SGrant [redacted].org writes:

Good morning Dr. McAnallen,

From below, I wanted to follow-up with you to see if you had the opportunity to consider my request to utilize your McAnallen Anxiety in Mathematics Teaching Survey (MAMTS) in my dissertation work. I have enjoyed reading your work as well as everything posted on your website. Thank you so much in advance for taking the time to consider my request. I appreciate it!

Sincerely,

SuAnn Grant

Baker University student

Home address:

SuAnn Grant

[redacted]

Appendix C: MTEBI

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

Developed by Enochs, Smith, and Huinker, (2000)

Please complete the following demographic information and then indicate the degree to which you agree or disagree with each statement that follows by circling the correct answer.

1. Current grade level(s) teaching PK K 1 2 3 4 5 6

2. Years of teaching experience (including this year) 1 2 3 4 5 6 7 8 9 10+

3. Highest Degree Bachelors Masters Educational Specialist Doctorate

4. Gender Female Male

****

		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1.	When a student does better than usual in Mathematics, it is often because the teacher exerted a little extra effort.	A	B	C	D	E
2.	I will continually find better ways to teach mathematics.	A	B	C	D	E
3.	Even if I try very hard, I do not teach mathematics as well as I do most subjects.	A	B	C	D	E
4.	When the mathematics grades of students improve it is often due to their teacher having found a more effective teaching approach.	A	B	C	D	E
5.	I know the steps necessary to teach mathematics concepts effectively.	A	B	C	D	E
6.	I am not very effective in monitoring mathematics activities.	A	B	C	D	E
7.	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	A	B	C	D	E
8.	I generally tech mathematics ineffectively.	A	B	C	D	E
		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

9.	The inadequacy of a student's mathematics background can be overcome by good teaching.	A	B	C	D	E
10.	The low mathematics achievement of some	A	B	C	D	E
11.	When a low-achieving child progresses in mathematics, it is usually due to the extra attention by the teacher.	A	B	C	D	E
12.	I understand mathematics concepts well enough to be effective in teaching mathematics.	A	B	C	D	E
13.	Increased effort in mathematics teaching produces little change in some students' mathematics achievement.	A	B	C	D	E
14.	The teacher is generally responsible for the achievement of students in mathematics.	A	B	C	D	E
15.	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	A	B	C	D	E
16.	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	A	B	C	D	E
17.	I find it difficult to use manipulative to explain to students why mathematics works.	A	B	C	D	E
18.	I am typically able to answer students' mathematical questions.	A	B	C	D	E
19.	I wonder if I have the skills necessary to teach mathematics.	A	B	C	D	E
20.	Given a choice, I would not invite my principal to evaluate my mathematics teaching.	A	B	C	D	E
21.	When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.	A	B	C	D	E
22.	When teaching mathematics, I usually welcome student questions.	A	B	C	D	E
23.	I do not know what to do to turn students on to mathematics.	A	B	C	D	E

Appendix D: MTEBI Approval

Re: Request permission to use MTEBI

DH

DeAnn M Huinker <[redacted]>

Reply|

Wed 10/26/2016, 5:32 PM

Grant, SuAnn

Inbox

SuAnn,

Yes, you have my permission to use the MTEBI in your dissertation work.

Best to you in your research and professional work.

DeAnn Huinker

On Oct 23, 2016, at 9:57 PM, Grant, SuAnn <[redacted]> wrote:

Dear Dr. Huinker,

I am respectfully requesting your permission to use your Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) in my dissertation work. I am reaching solely out to you because in my researching I read with sadness that Dr. Enochs passed away in June 2015. Additionally, I was unsuccessful in locating Dr. Smith.

My background is that I am employed in a K-9 public school district and I am also a doctoral student at Baker University in Kansas. For my dissertation work, I am interested in researching elementary school teachers' self-efficacy beliefs in teaching mathematics. Specifically, I intend to research if there is any relationship to these beliefs before and after the introduction of professional development in mathematics for the pre-kindergarten through the sixth grade setting in a small midwestern district. In my beginning review of the literature, I have found that the MTEBI has been widely used and would provide me an instrument with reliability and validity to measure teachers' beliefs in their abilities. I would very much appreciate your permission to use the MTEBI.

Please advise if there is anyone else that you would also like me to contact. Thank you for taking the time to consider my response. I look forward to hearing from you.

Sincerely,

SuAnn Grant
Baker University

[redacted]

Appendix E: School Board Permission

Regular Board Meeting (Tuesday, September 20, 2016)
Meeting Minutes

Action: 4.5 Action to Approve Doctoral Dissertation Study

Mrs. Grant requested approval of her proposed dissertation study and a sample type of survey (anonymously completed) that may be included as part of her research and data collection. Mrs. (A) made a motion to approve as recommended by Mrs. Grant, which was seconded by LTC (B). The motion carried a vote to approve 3 - oppose 0.

Appendix F: IRB Request

BAKER UNIVERSITY

IRB Request

Date 11/13/17 IRB Protocol Number ______ (IRB use only)

I. Research Investigator(s) (students must list faculty sponsor)

Department(s) Graduate School of Education

	Name	Signature	
1.	SuAnn Grant	SuAnn Grant	Principal Investigator
2.	Susan Rogers	Susan K Rogers	☑ Check if faculty sponsor
3.	Margaret Waterman	Margaret Waterman	☐ Check if faculty sponsor
4.			☐ Check if faculty sponsor

Principal investigator contact information Phone [redacted] Email Address

Note: When submitting your finalized, signed form to the IRB, please ensure that you cc all investigators and faculty sponsors using their official Baker University (or respective organization's) email addresses.

Faculty sponsor contact information Phone 785-230-2801

Email srogers@bakeru.edu

Expected Category of Review: ☑ Exempt ☐ Expedited ☐ Full ☐ Renewal

II. Protocol Title

The Impact of Professional Development in Mathematics on Elementary School Teachers' Efficacy Beliefs

III. Summary:

The following questions must be answered. Be specific about exactly what participants will experience and about the protections that have been included to safeguard participants from harm.

A. In a sentence or two, please describe the background and purpose of the research.

While secondary teachers through their licensure path specialize in one content area, the challenge exists for elementary teachers to become content knowledgeable and skilled instructors across all core content areas. Research has shown, however, that teachers' mathematics anxiety and low mathematical self-efficacies have negatively impacted some students' academic performance in mathematics (Bellock, Gunderson, Ramirez, & Levine, 2010; Kahle, 2008). Because of increased legislative demands that impact schools across America, it is important to study elementary teachers' perceptions of their mathematics anxiety, self-efficacy in mathematics, and mathematical teaching self-efficacy, and the impact of professional development in mathematics on their efficac

B. Briefly describe each condition, manipulation, or archival data set to be included within the study.

The quantitative data was gathered by a Project Director to measure the subjects' mathematics anxiety ratings, mathematics self-efficacy, and patterns of learning. Two instruments were used to collect the quantitative data including the Mathematics Teaching Efficacy Beliefs Instrument (Enochs, Smith, and Huinker, 2000) and the McAnallen Anxiety in Mathematics Teaching Survey (McAnallen, 2010).

IV. Protocol Details

A. What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

Archival data will be used. No data will be collected by the researcher.

B. Will the subjects encounter the risk of psychological, social, physical, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

Subjects will not encounter any risk of psychological, social, physical or legal risk.

C. Will any stress to subjects be involved? If so, please describe.

Subjects will not be subject to any stress during the length of the study.

D. Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

Subjects will not be deceived or misled in any way at any time throughout the course of the study.

E. Will there be a request for information which subjects might consider to be personal or sensitive? If so, please include a description.

No subjects will be requested for information that might be considered personal or sensitive.

F. Will the subjects be presented with materials which might be considered to be offensive, threatening or degrading? If so, please describe.

Subjects will not be presented with materials that might be considered offensive, threatening, or degrading in any manner.

G. Approximately how much time will be demanded of each subject?

No time will be demanded of each subject because archival data will be used.

H. Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

The subjects of the study are elementary teachers. The data was collect by the school district; therefore, no demand of solicitation or contact was made by the researcher because archival data will be used.

I. What steps will be taken to insure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

No inducements were offered to the subjects for their participation. The data was collected by the school district; therefore, no solicitation was made by the researcher.

J. How will you insure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

The data was collected by the school district as part of the professional development provided to elementary teachers.

K. Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

No aspect of the data will be made a part of any permanent record that can be identified with a subject.

L. Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher, or employer? If so, explain.

The fact that a subject did or did not participate will not be made part of any permanent record available to a supervisor, teacher, or employer.

M. What steps will be taken to insure the confidentiality of the data? Where will it be stored? How long will it be stored? What will be done with the data after the study is completed?

To insure confidentiality of the individual subjects, no direct identifiers such as names or email addresses will be collected. All subjects will be assigned a random number as the identifier which will be tied to the individual's demographic information including age, sex, current student grade level teaching, and years of experience. Data will be stored on a local server for the length of the study. After the data is disaggregated and presented in published form, all data will be destroyed.

N. If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks involved in the study.

O. Will any data from files or archival data be used? If so, please describe.

Data was collected in August 2016 and May 2017. The two instruments used to collect the quantitative data included the Mathematics Teaching Efficacy Beliefs Instrument (Enochs, Smith, and Huinker, 2000) and the McAnallen Anxiety in Mathematics Teaching Survey (McAnallen, 2010).

Appendix G: IRB Approval

Baker University Institutional Review Board

November 15th, 2017

Dear SuAnn Grant and Susan Rogers,

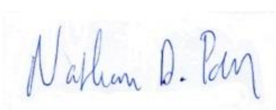
The Baker University IRB has reviewed your project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,



Nathan Poell, MA
Chair, Baker University IRB

Baker University IRB Committee
Scott Crenshaw
Erin Morris, PhD
Jamin Perry, PhD
Susan Rogers, PhD