ABSTRACT

Title of dissertation: AN ANALYSIS OF THE RELATIONSHIP BETWEEN MATHEMATICS BELIEFS AND MATHEMATICS TEACHING SELF-EFFICACY IN ELEMENTARY PRE-TENURE TEACHERS

Susan Vohrer, Doctor of Education, 2017

Dissertation directed by: Professor Margaret J. McLaughlin, Chair
College of Education

Preparing students to be college and career ready with 21st century skills requires elementary classroom teachers to effectively understand and execute the Common Core State Standards for Mathematics. In order to achieve this goal successfully, teachers need to possess both positive mathematics beliefs and mathematics teaching self-efficacy. The purpose of this study was to investigate the possible relationship between mathematics beliefs and mathematics teaching self-efficacy in pre-tenured elementary teachers in Title I schools as well as the relationship of these constructs with demographic factors such as grade level taught, number of years teaching (0-3), level and number of mathematics courses completed in high school and college, and completion of a mathematics degree. While there has been extensive research on the teaching self-efficacy for pre-service teachers, there is a paucity of research focusing on pre-tenured teachers.

An online survey based on a validated instrument, the Mathematics Teaching Efficacy Beliefs Instrument, was administered to a representative sample of 125 pre-tenured elementary teachers. A moderate relationship between mathematics beliefs and mathematics teaching self-efficacy was found. Further, it appears that the greater the numbers of mathematics courses completed (high school or undergraduate), the greater the mathematics teaching self-efficacy. No other significant relationships were found with any other variable tested. Implications regarding these findings and possible next steps are examined.

An Analysis of the Relationship between Mathematics Beliefs and Mathematics Teaching Self-Efficacy in Elementary Pre-Tenure Teachers

by

Susan Vohrer

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Advisory Committee:

Professor Margaret J. McLaughlin, Chair
Dr. Helene Cohen
Dr. John Norris
Professor Wayne Slater
Dr. Donna Wiseman

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NCSM Summer Board meeting when I had to “go write!” instead of being with the Board of Directors as previously planned. To my friends, I value your encouraging words more than you know and I am happy to say that now I can play tennis on Saturdays again and host book club as I should!

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Section 1: Introduction

> We begin with a simple question: “What causes student achievement?” In some schools, the responses are clearly associated with the actions of teachers and leaders. They attribute the causes of achievement to their own efficacy – their excellence in teaching, curriculum, feedback, high expectations, assessment, leadership, and other factors in their control. In other schools, the response…is strikingly different. Rather than their own impact, the second group attributes the causes of achievement to student demographic characteristics. The data from our studies suggests that where there is a high degree of teacher and leadership efficacy, the gains in student achievement are more than three times greater than when teachers and leaders assume that their impact on achievement is minimal (Reeves, 2008, p.4).

Concern regarding the mathematics achievement of students in the United States is a critical topic in the educational field, starting in the 1960s with the Russian space capsule Sputnik hurtling into space. In recent times, “President Barack Obama highlighted the importance of mathematics education, pledging the creation of new initiatives that will better equip our graduates for current and future jobs that focus on science, technology, engineering, and mathematics” (Uswatte, 2013, p.1) as a means for preparing students for careers in the 21st century. Additionally, the creation of the Common Core State Standards for Mathematics (CCSSM) (2010) demands a shift in the pedagogy of teaching mathematics as well as the knowledge to teach it effectively.

> The biggest challenge coming from the Common Core Standards is not the content itself, it's the notion of a learning target, or level of cognitive demand and critical thinking, attached to a content standard. These are overlays that demand changes in instructional practice. And, frankly, this change is revolutionary. It will cause a big change in how you do your job as a teacher (Achieve3000, 2012, p. 2).

These changes in instructional practice, coupled with the expectations for increasing student achievement in mathematics in order for students to be college and career ready, place a direct focus on the classroom teacher to deliver high quality mathematics lessons.

"One element that has been studied for its impact on teacher effectiveness and student learning is teacher efficacy" (Uswatte, 2013, p. 2). Teacher self-efficacy is grounded in Albert Bandura's social cognitive theory which defines this phenomena as a teacher's belief in his or her "capability to bring about desired outcomes of student engagement and learning even among those students who may be difficult or unmotivated" (Tschannen-Moran and Hoy, 2001, p.783). "Teacher efficacy has proven to be powerfully related to many meaningful educational outcomes such as teachers' persistence, enthusiasm, commitment, and instructional behavior, as well as student outcomes such as achievement, motivation, and self-efficacy beliefs" (Tschannen-Moran and Hoy, 2001, p. 783). Teaching self-efficacy is related to a belief structure that teachers develop over time beginning with their own mathematics experiences (Briley, 2012). This belief structure is the basis of mathematics teaching self-efficacy, which is different from teaching self-efficacy. Mathematics teaching self-efficacy may be defined as a teacher's judgment of his or her competence to bring about the desired outcomes of teaching and learning mathematics effectively as opposed to mathematics self-efficacy, which may be defined as one's own judgment of how adept one is with solving and utilizing mathematics. In other words, mathematics teaching self-efficacy is the ability to feel comfortable in teaching mathematics and feeling that the results of the teaching effort are satisfactory.

Problem of Practice and Research Questions

> Beginning teachers will likely carry responsibilities equal to or greater than their more experienced colleagues. The beginning teacher's teaching assignment, often including the most challenging students, room assignments, and schedules, is expected to be identical or even more difficult than the veteran teacher next door. In no other profession will novices be immediately expected to perform at the same level as their veteran counterparts (Kobett, 2016, p. 9).

This means that elementary pre-tenured teachers should be teaching high quality mathematics lessons while learning the curriculum, developing behavior management skills, and navigating the culture of their schools. They are expected to have the mathematics teaching self-efficacy to teach mathematics at the current level of rigor required by the CCSSM for their grade level. In the district of the study, many pre-tenured teachers begin their careers in Title I schools, creating an even greater challenge in their first teaching assignments. The problem to be investigated is that elementary classroom teachers, generalists who teach up to five content areas, appear to have a low level of mathematics teaching self-efficacy which may be the result of their mathematical beliefs based on their past life experiences and their comfort with teaching mathematical content.

Elementary teachers' beliefs toward mathematics play a key role in their effectiveness in teaching mathematics and in what may be described as quality teaching practices. "Knowledge and beliefs have a direct influence on instructional practice," Wilkins, 2008). Karen Karp, Professor of Mathematics Education at the University of Louisville and co- author of *Elementary and Middle School Mathematics: Teaching Developmentally*, states that studies have revealed that teachers with negative beliefs toward mathematics use more traditional instructional methods and are more likely to refrain from using constructivist practices (Wilkins, 2008). On the other hand, teachers who enjoy mathematics and feel effective in teaching it are more likely to use constructivist methods or inquiry-based problems to teach mathematics concepts (Wilkins, 2008).

As the review of literature shows, there is limited research regarding the mathematics teaching self-efficacy of elementary teachers, with pre-tenured teachers being a subset of that group. Therefore, the purpose of this study was to examine the relationship between the mathematical beliefs and mathematics teaching self-efficacy of elementary pre-tenured teachers in Title I schools and with other demographic characteristics such as number of years teaching, highest level of mathematics education, and the number of undergraduate mathematics courses completed. The study was conducted in a large suburban school district in the Mid-Atlantic region of the United States and collected data using a survey administered to pre-tenured teachers in Title I schools.

This study was guided by the following research questions:

1. In the district of study, is there a relationship between mathematical beliefs and mathematics teaching self-efficacy in pre-tenured teachers in Title I schools?
2. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the years of teaching experience of pre-tenured teachers in Title I schools?
3. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the grade level taught by pre-tenured teachers in Title I schools?
4. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the highest level of high school mathematics courses completed by pre-tenured teachers in Title I schools?
5. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the number of undergraduate college mathematics courses completed by pre-tenured teachers in Title I schools?
6. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the completion of a mathematics degree for pre-tenured teachers in Title I schools?

Definition of Terms

The following definitions provide additional clarification for the terms used in this study:

Beliefs: “psychologically held understandings, premises, or propositions about the world that are thought to be true. Beliefs are more cognitive, are felt less intensely, and are harder to change than attitudes. Beliefs might be thought of as lenses that affect one’s view of some aspect of the world or as dispositions toward action” (Philipp, 2007);

Constructivism: an educational theory that embodies the idea that learners are constructors of their own knowledge. "Encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing." (Educational Broadcasting Corporation, 2004);

Mindset: core belief about how one learns; may be a fixed mindset which is often combined with negative beliefs about mathematics or a growth mindset, which may be associated with positive beliefs about mathematics;

Mathematical dispositions: observable behaviors that demonstrate characteristics such as confidence with mathematics, perseverance in solving problems, flexibility with mathematical ideas, and an interest and curiosity for mathematics (Boaler, 2016);

Mathematics self-efficacy: one's own judgment of how adept one is with solving and utilizing mathematics (Briley, 2012);

Mathematics teaching self-efficacy: a teacher's judgment of his or her capabilities to bring about the desired outcomes of teaching mathematics effectively or in learning (Briley 2012; Uswatte, 2013);

Pre-tenured teacher: a teacher in the first three years of his or her teaching career; may be referred to as a non-tenured teacher;

Productive Disposition: the tendency to see sense in mathematics, perceive it as both useful and worthwhile, to believe that steady effort in mathematics pays off, and to see oneself as an effective learner and doer of mathematics *(*Kilpatrick, Swafford, and Findell, 2001);

Self-efficacy: the extent or strength of one's belief in one's own ability to complete tasks and reach goals (Bandura, 1986);

Social cognitive theory: Albert Bandura's theory of human behavior upon which self-efficacy was developed;

Teacher self-efficacy: a teacher's judgment of capabilities to bring about desired outcomes of student engagement and learning even among those students who may be difficult or unmotivated (Tschannen-Moran and Hoy, 2001).

Rationale for Study

As previously stated, concern regarding the mathematics achievement of students in the United States started in the 1960s with the Russian space capsule Sputnik "beating" the United States' outer space exploration. This generated heightened anxiety for improving the effectiveness of instruction for school mathematics. "The Cold War between the United States and the Soviet Union spawned demands for more academic courses in the schools and a greater emphasis on science and mathematics" (Coulter, 2010, p. 5). In 1983, the National Commission on Excellence in Education report, *A Nation at Risk*, examined the academic underperformance of students in the United States as compared to other nations. One finding in the report demonstrated that only one-third of the students could solve a math problem with several steps. As a result, the report made several recommendations to improve education in the United States, one of which was that teachers need to be competent in an academic discipline. Decades later, educational systems in the United States continue to have the same concerns, propelled by the changing nature of technology, tough competition in a global job market, and the need for college and career readiness. One of the results of these concerns is the adoption of the

Common Core State Standards (CCSS), a set of standards of knowledge and skills for mathematics and English language arts.

> Students need the appropriate skills and knowledge to become college- and career-ready, and in reality too few students are prepared for college and/or a career. The world of the future will require a new kind of worker, and these workers will have jobs that utilize a higher level and more diverse set of skills. Rather than just consuming information, students need to be able to produce and generate information and think creatively. They will also need to reason effectively, solve complex problems, and communicate clearly (Common Core State Standards Initiative: Rationale).

For the field of mathematics, preparing students to be college and career ready with 21st century skills require teachers to have a deep understanding of the mathematics they are teaching so they can provide engaging problems for students to solve, encourage mathematical discourse, and ask and reflect upon probing questions to assess student understanding. For teachers to be able to carry out these tasks, it is critical that they possess the mathematical beliefs and mathematics teaching self-efficacy for teaching elementary mathematics in order to provide effective lessons to promote student achievement (Ambrose, Phillipp, Chaunet, and Clement, 2003; White, Way, Perry, and Southwell, 2005/2006). While there have been many studies focused upon the mathematics teaching self-efficacy of pre-service teachers, there are few such studies focused on in-service teachers, and none regarding pre-tenured teachers. Because pre-tenured teachers are expected to rise to the level of performance of a veteran teacher (Kobett, 2016), there is an immense amount of pressure placed on these teachers.

> Millions of K-12 students are impacted daily by these new teacher's pedagogical and instructional decisions…[and these] students are learning or not learning mathematics, building their own notions about the role of mathematics in their lives, and developing internal dispositions for their own mathematics attainment. These students of beginning teachers are more likely to receive less effective instruction setting in motion a perpetuation of the existing achievement gap and even future income disparities (Kobett, 2016).

Addressing the achievement gap is prevalent in many schools, but is a primary focus in Title I schools, where historically, the data shows a lack of mathematical growth. According to the United States Department of Education, Elementary and Secondary Education Act, Section 1001, the purpose of Title I funding to schools is "to ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging State academic achievement standards and state academic assessments." This purpose can be accomplished by

- ensuring that high-quality academic assessments, accountability systems, teacher preparation and training, curriculum, and instructional materials are aligned with challenging State academic standards so that students, teachers, parents, and administrators can measure progress against common expectations for student academic achievement;
- meeting the educational needs of low-achieving children in our Nation's highest-poverty schools, limited English proficient children, migratory children, children

with disabilities, Indian children, neglected or delinquent children, and young children in need of reading assistance;

- closing the achievement gap between high- and low-performing children, especially the achievement gaps between minority and nonminority students, and between disadvantaged children and their more advantaged peers;
- holding schools, local educational agencies, and States accountable for improving the academic achievement of all students, and identifying and turning around low-performing schools that have failed to provide a high-quality education to their students, while providing alternatives to students in such schools to enable the students to receive a high-quality education;
- improving and strengthening accountability, teaching, and learning by using State assessment systems designed to ensure that students are meeting challenging State academic achievement and content standards and increasing achievement overall, but especially for the disadvantaged.

Given these expectations, one may wonder why pre-tenured teachers are placed in Title I schools since research shows that "almost 50% of public school teachers are likely to leave the teaching profession within the first five years" and that "high-poverty, high-minority, urban, and rural schools have the highest rates of turnover in the nation" (Kobett, 2016, p. 9). This speaks to the fact that the teachers need to have an elevated level of teaching self-efficacy to survive those first years. In elementary schools, having mathematics teaching self-efficacy may increase the likelihood of remaining in the profession.

The basis for success in mathematics begins in elementary school, and the success or failure to achieve can have profound effects on a student's future mathematics education, which then impacts employment and life earnings. "The more mathematics classes students take, the higher their earnings ten years later, with advanced mathematics courses predicting an increase in salary as high as 19.5% ten years after high school" (Boaler, 2016, p. xi). For example, the California Dropout Research Project (CDRP) initiated a seven-year study which examined the factors that affected the high school graduation rate of 48,000 students in the Los Angeles Unified School District. While the study looked at a variety of factors in the dropout rate, one significant indicator was that students who passed Algebra 1 increased their chances of graduating on time by 70%. Note that Algebra I is considered a gatekeeper course that makes students more likely to go to college (Silver, Saunders, and Zarate, 2008). Figure 1 shows how this achievement can relate to overall lifetime earnings (U.S. Census Bureau, 2002).

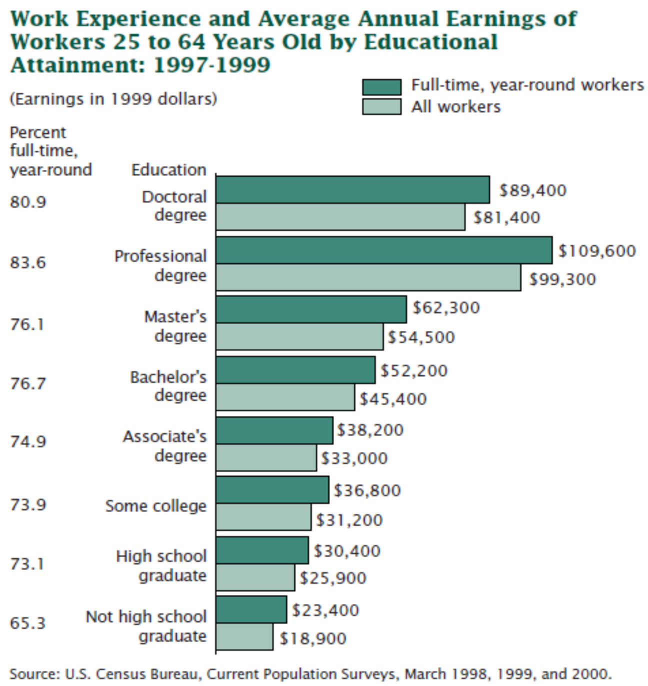

Figure 1: Annual earnings based on educational attainment per U.S. Census Bureau.

Teacher Disposition

Disposition is defined by the Merriam-Webster Online Dictionary as "a prevailing tendency, mood or inclination, temperamental makeup; the tendency of something to act in a certain manner under given circumstances." In other words, disposition describes a person's typical actions and emotional state over a period. Since teaching requires much more than just opening a book, the dispositions of successful teachers are being examined so that colleges of education may promote and assess these dispositions in pre-service teachers. The National Council for Accreditation of Teacher Education (NCATE) now requires these dispositions to be taken into consideration for accreditation. (Mall, 2012). While NCATE does not define exactly what knowledge and skills compose dispositions, it does offer this explanation:

> [Dispositions are] the values, commitments, and professional ethics that influence behaviors toward students, families, colleagues, and communities and affect student learning, motivation and development as well as the educator's own professional growth. Dispositions are guided by beliefs and attitudes related to values such as caring, fairness, honesty, responsibility and social justice. For example, they might include a belief that all students can learn high and challenging standards or a commitment to a safe and supportive learning environment (National Council for Accreditation of Teacher Education, 2002).

Disposition plays a role in mathematics education and is one of the strands of mathematical proficiency as shown in Figure 2.

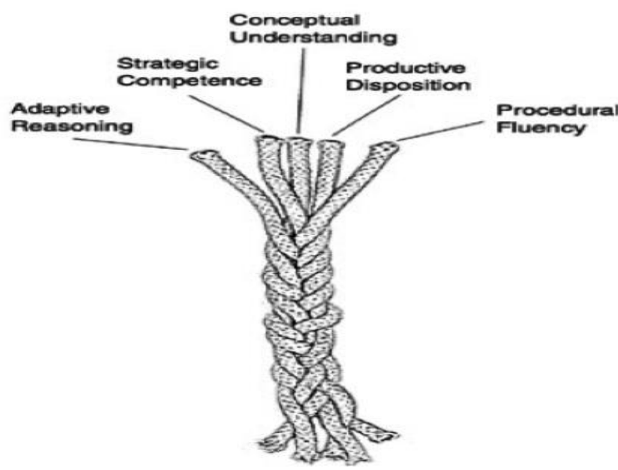

Figure 2: The five strands of mathematics proficiency which illustrates how productive disposition is integral to mathematics. (Kilpatrick et al., 2001)

In *Adding It Up: Helping Children Learn Mathematics*, Kilpatrick et al. noted that a "productive disposition refers to the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics" (Kilpatrick et al., 2001, p. 23). Developing a productive disposition is essential for mathematics success (Kilpatrick et al., 2001) as are the other interwoven strands of mathematics proficiency.

> As students build strategic competence in solving non-routine problems, their attitudes and beliefs about themselves as mathematics learners become more positive. The more mathematics concepts they understand, the more sensible mathematics becomes. In contrast, when students are seldom given challenging mathematical problems to solve, they come to expect that memorizing rather than sense-making paves the road to learning mathematics, and they begin to lose confidence in themselves as learners…Students' dispositions towards mathematics is a major factor in determining their educational success" (Kilpatrick et al., 2001, p. 23).

Professor Jo Boaler of Stanford University has written extensively on the characteristics of productive disposition which she refers to as mathematical mindset (Boaler, 2016). Note that "students" may be considered as those in school, college, or in-service courses when referring to having a productive disposition or mathematical mindset.

In 2012, the American Mathematical Society produced The Mathematical Education of Teachers II (MET II), a report written to address what pre-service and in-service teachers should know about mathematics in order to teach it effectively. MET II states that

- there is intellectual substance in school mathematics;

- proficiency with school mathematics is necessary but not sufficient mathematics knowledge for a teacher;
- the mathematical knowledge needed for teaching differs from that of other professions;
- mathematical knowledge for teaching can and should grow throughout a teacher's career (American Mathematical Society, 2012, p. xii).

These themes suggest that the mathematics one learns in school is not all that is needed to teach mathematics to children, and that teachers need to continue their intellectual growth in the area of mathematics in order to teach it well.

> Teaching the kind of mathematics described here calls for a teacher to deeply understand mathematics well beyond the grade level being taught. Professional recommendations call for secondary teachers to know mathematics at the level of a college major and for elementary teachers to have significant course work or professional learning that helps them understand the deep foundations of the number system (including the meanings of basic operations), concepts of measurement and geometry (including spatial reasoning) and basic notions of statistics and algebra (Mathematical Association of America 2015; National Council of Teachers of Mathematics and Council for the Accreditation of Educator Preparation, 2012.) For leaders, this means that every teacher should have a strong mathematical background (Seeley, 2016, p.15).

It is interesting to note that mathematical productive dispositions are actions and viewpoints derived from experiences which form a belief structure which develops mathematics teaching self-efficacy. "How a teacher views mathematics and its learning affects that teacher's teaching practice, which ultimately affects not only what the students learn but how they view themselves as mathematics learners" (Kilpatrick et al., 2001, p. 24).

Supporting Data

The International Association of the Evaluation of Educational Achievement administers the Trends in International Mathematics and Science Study (TIMSS) assessment every four years in the United States and 53 other nations. Recently for Grade 4 mathematics, the United States was among the top 15 nations, and in Grade 8, the United States was among the top 25 nations. The National Assessment of Educational Progress (NAEP), a national assessment that tests students in Grades 4 and 8 across the United States, compared the scores from the United States to other countries, and found that the United States performed at a mediocre level, which continued the concern over mathematics achievement in the United States (National Assessment of Educational Progress, 2015). In the district of study, the Maryland School Assessment scores maintained a stagnant 82% of proficient and advanced students, with special needs students scoring significantly lower (Free and Reduced Meals Students 69.4%, Special Education 47.8%, and English Language Learners 63.1%).

The Partnership for Assessment of Readiness for College and Careers (PARCC) was first administered to students in Grades 3-8 in the spring of 2015, with the second administration given in the spring of 2016. The PARCC data for the district of study are shown in Table 1.

Table 1

Student Proficiency Levels: Mathematics Standards PARCC 2015 and 2016

Grades 3-5	Number of Students	Level 1 Not Met	Level 2 Partially Met	Level 3 Approaching	Level 4 Met	Level 5 Exceeded	Level 4/5 Met and Exceeded
2015	18,918	8.3%	22.7%	28.8%	35.1%	5.8%	40.9%
2016	18,546	9.0%	19.4%	26.4%	37.8%	7.3%	45.1%

While the percentage of students in Grades 3-5 who met or exceeded the standard increased 4.2%, it remained low across all three grades. The quality of teaching in the classrooms may be a likely factor, but there are other variables that contributed to these scores, such as students having to sit for two rounds of testing on consecutive days, the use of online testing instead of paper/pencil, the amount of time devoted to mathematics, and a possible misalignment of curriculum (if teachers did not follow it with fidelity). Despite these other possible variables for the low scores, the fact remains that the scores need improvement, and that provides some reflection on the teaching students received.

There is also a concern generated from observational/anecdotal data from school visits that elementary school teachers struggle with the mathematics teaching self-efficacy needed to teach mathematics effectively. The researcher noted this early in her career, sparking the initial interest in this research topic. In the researcher's professional position, she has documented comments from elementary educators in the district of study reflecting this concern over the past four years:

- "I am struggling with providing appropriate PD [professional development] to change the way math is currently taught at my school. Last year, I worked to learn where the strengths and weaknesses of my staff lie. I feel strongly that I need to spend time with the CRA model, Number Talks, and Talk Moves this year to increase the discourse in the classroom. This in turn will help us meet our SIP goal of increasing oral and written communication to better prepare our students for success in higher level mathematics." Principal

- "I am so glad to learn these strategies to be able to teach my students. I had no idea!" Non-tenured teacher

- "After working with a coach for six years, I still did not understand the math." Math interventionist

- "I am starting to learn to plan better and anticipate student responses. This is hard work, and I did not know how to do this. I hope I did it right—like you wanted." Non-tenured teacher

- "Oh, I teach first grade because of math. I would never teach 4^{th} or 5^{th}!" Veteran teacher

- "I am not a math person. I like to teach reading." Veteran teachers- multiple grades

- "Why are we using balance scales when we are teaching addition equations? Seems out of place to teach measurement right in the middle of addition." Grade 1 teacher

- "My students can do $5 + 3 = ?$, but $? – 5 = 3$ is just too hard." Grade 1 teacher

While these statements are only a few examples of educators' belief statements in the district of study, they appear to validate the need for increasing mathematics teaching self-efficacy.

Pre-tenured teachers need support during their first three years in order to be successful, and this may be provided by additional graduate course work or by professional learning in the school district (Kobett, 2016). The district of study recognized this need, and developed the Right Start Program to support the district's pre-tenured teachers. This program enrolls approximately 320 new/pre-tenured elementary teachers per year with the goal of teacher retention. The district averages an 87% retention rate for pre-tenured teachers as per the district's Bridge to Excellence (2016). The district's Right Start Program assists new teachers throughout their first three years by providing a part-time mentor and professional learning sessions related to classroom management, cultural awareness, positive behavior intervention systems, and other relevant topics. However, little professional learning from the Office of Elementary Mathematics has been provided to the Right Start Advisors to share with their mentees on mathematical content or pedagogy to increase their mathematics teaching self-efficacy or influence their mathematical beliefs and mathematics teaching self-efficacy. The researcher has provided anecdotal experiences to the Right Start Advisors that shows their mentees demonstrating inaccurate mathematics or traditional pedagogy that perpetuates the lack of deep understanding of mathematics for the students in their charge. The Office of Elementary Mathematics offered to provide professional learning opportunities to the Right Start Advisors, however, this has not taken place. The district has not provided focused mathematics training to either the Right Start Advisors or specifically to pre-tenured teachers as a group to increase their capacity in elementary mathematics. Such training is critical because pre-tenured teachers "still need consistent support for developing content and pedagogical knowledge that is standards-based because standards-based mathematics instruction is often fundamentally different from what they experienced as students in their own learning environment and university school settings" (Kobett, 2016, p.28).

The federal legislation of the No Child Left Behind Act of 2001 (NCLB) mandated that every child, regardless of race, ability, or situation, would be proficient in reading and mathematics by 2014 (No Child Left Behind Act of 2001). Individual states were required to add accountability measures for meeting adequate yearly progress for students in Grades 3-8 and four high school subjects or face consequences/sanctions. In 2011, the Senate Committee overseeing NCLB approved an updated education bill, but bipartisan politics prevented any type of compromise even though there was an agreement that changes to the law were essential. Considering the stalemate, President Obama informed states that they could apply for a waiver to avoid the consequences/sanctions of not meeting the adequate yearly progress targets if they agreed to the following conditions contained in the federal initiative known as Race to the Top:

- adopt rigorous standards that would prepare students for college and career;
- recruit and retain effective teachers;
- raise scores at low performing schools; and
- build data systems to monitor student achievement and teacher effectiveness.

In 2015, Congress reauthorized the 50-year-old Elementary and Secondary Education Act, referred to as Every Student Succeeds Act (ESSA). The new law included provisions for

- college and career ready standards;
- annual state assessment for all students;
- innovative local assessments;

- student performance targets and ratings (state driven and based on multiple measures);
- accountability, interventions, and support for struggling schools (state developed identification and intervention for lowest 5%);
- teacher and leader evaluation and support systems based on student learning;
- inclusion of pre-kindergarten; and
- competitive program for innovation, replication of high quality charter schools, and support systems for vulnerable communities (Every Student Succeeds Act, 2015).

Mandated state assessments clearly link student achievement and teacher performance, placing a firm responsibility on teachers to ensure students are learning mathematics content and processes, and raising the bar on accountability. The consequences of not demonstrating mathematics teaching self-efficacy may result in low evaluations, and more importantly, students who are not able to use mathematics effectively in the real world which can impact college and career choices.

Mathematics understanding and application are essential skills in today's highly technical world. "We live in a time of extraordinary and accelerating change. New knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve" (National Council of Teachers of Mathematics, 2000). It is vital to have knowledgeable mathematics teachers in every classroom (Seeley, 2016), and the relationship between mathematics teacher beliefs and mathematics teaching self-efficacy is critical in the elementary school. Research suggests that a teacher's mathematics beliefs and mathematics teaching self-efficacy may influence his or her success in the teaching of mathematics as measured by student achievement (Ambrose et al., 2003). “Students’ understanding of mathematics, their ability to use it to solve problems, and their confidence in, and disposition toward mathematics are all shaped by the teaching they encounter in school” (National Council of Teachers of Mathematics, 2000). There is limited research based on elementary mathematics teachers’ beliefs, elementary mathematics teaching self-efficacy, and the relationship of beliefs and self-efficacy to student achievement. Emerging research has begun to examine teachers’ mathematics teaching self-efficacy as related to student achievement. The existing research suggests that professional development may increase mathematics teaching self-efficacy which may parlay into increased student achievement (Briley, 2012). However, prior to the current study, no research has been conducted regarding pre-tenured elementary mathematics teacher beliefs and mathematics teaching self-efficacy in the district of study.

Consideration of Barriers

In the researcher’s work with teachers over a 25-year span, several teachers have stated that they choose to teach at the primary level because they did not want to teach intermediate level mathematics. “I was never good at math when I was in school” or “I can’t wrap my head around the math” are often cited as reasons why teachers would not challenge themselves. Laurie Hart Reyes stated that a positive self-concept in mathematics is the perception or belief in one’s ability to do math well, which is related to mathematics teaching self-efficacy and disposition (Fennell, 2007). Based on the report of the National Research Council, *Adding It Up*, people need a “productive disposition" which is a "habitual inclination to see mathematics as sensible, useful, and worthwhile coupled with a belief in diligence and one's own efficacy" (Fennell, 2007, p.1). Teachers who do not possess a productive disposition are afraid of math, and they conduct their classes in a manner of "teaching not to lose" (Gojak, 2014, p.1). These teachers were most likely taught the same way when they were in school, and people tend to imitate the way they have been taught. Therefore, the researcher believes that the potential lack of mathematics skill and knowledge in the United States is caused, at least in part, by a teacher's beliefs about mathematics which drives his or her low mathematics teaching self-efficacy.

One possible cause of the lack of mathematics teaching self-efficacy is the lower number of mathematics methods courses being taught to pre-service teachers compared to the number of reading methods courses. President Barack Obama made clear his concerns regarding the lack of teacher preparation when he stated, "The vast majority of new teachers- almost two-thirds- report that their teacher preparation program left them unprepared for the realities of the classroom" (Chandler et al., 2014, p.7). Inquiries to universities in Maryland revealed that Early Childhood majors are required to take 9-12 credits of mathematics methods courses, while elementary majors are required to take a mere 6-9 credits of mathematics methods courses out of the 120+ credits needed to graduate. The number of mathematics courses compared to reading courses that an undergraduate student needs to successfully complete at Maryland colleges and universities is shown in Table 2. In 2015, Maryland passed a law that all teacher preparatory programs require four mathematics courses; however, the data gleaned did not consistently show compliance to the law. The information was retrieved from online course catalogs in January, 2016.

Table 2

Comparison of Required Undergraduate Reading and Mathematics Courses in MD

Institution	Program of Study	Number of Reading Courses Required	Number of Mathematics Courses Required
Loyola University	Elementary Education	6	2
McDaniel College	Elementary Education (Minor only)	5	5
Notre Dame University of Maryland	Elementary Education	5	1
Salisbury University	Elementary Education	4	1
Stevenson University	Early Childhood Education	5	4
Stevenson University	Elementary Education	4	4
Towson University	Early Childhood Education	3	3
Towson University	Elementary Education	6	4
University of Maryland	Early Childhood Education	4	3
University of Maryland	Elementary Education	6	4

Another possible cause for low mathematics teaching self-efficacy is the lack of professional development for elementary school teachers once they are in the classroom. If colleges are not preparing the teachers to instruct students at a high level in mathematics, then it becomes the responsibility of the district to do so. Some teachers fear math (lack of productive disposition/beliefs and mathematics teaching self-efficacy) and therefore do not opt to participate in district led professional development sessions if they are not mandatory. With the implementation of the Maryland College and Career Readiness Standards (CCSSM), the perceived lack of skills and knowledge regarding elementary mathematics has become a focus in the district of study. Teachers have stated to the district's union that what they are required to teach is a "heavy work load," meaning that they have to plan their lessons (which requires more understanding of what they are teaching) instead of following a book. Note that the new grade level content in the Common Core State Standards for Mathematics is approximately 75% the same as the content from the former Maryland State Curriculum that teachers have been teaching for the past twelve years. Teachers seem to struggle with collaboratively planning lessons with the standard and outcome in mind. The district's mathematics office posted 22 specific face-to-face professional development sessions to address the Maryland College and Career Readiness Standards (CCSSM), and the average attendance at each session was 25 out of 250+ teachers per grade level.

Literature Review

Mathematical knowledge and pedagogy.

Shulman (1986) brought forth the theory that there are "three kinds" of knowledge that are needed to allow a teacher to be effective: subject matter knowledge, pedagogical content knowledge, and curricular knowledge. He makes the distinction between knowledge that is content based alone and pedagogical content knowledge which is how to “shape a curriculum into something that is understandable by others” (Shulman, 1986, p.1). This type of pedagogical knowledge is critical for teachers to be able to implement in order to teach the mathematics content in a way that is understandable so students may learn conceptually and retain the knowledge. Exploring how best to do this leads to the constructivist theory of learning in which students construct their own knowledge “from perceptions and experiences” (Simon, 1995, p.119).

“All contributions to mathematics education include multifaceted work of teachers, curriculum designers, education materials developers, and researchers” (Simon, 1995, p. 117). This is a complex notion that involves many ideas and decisions on the teacher’s part. Wood, Cobb, and Yackel state that a

> teacher must… construct a form of practice that fits with their students’ ways of learning mathematics. This is the fundamental challenge that faces mathematics teacher educators. We have to reconstruct what it means to know and do math in school and thus, what it means to teach mathematics (Simon, 1995. p.117).

Knowing the rigorous trajectory of skills from the CCSSM, planning appropriate learning goals and targets can be an overwhelming job for a novice teacher. One can see from the Simon’s Mathematics Teaching Cycle below (Figure 3) that if a teacher does not possess a high degree of mathematics teaching self-efficacy, it is easy to resort to the traditional method of teaching mathematics through workbooks and worksheets.

> With the recent implementation of standards-based mathematics reform that emphasizes rigor including deep conceptual understanding, problem solving,

and multiple uses of tools and mathematical representations, students are expected to engage in high-leverage mathematical tasks and need environments that support student-learning experiences designed to promote student questioning, connections, and reflection. The beginning teacher has only experienced some degree of implementing instructional practices aligned with social constructivist theory (Kobett, 2016, p. 23).

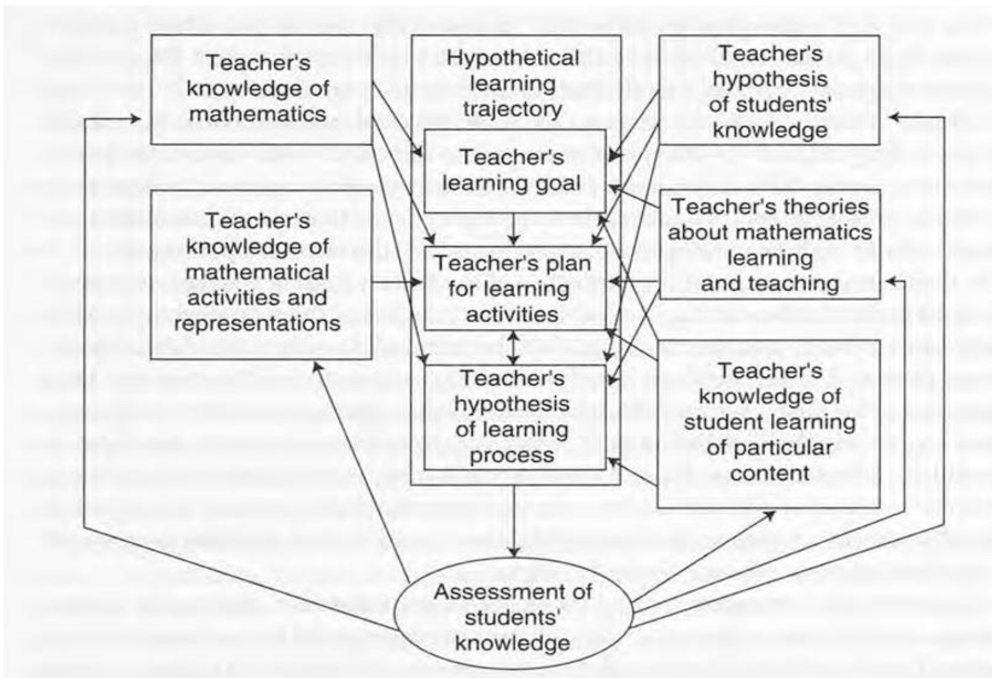

Figure 3: Simon's mathematics teaching cycle which demonstrates the complex nature of teaching (Simon, 1995, p. 137).

Developing mathematical beliefs.

What are beliefs and how do they affect people's actions? "Beliefs influence perception" (Ambrose et al., 2003 citing Pajares, 1992, p.2). This means that the beliefs a person has about something will determine what action he or she may take. “Beliefs are not all-or-nothing entities” (Ambrose et al., 2003, p.2). This idea applies to the fact that there are different degrees of beliefs, which may determine a variety of interpretations. “Beliefs tend to be context specific” (Ambrose et al., 2003, citing Cooney, Shealy, and Arvold, 1998, p.2). What one believes depends upon the context from which it is thought about and viewed. “Beliefs might be thought of as dispositions toward a topic” (Ambrose et al., 2003, citing Cooney et al., 1998, p.2). “Underlying a teacher’s mathematics pedagogical practices is a belief system for teaching mathematics that is built from a history of learning mathematics as well as university classroom and field placement experiences” (Kobett, 2016, p.23). Through people's actions, their belief constructs may be ascertained.

Considering the above statements, it becomes apparent that the beliefs held by a person play an important role in his or her thoughts and actions. It may be inferred that mathematics beliefs and dispositions are the precursors to mathematics teaching self-efficacy, as one needs to believe in something before one can make a judgment about one's capabilities in relation to it. Beliefs predispose a person to some type of action based on the strength of the belief. For example, what a mathematics teacher believes about mathematics and teaching mathematics will influence how effective that teacher is with students. “If a teacher believes that mathematics is symbols and calculations, they are likely to focus on symbols and calculations. If a teacher believes that mathematics is about reasoning [and sense-making], they are more likely to focus on reasoning [and sense-making]” (Ambrose et al., 2003; Coulter, 2010, p.14). The teacher who believes in making sense of mathematics and in his or her ability to teach math, will provide hands-on and innovative lessons so students can learn the connectedness of mathematical concepts. A teacher who uses rules and procedures will tend to teach in a traditional manner (Barker, 2012). "Teachers' beliefs influence the decisions that they make about the manner in which they teach mathematics" (National Council of Teachers of Mathematics, 2014, p.10). Figure 4 below visualizes how mathematical beliefs influence mathematics teaching self-efficacy and, as a result, influence the decisions teachers make about teaching mathematics.

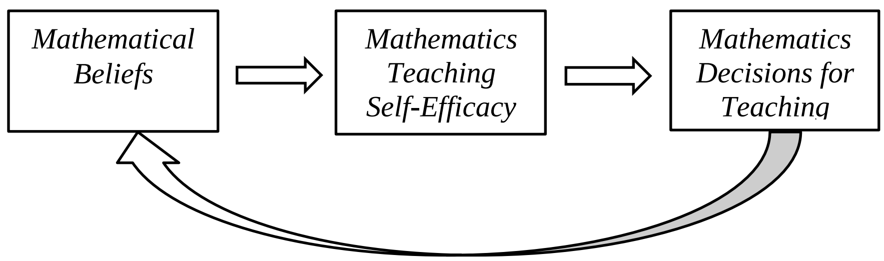

Figure 4: A visual representation of the effect of mathematics beliefs upon mathematics teaching self-efficacy and influencing decisions for teaching.

The table below shows how unproductive and productive beliefs may impact the teaching and learning of mathematics. "It is important to note that these beliefs should not be viewed as good or bad. Instead, beliefs should be understood as unproductive when they hinder the implementation of effective instructional practice or limit student access to important mathematics content and practices" (National Council of Teachers of Mathematics, 2014, p. 11).

Table 3

Beliefs about Teaching and Learning Mathematics

Unproductive Beliefs	Productive Beliefs
Mathematics learning should focus on practicing procedures and memorizing basic number combinations.	Mathematics learning should focus on developing understanding of concepts and procedures through problem solving, reasoning, and discourse.
Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.	All students need to have a range of strategies and approaches from which to choose in solving problems, including, but not limited to, general methods, standard algorithms, and procedures.
Students can learn to apply mathematics only after they have mastered the basic facts.	Students can learn mathematics through exploring and solving contextual and mathematical problems.
The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use this information to solve math problems.	The role of the teacher is to engage students in tasks that promote reasoning and problem solving and facilitate discourse that moves students toward shared understanding of mathematics.
The role of the student is to memorize information that is presented and then use it to solve routine problems on homework, quizzes, and tests.	The role of the students is to be actively involved in making sense of mathematics tasks by using varied strategies and representation, justifying solutions, making connections to prior knowledge or familiar contexts and experiences, and considering the reasoning of others.
An effective teacher makes the mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.	An effective teacher provides students with appropriate challenge, encourages perseverance in solving problems, and supports productive struggle in mathematics.

(National Council of Teachers of Mathematics, 2014, p. 11)

Beliefs may have a conceptual orientation or a calculational orientation. Teachers with a belief system of calculational orientation "have an image of mathematics as the application of skills and procedures, will tend to talk only about numbers in a problem and finding the algorithm, and pay little attention to the context of the problem" (Lambdin and Lester, 2010, p.48). Teachers with a calculational orientation may hold some or all of the unproductive beliefs indicated in Table 3. Teachers who demonstrate a belief system of conceptual orientation "are driven by the system of ideas around a topic, the ways students think about the ideas, and the materials and activities that can engage students in a productive way with the ideas" (Lambdin and Lester, 2010, p. 48). These characteristics relate to productive behaviors shown in Table 3 and support the constructivist approach to teaching (Kobett, 2016; Shulman, 1986; Simon, 1995).

Prior to school, children are subject to their parents' feelings and beliefs about mathematics (National Council of Teachers of Mathematics, 2014). Beginning in Grade 2, children perceive that some students appear smarter or learn faster than others (White et al., 2005/2006). As they progress through school, those students "who achieved higher test scores…perceived mathematics to be more useful than lower achieving students" (White et al., 2005/2006, p. 35). As a result, lower achieving students may develop a belief of "Why should I put forth effort if there is no positive result?" This belief process is related to the formation of mathematics beliefs and mathematics teaching self-efficacy, and it is the teacher's responsibility to provide positive and engaging mathematical experiences for the child in order to build positive beliefs.

Self-Efficacy.

Albert Bandura developed the concept of self-efficacy through his work with social cognitive theory, which began in the field of behavioral and social psychology. The basis of the social cognitive theory is "how children and adults operate cognitively on their social experiences and how these experiences influence their behavior and development" (Lockard, 2013, p.25). These experiences mold into beliefs and judgments of a person's own ability to successfully perform an action, which is self-efficacy. It is important to note that self-efficacy is not about ability or skills, but how a person perceives what they can do with their ability and skills.

Bandura defined self-efficacy as having two components: efficacy expectations and outcome expectations (Bandura, 1986). Efficacy expectations is the belief in one's capability to perform a behavior successfully, and outcome expectations determine that the behavior will result in a specific (positive) outcome (Briley, 2012). Performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousals are four sources of information that develop efficacy. Performance accomplishments can be described as mastery experiences and are based on how well a person performs when doing tasks. For example, a child who draws well will develop self-confidence and self-efficacy regarding his or her artistic skills. Vicarious experiences are when one person observes another person successfully completing a task. A Boy Scout watching his Scoutmaster tie knots is an example of a vicarious experience, as the Scout develops the sense of efficacy that he, too, can tie knots. Verbal persuasion is when others encourage people that they will be successful with a task. Overhearing a person say another person is wonderful at a task is an example of verbal persuasion as it supports the person's vision of doing the task successfully (and it is wonderful to know someone noticed). Finally, emotional arousal, or the affective state, is related to a person's emotional state when performing a task. For example, being speechless after a shocking event is an example of emotion affecting behavior. This thinking may be applied to teacher self-efficacy, the belief that one is capable of engaging students in the learning.

Teacher self-efficacy.

Teacher self-efficacy is subject matter specific. Many elementary classroom teachers have a lack of mathematics content knowledge and skills, which affects their mathematics teaching self-efficacy and teaching outcome expectancy. "Efficacy beliefs influence how people feel, think, motivate themselves, and behave" (Bandura, 1993, p.118). Therefore, if a teacher believes that he or she is not effective with mathematics, that teacher will not perform to the highest degree. Teacher efficacy may be defined as a teacher's "judgment of his or her capabilities to bring about desired outcomes of student engagement and learning" (Tschannen-Moran & Hoy, 2001, p.204). A teacher with a low self-efficacy tends to rely on extrinsic motivators, lecture or teacher led lessons, and worksheets with which to teach his or her classes. Linda Gojak, Past President of the National Council of Teachers of Mathematics, views this as "teaching not to lose" (Gojak, 2014, p.1). She states that teachers who teach in this manner present procedures instead of rich problems to solve, make math easy for the students, and prepare students for testing rather than teaching them how to think like mathematicians. However, a teacher with a high self-efficacy in mathematics will use a constructivist approach, letting the students solve problems in a variety of ways, providing rich tasks, encouraging discourse, and developing the students' interest and curiosity about the wonders of mathematics, which tends to increase student achievement (Bandura, 1993, Gojak, 2014). Ms. Gojak refers to this as "teaching to win" (Gojak, 2014, p.1). Teachers who teach to win have a mathematical growth mindset toward math, and are able "to appropriately create, select, or modify tasks…to understand the mathematical consequences of different choices of number, manipulative tools, or problem contexts" (American Mathematical Society, 2012, p.2).

In her article, "It's Elementary! Rethinking the Role of Elementary Classroom Teacher," Linda Gojak states, "In their undergraduate preparation, they may be required to take only 2 math courses-a methods course and a content course-yet be responsible for teaching mathematics in a way that will develop deep understanding in their students" (Gojak, 2013, p.1). Since mathematics is a critical content area with mandated testing, this is a surprisingly low number of required credits for pre-service teachers, with reading courses composing much of the coursework. In addition, it is the researcher's observation that pre-service teachers are not being taught the current pedagogy for effective teaching and learning of mathematics; rather, they are learning more of the same "drill and kill" methods that drive students away from wanting to learn more mathematics. In a discussion of this problem with Dr. Francis (Skip) Fennell and Dr. Beth Kobett, professors at McDaniel College and Stevenson University respectively, both concurred that undergraduate students come to them with limited mathematics knowledge, skills, and mathematics teaching self-efficacy as they begin their journey into education. Dr. Fennell and Dr. Kobett work to ensure the students in their charge learn what is needed to teach engaging and rigorous mathematics lessons, but find that some of their students will revert to strategies they are familiar with instead of adopting new strategies that are research-based.

As Albert Bandura states in his article, "Perceived Self-Efficacy in Cognitive Development and Functioning," "Self-efficacy beliefs contribute to motivation in several ways: They determine goals people set for themselves, how much effort they will expend, how long they will persevere in the face of difficulty, and their resilience to failure" (Bandura, 1993, p.131). It appears that many elementary school teachers perceive that they lack the capabilities of becoming excellent mathematics teachers. This becomes a vicious cycle, as the lack of knowledge and enthusiasm is transferred to the students, and they grow up to be adults who were "never good at math, either" (Fennell, 2007, p.1).

Teachers' beliefs in their own teaching efficacy affects their behavior; the learning environments that they create; and, ultimately, the level of academic progress achieved by their students (Bandura, 1993). Unproductive beliefs, such as people having a "math gene," may influence teaching and learning. "The fixed mindset considers cognitive abilities to be fixed from birth and unchangeable. In contrast, the growth mindset sees cognitive abilities as expandable" (American Mathematical Society, 2012, p. 9). If teachers believe that what they know about mathematics is fixed, this belief may be inadvertently passed on to the students they teach, and students will not be adventurous problem solvers, but get stuck when presented a problem without a clear solution path. Another unproductive belief is that elementary mathematics is easy, so teachers "learned all the mathematics they needed to know during their own schooling" (American Mathematical Society, 2012, p.10). This leads to the "teaching not to lose" (Gojak, 2014) classroom where "doing mathematics means following rules laid down by the teacher" and "knowing mathematics means remembering and applying the correct rule when the teacher asks a question" (American Mathematical Society, 2012, p.10).

Bandura's ongoing work regarding teaching self-efficacy has been the benchmark of conceptual models for other researchers. Through his research, Bandura established observable characteristics for determining high and low teaching self-efficacy in teachers. The beliefs that teachers hold are developed through cognitive processing that is "conveyed inactively, vicariously, socially, and psychologically" (Bandura, 1993). Once these ideas are formed, they set the stage for the behaviors that teachers exhibit.

Tschannen-Moran and Hoy's research supported Bandura's work on self-efficacy, but related it more specifically to teachers. "Efficacy affects the effort teachers invest in teaching, and the goals they set" (Tschannen-Moran and Hoy, 2001, p.783). In their research, the Rand measure was explained as a 2-item measure of "personal teacher efficacy" (Tschannen-Moran and Hoy, 2001, p.204). This spawned other researchers to develop their own studies. Gibson and Dembo created a Teacher Efficacy Scale that was later revised by Guskey and Passaro and noted a strong positive correlation between efficacy and responsibility for student success.

Further research discussed the construct of teacher self-efficacy in relation to different subject domains and populations. Briley (2012) examined the relationship of mathematics teaching self-efficacy, mathematics self-efficacy, and mathematics beliefs with pre-service teachers. He found a statistically significant positive correlation between mathematics beliefs and mathematics teaching self-efficacy. "The pre-service teachers who reported stronger beliefs in their capabilities to teach math effectively were more likely to possess more sophisticated math beliefs" (Briley, 2012, p.8). In another study, teacher efficacy was analyzed through arts education (Gavis and Pendergast, 2011). This investigation supported the theory of teacher self-efficacy as being the motivating factor for planning and teaching effective lessons. In the arts, teachers also need to develop efficacy. “Change in perceived capability with the arts requires early childhood teachers to develop the knowledge and skills in each of the arts domains” (Gavis and Pendergast, 2011, p.12).

Dr. Francis (Skip) Fennell (2007) discussed the lack of mathematics teacher self-efficacy in his National Council of Teachers of Mathematics article, “I Was Never Good in Math, Either.” He stated that in elementary schools, students display an eagerness to learn mathematics, but as they progress through the grade levels, there is a decline. This declining eagerness develops into adults who feel it is socially acceptable to tell the world they are not good in math. This concept was followed up by the idea of teaching to win (Gojak, 2014; Coulter, 2010) where teachers with high mathematics teaching self-efficacy will use strategies such as group work, rich tasks, reasoning and sense-making of mathematics to increase student achievement. Teachers who teach not to lose (Gojak, 2014) minimize risk by showing and telling and making math easy for the students. These teachers are demonstrating low mathematics teaching self-efficacy as they do not wish to teach any mathematics that they are uncomfortable with teaching because they feel they do not have a thorough understanding of the mathematics.

Study

The purpose of the study was to examine the mathematics beliefs and mathematics teaching self-efficacy in pre-tenured elementary teachers in Title I schools in a large suburban district in the Mid-Atlantic States. Elementary teachers are generalists, so a focus on mathematics as a high-stakes tested area is essential for student success. In the district of study, no specific professional development in elementary mathematics was performed with the targeted teacher population. However, the district's Title I Office provides a mathematics coach to Title I schools who provides support with teaching mathematics.

Mathematics PARCC scores in the district need improvement. The PARCC assessment is more rigorous than the former Maryland School Assessment, and the district saw a decline in test scores of about 35%. This led to a focus on the effective teaching of mathematics. "There is strong evidence that educators nationwide should expect significant reductions in the percentage of students deemed proficient when compared with the proficiency rates currently reported by states using their own assessments" (Larson & Leinwand, 2013, p.1). Previously, most states set their proficiency standards lower than NAEP, with only Massachusetts having proficiency set at the same level as the NAEP. For example, Kentucky reported 65% proficiency rate on previous state assessments and 40.6% on the new assessment based on the Common Core State Standards. In addition, the disaggregated data in the district of study show subsets of students who are not improving in mathematics, with Free and Reduced Meals (FARMS), African American, and special education showing an achievement gap, particularly in Title I schools.

The cost to students in time and knowledge due to ineffectual teaching as measured on state tests is quite high, and may never be recovered. If teachers' beliefs and the standards-based beliefs do not correspond, then daily mathematics instruction is compromised (Kobett, 2016). Research has found that if a student has an ineffective teacher for two years, educational loss is seldom recovered (Charit, 2010; Learning Loss, 2013). We must not let this happen—for the pre-tenured teachers or for the students. Understanding pre-tenured teachers' mathematics beliefs and mathematics teaching self-efficacy will be a step toward developing supports to improve instruction and, thus, improve student achievement.

Section 2: Study Design

Purpose

The problem that was investigated is whether elementary classroom teachers have a high, moderate, or low degree of mathematics teaching self-efficacy which may be the result of their mathematical beliefs based on their past life experiences and their comfort with teaching mathematical content. Mathematical teaching self-efficacy may be defined as a teacher's judgment of his or her capabilities to bring about the desired outcomes of teaching mathematics effectively, as opposed to mathematics self-efficacy, which may be defined as one's own judgment of how adept one is with solving and utilizing mathematics (Briley, 2012). In other words, mathematics teaching self-efficacy is the ability to feel comfortable in teaching mathematics and feeling that the results of the teaching effort is satisfactory. The purpose of this quantitative study was to explore factors that may show if a relationship exists between mathematical beliefs and mathematical teaching self-efficacy in pre-tenured teachers in Title I schools.

Research Questions

The following research questions were investigated in this study:

1. In the district of study, is there a relationship between mathematical beliefs and mathematics teaching self-efficacy in pre-tenured teachers in Title I schools?
2. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the years of teaching experience in pre-tenured teachers in Title I schools?

3. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the grade level taught with pre-tenured teachers in Title I schools?
4. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the highest level of high school mathematics courses completed for pre-tenured teachers in Title I schools?
5. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the number of undergraduate college mathematics courses completed by pre-tenured teachers in Title I schools?
6. In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the completion of a mathematics degree for pre-tenured teachers in Title I schools?

Research Study Design

The study used quantitative descriptive analysis in order to examine if a relationship exists between mathematical beliefs and mathematics teaching self-efficacy in the target population of elementary pre-tenured teachers in Title I schools. Descriptive analysis uses statistics to describe or summarize features of a collection of data or information. In this quantitative study, descriptive analysis utilized the statistics to summarize the findings in order to determine if relationships existed based on the research questions.

It is beneficial to understand what quantitative research is by definition. Quantitative research is “explaining phenomena by collecting numerical data that are analyzed using mathematically based methods” (Aliaga and Gunderson, 2000, as cited by

Muijs, 2011, p.1) The selection of quantitative research was based on a philosophical view of research approaches. Creswell (2014) and Muijs (2011) describe quantitative research as positivist or post-positivist, meaning that the research is focused on finding an "existing reality" (Muijs, 2011, p.3) in "which causes (probably) determine effects or outcomes" (Creswell, 2014, p.7; Muijs, 2011). The difference between positivism and post-positivism is that "post-positivists believe that research can never be certain…post-positivist social science focuses on confidence-how much can we rely on our findings?" (Muijs, 2011, p.5; Creswell, 2014; Hoy, 2010).

Using quantitative research for this study was appropriate because "data that do not naturally appear in quantitative form can be collected in a quantitative way. We do this by designing research instruments aimed specifically at converting phenomena that don't naturally exist in quantitative form into quantitative data which we can analyze statistically. Examples of this are "attitudes and beliefs" (Muijs, 2011, p.2). This conversion may be accomplished by developing a survey where participants rate statements that describe the phenomena and "give the answers a number" (Muijs, 2011, p.2). Other justifications for using quantitative research for this study are that surveys may be constructed to measure human judgments in an objective manner (Creswell, 2014; Hoy, 2010); are time bound; and may be straightforwardly distributed to a specific population electronically, which is economical in time and money. The study is descriptive by providing "systemic information about a phenomenon" (Baltimore County Public Schools, 2016, p.1). "In this type of inquiry, the phenomena described are basic information, actions, behaviors, and changes of phenomena, but always the description is about what the phenomena look like from the perspective of the researcher or the participants in the research" (Lunenberg & Irby, 2008, p.30). Using this type of research design should connect "the data to theory or prior research" (Lunenberg & Irby, 2008, p.31; Creswell, 2014).

When developing a quantitative study, there are issues surrounding the research, which lead to the development of a conceptual framework to guide the research and data collection. Bandura's theory of triadic reciprocal causation conceptual framework, Figure 5, illustrates how behavior, personal factors, and environment interact with each other to develop mathematics teaching self-efficacy. One part is not independent of the other parts, and one part of the triad may be more influential in certain contexts. (Gavis & Pendergast, 2011).

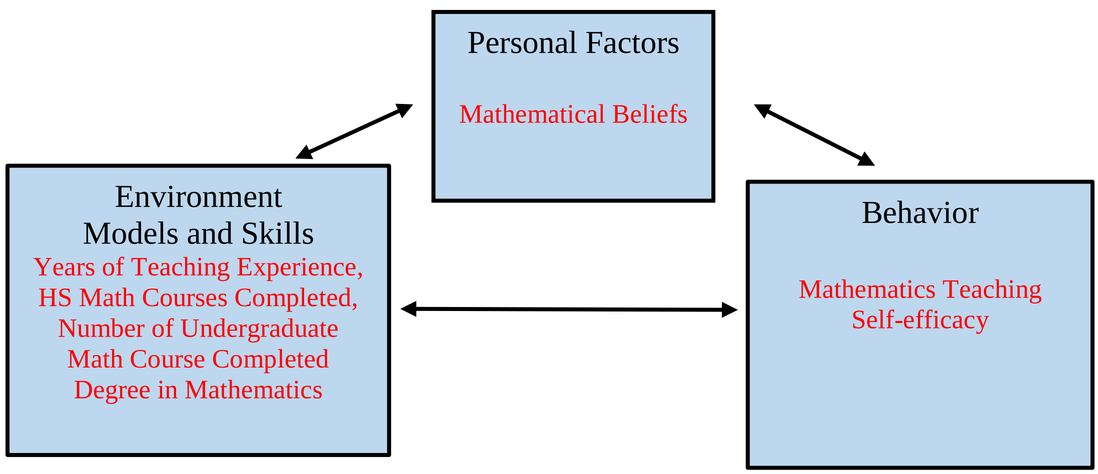

Figure 5: Adaptation of Albert Bandura's theory of triadic reciprocal causation showing factors related to the current study. (Bandura, 1986)

For this research study, the researcher applied the triadic causation theory to the problem of practice. The personal factors are the mathematical beliefs held by the pre-tenured teachers which may influence their behavior. Their behavior, or mathematics teaching self-efficacy, in turn, influences their ongoing beliefs about mathematics.

Environmental factors, such as years of experience in teaching, the highest level of mathematics attained, number of undergraduate mathematics courses completed, and whether one has earned a mathematics degree may influence both the personal factors (mathematics beliefs) and behavior (mathematics teaching self-efficacy) of the participants of the study. All three parts of the triad are closely inter-related and examined as part of the research study.

Participants

The researcher followed the guidelines for use of human subjects required by the Institutional Review Board for both the University of Maryland (See Appendix A) and the district of study. The frame population (Groves, et. al., 2009) for this study was from a pool of 223 pre-tenured elementary school teachers, Grades K-5, who were teaching in the district's twenty-six Title I elementary schools during the 2016-2017 school year. Pre-tenured teachers in Title I schools were chosen for the study because "teacher self-efficacy forms within the beginning years of teaching and according to theory, once developed, is resistant to change" Gavis & Pendergast, 2011, p.5; Kobett, 2016). Title I schools were chosen because they tend to have a high ratio of pre-tenured teachers with a range of experience from 0 – 3 years. In addition, Title I schools often have similar challenges so the teachers have comparable experiences in their first years of becoming acclimated as a classroom teacher. Finally, since Title I schools have a larger number of pre-tenured teachers, their college mathematics experiences may have a wide variety in terms of number of undergraduate courses completed, content, and pedagogy which could have an impact on the results.

After determining the population, the researcher then discussed the problem of practice with the Executive Director and Supervisor of the Instructional Data Division (IDD) from the district of study. To ensure confidentiality, the Supervisor provided the names of the teachers, how many years they have been teaching (1-3), and the schools in which they teach, in a password protected Excel spreadsheet. This information was necessary so that each pre-tenured elementary teacher in the specific Title I school in Grades K-5 could receive an email letter of invitation for the opportunity to participate in the study.

Methods

Upon approval by the Institutional Review Boards, an invitation email (see Appendix B) was created for sending to the invited participants as well as a follow-up reminder email (see Appendix C). The invitation email explained the study in detail, including statements that the provided link to the survey was completely anonymous and their participation was totally voluntary, with no repercussions of any kind, and that the only person to see the data was the researcher. Pre-tenured elementary teachers from the frame population self-selected to be in the study. To gain a confidence level of 95% and a 15% margin of error, 36% of the 223 pre-tenured elementary teachers (80 teachers) needed to participate in the study. Responses to the survey instrument were anonymous.

Survey Instrument

The study took place in the spring of 2017 and a survey was used for data collection. "Surveys are some of the most common instruments to use in descriptive study research" (Lunenberg & Irby, 2008, p.32). The survey was used to generalize viewpoints from pre-tenured teachers about their mathematics beliefs and mathematics teaching self-efficacy. The specific advantages of a survey for this study are "the economy for the design and the rapid turnaround in data collection" (Creswell, 2014, p. 157). The survey was distributed electronically and participants self-selected to be in the study.

The questionnaire used was the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), created by Drs. Enochs, Smith, and Huinker (2000). This particular instrument, used with permission from Dr. DeAnn Huinker (see Appendix D), was developed to align with the topics of mathematical beliefs and mathematics teaching self-efficacy. Built upon Bandura's self-efficacy work, the MTEBI is based on the Science Teaching Efficacy Belief Scale which was originally developed by Drs. Enochs and Riggs. The MTEBI contains two subscales: the Personal Mathematics Teaching Efficacy subscale and the Mathematics Teaching Outcome Expectancy subscale. The Personal Mathematics Teaching Efficacy subscale "specifically measures a teacher's self-concept of his or her ability to effectively teach mathematics" (Evans, 2010, p.5). The Mathematics Teaching Outcome Expectancy scale "specifically measures a teacher's belief in his or her ability to directly affect student learning outcomes." (Evans, 2010, p.5).

When using the MTEBI in their own studies, multiple researchers found Cronbach's alpha to be 0.88 for the Personal Mathematics Teaching Efficacy subscale and 0.77 for the Mathematics Teaching Outcome Expectancy subscale (Cronbach, 1951; Enochs et al., 2000; Evans, 2010). The researcher used an adapted version of the survey instrument that was divided into two sections. Section 1 had six demographic questions, and Section 2 had twenty-three Likert-style questions from previously administered and peer reviewed studies (Enochs et al.; Evans, 2010; Jansen, 2007; Uswatte, 2013), with two additional statements for clarification (totaling twenty-five items) for a sum of thirty-one items in the survey.

All items within the instrument were close-ended, requiring a respondent to select from predetermined categories. Items in the first section of the survey were to obtain background characteristics of persons who self-selected to be in the sample. These items focused on experiential backgrounds, current teaching assignments, and training experience in mathematics.

Substantive data was obtained from items in the survey's second section. A series of twenty-five items were included to form an index referred to as the *Mathematics Teacher Scale*. Using conventional survey research methodology, each of these twenty-five items received a rating value of one to five based on the level of respondent agreement. Figure 6 presents a schematic representation of the five-point Likert type of response scale used for items in Section 2 of the survey.

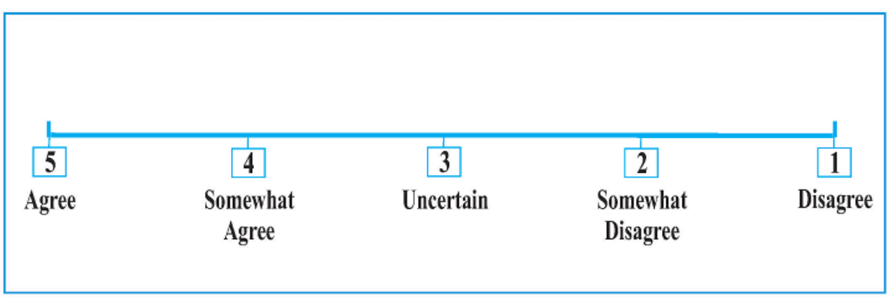

Figure 6: Schematic representation of Likert-type response scale used in survey to determine level of agreement.

As shown in the schematic, the strongest level of adherence to item content will elicit a response of Agree, which was assigned a value of five. When the respondent's viewpoint contrasts most intensely with a statement, the choice is "*Disagree*" and a value of one was assigned. Three intermediate response categories could be selected to indicate lesser levels of agreement or disagreement with items in this section of the survey. These ordinal-level item ratings were subsequently grouped into a composite value or "score" to reflect a respondent's overall perspective regarding mathematics beliefs and mathematics teaching self-efficacy.

To determine reliability, an internal consistency analysis was conducted for each of the two subscales that used the Likert-type response structure (Cronbach, 1951). Table 4 presents the results of the reliability analysis. For the overall Mathematics Teacher Scale, a reliability coefficient of .78 was found, based on twenty-five items. An even higher alpha coefficient of .81 was found for the 14-item Teaching Self-Efficacy subscale, which is consistent with previous studies. Both coefficients suggest robust measurement quality of the defined index. However, a moderate coefficient of .56 was calculated for the Mathematics Beliefs subscale, which is lower than that of previous studies. The research sample consisted of 76 cases which, although adequate, substantially influenced the coefficient values. Psychometric theory holds that larger sample sizes with their increased variability would have produced stronger item reliability coefficients. Thus, the moderate level noted for Mathematical Beliefs is quite adequate given the current sample size (Tucker, 1946).

Table 4

*Reliability Coefficients for "*Mathematics Teacher*" Total Scale and Subscales* (N=76)

Subscale	**Number of Items**	**Alpha Coefficient**
Mathematics Beliefs Subscale	11	.56
Teaching Self-Efficacy Subscale	14	.81
Total Mathematics Teacher Scale	25	.78

For actual scale scoring, a two-step procedure produced summary values for each of the total scale and two subscales generated from the Likert-type survey items. Initially, a mean value was generated for all items included in the scale or subscale. For example, the Teaching Self-Efficacy subscale consisted of 14 items and values for any single item could range from one to five. Consequently, a mean response for this subscale could be 4.21for a given respondent. Such calculations transform the ordinal level response values to a quasi-interval scale, with metric properties that allow for greater sensitivity in statistical analyses (Ferguson, 1951; Tucker, 1946). A second step in the scoring procedure involves multiplying the average response by ten to generate higher magnitude subscale scores, with values ranging from 10 to 50 points. These resulting scores maintain the characteristics of the original distribution, yet offer greater interpretation, similar to standardized tests scores (Babbie, 1973; Johnson, 1977; Winborne, 1992).

Table 5 presents descriptive statistics for the two subscales included in the survey instrument. For the Mathematical Beliefs subscale, a mean score of 33.11 was found with a standard deviation of 4.36. A mean of 35.80 was calculated for the Teaching Self-Efficacy subscale and the deviations were 6.59. For the overall Mathematics Teacher Scale, the respective mean and standard deviation values were 34.62 and 4.83.

Table 5

(N = 76)

*Descriptive Statistics for "*Mathematics Teacher*" Total Scale and Subscale Scores*

Type	Mean	Standard Deviation	Range
Mathematics Beliefs Subscale	33.11	4.36	20.9-46.3
Teaching Self-Efficacy Subscale	35.80	6.59	24.9-47.1
Total Mathematics Teacher Scale	34.62	4.83	26.8-46.8

Procedures

The survey was conducted using the University of Maryland's Qualtrics software program to import the data into the Statistical Package for the Social Sciences (SPSS) program. When participants opened the survey, a short introductory note explained the survey, guaranteed anonymity, and indicated that clicking on "Yes" meant voluntary consent. The survey gathered demographic information such as number of years teaching, grade level taught, highest level of mathematics courses completed, number of undergraduate courses completed, and if the participant had a degree in mathematics. Next, the survey made statements about mathematical beliefs and mathematics teaching self-efficacy for participant response. The survey opened on March 22, 2017, and closed

April 30, 2017. During this time, one email was sent to the population reminding them to complete the survey (Appendix C). A total of 125 teachers logged on to the survey, with 81 attempting the survey and 76 completing the survey. Thirty-four teachers selected "no" to the initial question of consent which then exited them from the survey immediately. The respondents were all employed as full-time teachers in Title I elementary schools that served student populations enrolled in kindergarten through fifth grade. Subjects volunteered to participate in the research and were given uniform guidelines for responding to instrument items, with confidentially and anonymity responses guaranteed. Each participant was permitted to complete the survey at his or her own pace. The participants could pause their online sessions at any point and resume the process without loss of data. Further, the software allowed for reviewing and changing responses as needed by respondents. All responses were compiled into a database for analysis. A total of 81 (64.8%) of the sampled teachers responded to some portion of the survey; 76 (60.8%) completed the survey for the actual statistical analysis.

Analysis

For gathering data, the study used a self-completed survey instrument consisting of twenty-five Likert-type response items and six demographic items. Data generated from the instrument were combined into an overall score with interval-level measurement properties and two subscale scores with the same measurement characteristics. These scores are reflective of the intensity of agreement for respondents relative to the constructs of mathematics beliefs and mathematics teaching self-efficacy. Higher scores indicate a greater representation of the qualities inherent in the two research constructs.

Data analysis was performed in two stages, adhering to the exploratory design of the study and with respect to the research questions posed. First, descriptive statistics were used to detail background characteristics of subjects in the research sample. These descriptive statistics reflect score distributions and relevant differences in subject backgrounds for subgroup comparisons.

Next, statistical tests were performed on the overall scale score and the two subscale scores. These tests are of a causal-comparative nature, seeking to highlight any noticeable differences within the sample that might shape mathematics beliefs and mathematics teaching self-efficacy. For binary comparisons, t-tests were used for exploring probability levels of difference between defined subgroups. When statistical comparisons were required for three or more groups, the analysis of variance (ANOVA) method was used.

Section 3: Results and Conclusions

Focused on a sample of pre-tenured elementary teachers in Title I schools, this study explored teacher's mathematics beliefs and mathematics teaching self-efficacy. A self-completed survey instrument was administered to the sample of pre-tenured elementary teachers from a large suburban school district in the mid-Atlantic region of the United States. Substantive items were of a Likert-type format, requiring respondents to offer agreement ratings on the constructs of mathematics teaching self-efficacy and mathematics beliefs. The goal of the study was to provide insight into what possible factors may influence mathematics beliefs and mathematics teaching self-efficacy, which can influence student achievement in the area of mathematics (Evans, 2010; Fennell, 2007; Gojak, 2014; Kobett, 2016; Seeley, 2016).

This section presents results from the various SPSS statistical procedures, analyses of survey data gathered from the sampled teachers, and conclusions based on the six research questions and their respective hypotheses. Details of the sample characteristics are presented initially, followed by statistical analyses for each of the research questions. Descriptive analyses of the research sample include response frequencies, percentages, and graphic displays. Statistical tests are used to compare specific subgroups from the sample relative to subscale scores for the two constructs and scores of the total scale. Conclusions, including necessary limitations to the results, and implications are discussed to highlight the importance of key outcomes for the data analyses. A final part in this section addresses future research opportunities for improving the prevailing knowledge base of mathematics instruction drawn from current findings and recommendations for the school district based on the study.

Results

Table 6 presents a partial summary of demographics of the research sample. These data are from the survey's initial questions. Relative to years of teaching experience, 29 (38.7%) of the subjects had three years; 25 (33.3%) had two years; and 21 (28.0%) had one year of teaching experience. With respect to grade level taught, the largest portion of sampled teachers (17 or 22.7%) were assigned to second-grade classes, followed by those assigned to third-grade (16 or 21.3%) and fourth-grade (15 or 20.0%) classes. A frequency of 13 (17.4%) were assigned to fifth-grade classes, even smaller portions of the sample were assigned to kindergarten (10 or 13.3%) and first-grade (4 or 5.3%) classes.

Regarding academic preparation, the highest response frequency was noted for bachelor's degree (35 or 46.7%), followed by subjects with master's degrees (31 or 41.3%). Only nine subjects (12.0%) indicated earning an "other" degree. As shown in Table 6, a small portion of the sample (16 or 21.1%) indicated having a degree in mathematics, with a much larger portion (60 or 78.9%) having obtained college degrees in other fields.

Table 6

Descriptive Profile of Research Sample (N = 76)[1]

Characteristic	**Frequency**	**Percent**	**Cumulative Percent**
Total Years of Teaching			
1 Year	21	28.0%	28.0%
2 Years	25	33.3%	61.3%
3 Years or more	29	38.7%	100.0%
Grade Level of Teaching			
Kindergarten	10	13.3%	13.3%
Grade 1	4	5.3%	18.7%
Grade 2	17	22.7%	41.3%
Grade 3	16	21.3%	62.7%
Grade 4	15	20.0%	82.7%
Grade 5	13	17.4%	100.0%
Highest Degree Obtained			
Bachelor's Degree	35	46.7%	46.7%
Master's Degree	31	41.3%	88.0%
Other Degree	9	12.0%	100.0%
Degree in Mathematics?			
Yes	16	21.1%	21.1%
No	60	78.9%	100.0%

[1]Note that table values reflect actual responses from sampled teachers.

Table 7 shows the high school course profile for subjects in the research database. The largest portion of those responding (32 or 42.7%) indicated having taken calculus as their highest-level mathematics course. Those having taken geometry as the highest-level mathematics course had a frequency of 24 (31.6%), followed by 22 (28.9%) indicating algebra II as their highest-level course in high school. Only eight (10.5%) respondents noted algebra I as their highest-level mathematics course. With respect to college undergraduate mathematics courses, most subjects (24 or 31.6%) indicated having taken “three math courses,” with equal numbers (17 or 22.7%) having taken “two math courses” or “four or more math courses.” A much smaller portion of the sample (17 or 22.7%) indicated having taken “one math course” in college.

Table 7

Descriptive Profile of Research Sample (N = 76)[1]*continued*

Characteristic	**Frequency**	**Percent**	**Cumulative Percent**
Highest H.S. Math Course			
Algebra I	7	9.3%	9.3%
Algebra II	16	21.3%	30.7%
Geometry	20	26.7%	57.3%
Calculus	32	42.7%	100.0%
Number of College Math Courses			
One Math Course	8	10.5%	10.5%
Two Math Courses	22	28.9%	39.5%
Three Math Courses	24	31.7%	71.1%
Four or More Math Courses	22	28.9%	100.0%

[1]*Note that table values reflect actual responses from sampled teachers.*

Analyses for Research Question 1

Research Question 1 focuses on the relationship between the two major constructs in this study, mathematics beliefs and mathematics teaching self-efficacy, for a sample of pre-tenured elementary teachers from Title I schools within a large suburban school district. Specifically, the research question was framed as: In the district of study, is there a relationship between mathematics beliefs and mathematics teaching self-efficacy in pre-tenured teachers in Title I schools? The attendant hypothesis is expressed as: There will be a statistically significant correlation between mathematics beliefs and mathematics teaching self-efficacy subscale scores. To explore this hypothesis, descriptive statistics were generated from responses from the survey instrument. In addition, product-moment correlation analysis was conducted on the two subscale scores.

As discussed earlier, Table 5 presents descriptive statistics for the two subscales and the overall Mathematics Teacher scale. A mean of 33.11 and standard deviation of 4.36 were noted for the 11-item Mathematics Beliefs subscale, with individual means ranging from 20.9 to 46.3. The mean for the Mathematics Teaching Self-Efficacy subscale was 35.80 with a standard deviation of 4.83. There were 14 items in this subscale and the individual means ranged from 24.9 to 47.1. In direct response to the research question, a statistically significant, product-moment correlation of .43 ($p < .01$) was generated for the two sets of subscale scores.

Although significant, this correlation reflects a moderate relationship between the subscale mean scores of the Mathematics Beliefs and the Mathematics Teaching Self-Efficacy. This finding suggests that respondents' views of their mathematics teaching self-efficacy were not as strongly related to mathematics beliefs as anticipated. Rather, the data reflected a moderate adherence between what is believed about mathematics internally and one's ability to provide effective instruction.

Analyses for Research Question 2

Research Question 2 focuses on comparisons of how mathematics beliefs and mathematics teaching self-efficacy in pre-tenured teachers in Title I schools differed with regard to the number of years spent teaching. The attendant hypothesis may be expressed as: There will be differences in mathematics beliefs and teaching self-efficacy scores based on teaching experience levels.

Table 8 presents findings from the analysis of variance (ANOVA) procedure for Mathematics Beliefs subscale scores based on the years of teaching experience for subjects. An *F*-ratio of .47 was found in this comparison, which did not achieve statistical significance. Further, the groups' means were very close in magnitude, resulting in a low *F*-ratio in the analysis.

Table 8

Analysis of Variance Summary for "Mathematics Beliefs"
Subscale scores based on years of teaching experience (N = 76)[1]

Subgroup	Subgroup Values			*F-ratio*
	n	$\bar{X}$	σ	
Total Years of Teaching				
1 Year	*21*	*33.8*	*3.9*	
2 Years	*25*	*32.6*	*4.2*	*.47*
3 Years	*29*	*32.9*	*4.8*	

[1]*Note that table values reflect actual responses from sampled teachers.*

Table 9 contains results for mathematics teaching self-efficacy scores relative to analyses of variance. An *F*-ratio of .19 resulted from this comparison and the test proved not to be statistically significant. Again, the groups' means were very close in magnitude, influencing the resulting *F*-ratio. These findings suggest that years of teaching did not appear to influence the viewpoints of sampled teachers relative to mathematics beliefs or mathematics teaching self-efficacy.

Table 9

Analysis of Variance Summary for "Mathematics Teaching Self-Efficacy" *Subscale scores based on years of teaching experience* (N = 76)[1]

Subgroup	Subgroup Values			F-ratio
	n	$\overline{X}$	σ	
Total Years of Teaching				
1 Year	*21*	*35.8*	*7.2*	
2 Years	*25*	*35.7*	*5.9*	*.19*
3 Years	*29*	*36.3*	*7.0*	

[1]Note that table values reflect actual responses from sampled teachers.

Analyses for Research Question 3

Research question 3 focuses on the possibility of a relationship between the mean scores of mathematics beliefs with the grade level taught and mathematics teaching self-efficacy with regard to the grade level taught. The attendant hypothesis is expressed as: There will be differences in mathematics beliefs and teaching self-efficacy scores based on current teaching assignment.

The data analysis strategy used with this research question involved the application of two types of significance tests. The t-test was used for comparison of two groups relative to a continuous variable. The continuous variable in this instance is a score generated from survey responses to the Mathematics Beliefs subscale or Mathematics Teaching Self-Efficacy subscale. As an intermediate step, the original responses gathered from subjects about their current teaching assignments were recoded into a dichotomous variable:

- teachers assigned to kindergarten, first-grade, and second-grade classes were combined into a group designated "lower elementary," consisting of 31 subjects
- teachers assigned to third-grade, fourth-grade, and fifth-grade classes were combined into a group designated "upper elementary," consisting of 44 subjects

Table 10 contains results of the t-test analyses for Mathematics Beliefs subscale scores based on dichotomized coding of background variables. A *t*-ratio of -0.11 was generated for the two groups defined by current teaching level. The means for lower elementary and upper elementary were nearly equal, which explain the very low t-ratio.

Table 10

*Summary of t-Tests on "*Mathematics Beliefs*"*

Subscale scores Based on Dichotomized Recodings of Background Variables (N = 76)[1]

	Subgroup Values			
Subgroup	***n***	$\overline{X}$	σ	***t-ratio***
Current Teaching Grade Level				
Lower Elementary	*31*	*33.0*	*3.7*	*-.11*
Upper Elementary	*44*	*33.1*	*4.8*	

[1]Note that table values reflect actual responses from sampled teachers.

As shown in Table 11, the comparison of these same two groups for the Mathematics Teaching Self-Efficacy scores yielded a higher t-ratio of -1.86, which was not statistically significant, despite the noticeable mean differences. In this instance the respective means were ($\overline{X}$ =34.1; σ=6.7) for the lower elementary group and ($\overline{X}$ = 37.0; σ=6.4) for the upper elementary group. These findings suggest that grade-level assignment for subjects in the sample had no influence on perceptions of mathematics beliefs or teaching self-efficacy.

Table 11

Summary of t-Tests on "Mathematics Teaching Self-Efficacy"

Subscale Scores based on Dichotomized Recodings of Background Variables (N = 76)[1]

	Subgroup Values			
Subgroup	***n***	$\overline{X}$	σ	***t-ratio***
Current Teaching Grade Level				
Lower Elementary	*31*	*34.1*	*6.7*	*-1.86*
Upper Elementary	*44*	*37.0*	*6.4*	

[1]Note that table values reflect actual responses from sampled teachers.

Analyses for Research Question 4.

This research question has its focus on whether the level of high school mathematics courses plays a role influencing mathematics beliefs and mathematics teaching self-efficacy in pre-tenured elementary teachers in Title I schools. The attendant hypothesis is expressed as: There will be differences in mathematics beliefs and mathematics teaching self-efficacy scores the higher the level of high school mathematics completed.

A t-test was used to compare the subscale scores of respondents with different levels of high school mathematics coursework. First the responses were recoded into two groups as described below:

- One group consisted of 23 subjects (30.7%) who reported having completed "Algebra & Geometry" courses.
- A second group consisted of 52 subjects (69.3%) who reported having completed "Calculus."

Table 12 presents the t-test analyses for mathematics beliefs subscale scores based on recoded coursework. A *t*-ratio of -1.73 was found for the two groups defined by high school courses completed. The mean Mathematics Beliefs for subjects completing algebra and geometry courses ($\overline{X}$ =31.9; σ=3.1) was lower than those respondents who had completed calculus courses in high school ($\overline{X}$ =33.6; σ=4.7). Although means differed noticeably for the two groups, the difference did not attain statistical significance.

Table 12

*Summary of t-Tests on "*Mathematics Beliefs*"*

Subscale scores Based on Dichotomized Recodings of High School Courses Completed

(N = 76)[1]

Subgroup	***n***	**Subgroup Values** $\bar{X}$	σ	***t-ratio***
Highest H.S. Math Course				
Algebra & Geometry	23	31.9	3.1	-1.73
Calculus	52	33.6	4.7	

[1]Note that table values reflect actual responses from sampled teachers.

As shown in Table 13, the comparison of these same two groups for the mathematics teaching self-efficacy scores yielded a considerably higher *t*-ratio of -3.79 ($p < .01$), which proved statistically significant. In this comparison, the respective means were $\bar{X}$ =34.1 (σ=6.7) for the algebra and geometry group and $\bar{X}$ =37.5 (σ=6.4) for the calculus group. These findings indicate that completing higher levels of mathematics courses during high school resulted in stronger feelings of mathematics teaching self-efficacy among the sampled teachers. However, this same training difference did not appear to influence mathematics beliefs.

Table 13

Summary of t-Tests on "Teaching Self-Efficacy"

Subscale Scores based on Dichotomized Recodings of High School Courses Completed (N = 76)[1]

Subgroup	***n***	**Subgroup Values** $\bar{X}$	σ	***t-ratio***
Highest H.S. Math Course				
Algebra & Geometry	23	32.0	5.4	-3.79**
Calculus	52	37.5	6.5	

[1]Note that table values reflect actual responses from sampled teachers.
***p* < .01

Analyses for Research Question 5

This question was stated as: In the district of study, is there a difference in mathematics beliefs scores and mathematics teaching self-efficacy scores based on the number of undergraduate mathematics courses completed by pre-tenured elementary teachers in Title I schools? An attendant hypothesis could be expressed as: There is a difference in the mathematics beliefs and mathematics teaching self-efficacy based on the number of undergraduate mathematics courses completed.

Group comparisons based on college courses taken are displayed in Table 14. Findings from the analysis of variance procedure for Mathematics Beliefs subscale scores based on number of college courses taken were not statistically significant. An F-ratio of .73 was found in this analysis, based on respective means of 32.4 (4.3) for the group with "one or two" courses; 33.3 (4.4) for "three courses"; and 33.9 (4.5) for "four or more courses." The groups' means were very close in magnitude, resulting in a low F-ratio in the analysis.

Table 14

Analysis of Variance Summary for "Mathematics Beliefs"
Subscale scores based on number of undergraduate courses (N = 76)[1]

Subgroup	***n***	$\bar{X}$	σ	***F-ratio***
	Subgroup Values			
Number of College Math Courses				
One or Two Courses	*30*	*32.4*	*4.3*	
Three Courses	*24*	*33.3*	*4.4*	*.73*
Four or More Courses	*22*	*33.9*	*4.5*	

Table 15 presents a comparisons of mathematics teaching self-efficacy scores relative to college mathematics courses taken. The *F*-ratio of 2.06 reflected considerable variation within group means, yet the statistic did not reach the significance level. Means presented in Table 15 show that scores for the Mathematics Teaching Self-Efficacy scale increased noticeably for subjects with more mathematics course work in college. Those with "one or two" courses had a mean of $\bar{X} = 34.04$ ($\sigma = 6.3$), while subjects with "three courses" achieved a mean of $\bar{X} = 36.6$ ($\sigma = 6.3$). The highest mean ($\bar{X} = 37.5$; $\sigma = 7.0$) was attained by subjects with "four or more courses." In summary, these results indicate that undergraduate college mathematics courses had a greater influence on mathematics teaching self-efficacy than on mathematics beliefs. However, the relative level of differences in beliefs requires more careful exploration as statistical significance was not found with this sample.

Table 15

*Analysis of Variance Summary for "*Mathematics Teaching Self-Efficacy*"*

Subscale scores based on number of undergraduate courses (N = 76)[1]

	Subgroup Values			
Subgroup	***n***	$\bar{X}$	σ	***F-ratio***
Number of Undergraduate Mathematics Courses				
One or Two Courses	*30*	*34.0*	*6.3*	
Three Courses	*24*	*36.6*	*6.3*	*2.06*
Four or More Courses	*22*	*37.5*	*7.0*	

[1]*Note that table values reflect actual responses from sampled teachers*

Analyses for Research Question 6

Research Question 6 centers on the formal credentials of teachers sampled in the current study. Specifically, comparisons are highlighted to determine if a degree in mathematics influences viewpoints. Therefore, the research question was stated as: In the district of study, are there differences in mathematics beliefs scores and mathematics teaching self-efficacy scores based on whether a teacher has a degree specifically in mathematics for pre-tenured teachers in Title I schools? The attendant hypothesis is expressed as: There will be differences in mathematics beliefs and mathematics teaching self-efficacy scores based on whether a teacher has a degree in mathematics. A question was posed in the questionnaire regarding attainment of a degree in mathematics (see Table 6). Descriptive analyses revealed that 16 (21.1%) of subjects responded “yes” indicating that a mathematics degree was attained, while 60 (78.9%) responded “no." A t-test analyses for Mathematics Beliefs subscale scores resulted in no significant t-ratio. The respective group means were $\overline{X} = 31.9$ ($\sigma = 3.4$) for the group having a degree in mathematics and $\overline{X} = 33.4$ ($\sigma = 4.5$) for those subjects with degrees on other fields. In sharp contrast to this finding, comparison of these same two groups relative to Teacher Self-Efficacy scores reveals a significant t-ratio of -6.09 ($p < .01$). The means for the group indicating having a degree in mathematics was $\overline{X} = 29.6$ ($\sigma = 3.94$) compared to $\overline{X} = 37.4$ ($\sigma = 6.2$) for those teachers who had degrees in other fields. These findings reveal a stronger sense of teaching self-efficacy for teachers without a degree in mathematics.

Conclusions

The purpose of this study was to explore factors that may influence mathematics beliefs and mathematics teaching self-efficacy in pre-tenured elementary teachers in Title I schools. Although this study was limited by the overall sample size, which was purposeful in design, it did generate interesting conclusions. Note that due to the small sample size, this study cannot be generalized to the entire population of pre-tenured teachers in Title I schools.

In reviewing the data, one question that emerged instantly was why, among the 125 pre-tenured teachers who opened the survey, 81 chose to complete it or partially complete it while the remaining pre-tenured teachers exited the survey? There may be several possible explanations. One explanation may be systemic selection bias. While the survey was sent to all pre-tenure elementary teachers in the district's Title I schools, it may be that only the pre-tenure teachers that already felt comfortable teaching mathematics in some capacity took the survey, which may also reflect on why the Teacher Self-Efficacy scale tended to have greater significance in the data then those of mathematics beliefs. In other words, teachers who felt some confidence with their experiences with teaching mathematics may have elected to take the survey, while others who may not have the attendant beliefs in their ability with mathematics may have exited the survey. It may be that even in a situation of anonymity, subjects may have felt some type of anxiety in relation to mathematics and chose not to move forward with concerns the questions might be mathematics problems. Another possibility is that there was a perception that the survey would take too much time. While stated at the beginning of the survey that it should take about fifteen minutes, some teachers may have felt that was too much to ask given their myriad of duties. Finally, it may be that after reading the initial information, subjects were not interested or engaged enough to move forward.

A second observation is that the reliability for the adapted instrument had a Cronbach's alpha of 0.78, which is strong. The instrument had two subscales. According to the past research, Cronbach's alpha for the Personal Mathematics Teaching Efficacy subscale was found to be 0.88 and for the Mathematics Teaching Outcome Expectancy subscale was 0.77 (Enochs et.al., 2000; Evans, 2010; Jansen, 2007). For this study, the Cronbach alpha for the Personal Mathematics Teaching Efficacy subscale was 0.81, which shows a strong reliability. For the Mathematics Teaching Outcome Expectancy, the Cronbach alpha was 0.56, which shows a weaker reliability. As discussed earlier, the fact that there were only 76 respondents might have substantially influenced the coefficient values. Psychometric theory holds that larger samples sizes would have produced stronger item reliability coefficients (Tucker, 1946).

Research question 1 looked at the relationship between mathematics beliefs and mathematics teaching self-efficacy. Although this research indicated that mathematics beliefs were moderately related to mathematics teaching self-efficacy, it can be noted that the pre-tenured teachers in the study seemed to feel fairly confident in their ability to teach mathematics. While this finding does differ from the research (Ambrose et.al., 2003, Briley, 2012, Coulter, 2010, Philipp, 2007, Wilkens, 2008, Uswatte, 2013, Seeley, 2016), one reason may be that the pedagogy of actually teaching mathematics superseded beliefs about mathematics content. For example, a teacher may not believe in Communism, but be able to teach it well. This same idea might apply here.

Another plausible reason is that each Title I school in the district of study has a dedicated mathematics resource teacher. The resource teacher takes part in monthly professional learning to support his or her mentees which involves content, coaching strategies, and leadership strategies. Having this support during the first years of teaching is essential (Kobett, 2016) in order to support the level of mathematics teaching self-efficacy "that falls during the first years of teaching before settling into a stable sense of [mathematics] teaching self-efficacy that is difficult to shift" (Kobett, 2016 citing Ross, 1998). It might be inferred that with this type of support within their schools, the pre-tenured teachers may view themselves as capable to teach mathematics. This is a critical factor to consider in future work.

Research question 2 looked at the relationship of the number of years teaching to mathematics beliefs and mathematics teaching self-efficacy. According to Bandura's work (1993), teaching self-efficacy increases with mastery experiences. In other words, the more successful teaching experiences a teacher has, the higher the self-efficacy. It makes sense that the more years of teaching mathematics, the greater the mathematics teaching self-efficacy (Bandura, 1993, Kobett, 2016). In the current study, the means for both mathematics beliefs and mathematics teaching self-efficacy were very close, with an F-ratio of 0.47 and 0.19 respectively, which indicated that the mathematics beliefs/mathematics self-efficacy for this sample of teachers did not differ based on years of experience. One potential conclusion that might be drawn is that pre-tenured teachers may tend to maintain their higher perceptions of mathematics teaching self-efficacy from college experiences with school-based support, such as a mathematics resource teacher. In addition, the total number of years teaching may not be in the same grade, as the study did not ask that clarifying question. This is a factor that may influence the responses for this research question as well as considering if mathematics teaching self-efficacy changes over a longer span of time.

Research question 3 explored the relationship between mathematics beliefs and mathematics teaching self-efficacy and grade level taught. This study showed that there was no relationship and it did not make a difference what grade level mathematics was taught by the pre-tenured teachers. The t-test administered did not reveal any significant differences, which indicates that the teachers felt about the same no matter what grade they taught. School culture and the grade level team teachers are assigned to may be factors that can influence feelings about teaching mathematics in that specific grade level.

Kobett (2016) found that new teachers placed in a situation will tend to conform to the culture of the school and their assigned grade level team. For example, if a new teacher comes to a school with a strong constructivist based teaching style, and the team practices more traditional approaches to teaching mathematics, the new teacher will most likely conform to those norms. Therefore, a conjecture that may be made is the grade level taught may not influence the mathematics beliefs or mathematics teaching self-efficacy at all, nor can the grade level taught predict the level of mathematics teaching self-efficacy. Uswatte (2013) also found this to be true in in her study as well.

Research question 4 centered on the relationship between the level of high school mathematics courses completed with mathematics beliefs and mathematics teaching self-efficacy, and research question 5 posed the same regarding the number of undergraduate mathematics courses taken. It is interesting that there were no significant differences in mathematics beliefs regardless of level of high school mathematics courses or number of undergraduate mathematics course taken. However, both were significantly related to higher mathematics teaching self-efficacy. Referring again to Bandura’s work (1993), mastery (doing and being successful with a task) and vicarious experiences (watching others model a task so one may imitate it) may play a part in a person continuing with higher level mathematics in high school and taking more than one or two college mathematics courses. This may indicate that a person’s background knowledge in mathematics is solid, and so he or she has a higher level of efficacy. Stated another way, the more mathematics experience a person has, the more capable that person may feel with teaching mathematics.

Research question 6 looked at how mathematics beliefs and mathematics teaching self-efficacy were influenced by whether one held a degree in mathematics. Interestingly, the data reveal a stronger sense of teaching self-efficacy for teachers who did not attain a degree in mathematics. It may be reasonable to assume that many of the teachers who responded attained degrees in education which likely had a focus on both content and pedagogy. A continued focus throughout college on pedagogy may increase a teacher's mathematics self-efficacy and may indicate that continued professional learning for mathematics could continue to increase a teacher's sense of mathematics teaching self-efficacy. A conjecture might be that a person with a degree in mathematics will probably not be teaching in an elementary classroom; rather, they may take on a STEM career or one that uses higher level mathematics. Those trained as educators who are not mathematics majors are supported in their college years with teaching strategies which helps to increase mathematics teaching self-efficacy.

A final thought regarding these results is that sometimes, people do not have a complete understanding of what they should know. If one does not know the questions to ask, one may feel knowledgeable despite having a lower level of information. This may possibly be demonstrated in two scenarios. First, a mathematics major may take some education courses to increase teaching knowledge, but may still may not understand the full range of pedagogical thinking that may be necessary to teach effectively. Second, because a pre-tenured teacher may feel that because his/her students are doing well, he/she may feel confidence without fully understanding the scope of their mathematics teaching assignment.

Summary

This study focused on factors that may influence mathematics beliefs and mathematics teaching self-efficacy. The study noted a moderate significance for the relationship between mathematics beliefs and mathematics teaching self-efficacy. The data were quite significant with regard to the level of high school mathematics courses completed as well as with the number of undergraduate mathematics courses completed with regard to mathematics teaching self-efficacy. This could indicate that the more mathematics a person has engaged in, the higher the mathematics teaching self-efficacy. The study did not generate results that proved statistically significant in the area of mathematics beliefs relative to the environmental factors of teaching experience, grade level, highest level of mathematics completed in high school, and number of undergraduate mathematics courses completed.

There were possible limitations to the study. There existed a concern on the part of the researcher that 36% of the survey pool may not have opted to be in the study, which would reduce the confidence level of the results. Due to the smaller number of participants, the results are not be generalizable to the whole population of Title I elementary school teachers, but could shed light on this population, especially within the district. In actuality, there were 125 teachers who responded to the study, with 76 completing the survey and 5 partially completing the survey.

Another concern was that there could be web based issues that would prohibit a participant from completing the survey; or the email may go to the participant’s junk mail and thus prevent the participant from seeing the invitation to participate. There was no possible method for the researcher to determine if this was the case, especially for the 98 teachers that did not respond at all.

There may be systemic selection bias, which means that a certain type of people may self-select to be in the study and they may all have similar characteristics as opposed to a pure random sample. Systemic selection bias could influence the results; however, the researcher was not able to determine if this were the case with any participants due to the anonymity of the survey.

Finally, there should be some consideration of how difficult it is to quantify human feelings with regard to reliably measuring constructs such as beliefs and self-efficacy. While the use of surveys are used extensively in research to quantify perceptions and feelings, it may not give the same level of confidence as another types of research. For example, how one person quantifies their feelings or perceptions on a survey instrument may be different than another person who may feel the same way. In the real world, this may play out as a teacher feeling like he/she has taught an amazing lesson, only to find out that the observing administrator had a different perspective on the lesson.

While the study was purposefully limited in scope, future studies may seek to determine how these factors affect mathematics beliefs and mathematics teaching self-efficacy in a larger group of pre-tenured teachers. It might appear from this study that mathematics beliefs have little bearing on mathematics teaching self-efficacy, which is in contrast to the literature and the studies that have begun to look at this construct. Therefore, restructuring the study with a larger population may provide alternate data that can have more direct implications for pre-tenured teachers.

Implications of Study for the District

Teaching efficacy is content specific (Tschannen-Moran, Hoy, and Hoy, 1998). Therefore, it is important to consider mathematics teacher self-efficacy as a construct of its own in terms of developing new teachers. Being early in their careers, pre-tenured teachers may be open to strategies to improve their practice (Coulter, 2010). The one possible finding from the present study that deserves more exploration is whether the presence of a mathematics resource teacher in each Title I elementary school had some effect on the teachers' feelings of self-efficacy. This may align with findings from a study that noted "many of the new teachers lacked the confidence to translate the concepts learned in the university classroom to their classrooms unless they had opportunities to try out the concepts with a school mentor or university supervisor support" (Kobett, 2016). The presence of the resource teacher provides opportunities to "try out the concepts" involved in teaching mathematics so they feel they can teach the concept with confidence. Also, teaching efficacy has been shown to be influenced by interpersonal relationships during the first three years (Tschannen-Moran et al., 1998). It is possible that having a resource teacher developing trusting relationships with the pre-tenured teachers provides the assistance to foster the teacher's ability to succeed. In the district of study, it is a priority for Title I resource teachers have monthly meetings to train them on coaching, mathematics content, and leadership skills. A speculation is that this format may have translated into pre-tenured teachers in the Title I schools having a higher sense of mathematics teaching self-efficacy through the working relationship with their resource teacher. If this is the case, it is recommended that the district continue to support this program (even though it is sometimes a hard economic decision to do so.)

As per the findings from research questions 4 and 5, it appears that the more mathematics courses one participates in, the higher the mathematics teaching self-efficacy. This finding is supported by the literature that points to the effects of high quality professional development and teacher confidence. Chen, McCray, Adams, and Leow, (2013) found that "for children to gain understanding, teachers must feel confident in teaching mathematics and be math proficient" (p.374). In order to achieve this goal, they state that, "Professional development that integrates beliefs and confidence are most likely to produce stronger learner outcomes and sustain it for longer periods of time" (p.374). Briley (2012) noted that "mathematics teaching efficacy of elementary pre-service teachers increased during coursework" (p.9) and Coulter (2010) found examining teacher efficacy with elementary and middle school mathematics teachers that the "biggest ideas to be culled from this research are the notions that Professional Learning Communities, mentor relationships, and the opportunities to create and evaluate mastery experiences are most important to sustain high levels of teachers" (p.127).

The Mathematical Education of Teachers II (2012) made five recommendations to remedy the problem of mathematical knowledge and the teaching of mathematics:

- Prospective teachers need mathematics courses that develop a solid understanding of the mathematics they will teach.
- Coursework that allows time to engage in reasoning, explaining, and making sense of mathematics that a prospective teacher will teach is needed to produce well-started beginning teachers. Although the quality of the mathematics preparation is more important than the quantity, the

following recommendation(s) are made for the amount of mathematics coursework for prospective teachers.

- Prospective elementary teachers should be required to complete at least 12 semester hours on fundamental ideas of elementary mathematics, their early childhood precursors, and middle school successors.
- Throughout their careers, teachers need opportunities for continued professional growth in their mathematics knowledge.
- All courses and professional development experiences for mathematics teachers should develop the habits of mind of a mathematical thinker and problem-solver, such as reason and explain, modeling seeing structure, and generalizing. Courses should also use the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students. (American Mathematical Society, 2012, p.17-19)

In conclusion, this study was exploratory and leads to other thoughts on possible next steps. One idea is to recreate this study with a wider sample of participants. This may provide data that is more consistent with the literature and inform future decisions regarding mathematics programs and professional learning in the district. Additionally, it might be useful to conduct a study of mathematics teaching self-efficacy in all elementary schools, making the comparison with those schools who have a dedicated resource teacher versus those schools who do not have a resource teacher. This information may provide the necessary data for funding a resource teacher program throughout the district. Another pathway is to investigate the relationship between mathematics teaching self-efficacy and student achievement as a lever for professional learning with regard to formative and summative assessment. Another option is to investigate measures of mathematics teaching self-efficacy with administrative leadership to determine what effect the principal has on this construct. As there are limited studies regarding mathematics teaching self-efficacy, and a continued focus throughout the country on mathematics and STEM, more research needs to be conducted in the area of mathematics teaching self-efficacy so that all students have the experience of teachers who are not only knowledgeable, but confident in their abilities to teach mathematics effectively.

Appendix A

IRB Approval

February 23, 2017

Please note that University of Maryland College Park (UMCP) IRB has taken the following action on IRBNet:

Project Title: [1019165-1] An Analysis of the Relationship between Mathematics Beliefs and Mathematics Teaching Self-efficacy in Elementary Pre-Tenured Teachers Principal Investigator: Susan Vohrer, graduate

Submission Type: New Project
Date Submitted: January 27, 2017
Action: APPROVED
Effective Date: February 23, 2017
Review Type: Expedited Review

Should you have any questions you may contact Linette Berry at lberry2@umd.edu.

Thank you,
The IRBNet Support Team

www.irbnet.org

Appendix B

Email of Invitation to Participate in Survey

Dear

Do you love math—or not so much? Either way, I would like to know what you think! Please accept this invitation to participate in a study examining elementary pre-tenure teachers' mathematics beliefs and self-efficacy which relates to how you feel and think about elementary mathematics. This research is being conducted as part of my dissertation and has been approved by AACPS and the University of Maryland.

You have been exclusively selected for the study because AACPS identified you as an elementary teacher in either the first, second, or third year of your teaching career. As you are charting your career path, it is vitally important that we understand *your* feelings about teaching mathematics. The research will be used to inform the district's future professional development initiatives related to the teaching and learning of elementary mathematics. Your voice is important to hear!

I am personally offering you the **opportunity to participate in an *anonymous online survey* that will take about 10 -15 minutes to complete.** You will be asked to respond to questions about your mathematical beliefs, mathematics teaching self-efficacy, and your previous experiences with mathematics. When you begin the survey, you will need to read and agree to the consent statement by clicking "Yes." If you click "No," the survey will close.

Thank you in advance for your anticipated participation in the study. If for some reason, you believe this does not apply to you, please reply to this email indicating it does not apply. Feel free to contact me at svohrer@comcast.net if you have any questions.

Please click on the link below to be taken to the survey.

https://umdsurvey.umd.edu/jfe/form/SV_86e0IG4VcHEeblj

With much appreciation,

Sue Vohrer
Doctoral Candidate
University of Maryland

Appendix C

Email to Remind Teachers about Survey

April 6, 2017

Good Morning!
Many, many thanks to those of you who took my survey regarding mathematics beliefs. It is much appreciated! Because of your help, I am close to my goal—I only need 57 more survey completions! If you have not participated on the survey, I'd like to invite you to take the survey by clicking on the anonymous link below. It will take about 10 minutes and may inform future professional learning for the district.

https://umdsurvey.umd.edu/jfe/form/SV_86e0IG4VcHEeblj

With much appreciation,

Sue Vohrer
Doctoral Candidate, University of Maryland
Former Coordinator, AACPS Elementary Mathematics

Appendix D

Permission to Use Mathematics Teaching Efficacy and Beliefs Instrument

From: DeAnn M Huinker [mailto:huinker@uwm.edu]
Sent: Sunday, November 20, 2016 7:57 AM
To: Vohrer, Susan S <SVOHRER@AACPS.org>
Subject: Re: MTEBI

Sue,

Yes you have my permission to use the instrument in your research.

Best regards,
DeAnn Huinker

On Nov 19, 2016, at 6:29 PM, Vohrer, Susan S <SVOHRER@AACPS.org> wrote:

Dear Dr. Huinker,
I am a doctoral student at the University of Maryland working on a dissertation regarding the mathematical beliefs of teachers and how that relates to their math teaching self-efficacy. I have looked at the instrument you co-authored with Dr. Larry Enochs and it may be helpful as I design my survey. I am writing to ask permission to use it as part of my survey.

Thank you for your time and consideration for this request.
Sue Vohrer

<image001.png>
Sue Vohrer
Coordinator of Elementary Integrated Mathematics
Division of Curriculum and Instruction
Anne Arundel County Public Schools

Appendix E

Mathematics Teacher Survey

An Analysis of the Relationship between Mathematics Beliefs and Mathematics Teaching Self-Efficacy in Pre-Tenured Teachers

This survey is being conducted by Susan Vohrer at the University of Maryland, College Park. The purpose is to investigate the degree to which prior experiences with mathematics of early career elementary teachers might relate to their personal mathematical beliefs and mathematics teaching self-efficacy.

You will be asked to participate in an anonymous survey containing 25 questions. The survey should take 10 -15 minutes to complete. The survey will ask you questions such as

- Your highest level of mathematics course taken
- Your perceived effectiveness in teaching mathematics
- Your overall beliefs about mathematics

There are no known risks as a result of participating in the anonymous survey and there are no direct benefits to you for participating in this research. The results have the potential to be used by the district to design targeted professional development to meet the needs of pre-tenured teachers.

The survey is totally anonymous. You have been provided a link to the survey in which your responses will only be identified by a code with no connection to you. All results will be reported in aggregate and no individual responses will be reported. The school district will not be identified. All data files will be maintained in a password protected computer that only I will access.

Your participation in this survey is completely voluntary. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

If you decide to stop taking part in the survey, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the investigator:

Susan Vohrer

401 Federal Street Suite 2 Dover Delaware 19901

Email: svohrer@comcast.net

If you have questions about your rights as a research participant or wish to report a research-related injury, please contact:

University of Maryland College Park, Institutional Review Board Office

1204 Marie Mount Hall College Park Maryland, 20742

E-mail: irb@umd.edu Telephone: 301-405-0678

This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.

Statement of Consent

By indicating "yes" below you indicated that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in this research study.

I have read and understood the consent form. Of my own free will, I am participating in this study.

- o Yes
- o No

Survey Instrument
Section 1 – Demographic Information

Please enter the number of years teaching.

- 1
- 2
- 3

Please enter the grade level you teach.

- K
- 1
- 2
- 3
- 4
- 5

What was the highest level of math course work you took in high school?

- Algebra I
- Algebra II
- Geometry
- Calculus

Please enter the highest level of your education.

- Bachelor’s degree
- Master’s degree
- Other

Please enter if you have earned a degree in mathematics.

- Yes
- No

How many mathematics courses did you take in your undergraduate program?

- 1
- 2
- 3
- 4 or more

Section 2

Survey statements that participants responded to using a Likert-type scale.

Statement Number	Statement
1	When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2	I will continually find better ways to teach elementary mathematics.
3	Even if I try very hard, I do not teach elementary mathematics as well as I do other subjects.
4	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
5	I know the steps necessary to teach K-5 mathematics concepts effectively.
6	I am not very effective in monitoring elementary mathematics activities.
7	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
8	I generally teach elementary mathematics ineffectively.
9	The inadequacy of a student's mathematics background can be overcome by good teaching.
10	The low mathematics achievement of some students cannot generally be blamed on their teachers.
11	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
12	I understand mathematics concepts well enough to be effective in teaching elementary mathematics.
13	Increased effort in mathematics teaching produces little change in some student mathematics achievement.
14	The teacher is generally responsible for the achievement of students in mathematics.
15	Students' achievement in elementary mathematics is directly related to their teacher's effectiveness in mathematics teaching.
16	If parent comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
17	I find it difficult to use manipulatives to explain to students why mathematics works.
18	I am typically able to answer students' K-5 elementary mathematics questions.
19	I wonder if I have the necessary skills to teach mathematics.
20	Given a choice, I would not invite the principal to evaluate an elementary mathematics lesson.
21	When a student has difficulty understanding an elementary mathematics concept, I am usually at a loss as to how to help the students understand it better.
22	When teaching mathematics, I usually welcome student questions.
23	I do not know what to do to turn students on to elementary mathematics.
24	The textbook tells the one correct way to solve a problem.
25	I rarely try something new when teaching elementary mathematics.

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