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An exploration of elementary teachers' self-efficacy beliefs about teaching mathematics among teachers with advanced degrees

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ABSTRACT

AN EXPLORATION OF ELEMENTARY TEACHERS' SELF-EFFICACY BELIEFS ABOUT TEACHING MATHEMATICS AMONG TEACHERS WITH ADVANCED DEGREES

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The present study sought to explore the sources of elementary teachers' mathematics teaching self-efficacy beliefs. Through the use of Seidman's in-depth interviewing protocol, four teachers with master's degrees in reading education and four teachers with master's degrees in mathematics education described their perceived sources of self-efficacy, including their experiences as students and teachers. The first research question addressed the three areas of mathematics teaching self-efficacy: content knowledge, instructional methods, and assessment techniques. The second research question examined whether there were differences in the perceived sources of self-efficacy based on the participants' degrees. Data were analyzed using descriptive coding and focused coding.

Sources of the teachers' self-efficacy beliefs included mastery experiences such as early learning experiences and teaching experiences. Sources of verbal persuasion included family members, peers, elementary teachers, colleagues, and college professors. Sources of vicarious experiences included peers in elementary school, college professors, and master's degree classmates. There were also sources of physiological state such as the participants' affect toward mathematics in elementary and secondary school. The most salient source of mathematics

teaching self-efficacy that emerged for content knowledge was physiological affect, for instructional methods was verbal persuasion, and for assessment techniques was mastery experience. Implications for parents, teachers, professors, and school district leaders are explored.

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AN EXPLORATION OF ELEMENTARY TEACHERS' SELF-EFFICACY BELIEFS ABOUT TEACHING MATHEMATICS AMONG TEACHERS WITH ADVANCED DEGREES

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DEDICATION

To my husband, Frank, and my children, Aubrey and Tyler,

for their unconditional love and support

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CHAPTER 1

INTRODUCTION

Purpose

The purpose of this research was to examine elementary school teachers' beliefs about their ability to teach mathematics. Teacher self-efficacy refers to the belief teachers have with regard to their abilities to execute a teaching task in order for students to be successful in learning (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). Teachers' self-efficacy beliefs have been shown to be predictive of teacher practice, student self-efficacy, and student achievement (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2007; Woolfolk & Hoy, 1990). Although these studies have focused on outcomes of teacher self-efficacy beliefs, fewer studies have focused on teachers' narratives about how those beliefs develop (Tschannen-Moran et al., 1998). The sources of teachers' self-efficacy include Bandura's (1997) four sources of self-efficacy: mastery experiences, verbal persuasion, vicarious experiences, and physiological state. This study used qualitative methods of inquiry to ask teachers to describe their self-efficacy beliefs and how those beliefs developed pertaining to mathematics teaching tasks.

When teachers describe their self-efficacy beliefs, their beliefs may reflect the current landscape in education which includes the recently developed Common Core State Standards for Mathematics (CCSSM) that outline a set of learning objectives for students in kindergarten through 12th grade (National Governors Association Center for Best Practices and Council of

Chief State School Officers [NGA Center & CCSSO], 2010). With the adoption of the CCSSM, teachers may have started learning new mathematics content, determining new instructional methods to teach the content to students, and developing assessments to accurately evaluate their students' mathematical understanding. Although the CCSSM may be a catalyst for teaching changes, this study included teachers' self-efficacy beliefs about areas of mathematics teaching that are used regardless of which standards are adopted. This research study focused specifically on teachers' self-efficacy beliefs about (a) their mathematics content knowledge, (b) their use of various instructional methods, and (c) their use of assessment techniques. The study examined the content of teachers' beliefs in these three areas as well as teachers' perceptions of the sources of these beliefs including life experiences as sources of self-efficacy. A specific life experience that was examined was the teachers' experiences with taking advanced classes. Analyses compared these multiple dimensions of teachers' self-efficacy beliefs held by teachers who had obtained master's degrees in mathematics education and those who had obtained master's degrees in reading education.

Statement of the Problem

Research suggests that mathematics, in particular, is a subject in which elementary teachers' self-efficacy beliefs can influence student outcomes. Specifically, Midgley, Feldlaufer, and Eccles (1989) found that students had lower mathematics self-efficacy when their teachers had lower mathematics teaching self-efficacy (MTSE). When students have a low sense of mathematics self-efficacy, Bouffard-Bouchard, Parent, and Larivee (1991) found the students were less successful in solving conceptual problems than were children of equal ability but

higher perceived self-efficacy. Students with high mathematics self-efficacy were not only more successful in solving conceptual problems but were also more persistent in solving challenging mathematical problems and continuing to seek multiple solutions (Bandura, 1997). This persistence is essential as students continue to learn more challenging mathematical content.

Because student mathematics self-efficacy is a strong predictor of student success (Bouffard-Bouchard et al., 1991), and teacher self-efficacy is a strong influence on student self-efficacy (Anderson, Greene, & Loewen, 1988), it is important to study the sources that contribute to teacher self-efficacy for teaching mathematics (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2007; Woolfolk & Hoy, 1990). Although studying the effects on students' self-efficacy beliefs and achievement outcomes was outside the scope of this study, it could be the subject of future research studies.

Teacher self-efficacy can derive from a variety of sources such as professional development experiences, colleagues' comments, and administrators' feedback (Bandura, 1997). A source of teachers' self-efficacy beliefs may be graduate classes. When teachers take graduate classes, they have the opportunity to build their mastery experiences. When a teacher takes a mathematics education graduate class, for example, he/she may learn about a new instructional method to teach fractions. By having success learning this method in a graduate class, this teacher may build his/her mastery experiences that may lead to increased teacher self-efficacy. On the other hand, if a teacher takes a mathematics graduate class and experiences frustration when learning the content, his/her teacher self-efficacy about content knowledge may decrease. Graduate classes may also be a source of vicarious learning because teachers have the opportunity to learn from classmates. When one teacher in a graduate class describes his/her success in implementing a new instructional method, the teacher may begin to feel more

empowered to also try the strategy to help students achieve success. Graduate classes can also be a source of verbal persuasion because the instructors can provide positive or negative encouragement to teacher-students. To illustrate, a mathematics education professor may boost a teacher's self-efficacy beliefs by making statements such as, "You really have the idea of creating constructivist mathematics learning opportunities for real-world problem solving. The way you designed the lesson will really assist students in learning the concept of division." Of course, a professor may instead provide discouragement such as telling a teacher-student to not use a specific instructional method, which would lead to lowering a teacher's self-efficacy beliefs if the teacher had been invested in that method of helping his/her students achieve success. Graduate classes can also lead to teachers experiencing joy and excitement during the experience of learning new concepts, which would further increase teachers' self-efficacy. However, the teachers may also experience discouragement or anxiety during graduate classes if they do not fully understand the content. Because graduate classes may contribute to all four sources of self-efficacy (mastery experiences, verbal persuasion, vicarious experiences, and physiological state), the present study explored the influence of the graduate classes on teachers' mathematics teaching self-efficacy beliefs.

Educational Landscape

An article by Elizabeth Green in *The New York Times Magazine* (2014) describes how mathematics teachers in the United States are using traditional ways of teaching mathematics that do not work. The article describes how teachers are stuck in the rut of teaching the same way they were taught. The result is that American students may struggle to develop adequate

numeracy skills. According to an assessment called the *Survey of Adult Skills* given around the world by the Organisation for Economic Co-Operation and Development (OECD, 2013), there were areas of weakness in the Americans' numeracy and problem-solving skills. In order to continue to strengthen Americans' numeracy skills, a research team designed the Common Core State Standards for Mathematics, a set of learning objectives with clear foci, coherence across grade levels, and rigorous problem-solving skills (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). The United States Congress was also behind the research team's creation of more rigorous mathematics standards because the Congress reauthorized the Elementary and Secondary Education Act in 2010 (U.S. Department of Education, 2010) that includes the United States Government's priorities for education. These priorities include the need for "implementing college- and career-ready standards and developing improved assessments aligned with those standards" (p. 3).

To assist schools in determining whether teachers are implementing strategies that will help students reach these standards, the National Council of Teachers of Mathematics (NCTM) constructed a document called *Principles to Actions: Ensuring Mathematical Success for All* (2014) that outlines six guiding principles for effective school mathematics instruction including three that are the focus of this research study: teaching and learning, curriculum, and assessment. See Table 1 for a description of the NCTM's (2014) guiding principles for school mathematics and whether the principles are reflected in the present study.

Because the Common Core State Standards for Mathematics are relatively new, their impact on student outcomes is not known. The present study did not seek to examine the impact of the CCSSM on student outcomes and was not based on the assumption that the adoption of these standards will ultimately benefit students. The present study focused instead on teacher

Table 1

Guiding Principles for School Mathematics

NCTM principles	Included in study
Teaching and learning	Yes
Access and equity	No
Curriculum	Yes
Tools and technology	No
Assessment	Yes
Professionalism	No

self-efficacy about practices suggested by the CCSSM (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010) and the NCTM (2014). There were two reasons for this focus. First and foremost, the belief a teacher has in whether he/she can be effective at teaching students strongly affects students' actual achievement (Ashton & Webb, 1986; Guo, Connor, Yang, Roehrig, & Morrison, 2012; Hoy & Woolfolk, 1993). Thus, teachers' beliefs about their teaching abilities may be more important than a particular set of standards. Second, on a practical level, because the CCSSM are required in the state in which this study took place, teachers were making instructional changes to implement these new standards. This study addressed the concrete areas related to the CCSSM (content knowledge, instructional methods, and assessment techniques) in which teachers may have had to make changes. The degree to which teachers are able to effectively utilize the NCTM (2014) principles in their practice is likely to be influenced, at least in part, by teachers' beliefs about their ability to effectively implement the changes in their classrooms and their beliefs about their abilities to positively influence student learning through these adjustments (Gregorie, 2003). While future research might investigate the impact of the CCSSM on student learning, the present study

focused on teacher self-efficacy about practices thought to be essential for effective implementation.

Because the CCSSM involves a new set of standards with different content at each grade level, teachers may need to draw upon their mathematics self-efficacy to develop their skills with new content and be able to teach that content to students. Teachers' self-efficacy beliefs may also be one reason behind the instructional methods they use to teach students, which will also impact students' success. For example, teachers with higher self-efficacy may use a greater variety of instructional methods (Riggs & Enochs, 1990). Teachers with lower self-efficacy tend to use more teacher-directed instructional methods, such as lecture, as opposed to student-centered activities (Czerniak, 1990). In order for students to be successful in mathematics, they need time to talk about mathematics without only hearing the teacher talk (National Council of Teachers of Mathematics, 2014). The CCSSM specifically do not mention which instructional techniques to use to help students learn the content; therefore, it is up to the teachers to draw upon their knowledge of instructional techniques (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). Finally, teachers also need to draw upon their self-efficacy about assessment because establishing different learning pathways through learning the CCSSM requires teachers to evaluate students' current knowledge and make data-based decisions about the future content and instructional methods to use with the students. This study explored life experiences, including advanced education, as sources for these areas of self-efficacy.

In the paragraphs that follow, there is a brief outline of the areas of teacher practice emphasized by the Common Core State Standards for Mathematics and the NCTM Principles for

Action and then discussion about how teachers' MTSE beliefs may be an essential factor in the effective implementation of those areas of practice.

Conceptual Framework

Self-efficacy refers to the belief a person has about whether he/she will succeed or fail at a task (Bandura, 1977). Self-efficacy beliefs can be more predictive than actual ability in determining the outcome of a task (Bandura, 1997). In the academic context, self-efficacy influences the performance of both students and teachers. Bandura (1977) determined there were four sources that contribute to an individual's self-efficacy beliefs: mastery experiences, verbal persuasion, vicarious experiences, and physiological state. Bandura described mastery experiences as an individual's experiences of success or failure with specific tasks. Verbal persuasion involves another person socially persuading an individual about the abilities he/she possesses to accomplish a task. Bandura (1994) described vicarious experiences as an individual watching other people model a task, and physiological state as an individual's interpretation of his/her feelings and moods. All four of these sources contribute in different ways to a person developing his/her self-efficacy.

Teacher self-efficacy is the belief a teacher has in his/her abilities to execute a teaching task in order for students to be successful in learning (Tschannen-Moran et al., 1998). While some teachers' self-efficacy beliefs may be consistent across subject areas (e.g., "I am confident in my ability to form positive relationships with my students"), each academic discipline involves subject-specific teacher self-efficacy perceptions (e.g., "I am confident in my ability to teach reading strategies but not fractions"). Teachers with a high self-efficacy will be more likely

to persevere when students do not master content, and they will be more willing to experiment with multiple instructional methods (Ashton & Webb, 1986; Guskey, 1987; Guskey, 1988).

Areas of Emphasis for Teaching Mathematics

Schools across the country are determining how to best prepare students and teachers to meet the demands of these new mathematics standards (Mongeau, 2014). To assist students in being successful at learning the CCSSM, elementary teachers must (a) increase their mathematics content knowledge, (b) use a variety of instructional methods, and (c) implement assessment techniques to accurately evaluate learning (National Council of Teachers of Mathematics, 2014).

Increasing Content Knowledge

"Mathematics teaching demands subject-specific understanding and insight so that teachers can skillfully carry out their work in mathematics classrooms" (National Council of Teachers of Mathematics, 2014, p. 12). Teachers' mathematical content knowledge and being able to use it to teach mathematics classes are important to student learning (Ball, Thames, & Phelps, 2008). With the adoption of the CCSSM, there is new mathematics content at each grade level with more focused standards (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The focus of the standards is on students' conceptual understanding of numerical concepts rather than rote procedures. For example, one of

the second-grade mathematics standards, CCSS.Math.Content.2.NBT.B7, states that the student must be able to

> Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds. (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010, p. 19)

This standard does not state that students need to simply compute a problem such as 537 – 259 by lining up the numbers vertically and subtracting. The teachers need to have the content knowledge to understand the concept of place value in subtraction before being able to guide their students to deep understanding.

In addition to having the content knowledge for a particular grade's standards, teachers also must have a broad knowledge base of the standards across grade levels in order to assist students in linking mathematical concepts (National Council of Teachers of Mathematics, 2014). The CCSSM were intentionally structured into learning progressions based on research about student learning (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). Therefore, elementary teachers must have strong content knowledge about all the mathematics standards from kindergarten through eighth grades in order to build on previously learned concepts and lead into future learning goals. When teachers lack strong content knowledge, they cannot help their students connect previously learned concepts to new concepts. For example, one such area for which strong content knowledge is necessary is teaching fractions. A fifth-grade mathematics standard, CCSS.Math.Content.5.NF.B.4, states students should "apply and extend previous understandings of multiplication to multiply a

fraction or whole number by a fraction" (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010, p. 36). Students do not just memorize the formula for multiplying the numerators and denominators; they need to communicate how multiplication works for fractions. Therefore, to teach this standard, the teacher needs to have strong content knowledge about students' previous learning such as the concept of fractions in second grade. In addition, teachers must know the middle school content about how multiplying fractions connects with concepts such as ratios. In sum, the structure of the CCSSM explicitly requires deep content knowledge in mathematics.

The NCTM (2014) recommends that teachers can develop their content knowledge by "becoming familiar with the content standards through reading and reflecting on the main ideas of the standards and the learning progressions that students follow" (p. 115). A teacher's mathematics self-efficacy beliefs will likely influence how well a teacher succeeds in accomplishing this goal.

Using a Variety of Instructional Methods

With a deep understanding of mathematics content, the next part of the teaching equation is to be able to choose the best instructional methods to help students understand this content (H. C. Hill, Rowan, & Ball, 2005). The CCSSM includes content standards for each grade level and Standards for Mathematical Practice (SMP) for students to employ as they learn mathematics throughout their lives (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010). The NGA Center and CCSSO (2010, pp. 6-8) list the Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for an express regularity in repeated reasoning.

In order to help students develop these mathematical practices, teachers need to be very adept at choosing instructional methods that will foster a mathematically rich learning environment. As part of its eight guiding principles for school mathematics, the NCTM (2014) includes the principle of teaching and learning which requires that teachers consistently implement the SMP. However, the NCTM did not simply suggest that teachers use the SMP, the committee detailed eight mathematics teaching practices that are well-researched instructional methods for teachers to use in mathematics classrooms in order to help students develop these mathematical practices.

Four of the eight mathematics teaching practices were utilized in the present study to structure the interview questions about instructional practices, and the other four mathematics teaching practices were utilized to structure the interview questions about assessment techniques. See Table 2 for a description of the NCTM teaching practices were in this study. The four practices that guided the questions about instructional practices were “establish mathematics goals to focus learning,” “implement tasks that promote reasoning and problem solving,”

"facilitate meaningful mathematical discourse," and "support productive struggle in learning mathematics" (National Council of Teachers of Mathematics, 2014, p. 10).

Table 2

The NCTM Teaching Practices

Teaching and learning practices	Category in present study
1. Establish mathematics goals to focus learning.	Instructional methods
2. Implement tasks that promote reasoning and problem solving.	Instructional methods
3. Use and connect mathematical representations.	Assessment techniques
4. Facilitate meaningful mathematical discourse.	Instructional methods
5. Pose purposeful questions.	Assessment techniques
6. Build procedural fluency from conceptual understanding.	Assessment techniques
7. Support productive struggle in learning mathematics.	Instructional methods
8. Elicit and use evidence of student thinking.	Assessment techniques

The instructional method of establishing mathematics goals to focus learning requires teachers to convey clear learning expectations to students because the students perform at higher levels when the classroom expectations are clear (Hattie, 2012). Teachers are encouraged to use these learning goals to help students understand how specific activities connect to their past learning and contribute to their current learning (National Council of Teachers of Mathematics, 2014). Another powerful instructional method researched by the NCTM (2014) is to implement tasks that promote reasoning and problem solving which includes teachers "selecting tasks that provide multiple entry points through the use of varied tools and representations," "posing tasks on a regular basis that require a high level of cognitive demand," and "supporting students in exploring tasks without taking over student thinking" (p. 24). The ultimate outcome for

implementing this instructional strategy is that students learn the most when they engage with tasks that require higher-level thinking skills (Boaler & Staples, 2008).

A third instructional method that the NCTM (2014) recommends for all teachers is to facilitate meaningful mathematical discourse which includes allowing students the opportunities to describe their approaches to solving problems, listening to others, and critiquing each other's strategies. To have this discourse requires a teacher to set up a positive classroom atmosphere where students' voices are the dominant ones, and this discourse contributes to students developing a deep understanding of mathematical concepts (Michaels, O'Connor, & Resnick, 2008). A fourth instructional method recommended by the NCTM (2014) is the practice of supporting productive struggle in learning mathematics. When students have the opportunity to encounter challenging tasks, they do not merely view mathematics as a subject in which to seek the correct solutions; they begin to view mathematics as interrelated problem-solving skills that can be applied to new learning situations (Kapur, 2010). When teachers plan lessons, they may want to investigate the misconceptions that may occur and think about how they will support the students through these challenges rather than try to give students the answers and thereby lower the cognitive demands of the tasks (National Council of Teachers of Mathematics, 2014). This will lead to more long-term success for students.

Imploring Various Assessment Techniques

An important component of teaching involves assessing students' knowledge through formative and summative assessments. Formative assessments involve teachers determining students' levels of knowledge during the instruction in order to create a learning pathway to meet

the students' needs. Summative assessments involve teachers evaluating students' knowledge gained at the end of units of instruction. Currently, there is societal emphasis on summative assessments because of high-stakes testing. In 2011, the two national consortia presented their plans for mathematics assessments to evaluate students' progress in learning the CCSSM. The Partnership for Assessment of Readiness for College and Careers (PARCC) is one of the organizations that provided a blueprint for mathematics assessments that includes emphasis on formative assessments throughout the school year as well as summative assessments that include more emphasis on depth of mathematical understanding rather than procedural knowledge (Krupa, 2011). Not only is the content of the test different, the students take the test on the computer rather than by using paper and pencil. Because these new assessments are given throughout the year and emphasize the application of content knowledge to new situations, many teachers are anxious about how to prepare students for these assessments (National Council of Teachers of Mathematics Research Committee, 2013).

To help school staff members such as principals, teachers, and coaches implement the CCSSM, the NCTM (2014) recommends following the assessment principle that teachers develop common assessments, evaluate students' learning based on multiple assessments, and utilize the assessments to drive instructional decisions. The last tenet is essential because the purpose of assessment is to "gather data that support the teaching and learning of mathematics" rather than "focus on assessment for accountability" (National Council of Teachers of Mathematics, 2014, pp. 89-90). Making formative assessment a regular part of instruction is associated with improved student learning because students have the opportunities to examine their strengths and areas for growth rather than merely receive a meaningless grade (Popham, 2008). Summative assessments also play a role in determining how well students master

particular concepts; however, they are not the primary method for determining student understanding because they do not show the progress of understanding the mathematics concepts. By focusing on formative assessments, teachers can provide more opportunities for the students to grow, and then they will view mathematics as a continuous problem-solving process rather than as a finite set of isolated skills to be mastered for summative assessments.

Formative assessment can include a variety of practices. There are four other mathematics teaching practices described by the NCTM (2014) that influenced the present study's interview questions about assessment techniques. See Table 2. The first practice is to "use and connect mathematical representations" which includes teachers assessing students about solving problems in multiple ways (National Council of Teachers of Mathematics, 2014, p. 29). The second practice is to "pose purposeful questions" because teachers will not know a student's true depth of knowledge without asking deep-thinking questions (National Council of Teachers of Mathematics, 2014, p. 41). The third practice is to "build procedural fluency from conceptual understanding" when teachers ask students to explain the procedures they used to solve problems (National Council of Teachers of Mathematics, 2014, p. 47). The fourth practice is to "elicit and use evidence of student thinking" in which teachers can scaffold a student's thinking by posing targeted questions as well as use the student's evidence of thinking to inform future instructional decisions (National Council of Teachers of Mathematics, 2014, p. 56). Assessing a student's true knowledge and depth of understanding in mathematics is a complex task that requires strong content knowledge and effective instructional practices. In order to be able to implement all of these assessment techniques, teachers need to have strong self-efficacy beliefs.

Advanced Education as a Context for Providing Sources of Teacher Self-Efficacy

Because certain aspects of teacher self-efficacy are presumed to be global and others are presumed to be content-specific (Woolfolk & Hoy, 1990), it is not entirely clear from a theoretical perspective how much graduate education that specializes in teaching content other than mathematics would impact teachers' self-efficacy beliefs regarding the dimensions of mathematics education examined here. According to the Illinois Board of Higher Education Degree Program Inventory (2012) database, master's degrees in reading education were much more common than master's degrees in mathematics education. In Illinois in 2011, approximately 1,097 master's degrees in reading education were conferred and 107 master's degrees in mathematics education were conferred. One aim of this study was to explore whether having an advanced degree in a nonmathematics content area, specifically reading, provided a context for enhancing overall teacher self-efficacy for teaching mathematics to the same degree as having an advanced degree in mathematics education. Determining the answer to this question is important as districts are faced with making decisions about what types of graduate degrees to encourage and support for their students.

Research Questions

The study addressed the following research questions:

1. How do elementary teachers describe the nature and sources of their self-efficacy for teaching mathematics in the areas of content knowledge, instructional methods, and assessment techniques?

2. Do these descriptions differ depending on whether teachers have earned an advanced degree in mathematics education or reading education?

Operational Definitions

Advanced coursework	Coursework in the area of mathematics education or reading education leading to a master's degree
Assessment techniques	Techniques used to determine students' current knowledge and understanding about a topic; may include formative and summative assessment
Content knowledge	A teacher's description of his/her understanding of the Common Core State Standards for Mathematics including the Standards for Mathematical Practice
Formative assessment	Techniques used to gather information about students' current levels of performance in order to determine instructional methods to help students improve
Graduate classes	Classes leading to master's degrees in mathematics education or reading education
Integrated tasks	Authentic and complex mathematics problems
Instructional methods	Teachers' descriptions of practices they use in mathematics classes to help their students understand the content
Mastery experiences	Teachers' personal experiences with success or failure on specific tasks related to teaching mathematics

MTSE	Mathematics teaching self-efficacy: teachers' self-judgments about their ability to teach mathematics including content knowledge, instructional methods, and assessment techniques
Physiological state	Emotions such as dread or joy that occur when thinking about an upcoming performance related to teaching mathematics
Self-efficacy	Self-judgment about one's ability to perform a specific task
Summative assessment	Techniques used to gather information about students' current levels of performance in order to determine students' learning over time
Teacher self-efficacy	A teacher's belief in his/her ability to instruct his/her students; consists of multiple dimensions including content knowledge, instructional methods, and assessment techniques
Verbal persuasion	The verbal feedback to convince or encourage a teacher
Vicarious experiences	Teachers observing other educators in order to imitate the observed strategies

Overview of Methodology

Much of the research to date about teacher self-efficacy utilizes quantitative methodologies. The drawback of such methods is that they do not easily enable the researcher to develop an understanding of how a teacher's past and present life experiences have shaped these

self-efficacy beliefs. In order to better understand the sources of teacher self-efficacy for teaching mathematics, this research study utilized a qualitative method.

The qualitative method included using Seidman's (2013) three-interview approach to explore the nature and sources of teachers' self-efficacy beliefs about teaching mathematics among a small number of elementary teachers with advanced degrees in mathematics education or reading education. All three interviews focused on the three aspects of teacher self-efficacy for teaching mathematics described in the research questions. During the first interview, the teachers had the opportunity to describe their experiences as children as the experiences related to developing their mathematics self-efficacy and their MTSE within their first 2 years of teaching. In the second interview, the teachers described their current MTSE since completion of their advanced degrees. The third interview focused on the meaning the teachers made from their experiences. By having three interviews, the teachers had the opportunity to share specific details about how different experiences led to their MTSE.

This study involved my coding of teacher responses. During that process, I kept an analytic memo in order to document all of the reasons behind the codes. To analyze the interview transcripts, I used descriptive coding for the first round. With descriptive coding, I examined each passage of qualitative data and summarized it with a word or short phrase (Saldaña, 2013). After all of the passages with the same code were grouped together, the focused coding method was used for the second round of coding (Saldaña, 2013). Focused coding involved looking over the grouped codes and then determining whether some codes could be merged, modified, or deleted.

Limitations

Because this study utilized an in-depth approach to qualitative interviewing, there was a limited number of participants, and therefore, the study is not transferrable. The study also focused on one school district where the teachers may have had more similar experiences compared to teachers in various school districts. The qualitative interviews focused on teachers' recollections of their experiences and, therefore, may contain slight inaccuracies depending on the teachers' memories. In addition, some teachers may have embellished their experiences in order to provide rich descriptions during the interviews. Because I am a member of the elementary education profession, I tried to limit researcher bias by recording every interview and using teachers' words as much as possible to tell their narratives in relation to the research questions. However, what could have been a limitation (i.e., my being a part of the profession ad possibly being biased) became a strength because the teachers seemed to value my understanding about their experiences as teachers.

CHAPTER 2

REVIEW OF THE LITERATURE

Self-Efficacy Definition

The concept of self-efficacy was first developed in 1977 by Albert Bandura who theorized that people's beliefs in their abilities to perform in situations was separate from their actual abilities to perform. Bandura (1977) explained, "people process, weigh, and integrate diverse sources of information concerning their capability, and they regulate their choice behavior and effort expenditure accordingly" (p. 212). Therefore, self-efficacy is a person's beliefs in his/her ability rather than his/her actual ability (Tschannen-Moran & Woolfolk Hoy, 2007). If people believe they will experience success, they will have different motivation and commitment to tasks than if they believe they will experience failure. People with low self-efficacy may believe they are not able to accomplish a specific task and, therefore, do not expend energy to accomplish that task. On the other hand, people with high self-efficacy may feel prepared and calm when facing a task and expend more energy to complete it (Pajares, 1996). Therefore, a person's self-efficacy is a contributing factor in determining changes in behavior because it determines the person's effort, persistence, and resilience.

> A strong sense of [self-]efficacy enhances human accomplishment and personal well-being in many ways. People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. People who doubt their capabilities shy away from difficult tasks, which they view as personal threats. (Bandura, 1994, p. 71)

Examining a person's self-efficacy beliefs, therefore, can help us to predict when a person is likely to persist with challenging tasks and show resilience in the face of repeated failures. Efforts to increase self-efficacy at that point should then result in behaviors that reflect increased effort, even with challenging tasks. This relationship between beliefs and behaviors has been observed in the contexts of academic behaviors (Pajares, 1996), health-related behaviors (Olander et al., 2013), and professional behaviors (Bandura, 1995). Therefore, it is logical that this relationship can also be used to examine teacher self-efficacy.

Focus on Teacher Self-Efficacy

In 1998, Tschannen-Moran et al. investigated the internal and external forces contributing to teacher self-efficacy and described the construct as a "teacher's belief in his capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (p. 233). Henson (2001) similarly found that teachers examine a task and their competence simultaneously, which results in teachers' self-efficacy for a specific context. Tschannen-Moran and Woolfolk Hoy (2007) later defined teacher self-efficacy as a teacher's personal teaching competence based on the requirements of a specific teaching task:

> Instructors who judge themselves to be capable of orchestrating the complex knowledge and skills required to design instruction based on individual students' needs, taking into account the challenges of a particular teaching context, will likely exert greater effort, persistence, and resilience as a result of stronger self-efficacy beliefs. (p. 946)

For this research study, the term teacher self-efficacy refers to a teacher's beliefs in his/her personal teaching competence for teaching mathematics within the three areas described in the

research questions. The acronym MTSE was also created to refer to mathematics teaching self-efficacy.

Dimensions of Mathematics Teaching Self-Efficacy

Prior research has examined teacher self-efficacy in the areas of mathematics content knowledge and instructional methods (Bates, Kim, & Latham, 2011; Czerniak, 1990; Guskey, 1988). However, no research studies emerged specifically about teacher self-efficacy about assessment techniques. Two additional facets of teacher self-efficacy that have been studied but are beyond the scope of this research study are (a) collective self-efficacy, which refers to a group of teachers' beliefs in their abilities to influence student outcomes, and (b) teacher self-efficacy for classroom management, which refers to a teacher's belief about managing student behaviors (Tschannen-Moran et al., 1998). Because the present study was focused on individual teachers and the specific discipline of mathematics, these two facets of teacher self-efficacy were not studied.

Preservice Teacher Self-Efficacy for Content Knowledge

In order to learn the new content in the CCSSM, a teacher draws upon his/her current self-efficacy beliefs for the subject of mathematics. Deep understanding of mathematics content should occur in elementary and secondary school. However, many preservice elementary teachers in undergraduate programs still need to develop their depth of content knowledge. Some elementary preservice teachers bring low mathematics self-efficacy beliefs from their

mathematics experiences as students to their teacher preparation education classes and then to their first teaching jobs (Swars, Daane, & Giesen, 2006). Throughout the preservice college mathematics instructional courses, these teachers must begin to (re)learn mathematics content to be able to teach it effectively. These courses can lead teachers to enhancing their mathematics content knowledge and mathematics self-efficacy (Swars, Hart, Smith, Smith, & Tolar, 2007).

In a study of preservice teachers, if the preservice teacher's mathematics self-efficacy was higher, the mathematics teaching self-efficacy was also higher (Bates et al., 2011). Therefore, the present study explored the way teachers developed their self-efficacy beliefs about their mathematics content knowledge.

Teacher Self-Efficacy for Instructional Methods

Teacher self-efficacy is important in selecting the best instructional methods because teachers with high self-efficacy tend to experiment with methods of instruction and seek improved teaching methods (Guskey, 1988). Because the CCSSM have brought about change in what the students are learning, teachers are also examining different instructional methods in order to assist the students in these new learning pathways. Teachers may not be able to rely on the instructional methods they experienced as students years ago for teaching mathematics (National Council of Teachers of Mathematics, 2014). They need to examine current research to select the specific methods that allow all students to have access to mathematics content. If teachers have low MTSE, they are less likely to explore different instructional methods to meet students' needs (Guskey, 1988).

As the instructional methods described by the NCTM's (2014) research suggest, student ownership is vital in making the shift to helping students become successful with the CCSSM. Teacher self-efficacy plays a role in creating mathematics classroom environments where student ownership is high because highly self-efficacious teachers tend to be more likely to use inquiry and student-centered teaching strategies whereas teachers with lower self-efficacy tend to use more traditional teacher-directed activities (Czerniak, 1990).

Teacher Self-Efficacy for Assessment Techniques

Teacher self-efficacy is likely an influence on the creation of effective assessments and use of the data to create successful instructional opportunities for all students. Previous studies such as Tschannen-Moran and Woolfolk Hoy's (2001) have investigated teacher self-efficacy for assessment techniques as part of teacher self-efficacy for instructional methods. Bandura (1997) postulated that self-efficacy is specific to a task. Although assessment is an integrated part of making instructional decisions, it is also a different task because it requires creating assessments to understand students' true depth of knowledge and then using that information to choose instructional methods to continue developing students' mathematical ideas (National Council of Teachers of Mathematics, 2014). Teacher self-efficacy plays a role in these processes.

The NCTM (2014) principles suggest teachers should view the primary purpose of assessment as "to inform and improve the teaching and learning of mathematics" (p. 91). To be able to make instructional decisions, teachers likely need self-efficacy for creating accurate formative assessments and for purposefully using summative assessment data. When teachers utilize formative assessment, they examine a variety of ways to assess students' current

knowledge and use this information to select instructional methods to meet students' needs. This requires teachers to believe in their abilities to help struggling students. Gibson and Dembo (1984) found that teachers with low perceived self-efficacy were more likely to give up on students if the students did not easily understand concepts and were more likely to criticize the students for their failures. For the CCSSM learning progressions, teachers need to analyze their students' mathematical thinking in order to assist them in developing their problem-solving skills and need to assist struggling students in persevering to learn the content.

Summative assessment is also an opportunity to gain information about students' mathematical progress and adjust instruction accordingly. Whether the summative assessments include externally created assessments such as the PARCC or classroom-based unit tests, there is an opportunity for teachers to use the information. Summative assessment results are "not always analyzed appropriately and used to improve instruction" (National Council of Teachers of Mathematics, 2014, p. 90). Teachers may not have positive self-efficacy beliefs about how to analyze the assessment items and interpret the results. Overall, teachers' self-efficacy for creating formative and summative assessments, interpreting the data accurately, and utilizing the data to make decisions about instructional methods is an area for continued exploration.

Other Dimensions of Teacher Self-Efficacy

Two other dimensions of teacher self-efficacy that have been examined in prior research are collective self-efficacy and classroom management self-efficacy. Because the present research study focuses on the aspects of implementing the CCSSM, these two dimensions are outside the scope. Although they may influence teachers' classroom climates, they are not

directly related to mathematics specifically as are content knowledge, instructional methods, and assessment techniques.

Collective self-efficacy involves a group of teachers evaluating tasks and personal competence (Tschannen-Moran et al., 1998). When teachers work in schools with students of low socioeconomic status, there may be a collective sense of being overwhelmed because of the students' physical, social-emotional, and academic needs. These overwhelmed feelings may lead to teachers having a lower collective self-efficacy if they do not see student achievement, which may affect student achievement because teachers then exert less effort to help the students learn (Tschannen-Moran et al., 1998).

Teachers plan for a variety of tasks every day that require self-efficacy for multiple facets such as classroom management. Classroom management is a task-specific part of teacher self-efficacy because it impacts the instructional methods that teachers utilize in the classroom (Ross & Bruce, 2007). In student-centered classrooms, there are many activities going on at the same time in order to scaffold for students with various abilities. Effective classroom management may lead to more student achievement, which in turn may influence teacher self-efficacy.

Although there are many different dimensions of teacher self-efficacy, the present study did not focus on collective self-efficacy or classroom management self-efficacy.

Sources of Self-Efficacy

The present study explored teachers' descriptions of the sources of their self-efficacy beliefs for teaching mathematics. During interviews, the teachers had the opportunity to describe how their life experiences contributed to their MTSE. The interviews were focused on a life

history of the development of these sources, so the teachers referred to their experiences as children completing mathematics tasks as well as their experiences as teachers of mathematics. Within these life experiences, the teachers in the present study obtained advanced degrees in either mathematics education or reading education. Therefore, I asked specific questions about their graduate experiences and how those may have led to increased or decreased MTSE. Other than questions about graduate experiences, the teachers could describe any factor they perceived as contributing to their self-efficacy. The questions did not specifically ask about each of the four sources of self-efficacy but expected that teachers' open-ended narratives would incorporate descriptions of how mastery experiences, verbal persuasion, vicarious experiences, and physiological state contributed to increasing or decreasing their MTSE. There was no preconceived notion about which sources of self-efficacy the teachers would view as the most salient.

Mastery Experiences

Mastery experiences have also been called performance accomplishments or personal mastery because they are based on an individual's perceptions of their successes and failures (Bandura, 1977). Mastery experiences can be defined as a person experiencing repeated success in a particular task and therefore can lead to higher self-efficacy. If a person experiences repeated failures with a task, it may lead to lower self-efficacy. As explained by Bandura (1994) and Schunk (1989), these mastery experiences may also include success at persevering through challenging tasks because the person can then begin to believe his effort made the difference. If a

person experiences success too easily, the person may try to avoid failure and therefore have lower self-efficacy.

Teachers bring with them their experiences of learning mathematics as students. If the teachers had successful experiences as students, they may have higher mathematics self-efficacy. Teachers may remember themselves solving challenging mathematics problems, thereby creating mastery experiences that positively influenced their mathematics self-efficacy. However, teachers might also recall experiences in which they felt frustrated when doing their middle school mathematics homework which may have negatively influenced their mathematics self-efficacy. A teacher's personal mathematics self-efficacy is positively correlated with teacher self-efficacy for teaching mathematics (Bates et al., 2011).

In addition to mathematics experiences as students, the teachers in this research study described mastery experiences that came from past performances of teaching tasks with students (Tschannen-Moran et al., 1998). Teachers have a great deal of work to do in planning lessons and constructing experiences for students; however, teachers do not necessarily derive self-efficacy beliefs from these actions without seeing how a group of students responds during the lesson. Teachers' self-efficacy for mathematics content knowledge is built when they "implement tasks that promote reasoning and problem solving" (National Council of Teachers of Mathematics, 2014). If the student experiences success with a chosen task and his/her learning of a concept is deepened, this will be a mastery experience for the teacher, which leads to a higher sense of self-efficacy. The teacher may then feel that his/her content knowledge is strong enough to enable him/her to choose from tasks or create tasks that will efficiently teach the content.

An example of how mastery experiences can be a source of teacher self-efficacy for assessment techniques is through mental mathematics explanations. For example, there are many

different methods to solve a computation problem such as 75 – 29. In order to elicit students' mental thinking about solving the problem, teachers must be able to pose specific questions. When teachers ask a question such as "How can you group tens and ones to solve the problem?" and students can verbally explain their thinking, teachers' self-efficacy will increase through this mastery experience

However, if the teacher cannot pose applicable questions (e.g., "Would you explain the strategy you used to solve the problem? Why did you choose that specific strategy to solve the problem?") to determine the depth of student thinking behind the process of solving, the teacher may experience failure in being able to accurately assess the students' knowledge. This lack of a mastery experience may decrease the teacher's self-efficacy for using assessment techniques.

I focused on asking teachers about how master's degree courses in mathematics and reading may have influenced their MTSE. In order for teachers to improve their practices, many teachers sign up for programs leading to master's degrees. In elementary school, teachers instruct all disciplines including mathematics and reading. It can be challenging for them to decide which courses will most benefit them in refining their teacher practice. Although all disciplines have similar teaching practices to produce successful student learning experiences, each discipline has specific instructional methods and assessment techniques that support student learning in that particular domain (H. C. Hill et al., 2005). When teachers decide to take courses in mathematics, they may have opportunities to interact with mathematics content and develop a deeper understanding of the content knowledge, instructional methods, and assessment techniques leading to mastery experiences as a source of self-efficacy for teaching mathematics. Because mathematics is such a complex discipline resulting in many teachers entering it with feelings of anxiousness about the content, teachers' MTSE beliefs may increase more when they have direct

mastery experiences in mathematics as opposed to experiences in reading (Swars et al., 2006). On the other hand, teachers who take advanced classes in reading may still have the opportunity to have mastery experiences about instructional methods that transcend any academic discipline. When teachers become graduate students, they have the opportunity to view learning in a new manner. By experiencing success with learning content, the teachers may feel a sense of mastery that gives them stronger self-efficacy for teaching.

Therefore, the present research study explored the possible mastery experiences as sources of MTSE, which the teachers brought from their childhood, teaching careers, and master's degree experiences.

Verbal Persuasion

Verbal persuasion is another source of self-efficacy that occurs when an individual is socially persuaded about the ability he/she possesses to accomplish a task. "People who are socially persuaded that they possess the capabilities to master difficult situations and are provided with provisional aids for effective action are likely to mobilize greater effort than those who receive only the performance aids" (Bandura, 1977, p. 198). People can be socially persuaded in a positive or negative manner. Persuasive comments by others can be effective at convincing an individual that he/she can do it but can often be even more effective at convincing him/her that he/she can't (Jourden, 1992). When exploring the science, technology, engineering, and mathematics (STEM) fields, there are a variety of stereotypes about females' abilities to do the jobs, and some people can reflect stereotypes when making negative comments. Unfortunately, these comments can influence a female teacher's self-efficacy beliefs in an even

more powerful way than positive persuasive comments about the STEM field (C. Hill, Corbett, & St. Rose, 2010).

The teachers in this study had the opportunity to describe past experiences that included verbal persuasion as a source of self-efficacy. Some of their narratives included people in their past who used verbal persuasion for mathematics self-efficacy. A teacher reflecting on his/her experiences as a mathematics student might remember an elementary teacher who took extra time to say, "Look at how you persisted in solving that problem. You found the patterns. I know you can do this for other mathematics problems as well." This verbal encouragement for solving the mathematics problems could lead the student to feel higher self-efficacy for mathematics content (Zeldin & Pajares, 2000).

Some of the verbal persuasion for the teachers could have come from more recent experiences with administrators. "Verbal persuasion can be general or specific; it can provide information about the nature of teaching, give encouragement and strategies for overcoming situational obstacles, and provide specific feedback about a teacher's performance" (Tschannen-Moran et al., 1998, p. 230). An administrator could observe a teacher's mathematics lesson and provide positive feedback about how well the teacher chose instructional methods to facilitate the students' learning. The teacher could then interpret the positive feedback as a confidence booster that leads to higher MTSE for instructional methods. However, the way the teacher interprets the feedback depends on the credibility, trustworthiness, and expertise of the persuader (Bandura, 1997). If the teacher receives positive feedback from an administrator who had never taught mathematics, the teacher may not deem him/her as a credible teaching expert and therefore not give as much weight to the person's compliments.

Another source of verbal persuasion for teachers comes from their students' parents. Elementary teachers are asked by parents about the mathematics content such as, "What is this new mathematics?" or "Why does my child have to learn this strategy when he already knows how to multiply?" Some teachers may take these questions as judgments about their lack of mathematics content knowledge. If this feedback is overly harsh and critical, the teachers may interpret this feedback as information proving their teaching competence is lower, and therefore the comments may decrease their self-efficacy (Tschannen-Moran et al., 1998). The teacher with high self-efficacy for teaching mathematics in the area of content knowledge will be able to explain the various strategies to develop a child's number sense and not take verbal comments as a threat to his/her self-efficacy.

The present study was also focused on how experiences in master's degree classes contributed to self-efficacy. Teachers who take master's degree mathematics classes have the opportunity to interact with other colleagues and professors who value the discipline of mathematics. The teachers may be able to connect with the mathematics education professors and feel similar to them because they are also teachers of mathematics. By seeing themselves as similar to the professors, a few well-chosen encouraging comments from an instructor could be taken as verbal persuasion. A professor of a mathematics methods course could describe the importance of utilizing challenging mathematics tasks in the classroom and provide the time for teachers to work with each other in the course to create these tasks. Then, the professor could require the teacher-students to attempt to implement these tasks within their classrooms. By verbally encouraging the teacher-students to try these instructional methods, the instructors may feel more self-efficacious for teaching mathematics. Of course, the verbal persuasion may lead to teachers feeling less self-efficacious if they do not have the skills to change their teaching

practices (Schunk, 1989). Teachers in master's degree reading courses may receive the same type of verbal persuasion for trying new instructional methods while teaching reading. When they find success in trying the methods, they may feel more self-efficacious for reading; however, they may not be able to apply the specific new strategies to mathematics classes.

On the other hand, professors in master's degree classes may provide teachers with verbal persuasion about the general nature of teaching. Teachers who take master's degree classes in mathematics or reading may feel more self-efficacious for teaching mathematics simply by learning more information about teaching and student needs. Formative assessment is a component of effective teaching practices in mathematics and reading. When professors spend time discussing the importance of formative assessment for making instructional decisions that enable students to be successful, the concept can transcend disciplines. The teachers' narratives in the present study included some descriptions of how verbal persuasion was a source of MTSE that arose from various life experiences, including different master's degree classes.

Vicarious Experiences

A third source of increasing self-efficacy is through vicarious experiences, which includes teachers watching other people model or perform a task. When someone sees a person similar to himself/herself succeeding with strong effort, the person may believe he can also perform in a similar manner (Bandura, 1994). The vicarious experience source of self-efficacy is strongest when the observer perceives himself/herself to be similar to the model (Bandura, 1986; Schunk, 1989). When people perceive the models as very different from themselves, they are not as influenced by the models' behavior. As with verbal persuasion, in order to have vicarious

experiences that increase teacher self-efficacy, the teacher must feel similar to the model. If the model differs in education, experience, gender, race, or training, the teacher might not believe he/she is capable of doing the thing the model demonstrated, and therefore, there is no change to his/her self-efficacy (Tschannen-Moran & Woolfolk Hoy, 2007).

For the present study, teachers had the opportunity to reflect on their childhood experiences with mathematics. In a qualitative study of 15 women in mathematics careers, Zeldin and Pajares (2000) found that mathematics self-efficacy was based on vicarious experiences, including exposure to mathematics concepts at an early age that led to resiliency and persistence in order to master the mathematics content. A teacher may recall an early elementary experience in his/her life in which a peer explained a strategy for solving a mathematics problem, and then it made sense. This is an example of a vicarious experience having a positive influence on mathematics self-efficacy. On the other hand, a teacher may reflect on an experience of completing mathematics homework with his/her parents and hearing one parent say, "I am not a mathematics person." This vicarious experience may lead to negatively influence that teacher's mathematics self-efficacy and could directly decrease his/her MTSE.

Vicarious experiences contributing to teacher self-efficacy can come from watching other colleagues model or perform demonstrations. The teachers in the current research study also had the opportunity to describe more recent experiences that may have influenced their MTSE. The Internet and social media allow teachers to have vicarious experiences through the use of videos, blogs, or tweets. A teacher may want to know more about instructional methods in order to work with English language learners in mathematics and then watch a video on a website that demonstrates the use of a specific strategy such as graphically representing the mathematics

academic vocabulary. Through this vicarious experience, the teacher may begin to have higher self-efficacy about using this instructional method with English language learners.

As with the other sources, vicarious experiences may also lead to lowered teacher self-efficacy. If teachers meet in professional learning communities, and one teacher discusses his/her class's exceptionally high mathematics student assessment scores and another colleague's class has the lowest mathematics assessment scores, the second teacher may begin to have lower self-efficacy because his/her perception may be that he/she cannot assist his/her students in achieving better scores on the assessments.

The present research study asked teachers to think specifically about their experiences in master's degree classes and how those experiences contributed to their MTSE. Often, in graduate classes for teachers, the teachers have the opportunity to conduct lessons for and with each other. In an advanced mathematics education methods class, one assignment might be for the teachers to conduct a lesson about standard measurement in front of their classmates. A classmate who observes this teacher conducting the lesson may believe he/she also has the ability to conduct the lesson in his/her classroom. The same could happen in an advanced reading education methods class. However, conducting the actual lessons may only happen in the same relative disciplines in graduate classes. Therefore, a teacher in an advanced reading education class may not have the opportunities for vicarious experiences to become sources of MTSE.

The benefit of having advanced classes with other teachers is that there is time to discuss teaching practices. Listening to the teachers' failures, though, can also lead to decreased self-efficacy. In the current culture of standards and high-stakes assessments, there can be more negative discussion than positive as well as talk about ineffective teaching practices. Because of the culture, teachers taking graduate classes can also dismiss the graduate classes as not relevant

to their classroom needs. Therefore, these negative vicarious experiences do not differ based on the content area.

Physiological State

The fourth source of self-efficacy is a person's physiological state. When people feel stressed or depressed, they may interpret these feelings as having a low sense of self-efficacy (Bandura, 1997). Positive moods, on the other hand, may contribute to a person interpreting his/her self-efficacy as higher. It is not

> the sheer intensity of emotional and physical reactions that is important but rather how they are perceived and interpreted. People who have a high self-efficacy are likely to view their state of affective arousal as an energizing facilitator of performance, whereas those who are beset by self-doubts regard their arousal as a debilitator. (Bandura, 1994, p. 73)

In order to be able to interpret the emotions, the person has to have awareness of his/her physiological state. For a teacher, the task itself may require his/her complete attention or the students' needs may be all-consuming, therefore leading to the teacher not being able to attend to his/her affective state (Tschannen-Moran et al., 1998). If the teacher does not have the attentional resources to focus on his/her own emotions during the task, he/she may not experience a change in teacher self-efficacy.

Teachers develop their self-efficacy through their childhood physiological experiences with mathematics. Some teachers may think about the physiological states they felt as children during mathematics classes. Some preservice teachers think about their feelings towards mathematics as children, and they think about the anxiety they felt and how they believed

mathematics was simply a series of procedures to be memorized (Swars et al., 2006). For other teachers, they think back about their feelings towards mathematics as children, and they become excited because they enjoyed the discipline (Burns, 1998).

Physiological states can come from the joy a teacher experiences when teaching a successful lesson or the anxiety produced when a lesson does not go well. When a teacher feels relaxed and calm in a teaching situation, he/she can interpret his affective state as a sign of teaching competence and therefore have a higher self-efficacy (Bandura, 1997). When a teacher has a student who does not understand division, and the teacher can draw upon his/her instructional methods to help the student succeed, the teacher may experience joy. This joy may influence MTSE in the areas of content knowledge and instructional methods.

When a teacher attributes arousal such as stress or anxiety to a negative experience, the teacher may attribute it to a lower teaching competence level and therefore not feel as self-efficacious about the teaching situation. Using the above example, the teacher may be working one-on-one with a student who does not understand division. If the teacher feels anxious about his/her own mathematics content knowledge, he/she may experience a great deal of stress in the teaching moment. This stress may negatively influence MTSE.

In master's degree classes, teachers may also experience joy or anxiety as sources of self-efficacy. For some teachers, simply mentioning that they have to take a mathematics methods course creates anxiety. Once a teacher is in such a course, he/she may have to take tests to demonstrate his/her learning. If he/she experiences anxiety during the assessments, he/she may feel less self-efficacious when using assessments in his/her classroom to evaluate his/her students' knowledge. Physiological reactions occur when a situation reminds a person of a similar situation. Therefore, if a teacher in an advanced mathematics class experiences anxiety

during assessments, he/she may begin to feel the same anxiety using assessments in mathematics class but not feel the same reactions when using assessments in reading class because the reading assessment process feels different. In that respect, experiences with physiological state in advanced classes as a source of self-efficacy may influence teacher self-efficacy only if the disciplines are the same.

On the other hand, the physiological state teachers experience in advanced classes may not differ depending on whether the coursework is in mathematics or reading. Some teachers take master's degree classes to continue their learning processes and therefore may experience joy as their physiological state when taking mathematics or reading courses because the general process of learning excites them. This passion for learning may ignite feelings about why teachers chose the teaching profession to begin with: to inspire their students to be lifelong learners. This general joy of learning in graduate classes may positively influence MTSE because the teachers taking graduate classes are able to relate to their students and want their students to experience joy when learning mathematics.

Mathematics anxiety has been the subject of much research (Ashcraft, 2002; Boaler, 2012; Geist, 2010; Swars et al., 2006). Math anxiety is more than a discomfort with mathematics; it can lead to mathematics avoidance and loss of complete self-efficacy for the subject (Tobias, 1995). Approximately 50% of the United States population experiences mathematics anxiety (Boaler, 2012). For students with mathematics anxiety, their mathematics self-efficacy is directly impacted. First, the anxiety itself causes a negative physiological state that disrupts the student's ability to cognitively reason through mathematics problems (Ashcraft, 2002). Second, this anxiety, in turn, leads to students avoiding mathematics situations which thereby leads to students engaging in fewer mathematics classes (Geist, 2010). Therefore, the

students have fewer opportunities to experience mastery experiences, and their mathematics self-efficacy does not have a chance to increase.

Swars et al. (2006) conducted a study of preservice teachers in a mathematics class and found that the preservice teachers with high mathematics anxiety had lower mathematics teaching self-efficacy, while the preservice teachers with low mathematics anxiety had higher mathematics teaching self-efficacy. The preservice teachers with higher mathematics anxiety had past negative physiological experiences in mathematics classrooms and failing mastery experiences in which they viewed mathematics in terms of tests and quizzes that assessed their procedural knowledge (Swars et al., 2006). The preservice teachers with lower mathematics anxiety described vicarious experiences with positive parent role models and mastery experiences with successful problem solving as a student (Swars et al., 2006). Based on the Swars et al. (2006) study, mathematics anxiety impacts MTSE. In a study of preservice elementary teachers, self-efficacy for teaching mathematics was generally lower than for other subject areas, especially among teachers with mathematics anxiety (Swars, 2005). It is a cycle in which anxiety, students' mathematics self-efficacy, and teacher self-efficacy for mathematics are interconnected.

Teachers' mathematics anxiety influences their teaching self-efficacy and may also impact student achievement. In a study by Beilock, Gunderson, Ramirez, and Levine (2010), female students had lower mathematics achievement when their female teachers had high mathematics anxiety.

Summary of Sources of Self-Efficacy

Mastery experiences, verbal persuasion, vicarious experiences, and physiological state are four important sources of self-efficacy that may contribute to MTSE in the areas of content knowledge, instructional methods, and assessment techniques. The present research study sought to explore the degree to which these four sources emerge in teachers' description of their teaching self-efficacy. The research study examined how teachers with mathematics master's degrees and teachers with reading master's degrees had similarities or differences in their explanations of how the four sources of self-efficacy influenced their teacher self-efficacy.

Salient Influences on Self-Efficacy Depending on Context and Personal Characteristics

There is a myriad of factors that can contribute to a person's self-efficacy including personal characteristics and contextual variables. In teaching, the four sources of self-efficacy may not be equal in determining a teacher's self-efficacy beliefs because there may also be outside contextual variable contributions. A person's mastery experiences, verbal persuasion, vicarious experiences, and physiological state can contribute in complex ways (both positive and negative) to a teacher's self-efficacy beliefs. The specific nature and magnitude of the influence (i.e., context), however, depends on characteristics of the person and of the contextual variables. The way an individual interprets the sources of information influences the resulting self-efficacy (Britner & Pajares, 2006). Personal characteristics that might exert influence on the relative value of different sources of self-efficacy include cultural background, gender, and number of

years of job experience. Contextual variables that may influence the way teachers interpret the four sources of self-efficacy include school climate and student performance.

A person's cultural background may be a personal characteristic that influences the interpretation of the sources of self-efficacy. In the Stevens, Olivarez, Lan, and Tallent-Runnels (2004) study of self-efficacy and motivation in mathematics performance, the findings suggest that students from different cultural backgrounds had differing exposure to verbal persuasion and vicarious experiences. The findings support the notion that students who were White had numerous experiences with verbal persuasion and vicarious experiences in order to strengthen their sense of mathematics self-efficacy even in the face of threats such as poor grades. Students who were Latino did not have as much access to verbal persuasion or vicarious experiences; therefore, one failure, such as a poor grade, seemed to threaten Latino students' interpretation of their mathematics self-efficacy. One possible reason for this finding is that the Latino students did not identify with their teachers' actions as vicarious experiences that would increase self-efficacy because the teachers were not of the same cultural background. Because students' self-efficacy beliefs vary based on their background cultures and exposure to the four sources, teachers' self-efficacy beliefs may also be influenced by this variable. In the United States, 82% of teachers are White and 76% of teachers are females (U.S. Department of Education, 2010). If teachers do not have colleagues with the same background as theirs, they may have a more difficult time experiencing verbal persuasion or having vicarious experiences because they may not see themselves as similar (Bandura, 1986).

Gender may be another personal characteristic in determining self-efficacy. Pajares (1996) conducted a review of self-efficacy research that determined that female undergraduates had lower mathematics self-efficacy than males. The mathematics self-efficacy was more

predictive than mathematics achievement or mathematics outcome expectations of female undergraduates choosing mathematics classes or mathematics majors. Because physiological state is a source of self-efficacy, females and males who experience different levels of stress also interpret their experiences differently. In a long-term study of science students, Schmidt and Shumow (2014) found that female students reported experiencing more stress in high school science classes than male students. The notion that female students have lower mathematics self-efficacy has been a focus on much research that includes STEM. Therefore, not only is gender an influence on interpreting the four sources of self-efficacy, but it may be a more prominent influence in STEM fields such as mathematics (Lent, Brown, Gover, & Nijjer, 1996). Although the above research is focused more specifically on students, gender may also be an influence on teacher self-efficacy. Female and male teachers may experience the same circumstances in two different ways due to previous mastery experiences and physiological reactions within themselves.

In addition to teachers' cultural background and gender, teachers' years of experience might also influence their perceptions of sources self-efficacy. Tschannen-Moran and Woolfolk Hoy (2007) conducted a study of novice and experienced teachers. Their research findings suggest that experienced teachers had higher self-efficacy than novice teachers and that mastery experiences made the strongest contribution to experienced and novice teachers' self-efficacy beliefs. Another finding was that verbal persuasion seemed to make a bigger difference to novice teachers' self-efficacy beliefs, whereas it did not make as much of a difference to experienced teachers' self-efficacy beliefs. This may be because experienced teachers have already been saturated with mastery experiences and previous verbal persuasion, but the novice teachers are still building their experiences. This also confirms Bandura's (1997) theory that self-efficacy

beliefs are most variable early in learning and tend to become stable and resistant to change over time.

One of the contextual variables that influences a teacher's perceptions of the sources of self-efficacy is school climate. The school climate can influence all four sources because teachers may not perceive mastery experiences, verbal persuasion, or vicarious experiences in the same manner when they work in a negative climate in which there is blame for student failure rather than attempts to collaborate to ensure all students succeed. Stronger self-efficacy beliefs have been found among teachers who perceived a positive school atmosphere and experienced a sense of community (Tschannen-Moran & Woolfolk Hoy, 2007).

Guskey (1987) researched another contextual variable that may influence the magnitude of a source of teacher self-efficacy: how a teacher interprets student performance (either success or failure). The results suggest that teachers differ in their perceptions of self-efficacy when students' performance was successful compared to unsuccessful. Teachers tended to believe the positive outcomes were due to their teaching skills but negative outcomes were due to factors outside of their control (Guskey, 1987). However, there was some discrepancy between individual and group performances. If a group performed poorly, teachers were more likely to accept personal responsibility for the results (Guskey, 1987). For individual students, teachers believed some of the students' learning was beyond their influence (Guskey, 1987). If the teachers attributed the students' failures to factors outside of their influence, their self-efficacy beliefs would not decrease.

The personal characteristics and contextual variables represent a few possible influences on the ways people interpret sources of self-efficacy. While it may not be possible to eliminate variability in the teachers' background influences in the present research study, I made some

attempts at limiting these influences. For personal characteristics, I took these into account by matching, to the extent possible, the two different groups of teachers (those with mathematics master's degrees and those with reading master's degrees) based on current teaching positions, number of years since completion of the master's degree program, gender, and number of years of teaching experience. To address the contextual variables, the teachers in the present study were all from one school district. Although each teacher's school climate may have been different, there was a district climate that may have provided a similar contextual variable for these teachers. Although there were efforts to limit the differences in personal characteristics and contextual variables in the present study, it is important to remember that these variables may still have had an influence on the studied teachers' interpretations of sources of self-efficacy.

Need for Present Study

Teacher self-efficacy is an important construct to continue studying because it can be a factor in student achievement as well as in the overall health of the school organization (Ashton & Webb, 1986; Hoy & Woolfolk, 1993). The introduction of new standards in 2010 and new assessments in 2015 created an opportune time to investigate MTSE. The NCTM issued a report that stated the dire need for the study of mathematics classrooms: "the links between CCSSM, the enacted curriculum in classrooms, and the performance of students on high-stakes assessments must be rigorously explored" (National Council of Teachers of Mathematics Research Committee, 2013, p. 346). Mathematics has been through many shifts in types of curriculum and assessment, so the move forward towards deep understanding represents an important time in education. The present research study may assist school districts in

understanding more about how teachers develop MTSE and then be able to provide impactful professional development experiences. It is an addition to the literature on teacher self-efficacy for teaching mathematics and provides more narratives about the study of teacher self-efficacy.

Although there is a great deal of research on teacher self-efficacy, there is limited research about elementary mathematics teaching. One of the first mathematics self-efficacy instruments was the Mathematics Teaching Efficacy Beliefs Instrument, validated by Enochs, Smith, and Huinker (2000), which focused on preservice teachers' mathematics teaching self-efficacy beliefs and mathematics teaching outcome expectancy. However, the use of this instrument only focused on preservice teachers. More research is necessary for inservice teachers.

The present study was also necessary because the current teacher self-efficacy research is largely based on teacher surveys, and there is a need for more qualitative studies in which teachers' thoughts are probed as they reflect on their self-efficacy (Coladarci, 1992). Specifically, Tschannen-Moran et al. (1998) stated, "Qualitative research could explore what events and influences teachers attribute to the development of their efficacy beliefs" (p. 242). There are many influences affecting teachers' beliefs (Fives & Buehl, 2011). Teachers need to have the opportunity to explain their sources of self-efficacy in depth, and using the qualitative approach of interviewing afforded teachers this opportunity. In addition, by interviewing teachers, they had an opportunity to explore their beliefs more deeply. By exploring their beliefs, teachers can more deeply reflect on how their practices are congruent or incongruous with their beliefs. Then, teachers can continue to use professional development to understand the reasons behind the incongruous beliefs.

CHAPTER 3

METHODOLOGY

Research Questions

This study was designed to explore teachers' mathematics teaching self-efficacy beliefs. There were two research questions guiding this study:

How do elementary teachers describe the nature and sources of their self-efficacy for teaching mathematics in the areas of content knowledge, instructional methods, and assessment techniques? Do these descriptions differ depending on whether teachers have earned an advanced degree in mathematics education or reading education?

In order to study these questions, Seidman's (2013) approach was used to collect qualitative data through multiple interviews with teachers. This approach allowed understanding of the multiple ways teachers perceive their life experiences, including their graduate education, as having contributed to their current self-efficacy beliefs for teaching mathematics.

Overview of Research Design

Teacher self-efficacy research has largely been quantitative (Ashton & Webb, 1986; Gibson & Dembo, 1984; Tschannen-Moran & Woolfolk Hoy, 2001). Although quantitative data in the form of surveys can provide one glimpse of teachers' self-efficacy beliefs, it may be

difficult to understand the sources of those beliefs in-depth. In the study by Tschannen-Moran and Woolfolk Hoy (2007), the authors mentioned the need for more "exploration into the antecedents of teachers' self-efficacy beliefs" as well as how those beliefs are "formulated and sustained" (p. 954). The present study attempted to contribute to filling that gap in the literature by obtaining teachers' narratives about their life experiences that led to their MTSE. Conducting in-depth interviews in which teachers had the opportunity to describe their beliefs in terms of their sources and meaning provided some insight into teachers' beliefs and the reasons behind their beliefs. Although I considered the possibility of observation as a research methodology, I ruled out that method because it would not lead to answering the question about the sources of the teachers' self-efficacy beliefs.

The present research study used Bandura's (1977) theory of self-efficacy as background information to aid in understanding teachers' responses about their sources of MTSE. As Maxwell (2005) stated, "Every research design needs *some* theory of the phenomena you are studying" to "guide the other design decisions you make" (p. 46). Therefore, the theory of the four sources of self-efficacy provided the background knowledge that was the basis of the design of this study. However, the teachers' experiences provided the descriptions of the actual phenomena of teachers' sources of self-efficacy beliefs.

Because the teachers were describing the phenomena of developing MTSE, the present research study could be considered part of the phenomenological approach to qualitative research. According to Moustakas (1994), phenomenology involves researchers collecting data from people who have experienced a phenomena and describes the themes across the people's descriptions. The present research study sought to explain what sources of MTSE the teachers experienced and how they experienced them. In order to accomplish this goal, I used Seidman's

(2013) approach to qualitative interviewing which involves a deep "interest in understanding the lived experience of other people and the meaning they make of that experience" (p. 9). Seidman (2013) mentioned four themes of interviewing: the transitory nature of human experience, subjective understanding, lived experiences as the foundation of phenomena, and the emphasis on meaning in context. With these four themes, interviewers are aware that participants are the ones making meaning of their experiences. In addition, "context is crucial to understanding the meaning of participants' experiences from their point of view" (p. 19). Because context is crucial, Seidman developed a three-interview series. Each interview lasts approximately 90 minutes.

Researcher Bias

As Fischer (2009) pointed out, every researcher is analyzing the data through his/her perspective. My perspective as an elementary classroom teacher and instructional coach has led to my fascination with teaching mathematics. Based on my interactions with teachers, students, and parents, I have heard many negative comments about mathematics. This has always made me curious about elementary teachers' perspectives because they instruct all academic disciplines. To bracket my perceptions about teaching and the subject of mathematics before beginning the interviews, I wrote down all of my personal experiences and set those aside as suggested by Bogdan and Biklen (2007). After putting aside my personal experiences, I focused on using teachers' descriptions. By using teachers' exact words to explain the phenomena of sources of their self-efficacy beliefs, I was careful to let the themes emerge through the data rather than through my perspective.

For full disclosure, I chose the research setting based on my connection with the school district. This connection proved to be advantageous because I am familiar with the district's professional development and the curricular expectations. This led to strong rapport with the teachers, and they felt that I was genuine about seeking to tell their stories and that I understood their specific descriptions. While I believe that my role as an insider in the district primarily benefitted the study, it is possible that my familiarity with this context may have prevented me from recognizing salient features of participants' experiences because I take them for granted (Mercer, 2007). Insider research can assist the researcher with having a better understanding of the setting and assessing the implications of the participants' narratives. On the other hand, an insider's familiarity could lead the interviewees to not explain their experiences in-depth if they believe the researcher already knows about a situation. Based on this information, during the interviews, I asked participants to explain their experiences in as much detail as possible in order to put aside my own perspective. To further reduce bias, I was not employed by the school district during the school year in which the interviews were conducted.

Setting

The setting for this study was a school district in a midwestern city that included students from early childhood through 12th grade, although the study focused specifically on the elementary schools (kindergarten through fifth grade) in the district. The district enrolled approximately 17,000 students and included approximately 1,000 teachers. The district spent approximately $8,000 each year per student on instructional expenses within a total operational expenditure of approximately $13,000 per student. The 4-year high school graduation rate in the

district was 96%. As far as testing, the district had 80% of its students at the meets-or-exceeds level according to the 2013 state test results.

As far as the district's demographics, approximately 68% of the student population was White, 15% was Asian, 9% was Latino, 5% was Black, and 3% was multiracial. The student population also included 13% low income, 9% with disabilities, 4% English language learners, and 1% homeless.

Of the approximately 1,000 teachers in the district, approximately 79% had at least one master's degree. The district did not keep records about the specific types of master's degree programs that local universities offered. These local master's degree programs were typically comprised of teachers from one district, and sometimes surrounding school districts, who worked with local universities to complete advanced degrees. Many of these programs involved cohorts of students in which the students took all of the classes together. The benefit of having the universities do outreach degree opportunities can be that the teachers learn new content with district colleagues and encourage each other to practice new instructional methods within their classrooms. Some local master's degree programs that have been offered to the school district include curriculum and instruction, educational administration, mathematics education, and reading education. In addition to graduate coursework, the teachers in this research study's school district participated in approximately 60 hours of district-sponsored professional development opportunities throughout the school year in the form of institute days or district-sponsored classes. The institute days were spread throughout the year as 1 full day or half day in each month of the school year, and these opportunities were designed to help teachers improve their teaching practices. For example, some of the topics for the district's professional development during 2011 to 2013 included how to implement the Common Core State

Standards, utilize reading assessments, incorporate integrated mathematics problem-solving tasks, and respond to students in culturally responsive ways. In addition to the required institute days, the district offered optional in-district classes about topics such as mathematics numeracy, technology integration, and mathematics problem solving. Staff members could sign up for these classes that met after school hours or through online forums.

Teachers as Participants

I utilized purposeful sampling to select the teachers (Patton, 1990). The two groups included elementary teachers with master's degrees in mathematics education and elementary teachers with master's degrees in reading education. Although the district did not have specific records about the teachers' specific master's degrees, to the best knowledge of the district staff, there was only one group of elementary teachers to enroll in a local university's mathematics master's degree program. This group consisted of 11 staff members. Six of those staff members were in different positions throughout the school district including district office and in mathematics coaching positions, and the other five staff members were teachers.

The research study included four elementary teachers with master's degrees in mathematics education and four elementary teachers with master's degrees in reading education. No participant had a master's degree in both. All the teachers instructed mathematics for at least a portion of their day. The reason the study focused on elementary teachers as opposed to middle or high school teachers was because elementary teachers need to teach all academic disciplines, whereas teachers in middle and high schools tend to teach one or two subjects. In addition,

teachers at middle and high schools tend to have degrees in their content areas rather than a general education degree, as is the case with elementary teachers.

First, I contacted the five elementary teachers with mathematics education master's degrees to ask about their interest in participating in the study. One of the teachers with a mathematics education master's degree was willing to join at first but then felt he did not want to do the interviews without the questions ahead of time. After four of the teachers with master's degrees in mathematics education agreed to participate in the study, I began the process of purposefully selecting the teachers with reading education master's degrees. The sample of teachers was collected through a snowball procedure that involved contacting instructional coaches and reading specialists in all elementary schools in order to obtain names of teachers with reading education master's degrees. Using the names provided, I then contacted 11 possible teachers with reading education master's degrees to determine if they were willing to participate in the study. Due to the number of work obligations and the amount of time needed to do the interviews, five of the teachers decided not to participate.

Out of the remaining six teachers who were willing to participate, I attempted to match the teachers according to teaching position. I attempted to match the teachers with reading education master's degrees to the teachers with mathematics education master's degrees according to the current teaching positions, number of years since completion of the master's degree programs, number of years of teaching experience, and gender. Unfortunately, I only found one gifted education teacher who had her reading education master's degree, but she had completed it more than 15 years ago. Therefore, there was another participant, Kris, who had taught gifted mathematics in the previous year. See Table 3 for a description of the matched teachers.

Table 3

Teacher Descriptions

Teachers with mathematics master's degrees				Teachers with reading master's degrees			
Teacher	Current position	Years of experience	Years since master's degree completion	Teacher	Current position	Years of experience	Years since master's degree completion
Hannah	Special education	9	3	Leah	Special education	4	2
Julia	Gifted education	9	3	Kris	Fourth grade	15	7
Michelle	Fifth grade	7	3	Grace	First grade	9	2
Nora	Second grade	7	3	Amber	Second grade	5	1

The teachers with mathematics education master's degrees included a primary teacher, an intermediate teacher, a gifted education teacher, and a special education teacher. The teachers with reading education master's degrees included two primary teachers (one of which had taught intermediate before), an intermediate teacher (who had also taught gifted mathematics before), and a special education teacher. There was one teacher with a mathematics education master's degree that took time off to raise her children, and there was also one teacher with a reading education master's degree who did the same. The average number of years of experience for the teachers with mathematics education master's degrees was 8 years and 8.25 years for the teachers with reading education master's degrees. All the teachers had more than 3 full years of teaching experience; therefore, they could reflect on how the differences in their beginning years of teaching compared to their current teaching.

The names of all the teachers in the study have been changed to pseudonyms to protect their identity. The descriptions below include the information the teachers provided in their first

interview when discussion demographic characteristics and my impressions about their personalities.

Amber

Amber is a second-grade teacher who has had all 5 years of her full-time teaching experience in one elementary school. She grew up as a White girl in a midwestern suburb close to her current school district with her parents and brother. Both of Amber's parents were teachers. After high school, Amber attended community college for 2 years and then completed her bachelor's degree in elementary education at a state university. Before becoming a full-time teacher, Amber substitute-taught for half of a year. She obtained her master's degree in reading education 1 year ago.

Amber is a very focused and dedicated individual who constantly seeks new learning. She is a leader on her team and enjoys completing work in an efficient manner. During the interviews, she was very honest and open about her experiences as a student and a teacher. She made sure she was telling the sequence of events in order and expressed her enthusiasm for teaching. She considered herself a person who had anxiety about mathematics from a very young age.

Grace

Grace is a teacher who has spent 5 years teaching first grade in the same elementary school. She grew up as an Asian girl in a midwestern suburb approximately 60 miles from her

current school district with her parents and brother. Grace's parents were first-generation immigrants and believed in the value of hard work. She said her parents always helped her understand the importance of the subject of mathematics. Grace earned her bachelor's degree in elementary education at a large state university. After completing her degree, she taught second and third grades in a mixed-age classroom for 4 years in a private elementary school. After that, she took 9 years off to be a full-time mother. Then, she re-entered the teaching profession in her current position. She received her master's degree in reading education 2 years ago and received a second master's degree in curriculum leadership 1 year ago.

Grace is a very thoughtful individual who takes time to learn before making judgments. She is a teacher who continuously seeks new learning opportunities and continuously improves her lessons. During the interviews, Grace listened carefully to the questions and paused before answering. She said the interviews made her really reflect on her mathematics experiences. As she started discussing her experiences, one experience would remind her of another one. Then, she would freely explain her memories in detail. As a young elementary student, Grace believed she had strong mathematics skills; however, she began to doubt her mathematical ability in high school.

Hannah

Hannah is a special education teacher who works with students in kindergarten through fifth grade. She grew up as a White girl in the local midwestern suburb in which she currently teaches. Her family includes her parents and two brothers. One of her brothers has special needs. After high school, Hannah went to a state university to earn a bachelor's degree in psychology.

She worked for a few years in another career before obtaining her master's degree in special education. When she first became a teacher, she taught early childhood and then became a special education teacher for the rest of the 9 years of her teaching career. Hannah received her master's degree in mathematics education 5 years ago.

Hannah is a quiet individual who is very observant and thoughtful. During the interviews, Hannah expressed her appreciation for all of her family members, coworkers, and classmates. She believes she learns a great deal from other people. She worked hard to learn mathematics but was never anxious about it.

Julia

Julia is a gifted-education teacher who teaches mathematics and literacy to students who are academically talented. As a child, Julia grew up as a White girl with her parents and siblings. Julia's most prominent memory of her childhood was she moved several times and remembered the powerful experience of not knowing anybody at her new school. Julia said her parents always told her to she would go to college but did not help her with the process. She decided to major in finance because she believed she could find a job. After a few years in finance, she stayed at home to be a full-time mother; her sons now both have their own careers. While she stayed at home, she volunteered for many positions in her sons' elementary schools in the same district as her current position. Later in life, Julia went back to school for her master's degree in education. When Julia first became a full-time teacher, she worked for a year in a school district with many financial needs. Julia has been in her current position of teaching gifted students in third, fourth,

and fifth grades in the same district for 7 years. She received her mathematics education master's degree 3 years ago.

Julia is a confident and well-spoken individual who drew upon her many life experiences such as motherhood, her financial career, and different positions in schools during the interviews. She has very strong philosophies about teaching and learning, and she wants students to become self-directed learners. She puts in a great deal of time into her lessons and believes wholeheartedly in her teaching methods. Julia expressed her confidence in her mathematics and teaching abilities. She said she felt glad when she was able to solve the complex problems with her peers during her mathematics education master's degree classwork.

Kris

Kris is a fourth-grade teacher who previously taught one section of the gifted-mathematics curriculum. Kris grew up as a White boy in a large city in the South and a midwestern suburb. His parents divorced when he and his sister were young. As an elementary student, Kris was placed in a gifted program. After high school, he attended a large state university where he majored in elementary education. He has taught second, third, and fourth grades for 15 years in three school districts. His first school district had students from diverse ethnicities, and approximately 40% of the students qualified for free and reduced-price lunch. He has been at his current school for 8 years; 97% of its students scored in the meets-and-exceeds range on state tests. Kris received his reading education master's degree 7 years ago and is a National Board Certified Teacher.

Kris' personality is very lively, vivacious, and enthusiastic. It is obvious that he is passionate about teaching. During the interviews, he liked to make jokes about himself and enjoyed laughing with me. Kris' confidence in teaching seemed to stem from his ability to reflect about his successes and failures in trying new methods. He said he had always been a good mathematics student, but he was never interested in the subject. He said he preferred the humanities because he craved connection with people.

Leah

Leah is a special education teacher who works with students in kindergarten through fifth grade. She grew up as a White girl in the midwestern suburb with her parents and brothers in which she currently teaches. Her mom was a first-grade teacher in the elementary school that Leah attended. As a high school student, Leah enjoyed tutoring other students and teaching swim lessons to younger children. Leah obtained her undergraduate degree in special education and elementary education at a state university. Then, she became a special education assistant and then a teacher. She has taught special education in the same school for the last 4 years. She received her reading education master's degree 2 years ago.

Leah's personality is very confident, well-spoken, and curious. During the interviews, Leah had a strong voice and talked in detail about her learning and teaching experiences. She made several jokes during the interviews and seemed to maintain a balance between formal and informal language. Leah seems to be someone who thrived on helping others and takes great pride in being able to do things independently. She considers herself strong in mathematics throughout her childhood.

Michelle

Michelle is a fifth-grade teacher who has been in her current position in the district for 6 years. Michelle grew up with her parents and two brothers as a White girl in the same Midwestern suburb where she currently teaches. Michelle became an interior designer for a brief time before becoming a teacher. After receiving a master's degree in elementary education, she obtained a job as a kindergarten teacher. Then, she started her current position. She received her master's degree in mathematics education 3 years ago.

Michelle's personality is very bubbly and enthusiastic, and she had a smile on her face during the entire three interviews. She looks for creative ways to teach her students and seems to really enjoy working with others. Michelle seems to be the type of person who captivates others with her balance of lightheartedness and intense work ethic. She described how she struggled with anxiety towards mathematics for her whole life. After becoming a teacher and working with a mentor, she decided she wanted to strengthen her mathematics skills and mathematics teaching skills by obtaining a degree in mathematics education.

Nora

Nora is a second-grade teacher who spent most of her 7 years of teaching as a kindergarten teacher. She grew up as a White girl in a midwestern city with her parents and two sisters. Both of her parents worked in the field of education. After competing a degree in elementary education at a state university, Nora became a first-grade teacher in a school district geographically close to her current teaching district. After teaching kindergarten and first grade

in that district, she moved to her current district and has been there for 2 years. She received her mathematics education master's degree 3 years ago.

Nora's personality is very confident, talkative, and straight-forward. During the interviews, Nora was able to easily recall very specific experiences. She has very specific opinions about mathematics teaching and draws upon her colleagues to continue to learn. She was very positive about this research study and was very curious about the findings. As a child, Nora always considered herself a strong mathematics student and loved to solve complex problems with her dad at the dinner table. Her dad recommended that she major in mathematics, and she decided not to pursue that option because she wanted to work with younger students.

Sources of Data

The primary source of data was the three-interview series conducted with each teacher. In order to develop the semistructured interview questions, I piloted the initial set of research questions with a mathematics coach who had received her mathematics education master's degree. After the pilot, I revised the questions to provide more focus on the three areas of the research study: content knowledge, instructional methods, and assessment techniques. The pilot confirmed that the research questions in the three areas provided detailed information about possible sources of self-efficacy.

After updating the research questions based on the pilot interview and recruiting the teachers through a study summary (see Appendix A), I asked each teacher to schedule their three 90-minute interviews. The three interviews were spaced from 3 to 7 days apart for each teacher.

The interviews were conducted at a neutral location, and all 24 interviews were completed within 6 weeks.

At the beginning of the semistructured interview with each teacher, I explained that the topic was self-efficacy, which could best be understood as confidence. Each teacher signed a consent form (see Appendix B). I recorded all interviews using a handheld digital recording device. I used interview guides in order to provide general questions that kept the interviews focused on the key topics; however, I also utilized follow-up questions based on each teacher's answers (Seidman, 2013). During the interviews, I also kept a research journal of notes in order to actively listen and write down teachers' descriptions that may have required further exploration during a later time in the interview or in future interviews.

The first interview was a focused life history in which teachers told "as much as possible about him or herself in light of the topic up to the present time" (Seidman, 2013, p. 21). In order to understand each teacher's educational experiences, the interview began with some general demographic questions (see Appendix C). More specifically, the first interview focused on the teachers' mathematics experiences before starting their master's degree classes, which included describing their mathematics experiences as students in elementary school through their undergraduate years and during their first 2 years of teaching. The interview guide provided the general questions to ask about these experiences (see Appendix D). The questions were open-ended, utilized words such as "tell a story," and were designed to enable the teachers to reconstruct their experiences and provide concrete details rather than talk generally about a subject (Seidman, 2013, p. 89). The first interview examined the teachers' mathematics experiences as a student in order to explore their first experiences with mathematics self-efficacy. Then, it focused on the teachers' sources of self-efficacy by asking about experiences

that increased or decreased MTSE for content knowledge, instructional methods, and assessment techniques within the first 2 years of teaching mathematics. The information from these interviews provided specific examples of how novice teachers developed their mathematics self-efficacy and MTSE.

The second interview in Seidman's three-interview series is supposed to "concentrate on the concrete details of the participants' present lived experience in the topic area of study" (Seidman, 2013, p. 21). During the present study's second interview, the teachers focused on their MTSE during their master's degree program and their current mathematics teaching experiences. The questions (see Appendix E) mirrored the first interview's by focusing on the teachers' self-efficacy for content knowledge, instructional methods, and assessment techniques. The teachers provided specific details about their master's degree experiences and their current mathematics teaching experiences.

The third interview in Seidman's three-interview series is supposed to be a reflection on meaning (Seidman, 2013).

> Making sense or meaning making requires that the participants look at how the factors in their lives interacted to bring them to their present situation. It also requires that they look at their present experience in detail and within the context in which it occurs. (Seidman, 2013, p. 22)

During the present study's third interview, the teachers reflected on their present MTSE and how it had been influenced by their previous experiences including graduate classes. In order to prepare for the third interview with each teacher, I first transcribed the audio recordings of the first two interviews with each one and created a third interview guide. Therefore, each teacher's third interview guide was different because it was specifically based on the details of the first two interviews. The third interviews focused on the teachers making meaning of their sources of

self-efficacy beliefs about teaching mathematics. The teachers were able to clarify previous mathematical experiences. I noticed that the teachers' third interviews had repetitive information from the first two interviews; therefore, it appeared that there was a level of saturation of information that was reached.

After all three interviews with the teachers were completed, I listened to all three interviews, in order, for each teacher. While listening to the first two interviews, I checked over the transcripts previously written, and then I transcribed the third interview in its entirety. By transcribing all three of the interviews myself, I was able to hear the specific emotions in the teachers' voices and gain a more detailed understanding of their experiences.

Coding and Analysis Procedures

After all of the transcripts were completed, I began to analyze the data and develop thematic patterns that represented the experiences of how teachers develop their self-efficacy for teaching mathematics. During the first round of coding the data, I used the descriptive coding method because it helped summarize the topics within the passages of interview data (Saldaña, 2013). As Saldaña (2013) described, this process of descriptive coding involves reading the transcripts and marking the topic of each sentence or passage in the margin. The description could be a word or phrase that captures the essence of the teachers' comments. "During initial coding, the goal is to remain open to all possible theoretical directions indicated by your readings of the data" (Charmaz, 2006, p. 46). The initial descriptive codes were based on the teachers' narratives rather than the categories of the research questions or any previous literature. To be able to effectively code the data, "descriptive data need to be studied, not merely skimmed"

(Wolcott, 1994). I studied each transcript at length. By studying the whole transcript for each teacher, I preserved the timeline of the teacher's life experiences, which was important to my understanding of the whole (Wolcott, 1994).

In order to keep track of the category labels and the reasons for each category, I kept an analytic memo with thoughts behind my decisions. As Saldaña (2013) asserted, the analytic memo is often crucial because it details the reasons certain pieces of data were coded in a specific manner. Initially, there were 72 codes that I used to characterize the teachers' descriptions of sources of self-efficacy (see Appendix F). After coding the first teacher's transcript, each subsequent transcript was coded by using the previous codes and establishing new codes as needed. This descriptive coding process continued until all eight teachers' transcripts were coded. Each transcript had comments in the margin listing a code number and a code name for each piece of data. Some of the pieces of data applied to more than one coding category and contained all possible relevant codes.

After coding all of the transcripts, I began to examine all of the codes as a whole. For ease of reading the data, codes were assigned to reflect each teacher's position, his/her master's degree, the interview number, and the lines of the interview transcript. The special education teachers, Hannah and Leah, were given the code ST. The gifted-education teacher, Julia, was given the code GT. The general education teachers, Amber, Grace, Kris, Michelle, and Nora, were assigned codes according to their grade-level positions. For example, Amber's code was 2T, meaning second-grade general education teacher. Grace had the code 1T, Kris had the code 4T, Michelle had the code 5T, and Nora had the code 2T. The teachers who had mathematics education master's degrees had the code MM, and the teachers who had reading education master's degrees had the code RM. The next code assigned represented the interview number.

The first interview was 1I, the second interview was 2I, and the third interview was 3I. Finally, all three interviews for each teacher were compiled, and the lines of the transcripts were numbered. Therefore, L105 stood for the 105th line of the interview transcript. As an example of the full coding sequence, ST:MM:1I:L258-261 refers to Hannah, a special education teacher with a mathematics education master's degree, and the comments referred to were made during her first interview on lines 258-261 of the interview transcript. Within the narratives described in the next chapters, I wrote these codes in the parentheses by the quotations. If the teacher's name was not already within the text in the sentence, I included the teachers' name in the parentheses as well.

After having the codes to work with, including all the line numbers, I then printed out each transcript onto a specific color of paper for each teacher and cut and sorted the transcripts by the different 72 codes. Next, I put each of the piles of slips of paper into a separate file and counted the pieces of data under each code. For example, file #1, which consisted of the pieces of data about facts, had 9 slips of paper. See Appendix F for the frequencies of each code. The final part of the initial coding process involved reading each of the new files with the compiled information in that category. Seidman suggests, "After filling all the marked excerpts, reread all of them file by file. Start sifting out the ones that now seem very compelling, setting aside the ones that seem at this stage to be of less interest" (Seidman, 2013, p. 129). Once the interpretation part begins, the key is to allow the participants' words, in this case the teachers, to speak for themselves. I wrote explanations for the connections in the analytic memo but was careful to maintain the integrity of the teachers' own meaning.

Following the first round of coding, I began to do a second round of coding in which all the codes were refined through the use of focused coding (Charmaz, 2006). Focused coding

requires a deeper analysis of the codes generated in the first round and then concentrates on the "most salient categories" to "sort, synthesize, integrate, and organize" data (Charmaz, 2006, p. 46).

> You act upon your data rather than passively read them. Through your actions, new threads for analysis become apparent. Events, interactions, and perspectives come into analytic purview that you had not thought of before. Focused coding checks your preconceptions about a topic. (Charmaz, 2006, p. 59)

During focused coding, I determined whether some of the coding files could be combined (see Appendix G). I also examined whether the emerging themes were describing content knowledge, instructional methods, or assessment techniques. Within each of the three areas of MTSE, I determined whether the teachers were describing their experiences as students or as teachers. After this coding, there was a set of 20 themes with rich narrative data which described the sources of teachers' self-efficacy beliefs about content knowledge, instructional methods, and assessment techniques. Table 4 displays those codes that emerged.

After there was a set of themes that seemed to describe the data accurately and efficiently, the teachers had the opportunity to review those themes. There are several ways to establish credibility in qualitative research: some researchers believe in member checking with the participants, and others believe member checking may interfere with the analysis of the data (Creswell, 1998). For this study, each teacher was given his/her transcript with the comments about the themes on the side. Each teacher had the opportunity to review the themes and could have provided additional comments about any overlooked or unclear themes. No teacher reported inaccuracies or omissions.

Table 4

Emerging Codes

Content knowledge	Instructional methods	Assessment techniques
1. Participant as student a. Family b. Affect towards mathematics c. Learning experiences d. Peers 2. Participant as teacher a. Teaching assignment b. Standards c. Master's degree classwork	1. Participant as student a. Methods classes b. Preservice experiences 2. Participant as teacher a. Curriculum resources b. School colleagues c. Instructional coaches and mentors d. Students' individual experiences e. Students' group experiences f. Professional development g. Master's degree classwork	1. Participant as teacher a. Formative assessments b. District assessments c. Standardized assessments d. Master's degree classwork

After the coding for themes was completed, the interpretation phase included what Weiss (1994) called "an issue-focused report at the level of concrete material," which means that the final report contains thematic codes to describe teachers' sources of self-efficacy for teaching mathematics in the areas of content knowledge, instructional methods, and assessment techniques. Within each of the 20 themes, the teachers' narratives describe how the sources of self-efficacy increased or decreased their MTSE. In the next three chapters, each of the sources of MTSE is explained in detail with the teachers' descriptions.

CHAPTER 4

DESCRIPTION AND SOURCES OF MATHEMATICS TEACHING SELF-EFFICACY BELIEFS FOR CONTENT KNOWLEDGE

Mathematics Teaching Self-Efficacy in the Area of Content Knowledge: Participant as Student

Before developing mathematics teaching self-efficacy, teachers develop mathematics self-efficacy (Bates et al, 2011). When the teachers in this study described their MTSE, they began by detailing their sources of mathematics self-efficacy. These sources included their family, affect towards mathematics, kindergarten through 12th-grade learning experiences, and peers.

Family

The teachers described their sources of MTSE for content knowledge by describing their mathematics self-efficacy when they were students. Because the first interviews focused on the teachers' earliest experiences with mathematics, one of the first possible sources of mathematics self-efficacy that emerged was the family's influence. These family members included parents and siblings, as discussed in the sections below.

Parents

Solving Mathematical Problems. Half of the teachers, two teachers with reading education master's degrees and two teachers with mathematics education master's degrees, talked about ways their parents incorporated mathematics into their everyday lives and how these mastery experiences strengthened their real-world mathematics knowledge from a young age. Michelle talked about playing the game of Yahtzee with her parents in order to have her practice mathematics concepts:

> It was like we all got the [scoresheets]. . . . Everyone would always wait for me to add all my stuff and things like that. But I don't remember in those moments, I have two older brothers, them ever picking on me, but it seems like something they would have done. So, it's kind of interesting. I'm kind of, like, I wonder if they set that up. (5T:MM:1I:L178-182)

Nora talked about how her dad would pose mathematics problems, and they would work to solve them together. She explained the experience, "And we'll just be having dinner, and my dad will be like, 'So I had this problem at school today' or 'So I heard this problem on the radio.' And I'm like, 'Oh, you did?'" (Nora, 2T:MM:1I:L362-364). Nora described how she and her dad continued to give each other challenging mathematics problems because they both had a common interest in mathematics. She said that without her dad, "Well, I don't think I would've had the foundational skills and the practice I had. I mean, during the summer, we'd practice mathematics. Like at home, we'd practice mathematics" (Nora, 2T:MM:3I:L3114-3116). Nora went on to talk about her feelings about mathematics because of the work with her dad: "I wonder if I didn't have my dad at home doing all those things with me, how I would have felt or

because I never would have said mathematics is my favorite subject then" (2T:MM:1I:L596-597).

Two of the teachers with reading education master's degrees, Kris and Leah, described how their parents used real-world problems to teach them about mathematics. Kris also described how his parents incorporated mathematics into everyday situations but through his weekly allowance:

> My parents gave me an allowance. It started off, when I was in kindergarten or first grade, of 50 cents a week, so if I wanted [to get something from] the ice cream man, which was about 25 to 50 cents, I could save money and do that. (4T:RM:1I:L133-136)

Kris' experience of learning how to save and spend money assisted him in developing his real-world mathematics skills.

Like Kris, Leah talked about how she learned about real-world problem solving from building various projects with her dad:

> He would teach me a lot about the measurement and, like, how or what the nicks on the ruler meant or things like that. . . . Sometimes, if I wasn't sure, I would tell him, "Two and two little marks." He would be, like, "Look at the marks." Fraction sense and stuff like that. Now, I can relate it to fraction-like things. (ST:RM:1I:L520-523)

Leah went on to explain that she began to see the connection between projects with her parents and the mathematics topics at school:

> Especially, like, helping my dad or mom with doing measurement things. I think that had a stronger connection. And I think I just got better. I got better at comparing things and understanding numbers were around you and numbers had a purpose. (ST:RM:1I:L566-569)

Leah's dad had helped her understand mathematics on a deeper level.

Encouragement. Aside from doing mathematics problems with parents, three of the teachers described the beliefs their parents had about their mathematical capabilities. Grace and Leah, both of whom held a reading education master's degree, described how their parents encouraged them to use their strong mathematics skills. Their parents' encouragement was sources of verbal persuasion. Grace said,

> Yea, so he [Dad] had very high expectations, and I think he, you know -- I was always book smart, not as much street smart. I had a pretty good memory, so I think, you know, especially when you're younger, if you can learn things quickly, parents think you're brilliant. (1T:RM:1I:L107-109)

Grace continued to explain how her dad would verbally convince her that she had strong mathematics skills. He persuaded her to continue to strengthen her memory by working on mathematics facts.

Leah's parents also encouraged that she continue with her mathematics skills in her future career: "My parents really wanted me to go into business because they said I was good in mathematics, and I was decent in talking to people, so that's what they pushed" (ST:RM:1I:L765-767).

Like Leah's family, one of the teachers with a mathematics education master's degree, had a parent who wanted her to pursue mathematics in college. Nora's dad tried to verbally persuade her to major in mathematics:

> I remember applying to school. I remember my dad making me double-major in education and mathematics. And he's, like, "No. You should do that. You should do that [he emphasized again]." And, I was, like, "Okay. Okay." And, my first day on campus, when he wasn't there anymore, I went to my adviser, and I was, like, "I don't want to do mathematics classes." So, I wonder if he hadn't been pushing that [if] I would have felt [differently] about it. (2T:MM:1I:L599-603)

Nora's dad encouraged her to major in mathematics because he thought she had strong mathematics skills and wanted her to continue to use those skills. This encouragement increased Nora's mathematics self-efficacy, even though she did not want to major in mathematics.

Doing Homework. Parents' words of encouragement may have increased some of the teachers' mathematics self-efficacy beliefs. However, four of the teachers, two with a mathematics education master's degree and two with a reading education master's degree, expressed that the physiological state associated with actually doing mathematics homework with parents may have resulted in decreased mathematics self-efficacy. Hannah described another instance of becoming frustrated when doing mathematics homework with parents. She brought home multiplication problems using a method based on place value rather than the traditional algorithm her parents were familiar with. Hannah reflected,

> He's [her dad] an accountant, but he would get frustrated. Looking back now, I kind of laugh because we expect our [students'] parents, don't teach the shortcut method. Trust us. You know. But he was very much, that's what it is, "Here's how you're going to do it." I'd be, like, "But that's not what the teacher said." And he'd be, like, "Well, then, I'm not going to do it." And, he'd, like, leave. So, he wasn't very calm during it. (ST:MM:1I:L114-118)

When Hannah's dad became frustrated, it made Hannah feel a little anxious and uneasy. Another representative example of a teacher becoming frustrated when doing homework with parents is when Michelle reflected on her experience of doing homework with her dad:

> And then we'd get home, and then we'd have to do it. . . They [parents] said it was just like pulling teeth. And in the morning, Dad would remember some problem, and he'd be, like, "Hey do you remember whatever it was?" And I'd be, like, "I don't want to hear it!" (5T:MM:1I:L267-270)

Michelle became frustrated that her dad would not stop asking her questions about her homework. Both Hannah and Michelle became frustrated and dejected when doing mathematics homework because both of their fathers showed signs of irritation. Similarly, Amber and Grace, both of whom held reading education master's degrees, experienced negative emotions after trying to do mathematics homework with their parents. Amber reflected on her dad's frustration with her learning style. As a result, she did mathematics homework with her mom because of her dad's frustration:

> I'm very visual. I need to do it. I need to see it. So, it was hard for him [her dad] to kind of separate his being a teacher and being a dad. And, you know, making sure he was helping me and not just telling me, and my mom ended up helping me more just because we're similar learning styles. But my mom is not a mathematics person, either, so it's hard to say if I picked up more of her feelings or where that kind of frustration came from. (Amber, 2T:RM:1I:L25-30)

Amber became frustrated when doing homework with her dad. Grace had a similar experience when she reflected on the time she tried to do division homework with her dad, and he began yelling at her: "Why don't you get this? . . . This is so easy," and her response was, "I remember crying because I was, like, so frustrated" (1T:RM:1I:L277-278). When I asked her how she felt after that experience, Grace replied, "Probably stupid" (1T:RM:1I:L282). Collectively, Amber, Grace, Hannah, and Michelle, all experienced sadness and frustration about their mathematical abilities when doing homework with their fathers, which led to decreased mathematics self-efficacy.

Siblings

Parents were not the only family members who held mathematical beliefs that contributed to the teachers' mathematics self-efficacy. Working with siblings became a vicarious experience source of mathematics self-efficacy. Two of the teachers, Grace and Hannah, watched how their brothers experienced success in learning mathematics and how that propelled them to believe in themselves, too. Grace shared, "My brother was always my kind of go-to person because he had gone through it recently, and he knew all the teachers. So, he kind of guided me through my academic career" (1T:RM:1I:L358-360).

Grace felt she could follow her brother's lead about how to manage mathematics classes, and Hannah had a similar experience with her brothers. Hannah was inspired by her two brothers' mathematical minds: "I think in some ways, it made me think, they got this. I should be able to, too" (ST:MM:3I:L2424). Hannah wanted to be like her brother the same way Grace wanted to be like hers.

However, when two of the teachers watched their siblings complete mathematics problems, the vicarious experiences became a source that decreased their mathematics self-efficacy because they did not understand the reasoning behind the procedures. Leah and Michelle both described the experience of feeling frustrated when working with their brothers. They both needed their brothers to do more cognitive modeling, so they could then replicate the thinking when they attempted to solve new mathematics problems. For example, Leah described one time when her brother tried to help her with her algebra homework:

> It is a vivid memory. I just remember him smacking down his pencil and being, like, "Leah, why don't you understand this?" And I was, like, "I don't. I just don't understand this." And I was, like, "Why are there letters in this?" And he was, like, "The letters don't

> mean anything. Just. Just fill in the blanks." And just getting frustrated in that way. So, it was more kind of. He still sat next to me. He didn't get mad, mad at me. He just got really frustrated. I just remember him talking to me, like, very angrily, just frustrated, just mad that I wasn't getting it. And I knew he did get it, and it made me mad. I was just, like, "I don't know." (ST:RM:1I:L207-214)

Michelle described her similar feelings of not having skills that were as strong as her brother in mathematics: "But, in my younger years, it absolutely was HARD. And my brother was really, really still is, very intelligent, and he would explain it to me, and it was like a different language" (5T:MM:1I:L16-18). Like Leah, Michelle did not understand her brother's explanation of mathematics. Both Leah and Michelle felt discouraged because they could not understand mathematics the same way as their brothers.

Summary of Family

The teachers described the influence of their parents and siblings as sources of mathematics self-efficacy. Time spent doing mathematics problems and homework with the family, as mastery experiences, led to increased mathematics self-efficacy when the teachers felt as though they were understanding the concepts and could see the connection between work done at home and at school. Three of the teachers described their parents giving them encouragement as verbal persuasion that increased their mathematics self-efficacy. When parents, specifically fathers, became frustrated with doing mathematics homework, the teachers experienced negative feelings, and the experiences influenced their physiological states and may have led to decreased mathematics self-efficacy. Siblings also became a source of vicarious experiences.

The most salient source of self-efficacy seemed to be the parents' frustration when doing mathematics work with the teachers when they were young, a physiological state that led to decreased mathematics self-efficacy. By the end of high school, three of four of the teachers who experienced those negative feelings had lower mathematics self-efficacy.

Affect Towards Mathematics

Positive Feelings

The teachers described how, throughout their elementary and secondary years, how mathematics evoked different emotions ranging from enjoyment to frustration that were physiological sources of mathematics self-efficacy. Two of the teachers, Leah and Nora, described their positive feelings about their mathematics experiences. Leah described how she liked the subject of mathematics because it seemed uncomplicated: "I liked that there were answers. You got to an answer. You could prove it. I almost liked that you didn't have to talk about it very much. You could just do it" (ST:RM:1I:L133-134). Nora also enjoyed mathematics because she felt mathematics came easily to her. She described how she felt when her third-grade teacher gave her challenging mathematics problems after she got a high test score: "That was . . . an experience where, 'Oh, I didn't really realize, but I'm, I'm good at mathematics.' That was the first time I realized it. . . It was always kind of easy" (Nora, 2T:MM:1I:L32-34). Because Nora, like Leah, felt that mathematics came easily to her, she experienced joy, and that positive physiological state increased her mathematics self-efficacy.

Negative Feelings

Seven of the eight teachers talked about negative feelings towards mathematics. Both of the special education teachers, Hannah and Leah, described how mathematics became abstract and more complicated. Hannah had negative feelings about algebra: "I think, just because it felt abstract. It felt like I didn't get how it was all going to correlate and what these numbers were going to tell us" (ST:MM:1I:L401-403). Hannah became frustrated because the algebraic numbers did not make sense to her.

Like Hannah, Leah felt frustrated with mathematics but with proofs. Even though Leah, as stated above, enjoyed figuring out the answers to mathematics problems, her disposition towards the mathematics work was more negative when it came to proofs:

> Proof drawings were my absolute least favorite thing in the world. I don't want to write about the steps I took to do it. I just want to get the answer. Like, I loved the things you could do, but I hated writing it out. I hated it. Hated it! (ST:RM:1I:L91-94)

Leah found an area of mathematics for which she felt strong dislike.

Julia and Michelle, both of whom earned mathematics education master's degrees, also had negative feelings but from a different perspective. Neither initially thought of herself as a mathematics person. Julia simply stated, "It's interesting. I never thought of myself as a mathematics person" (GT:MM:1I:L239). Michelle echoed Julia's thoughts when she said, "K through 8, I STRUGGLED in mathematics. It was always difficult for me" (5T:MM:1I:L5-6). Julia and Michelle were feeling discouraged by mathematics and did not feel engaged in their learning experiences.

Although Julia and Michelle didn't ever feel like mathematics people, three other teachers with reading education master's degrees, Amber, Grace, and Kris experienced high mathematics self-efficacy at the beginning of elementary school which began to decrease when they started feeling frustrated and disinterested. For example, Amber had enjoyed mathematics until third grade. Then, it became difficult for her to learn her multiplication facts. Regarding after that experience, she said, "From then on, I just was not a mathematics person. I really delved more into reading" (Amber, 2T:RM:1I:L19-20). These negative feelings continued through her senior year of high school about which she expressed her low mathematics self-efficacy: "It was like I just reached that point mathematics-wise, that I . . . just wasn't . . . capable of doing any more" (Amber, 2T:RM:1I:L330-331).

Kris also echoed Amber's feelings about not being a mathematics person:

> That [mathematics] was never really my strong suit, believe it or not. I was really more of a humanities guy. I was always, like, "Yea. I really love science or social studies." I love it because it was less mathematics involved. It wasn't that I was averse to mathematics at all. It's just it was probably my least favorite subject because it was so dreary a lot of times. (4T:RM:1I:L272-276)

Kris later reflected on why he considered mathematics a dreary subject. He analyzed his experiences by saying,

> I'm a people person. I like to interact with people. . . Mathematics isn't [collaborative with others], even though it should be, and even though we're working on it, mathematics, when I was a kid was, you sit there. You do your work. You move on. There wasn't a group discussion. There wasn't check your work with a partner. There wasn't, "Let's solve these problems together." (Kris, 4T:RM:3I:L2285-2289)

Kris saw mathematics as a set of procedures to go through alone rather than a collaboration with others to solve problems.

Like Kris, Grace also talked about how her mathematics confidence dwindled over time. One of her most vivid memories was when she did not get into the higher level of calculus in high school: "But, I would say definitely towards high school, I started losing my confidence in mathematics. I was kind of leveling off" (Grace, 1T:RM:1I:L118-119). Grace continued, "It must have been junior year. I just remember feeling, like, I was pretty average at mathematics, and it was just too hard. I remember feeling, like, 'No, it's just too hard. I can't do it'" (1T:RM:1I:L495-497). Based on her mathematics experiences, Grace described that she viewed mathematics as a subject for logical thinkers. Because she characterized herself as a creative individual, she believed she was not a mathematics person.

Summary of Affect Towards Mathematics

Affect towards mathematics seemed to be a physiological source of the teachers' mathematics self-efficacy because they recalled enjoyable and frustrating feelings about the subject. Two of the teachers expressed their sense of accomplishment and enjoyment when doing mathematics problems, which seemed to raise their mathematics self-efficacy. But, seven of the teachers remembered negative feelings about mathematics content, which may have lowered their mathematics self-efficacy. Both of the special education teachers began to feel mathematics was too abstract and required too many explicit steps. Five of the other teachers, two with mathematics education master's degrees and three with reading education master's degrees, began to believe that mathematics was too difficult or uninteresting. The negative physiological

states seemed to be more salient than the positive physiological states for these teachers' mathematics self-efficacy beliefs.

Learning Experiences

The teachers reflected on their learning experiences in elementary through high school. One aspect of the teachers' learning experiences was their rapport with their elementary and high school teachers. Another aspect was their teachers' choices of instructional methods.

Rapport With Teachers

Two of the teachers, one with a mathematics education master's degree and one with a reading education master's degree, described how specific teachers worked to establish rapport when they were students. The positive relationships led to both of them experiencing physiological states of comfort. Amber had a teacher who made her feel supported and more comfortable with mathematics content. Amber explained how her fourth-grade teacher helped her feel valued and successful: "and she just seemed to know what you needed and to find a good balance of pushing you because it was difficult and then, you know, finding another area that you succeeded in" (2T:RM:1I:L172-174). Amber's teacher helped her to believe in her mathematical ability.

Michelle described such a relationship when she reflected on her sophomore high school teacher's calm demeanor and how he worked to develop an interest in each of his students:

> He was always walking about, and he would always greet us. And I remember in the halls, he would always greet us. I think it was just the relationship that we had, and then when I was in the class, I felt welcome. He would be at the door welcoming everybody. (5T:MM:1I:L396-400)

Because Michelle felt welcomed, she stated that she finally "felt okay to ask questions in mathematics" because "he just set that climate" (5T:MM:1I:L306-309).

Nora described the exact opposite relationship with her high school advanced placement calculus teacher. The teacher did not seem to develop rapport with his students, and this led to Nora's physiological feelings of not being supported and being inadequate. Nora went on to explain that she was the only female on the mathematics team, and the advanced placement calculus teacher was the coach. When her team went to compete at the state level, the teacher made it very clear that he did not expect Nora to perform as well as the male team members. This made her feel as if it was worthless for her to try to learn more mathematics content. She said that she began to give up learning calculus. This subsequently caused Nora to reflect on how positive rapport with her teachers influenced her self-efficacy:

> When I connected with the teachers, I try harder, so I think that [has] influenced my mathematics teaching in just trying to connect with those kids because I know that being connected with your teacher makes you want to show, to do better. (2T:MM:3I:L2681-2684)

Because Nora had already developed a high mathematics self-efficacy before senior year of high school, the dejected feelings about her high school teacher's lack of expectations seemed to only slightly decrease her mathematics self-efficacy. For all three teachers, the rapport with the teacher served to increase or decrease their mathematics self-efficacy.

Teachers' Instructional Methods

While the teachers were students in middle school and high school, they felt their classroom teachers' instructional methods became vicarious experiences. For an experience to be vicarious, Bandura (1997) asserted that cognitive modeling provides the thinking behind the experience in order for an observer to replicate it. Two of the teachers described how the process of watching their own teachers talk through the specific steps of solving mathematical problems allowed them to be able to replicate the steps on their own. When they could replicate the steps, the experience seemed to increase their mathematics self-efficacy for content knowledge. For example, Leah said that her eighth-grade mathematics teacher helped her by stating each step to complete a problem. She said, "I just remember mathematics always being straight-forward. . . . [The teacher would say], 'You listen to me. I'm going to show you exactly what you need to do, and here's things you need to practice on" (Leah, ST:RM:1I:L295-297). After the teacher talked through all of the steps, Leah could internalize the procedures and replicate them when solving problems on her own.

Nora also had a teacher who was explicit about her cognitive modeling: "She's, like, 'This is how you do it. This is the method'" (2T:MM:1I:L131-132). This teacher taught an advanced-level high school course for students like Nora who were still in middle school. Nora said that the teacher's instruction helped her develop her mathematics self-efficacy to learn the advanced content she was being taught.

Five of the other teachers did not feel as though their teachers' cognitive modeling supported their mathematical learning. Two teachers with mathematics education master's degrees described how their vicarious experiences of watching their teachers try to explain

procedures decreased their mathematics self-efficacy. Hannah, for example, had an eighth-grade mathematics teacher who did not attempt to verbally explain the process of solving algebra problems. Hannah offered this example of how the teacher provided instruction: "She [her teacher] would only assign the odds because the answers to the odd problems were in the back of the book. If you'd ask a question, she'd say, 'That's the answer' and move on" (ST:MM:1I:L9-11). Michelle also had a high school teacher who did not explain her thinking about how to solve mathematics problems. Michelle reflected, "I don't remember any amazing teaching strategies. You're just watching her at the board, and then do your homework, and then wanting to get it right" (5T:MM:1I:L231-232). Neither Hannah nor Michelle was able to internalize how their teachers modeled solving problems, which seemed to decrease their mathematics self-efficacy. Perhaps they needed more explicit cognitive modeling.

Three of the teachers with reading education master's degrees also explained how they needed more explicit cognitive modeling when watching their teachers demonstrate how to solve mathematics problems. Amber thought about her elementary school experience and said her teachers seemed to tell students about a strategy but not explain the thinking behind the strategy: "So the way they presented it was, 'Here's a strategy. Master it. Move on to the next'" (2T:RM:3I:L2467-2468). Grace also wanted to understand the reasoning behind a mathematics concept. She described how she did not understand long division when she was in elementary school. She watched the teacher say the steps but not explain the reasoning behind the steps. Grace said,

> I couldn't get long division. I didn't understand it. And part of the reason why was because they [her teachers] just taught us what to do, and they didn't explain the reason behind it. And that was my whole experience with mathematics. It was all memorization. It didn't – If it didn't make sense, it was okay. It was just all calculation. . . . I had no idea why. This is what you do. (1T:RM:1I:L241-246)

Grace reflected on the experience of watching her teachers carry out steps but not model the reasoning behind each step. She said, "And so, when those problem-solving experiences came, I felt like I was bad at it because I had never developed enough sufficient understanding where I could build upon that and, you know, actually feel confident about it" (Grace, 1T:RM:3I:L2481-2486). Grace did not have the confidence in her internal understanding of mathematical processes to be able to apply her knowledge to new problems.

Kris also described how he wasn't able to internalize the reasoning behind how to do proofs in high school geometry. Kris described his experience of trying to learn: "Oh, no, he [Kris' teacher] TRIED to teach me how to do it. I just didn't understand it. And I didn't understand why we were doing this. I didn't really have the reasoning behind it" (4T:RM:3I:L2519-252). For Kris, not understanding the reasoning behind the procedures meant he did not feel confident to complete new problems on his own.

Summary of Learning Experiences

Rapport with teachers was a physiological source of self-efficacy for three teachers. Two teachers described how positive relationships with their teachers increased their mathematics self-efficacy, and one teacher described how a lack of rapport with her teacher decreased her mathematics self-efficacy. Teachers also described the process of watching their teachers model the process of solving mathematics problems. For two teachers, these vicarious experiences seemed to increase their mathematics self-efficacy because their teachers used cognitive modeling. Five teachers, including three with reading education master's degrees, experienced learning in classrooms where their teachers did not make explicit the thinking behind solving

mathematics problems. This led to the teachers having a lack of understanding of the concepts and therefore lower self-efficacy. To be confident in learning the mathematics content, the most salient source that emerged from the teachers' learning experiences was the presence or absence of their teachers' cognitive modeling.

Peers

Social Comparison

The teachers described their teachers and their learning experiences, and they also described their peers. Social comparison with peers became an important process that impacted the teachers' mathematics self-efficacy because of the physiological state it evoked. Three teachers, one with a mathematics education master's degree and two with reading education master's degrees, described how understanding mathematics concepts more quickly than peers and being in the higher-level mathematics classes made them feel proud and happy about their mathematics skills. Kris remembered the feeling of doing better than his peers when he was placed into a gifted track, and he remembered feeling excitement about being with equally talented peers and still being able to perform as well or better. Like Kris, Leah remembered feeling that she caught on faster than her peers. Leah stated simply,

> I knew I caught on quicker than a lot of people did, so that part I did know. And figured out. And I knew friends struggled with it based off of homework or things like that or if they were in a different class. (ST:RM:1I:L261-263)

Because Leah felt she could understand the concepts easier than her friends, she felt proud. That physiological state led to increased mathematics self-efficacy. In addition to Kris and Leah, Nora also compared herself to others and felt delight when she could perform better than their equally talented peers. Nora described how she did better than most of her high school calculus class: "I remember thinking, 'I'm doing a lot better than everybody else.' There were a couple of kids who did better than me, but I remember, "I'm doing better than three-fourths of the class" (2T:MM:1I:L285-288). Nora's successful feelings based on her evaluation of her mathematics content knowledge as compared to her peers seemed to give a positive boost to her self-efficacy.

On the other hand, one teacher with a mathematics education master's degree and two with reading education master's degrees described how their social comparisons to peers led to discouraged physiological states, which seemed to lower their mathematics self-efficacy. Amber remembered her elementary and high school classes when she was in the lower-level mathematics classes, and she felt dejected about having less mathematics content knowledge than her friends in the higher-level mathematics classes. Like Amber, Grace had been in the advanced mathematics classes until she did not qualify for the advanced calculus class senior year of high school: "I just totally remember . . . that AP [advanced placement] placement, and me feeling like I was a failure. I just remember thinking calculus was so hard. That I would never get it" (1T:RM:1I:L474-477). She compared how hard she had to work to learn calculus content compared to her friends: "That's when I started realizing I wasn't that great in mathematics. I was getting by, but I had to study a lot harder than it seemed like my friends did" (Grace, 1T:RM:1I:L125-127). By needing to work harder than her peers, Grace began to feel

discouraged. Grace began noticing that she had to work a lot harder than her peers, but she also noticed that more boys than girls seemed to be in the highest-level mathematics classes:

> But I did remember a lot of boys that were good at mathematics and really quick at problem solving, and I would be intimidated at that. I don't know if I naturally attributed that to me being a girl, but there was some underlying. I think a lot of my girlfriends, also, like I was saying in the interview, just didn't like mathematics or didn't feel confident. I kind of, maybe, started to associate with them as well. . . . I mean I just remember mathematics club was filled with boys. It was rare that there were girls that were really excellent in. I might see one or two, but you don't really see them in a leadership position. (1T:RM:3I:L2622-2630)

Grace examined how she continued to compare herself to her peers, even as an adult, and how that comparison encouraged her to engage or disengage in mathematics activities:

> And, like, if everybody is trying to figure it out in the mind, and there's, like, this part of me that I shut down when I see those things. I don't want to take that challenge because I'm so used to someone being faster than me. (1T:RM:3I:L3339-3341)

Grace began to not want to accept challenges because she did not have high mathematics self-efficacy to solve the problems and felt discouraged by peers solving them so much faster than her.

Another teacher, Michelle, also remembered how she felt when she realized how she was underperforming compared to her peers. She described her thoughts about being in the lower mathematics classes while her friends were in the higher ones: "Yea, looking around. . . . It was definitely like we're the lower ones. . . . And then, you're, like, 'Wait. I was with these people last year. Why are my friends going to that class?'" (Michelle, 5T:MM:1I:L252; 220-222). Michelle felt discouraged that she was not learning the mathematics content as quickly as her friends, and this decreased her mathematics self-efficacy.

Summary of Peers

The teachers compared their mathematical skills to their peers' skills. Bandura (1997) explained this process of comparative self-evaluation, where observing similar peers' accomplishments and failures can influence affective states. All four teachers with reading education master's degrees described peers as a source of their mathematics self-efficacy. Two teachers experienced joy when comparing themselves to peers, which led to increased mathematics self-efficacy, while two experienced dejection when they felt they had weaker mathematics abilities, which led to decreased mathematics self-efficacy. Only two of the four teachers with mathematics education master's degrees described peers as a source for increasing or decreasing their self-efficacy. Perhaps the teachers with mathematics education master's degrees had higher self-efficacy and therefore were not as affected by social comparison.

Mathematics Teaching Self-Efficacy in the Area of Content Knowledge: Participant as Teacher

As the teachers transitioned from being students with emerging mathematics self-efficacy to being teachers, their mathematics teaching self-efficacy began to develop. The sources of MTSE that this study identified were: teaching assignment, standards, and master's degree classwork.

Teaching Assignment

Building Deeper Mathematical Understanding

Three teachers, Amber, Grace, and Hannah, discussed the idea that teaching mathematics, mastery experiences, actually helped them to build their understanding of mathematics concepts and fill in gaps from their learning as students. Amber expressed that her MTSE for content knowledge increased as she began to instruct her students about different ways to break numbers apart and find groups of 10:

> What I'm teaching them has made ME think more flexibly about numbers, and I don't remember being taught that way. So, I feel like through teaching that, I feel like I've increased my confidence just because you're seeing the kids, even the lower kids, just be able to apply and break numbers apart and be able to find that friendly group of 10. . . . So, I feel like my confidence has definitely increased from teaching that. (Amber, 2T:RM:2I:L2100-2105)

Amber gained a deeper understanding about how to think flexibly about numbers when she started to teach. Like Amber, Grace also discussed how she began to think differently about mathematics concepts when she began teaching. Grace described in detail about how her view of the mathematics discipline changed as she started teaching mathematics:

> I remember when I first started teaching mathematics, and I learned about mathematics is all around us. I'm, like, "Oh, yea." It was revolutionary to me. . . . I'm so used to seeing mathematics . . . on a paper. . . . I feel like I didn't learn real mathematics until I started teaching it. (1T:RM:1I:L254-258)

Grace elaborated about how she wasn't confident about mathematics content until she started teaching it, and she said, "I felt like I had to build that [confidence], almost like repairing and filling in some of the holes in my learning" (1T:RM:3I:L2451-2452). As Grace described, she

was most confident about mathematics content that involved computation and procedures instead of reasoning and thinking flexibly about numbers. However, Grace began to have the mastery experiences of teaching her students how to think flexibly about numbers by using a mathematics rack, a set of bars with red and white beads for quickly identifying 5s and 10s. She talked about how using the math rack was a difficult process for her:

> I had never learned mathematics that way, and it was really uncomfortable for me. I'm, like, "So, you can make 17 this way, 5 and 5 and 7." And, I was so used to thinking of 17 as 10 plus 7 that it was hard for me to kind of use the mathematics rack in that way and feel comfortable teaching it that way. (Grace, 1T:RM:2I:L2161-2162;2166-2169)

Grace began seeing the steps behind adding numbers rather than just memorizing the facts, but she admitted it was not easy.

Similarly, Hannah, a teacher with a mathematics education master's degree, also tried to describe how her mathematics learning experiences as a student focused on the rote procedures but how her mastery experiences of teaching helped her to learn more about the concepts behind the procedures:

> Looking back, as a kid growing up . . . my focus . . . was on the rote. Learn how to do that step. Learn how to do that process. But now, teaching kids, I really focus on why are we doing it and not just the shortcut or just how the steps come but understanding why. And I think that's been why and kind of cool for me to see . . . reasons behind this. That's why it works. (ST:MM:1I:L1090-1095)

The three teachers described how they had to learn mathematics content in a new way in order to be able to teach it to their students. When they were able to understand and teach the reasoning behind mathematics procedures, their MTSE increased.

Grade Levels

While some of the teachers used teaching to fill in the gaps in their mathematics content knowledge and began to build their MTSE, it seemed as though the teachers' MTSE beliefs depended on their teaching assignments. Three teachers, Amber, Grace, and Michelle, stated that they felt confident because they had taught the same grade level for several years, perhaps due to building mastery experiences in one setting over time. Amber shared her thoughts about the difference in content complexity between the primary and intermediate grades. Amber analyzed how she would feel if she had to start teaching fifth grade instead of second grade:

> It's just not the everyday mathematics that we're teaching in second grade, those basic skills. I mean, so I feel like I probably would be okay once I relearned the formulas and procedures. But I definitely feel like I would spend a lot of time over the summer, probably with a teammate, because I think that'd [fractions] be the area I feel least confident in. (2T:RM:3I:L2583-2585)

Amber expressed her nervous feelings about teaching mathematics in a new grade level. Grace echoed Amber's thoughts when she stated that she felt confident with the content in her first-grade classroom:

> Confidence-wise, I think it's different. Like, I feel confident teaching first-grade mathematics. I don't know how I'd feel about middle school mathematics. . . . I don't know if I can extend that far. I'm not sure if that's because I don't feel confident in my abilities or I'm just so used to teaching first grade now. (1T:RM:3I:L3230-3234)

As Amber and Grace explained their confidence with teaching primary grades, Michelle expressed confidence with teaching the intermediate grades. She asked herself how she would feel if she had to teach a primary grade: "Would I have the mathematics confidence, or would it still take a year to build up to that? I think I'd have to figure it out" (Michelle, 5T:MM:3I:L2940-

2941). Because she taught fifth grade, Michelle explained that she would have to learn primary mathematics content in order to be an effective teacher. Grace, Amber, and Michelle explained how they became confident with the content they were teaching and how it would have been difficult to learn another grade level's content in so much depth. Their MTSE for mathematics content knowledge might change if they taught a different grade.

Leah described how her MTSE decreased with new grade-level content: "If it's a skill I haven't taught before, obviously then I have a lot less confidence" (ST:RM:2I:L2174-2175). She needed more mastery experiences with teaching a new skill before she felt confident with her content knowledge. Leah and Nora had the experience of teaching different grades, and they described how their MTSE decreased. Nora talked about different addition methods: "So, like, the double-digit addition methods that I had to teach this year are unfamiliar to me. And I had to talk to my teammates and be, like, 'This is what it is, right?' Just to confirm" (2T:MM:3I:L3071-3074). Leah and Nora needed to add new mastery experiences in their new grade levels in order to regain their MTSE.

Summary of Teaching Assignment

By having the mastery experiences of teaching students the reasoning behind the mathematics concepts, teachers felt as though the gaps in their content knowledge decreased. Making the transition from student to teacher led to three teachers increasing their mathematics self-efficacy and then their MTSE for content knowledge. However, those mastery experiences seemed to be specific to the grade level the teachers taught. Three teachers reflected on how they believed their MTSE for content knowledge would decrease if they had to change grade levels,

and two teachers expressed that their MTSE decreased when they changed grade levels. Teachers need to have mastery experiences at their new grade levels before becoming fully confident to teach the new content.

Standards

Math Committee

As the teachers began utilizing the Common Core State Standards for Mathematics in their teaching, some of their MTSE for content knowledge changed. Three teachers, including two with mathematics education master's degrees and one with a reading education master's degree, reflected on how being on mathematics committees and writing a district curriculum helped them build their understanding and MTSE for content knowledge. Through these experiences, the teachers said they had the opportunity to discuss the meaning of the CCSSM and build their understanding. When their colleagues verbally persuaded the teachers about the meaning behind the standards, they felt more confident to be able to teach that content to students.

To illustrate this experience, Nora, a teacher with a mathematics education master's degree, explained her experience of writing the kindergarten curriculum while working with her mathematics committee members:

> Our kindergarten team just sat down and kind of threw out everything and just said, "These are the standards. How are we going to teach them? We'll teach these in this month, these in this month." And we went through every lesson. (2T:MM:3I:L2913-2917)

When asked to reflect how that experience of designing the guide to use to teach to the standards impacted her MTSE for instructional methods, she said,

> I feel like that year, I knew my kids were meeting the standards more so than I ever have any other year because that was what we were looking at the standards. And really digging deep, like what did that mean? What kinds of activities? What kinds of skills did the kids have to do to prove that? I definitely felt more confident with the standards in my planning. (Nora, 2T:MM:3I:L2937-2944)

Nora admitted that she felt more confident with the CCSSM after having discussions with her colleagues. Like Nora, Julia also believed her colleagues verbally persuaded her to learn about specific standards, and that helped her design learning pathways specific to her students' needs. Another teacher who reflected on writing a mathematics curriculum was Kris, a teacher with a reading education master's degree. He said mathematics committee participation afforded him the opportunity to investigate many curriculum resources and increase his MTSE for content knowledge. For all three teachers, colleagues verbally persuaded them to understand specific standards from students' points of view.

Questions

Three teachers described how the change from the previous state standards to the CCSSM led to more questions about the content, possibly because they did not have the mastery experiences of using the new standards with students. Two of the three mathematics committee members, Julia and Kris, said they had some questions about the standards being appropriate content for all students. For example, Julia had the opportunity to examine the previous state standards and began questioning the CCSSM content for younger children:

> If we're asking kids in kindergarten to do something that several years ago, we expected from second-graders, well, okay, maybe we can get to there over time. But maybe what we're asking them to do is totally inappropriate considering the developmental ability of kindergarteners. (GT:MM:3I:L2115-2119)

Julia was considering the possibility that she had lower MTSE for some of the standards because they did not seem to match students' needs.

Matching the content to students' needs also became a challenge for Kris. With the new standards, there was different content in each grade level. Kris talked about how the content changed for his fourth-grade students, and this affected his MTSE for content knowledge: "My confidence definitely went down suddenly when . . . [I'm] responsible for all these fraction pieces now because I hadn't taught it before, and I didn't know it" (4T:RM:2I:L1645-1647). Because Kris had to use new content with his students, at first, he did not feel as confident with teaching those new concepts.

Just as Julia and Kris examined the developmental appropriateness for their students, Leah had an experience where one of her students demonstrated that the mathematics content seemed to not be appropriate for the student's needs. The student had a learning disability and had difficulty learning different division strategies and still did not understand, so Leah was faced with a difficult decision about the content: "She was one that I had to push in other ways. Something's not clicking. Something's not breaking through, and it's, like, now we've spent so much time trying. Do I spend the time going back? I don't know" (ST:RM:3I:L3301-3304). Overall, Leah was trying to figure out how to help her students, mostly struggling learners, with the complex content and the mathematical practices. Her MTSE decreased when she had difficulty making the decision about how to match the content to her students' needs.

Summary of Standards

Learning the standards was a source of self-efficacy for the teachers. Three teachers described how their involvement in learning about the standards through mathematics committees and writing a district curriculum increased their MTSE for content knowledge. Their experiences on mathematics committees were sources of verbal persuasion because they had the opportunity to discuss the content standards with colleagues. Three teachers described how their questions about the appropriateness of the specific standards for students decreased their MTSE, perhaps because they needed more mastery experiences of teaching the standards.

Master's Degree Classwork About Content Knowledge

Mathematics Education Master's Degree Classwork About Content Knowledge

All four teachers with mathematics education master's degrees talked about how their mathematics content knowledge, specifically for integrated tasks, increased during their master's degree classes. The master's degree classwork seemed to increase teachers' MTSE through mastery experiences, verbal persuasion, and vicarious experiences. When the teachers became the students trying to complete the integrated tasks, they had mastery experiences that led to increased mathematics self-efficacy. One teacher, Hannah, talked about how her master's degree professors asked the students in the classes to engage in solving mathematics problems in order to experience the problems for themselves before using them with students. When she first started solving one of the problems, she "wanted to go right to a formula" and then realized that

would not be her students' first inclinations (Hannah, ST:MM:2I:L1453). When asked how she felt about the problem-solving experiences in her master's degree classes, Hannah replied, "I liked it because I think I felt like there was so much to learn. . . . I grew up learning the rote skill about how to do that, but . . . here's when you would apply it to real life" (ST:MM:2I:L1579-1581). Hannah's master's degree class was helping her view the content from a new perspective and helped her increase her mathematics self-efficacy.

Learning how to persevere through complex problems also helped Julia increase her mathematics self-efficacy. She expressed how valuable it was for her to have the mastery experiences of completing the integrated tasks:

> But there IS a point in us doing this [completing the problems] because we can experience the challenges that the kids are going to have, and I will often say to my kids when we're, you know, going over a problem of the week, "What did you think about this? Because when I did this problem, this tripped me up." And unless you wrestle with the problem, you don't have that experience to talk to the kids on that level. I mean, you can look at the teacher's guide, you can look at the key, but unless you actually do the problem and go through the thinking, you don't know it as deeply as if you try to do it. (Julia, GT:MM:2I:L1011-1017)

Julia understood the necessity of wrestling with complex mathematics problems and feeling successful when solving them. Those mastery experiences increased her mathematics self-efficacy.

Michelle also echoed the importance of the mastery experiences in problem solving when she said that struggling with the problem in her mathematics education master's degree class also helped her to be more confident:

> I almost always like that because it would make me feel like it was okay to think outside the box. It made me feel it was okay to not be confident with what I was doing, but it made it okay to take the risk. And it made it okay to do it with my students. (5T:MM:2I:L1421-1425)

When Michelle felt it was okay to take a risk, she increased her mathematics self-efficacy for persevering through problems and could understand the importance of students learning to persevere as well. Nora also learned about mathematics problem-solving experiences from a new perspective because she realized she would have to be "vulnerable in solving the equations" (2T:MM:2I:L2098). While she was vulnerable, Nora had mastery experiences of solving the complex problems, so her mathematics self-efficacy increased. The problems were complex, and yet Nora persevered in solving them.

As the four teachers with mathematics education master's degrees worked on the problems, they worked with their peers. Their peers verbally persuaded them to think about other strategies when solving the problems. Hannah said that when she was working with her classmates, she also realized the importance of "knowing that everyone comes from different perspectives," so it was helpful to hear all of the differences in solving the problems (ST:MM:3I:L2885). Nora also learned about her classmates' perspectives: "I was, like, 'I have no idea what you did.' It makes no sense to me, and we'd have to take the time to go through and explain it" (2T:MM:2I:L1527-1529). Nora increased her knowledge when her classmates persuaded her to understand their perspectives, and that gave her confidence for understanding her own students' perspectives when problem solving. Julia and Michelle also reflected on their experiences of learning the mathematics content through their classmates' various perspectives.

In addition to increasing their mathematics self-efficacy, the teachers with mathematics education master's degrees increased their MTSE for content knowledge. The teachers described how two of their master's degree professors demonstrated how to make mathematics content accessible for their students. Watching the professors instruct allowed the teachers to vicariously experience how to teach mathematics in their classrooms. Julia said that one of the important

things she learned was about using the correct terminology with students: "And, they're [some of the terms] little, they're little things, but they're really important because we want kids to be precise when they're talking about mathematics. So I think I learned a lot about how to talk about mathematics" (GT:MM:2I:L1120-1121). Like Julia, Hannah said her mathematics education master's degree professor helped her classmates and her examine the CCSSM and the learning progressions. The professor verbally persuaded his students about the shifts they would have to make in their instruction in order to teach the new mathematics content.

Along with the content standards, Nora said that she learned about the Standards for Mathematical Practice from her master's degree classes as well. She explained that by working on all the integrated tasks, the professor had been using the mathematics practices rather than just describing them. Nora continued,

> I remember thinking that it was very eye-opening, like, we don't talk about them [SMP]. I remember feeling like I'm not doing those things, and those would be so much better. And I think because even before we talked about them as a class, we had been living them. (2T:MM:2I:L1829-1833)

By watching her professor, Nora began feeling more confident to teach her students the SMP in addition to the specific content standards. All four teachers with mathematics education master's degrees were able to have mastery experiences, verbal persuasion, and vicarious experiences that increased their mathematics self-efficacy and MTSE for content knowledge.

Reading Education Master's Degree Classwork About Content Knowledge

Two of the teachers with reading education master's degrees also explained how their master's degree classes assisted them in understanding the CCSSM but did not increase their

MTSE for content knowledge. Kris learned about all the different literary genres and described the impact on his understanding of mathematics content as well. Kris explained:

> The only way they [students] get better is with rigorous practice or rigorous involvement and thinking. That applies to mathematics as well. They can't just say, "Okay, we tried it. Now, we're done." Math had genres, too, if you think about the difference between computation or geometry or measurement. And you think about the Common Core Standards, they're separating them [the domains of geometry, measurement, number and operations in base ten, and number and operations in fractions]. And you could really look at them as genres. (4T:RM:2I:L1417-1422)

By comparing math domains to literary genres, Kris began to understand the importance of how each domain had specific content and also how some of the mathematics content crossed over domains. Therefore, Kris' master's degree classes increased his confidence about being able to understand the CCSSM.

Leah's reading education master's degree class also aided in her understanding of the CCSSM:

> We talked more about how it related to the Common Core and what they're [the CCSSM writers] wanting, and I don't think it's been a surprise that they [the CCSSM writers] want you to teach, or that you're trying to teach kids to adapt to levels higher than what they're reading. You need them [students] to be able to kind of struggle through that and have the stamina to do that. (ST:RM:2I:L1764-1768)

Leah realized that student stamina was important for both literacy and mathematics. Although Kris and Leah did not specifically increase their MTSE in their reading education master's degree classes, they became more confident about their understanding of the standards in general.

Summary of Master's Degree Classwork About Content Knowledge

The master's degree classwork impacted the teachers' MTSE for content knowledge by strengthening their content knowledge as well as preparing them to guide students to success with the Common Core State Standards for Mathematics. The master's degree classwork seemed to be three sources of self-efficacy: mastery experiences, verbal persuasion, and vicarious experiences. All four teachers with mathematics education master's degrees described how their master's degree classwork increased their mathematics self-efficacy and their MTSE for content knowledge while none of the teachers with reading education master's degrees described specific increases or decreases of their MTSE.

Comparison of Teachers' Self-Efficacy Beliefs by Degree Type

The above descriptions about master's degree classwork seems to suggest that the subject-specific degrees influenced the teachers' MTSE for content knowledge. All four teachers with mathematics education master's degrees increased their understanding of mathematics content during their master's degree classes and their MTSE for content knowledge. Although two of the teachers with reading education master's degrees described how they began to have a deeper understanding of all of the new standards, they did not necessarily express how their MTSE for content knowledge directly increased. Within their graduate classes, the teachers with reading education master's degrees did not discuss the Standards for Mathematical Practices or the CCSSM, and therefore the reading classes did not seem to increase their MTSE.

When the teachers were describing their affect towards mathematics, three of the teachers with reading education master's degrees described how their mathematics self-efficacy decreased after they had previously been confident with mathematics content. Two of these teachers, Grace and Kris, described how they were never interested in the subject of mathematics by the end of high school even though they had strong mathematics skills in their elementary school years. They described their feelings about not wanting to take advanced math classes in college. Grace said, "So, I mean, I definitely knew I was not a mathematics person by the time I went to college because I remember saying to my friends, 'Oh, you're a mathematics major? You're crazy.'" (1T:RM:1I:L589-591). Kris described his thoughts about why he did not major in science education because of advanced mathematics classes: "When I got to college, I was, like, 'I don't know if I want to teach science.' You know, there's a lot of mathematics classes you have to take" (4T:RM:1I:L417-418). Because Grace and Kris did not take advanced mathematics classes in their undergraduate or graduate education, they did not have the opportunity to develop more of their mathematics self-efficacy or their MTSE for content knowledge.

The teachers' physiological states were salient sources of their MTSE. The teachers with mathematics education master's degrees and reading education master's degrees experienced similar negative affect at some point during their kindergarten through 12th-grade mathematics classes. Seven of the eight teachers, including all four teachers with reading education master's degrees, remembered feeling frustrated or disconnected with mathematics content. The negative physiological state seemed to decrease the teachers' mathematics self-efficacy. When they became teachers, they had to examine their beliefs and try to become more confident with the content they were teaching.

When developing their mathematics self-efficacy, the teachers with mathematics education master's degrees and reading education master's degrees had similar sources of self-efficacy including mastery experiences (i.e., family), verbal persuasion (i.e., family), vicarious experiences (i.e., family, learning experiences), and physiological state (i.e., family, affect towards mathematics). When it came to the master's degree classwork, the teachers with reading education master's degrees did not have as many discussions about mathematics and therefore did not have as many sources of MTSE as the teachers with mathematics education master's degrees.

Summary of MTSE Beliefs for Content Knowledge

Based on the teachers' descriptions, the most salient source of mathematics self-efficacy for content knowledge was their physiological states. Although Bandura (1997) postulated that mastery experiences were the most salient sources of self-efficacy, the teachers in the present study identified the physiological states they experienced as being even more influential. All eight teachers described times when they felt frustrated, discouraged, or disinterested in the subject of mathematics, even if they performed well on mathematics assignments. These negative feelings impacted their self-efficacy because they did not believe in their abilities, even if their abilities were strong. On the other hand, teachers described mathematics experiences with others (i.e., parents, teachers, and students) in which they felt excited, joyful, and supported. These positive emotions led to increased mathematics self-efficacy.

Three of the four teachers with mathematics education master's degrees had high mathematics self-efficacy before they became teachers and then had high MTSE. Only one

teacher with a reading education master's degree had high mathematics self-efficacy before becoming a teacher, which led to increased MTSE. However, the other three teachers with reading education master's degrees had lower mathematics self-efficacy and lower MTSE than the teachers with mathematics education master's degrees. Bates et al. (2011) had a similar finding: a teacher's mathematics self-efficacy is positively correlated with a teacher's MTSE.

As the teachers began their teaching careers, mastery experiences were another source of MTSE for content knowledge. They described how teaching helped them to learn the mathematics content in a deeper way. In addition, the teachers with mathematics education master's degrees developed more MTSE for content knowledge through their master's degree program experiences compared to the teachers with reading education master's degrees.

The teachers' MTSE for content knowledge was impacted by their mathematics self-efficacy. The teachers' childhood years led to their high or low self-efficacy about understanding mathematics content, which then led to similar feelings about the mathematics content they had to teach. The next chapter focuses on sources of self-efficacy for instructional strategies, which may not be as dependent on the teachers' mathematics self-efficacy as was here in this chapter.

CHAPTER 5

DESCRIPTION AND SOURCES OF MATHEMATICS TEACHING SELF-EFFICACY BELIEFS FOR INSTRUCTIONAL METHODS

This chapter describes the teachers' descriptions of their sources of MTSE for instructional methods. The themes that emerged resulted from experiences when the teachers were students and experiences as inservice teachers.

Mathematics Teaching Self-Efficacy in the Area of Instructional Methods: Participant as Student

The sources of mathematics self-efficacy for instructional methods started with the teachers' experiences in undergraduate mathematics methods classes and in preservice teaching. These experiences as students influenced the teachers' MTSE.

Methods Classes

Students to Teachers

Seven of the teachers described how they felt about their experiences transitioning from learning mathematics as students compared to learning the instructional methods to teach

students. As the teachers were studying to be teachers, four of them described how they developed a deeper understanding of mathematics instructional methods. Both Amber and Kris, two teachers with reading education master's degrees, had vicarious experiences during their college mathematics methods classes. Amber talked about how she learned how to use a specific mathematics manipulative from watching her professor: "I feel like when taking my mathematics [classes], the professor was super excited. [The professor] had a background in some sort of mathematics. Cuisenaire rods" (2T:RM:1I:L640-642). Amber said she had not had experience with using many manipulatives before her college mathematics methods class. By watching her professor use the Cuisenaire rods to explain addition and subtraction, Amber's MTSE for that instructional method increased.

In a similar manner, Kris remembered watching his professor instruct about the meaning of division:

> [I] still won't forget his [the professor's] whole discussion of partition versus divvying up in division and thinking about how do we do this. What do we teach, and what is division? And those concepts, I was, like, "Oh, I've never thought about what division is and what it's being asked to do." And I think that's the experience of a lot of kids, of just doing what they're told and not thinking about the experiences behind it. (4T:RM:1I:L484-489)

Kris was able to watch his professor teaching division and then replicate that instructional method during his preservice field experiences.

Like Amber and Kris, two other teachers with reading education master's degrees had experiences in their undergraduate mathematics methods classes that increased their MTSE. However, their experiences were more mastery experiences designed by their professors than vicarious experiences. Grace's college professor also encouraged his students to think about several ways to use manipulatives to teach mathematics concepts. She said she remembered

thinking, “How am I going to use this to plan this or to teach this?” (Grace, 1T:RM:1I:L731-732). Through repeated planning, Grace started gaining confidence to use concrete manipulatives as an instructional method.

Like Grace described learning with her college professor, Leah described her mastery experience of learning to think flexibly in her mathematics methods class:

> We took five pages to do it because you had to do it in six different ways. And you would have to analyze why you would teach it that way. And what’s another way you can think about it in this way? And I remember it being a really good class. (ST:RM:1I:L940-945)

Leah began to learn that instructing mathematics would require her to think about various ways to solve a problem.

Two teachers with mathematics education master’s degrees, Hannah and Nora, had methods classes that did not increase their knowledge about mathematics instructional methods. They watched their college professors use ineffective instructional methods, which led to vicarious experiences that did not increase their MTSE. Hannah’s professor put all the manipulatives on a table and asked the class what to do with them, and she knew that was not an instructional method she would use as a teacher. Nora had another example of not learning specific mathematics instructional methods. During one of her undergraduate mathematics methods classes for elementary teachers, Nora had a professor who did not help the class learn about mathematics instructional methods because she only used worksheets. Nora said, “She [the mathematics methods professor] brought in a bunch of kindergarten worksheets and said, ‘Okay, look at them. What do you think?’” (2T:MM:1I:L685-690). Nora already knew that she would not use as many worksheets with her students because that did not help them learn the Standards

for Mathematical Practice, such as perseverance, in order to solve problems. Both Hannah and Nora learned how not to instruct mathematics by watching their professors instruct.

Summary of Mathematics Methods Classes

College mathematics methods classes began the cognitive shift in teachers from thinking of mathematics as students to thinking of mathematics as teachers. These classes were sources of MTSE as mastery and vicarious experiences. Pajares (1996) reviewed teacher self-efficacy and found teachers' self-efficacy beliefs are well-established before they enter college. However, in the present study, it seemed the teachers entering college with lower mathematics self-efficacy were more likely to increase their self-efficacy than the teachers who entered with higher mathematics self-efficacy. All four teachers with reading education master's degrees increased their MTSE for instructional methods by thinking about multiple ways to teach a concept and using new instructional methods such as manipulatives. This supports the research by Swars (2005) and Swars et al. (2007) that found that teachers' participation in a mathematics methods class leads to increased MTSE. However, two teachers with mathematics education master's degrees did not experience an increase in MTSE for instructional methods because their college mathematics methods classes did not involve in-depth explanations for how to instruct mathematics to elementary students. Perhaps all four reading teachers were more affected by their college mathematics methods classes because they had entered college with lower mathematics self-efficacy than the teachers with mathematics education master's degrees. Because the two teachers with mathematics education master's degrees began college with higher mathematics self-efficacy, their experiences did not increase or decrease their MTSE.

Preservice Field Experiences

Instructional Methods in Action

When the teachers began their preservice field experiences, one teacher with a reading education master's degree described how the mastery experience of using the mathematics instructional methods increased her MTSE. Amber described her experience:

> I definitely think that [taking mathematics methods classes and doing a practicum at the same time] helped with the confidence because I was applying what I was learning, and I could use it right away instead of thinking, "Oh, when I have my own classroom." (2T:RM:3I:L2921-2923)

Amber was able to immediately apply instructional practices she was learning within her preservice experiences, and this led to her increased confidence.

Preservice experiences also increased MTSE for two more teachers with reading education master's degrees. They described their vicarious experiences of watching their co-operating teachers. Grace learned about the instructional method of using small differentiated groups because she watched her co-operating teacher use them. She remembered all of the students moving around, and she was able to use that experience when she began teaching. Kris also had a vicarious experience while watching his co-operating teacher plan for all possibilities in a lesson. "Because she felt that preparation was incredibly important. . . . Not just the general idea, but having a conceptual framework for knowing what the lesson was going to look like was really important" (Kris, 4T:RM:1I:L560-562). Kris began seeing that the instructional method behind teaching the activity was more important than the actual activity itself and used that to strengthen his planning techniques.

Three of the teachers with reading education master's degrees had experiences that helped them learn instructional methods for teaching mathematics. The fourth teacher with a reading education master's degree, Leah, seemed to have lower MTSE after the mastery experience of teaching mathematics in her preservice student teaching assignment because she did not feel as though she learned about how to apply mathematics instructional methods. The reason was that Leah realized that her philosophy differed greatly from her co-operating teacher's beliefs about teaching mathematics to children with special needs. When I asked why Leah felt she was not successful, she expounded,

> I think because I felt like I wasn't allowed to go off script. And I think I felt like I had to follow, and I think the mentality [was different]. I had a very good teacher. I don't remember her being bad or anything, but I really remember the mentality, or feeling like the mentality was, just present them with some stuff, and they were going to go learn it from that special ed teacher. Like, it's okay that they don't get it. They'll go with him [the special education teacher]. And I remember NOT liking that at all. (ST:RM:1I:L992-997)

Leah reported that her confidence for teaching mathematics at that point was "very low" (ST:RM:1I:L1015). She felt unsuccessful using the instructional method of dividing the students by mathematical ability, even though that was the co-operating teacher's method.

Summary of Preservice Experiences

All four of the teachers with reading education master's degrees described how their preservice experiences increased or decreased their MTSE for instructional methods. The two sources of self-efficacy that emerged were mastery experiences, during preservice experiences, and vicarious experiences, when observing their co-operating teachers. Because the teachers with

reading education master's degrees had not taken a mathematics class since their undergraduate classes, it made sense that they focused more on their preservice experiences compared to the teachers with mathematics education master's degrees. Another possible reason that none of the teachers with mathematics education master's degrees described their preservice experiences in detail may have been because their master's degree experiences were much more memorable than their preservice experiences; therefore, they spent more time during the interviews describing their master's degree classwork.

Mathematics Teaching Self-Efficacy in the Area of Instructional Methods: Participant as Teacher

After becoming an inservice teacher, new sources of MTSE for instructional methods emerged including curriculum resources, school colleagues, instructional coaches and mentors, students' individual experiences, students' group experiences, professional development, and master's degree classwork.

Curriculum Resources

Teaching Manuals

Six of the teachers described how their curriculum resources assisted them in using specific instructional methods. When teachers used their curriculum resources to examine models of effective instructional methods, the resources became sources of indirect modeling. Michelle, Kris, and Julia, two teachers with mathematics education master's degrees and one

teacher with a reading education master's degree, described how their student-centered curriculum resources encouraged them to use discovery-based learning with their students. For example, Michelle mentioned how she used a student-centered curriculum in which the students had to discover rules about fractions. Likewise, Kris described getting students to think flexibly about numbers by using a mental mathematics curriculum: "I think that really illuminates what kids are thinking mathematically. Even if they're easy problems, they [the kids] still tell me a whole lot about what they're doing" (4T:RM:1I:L1111-1112). By allowing the students to discuss their thinking, Kris began to become more confident with focusing on the students. Julia also used a resource that provided engaging student activities in a way that made students think about problem solving so that she could ask them, "Can you solve it? Is it possible to solve it?" (GT:MM:1I:L629-630). The resource led to questions that probed students' deeper thinking. She explained how the curricular resources helped her instruction:

> The thinking is so good. And when you have a good resource, then you can bring something to the table. I can bring something if the kids need extra [practice] . . . because I've got a really good base. I've got a really good foundation with that resource. (Julia, GT:MM:2I:L1172-1775)

By using the resources as models of how to instruct their students, Michelle, Kris, and Julia were able to increase their MTSE.

Amber, Grace, and Hannah, two teachers with reading education master's degrees and one teacher with a mathematics education master's degree, explained how their teaching manuals assisted them in developing their background knowledge about the type of instruction to use with students. Amber explained how the main district curriculum resource helped her to understand "the thinking behind it and the reasoning" behind the mathematics concepts (2T:RM:1I:L764-765). The background information also increased Grace's MTSE:

> I do, like, kind of backwards planning where I . . . look at [a] lesson [to see] what are the standards? What do they [the students] need to do for their homework? What do they need to do to show that knowledge of that standard? And then I kind of go backwards of what's the best way to teach it. (1T:RM:2I:L1971-1972;1973-1976)

Grace's teaching manual allowed her to view what students would truly need to be successful at learning mathematics concepts. All of the teachers except Leah described how the curriculum resources became sources of indirect modeling so they could replicate the instructional methods with their students.

The curriculum's background information also helped Hannah because she could read and understand the mathematics concepts: "I think looking at that, reading up on the background. There's also a part, I think it's on the assessment point. If they [students] struggle with those questions, [it shows you] what to go back and reteach. Looking at that is helpful" (ST:MM:1I:L1038-1041). To have a manual as a reference provided Hannah with the MTSE to reteach some struggling students.

Extra Resources

Four of the teachers, including three teachers with mathematics education master's degrees and one teacher with a reading education master's degree, described how certain mathematics resources seemed to decrease their MTSE for instructional methods. The curriculum resources were sources of indirect modeling, but the teachers believed the models impeded their instruction more than enhanced it. Julia, Michelle, and Nora, three teachers with mathematics education master's degrees, reflected on how they used to follow the curriculum resource as a script in their early years of teaching, but they knew more instructional methods to

vary their current teaching; however, one teacher with a reading education master's degree, Grace, felt as though she still needed to follow the curriculum resource exactly as written. Julia also said that when she first taught, she was told she had to "use a book and to go to this page on this day. . . . It was frustrating" (GT:MM:1I:L762-763). Julia was not the only one who described the feeling of needing to use all of the specific strategies in the resource. Michelle also explained her feelings about how the resource made her feel as though she was supposed to follow each step it outlined, even though it did not include enough problem solving:

> It was like a workbook, and we'd make copies out of it and stuff. That is what it was. But, yea, we always felt like there wasn't enough problem solving. I can't say any of us on the team ever took a risk to add it [problem solving], but it was something we thought was weak. (5T:MM:1I:L1105-1108)

So Michelle and her teammates felt as though they did not have the power or confidence to change the method of instruction. Nora echoed the idea that the manual was to be followed exactly during her first few years of teaching: "I followed what it said and did it. I went through and didn't give it much thought. It was just kind of like, now you read the book and just did that" (2T:MM:1I:L791-794). Although Nora realized that the students did not understand the concept of money when she used the manual's instructional method, she felt she had to do exactly what the manual stated. Michelle, Julia, and Nora were using their teaching manuals like recipe books in which they were trying to follow the steps that were outlined, but it did not feel like they were internalizing the instructional methods.

On the other hand, Grace explained how she still felt the curriculum resource was something to follow exactly: "I still feel like for mathematics, I still can't go much off of the curriculum" (1T:RM:1I:L1226-1227). She went on to explain about how she used a variety of resources in other academic disciplines: "I feel a lot more confident doing that [not looking at the

curriculum materials], whereas I don't try to think outside the box as much with mathematics" (Grace, 1T:RM:1I:L1254-1255). For Grace, it seemed as though using the manual as a recipe book contributed in a negative manner to her MTSE for instructional methods (1T:RM:1I:L 1282).

Summary of Curriculum Resources

The curriculum resources, including teachers' manuals and student workbooks, provided teachers with a source of MTSE for instructional methods. Six of the teachers described how the mathematics curriculum resources acted as sources of indirect modeling and increased their MTSE. Four of the teachers, including three with mathematics education master's degrees and one with a reading education master's degree, described how they tried to replicate the indirect models from their curriculum resources, and doing so led to decreased MTSE. Perhaps this is because the teachers did not feel ownership about the instructional methods, and they were only carrying out the procedures from the resources. It was more about doing what the teacher's manual prescribed than choosing instructional methods that they felt confident using. The teachers with mathematics education master's degrees described how they no longer felt bound by the curriculum resources because they felt more confident about their instructional methods. One teacher with a reading education master's degree did not feel as confident with her instructional methods and still felt she needed to continue to follow the modeled instructional methods from the curriculum resource.

School Colleagues

Learning From Colleagues

All eight of the teachers described in great detail the impact of their colleagues. Seven of the teachers described their mathematics discussions with colleagues as sources of verbal persuasion that increased their MTSE, and one teacher described how an observation by her colleague became a vicarious experience for her. As an example of verbal persuasion, Amber mentioned a specific example of how one of her colleagues helped her learn how to have students prove their mathematical thinking. She explained, "And the conversations we've had as a team and within my classroom this year demonstrate that the proof is [for the students to] just show" they understand how to solve it (Amber, 2T:RM:2I:L2302-2304). Amber's teammates had persuaded her about the importance of having the students show proof to explain their mathematics understanding.

Amber had informal discussions with her colleagues and was verbally persuaded to try new instructional method, but there were also more formal discussions among the teachers and their colleagues. The teachers in the study were involved in different forms of professional learning communities in their schools where time was set aside for the teachers to discuss instructional methods and assessment techniques. However, each school had a unique format and allocated a different amount of time. Some of the teachers wanted more time to collaborate with their colleagues, and some of the teachers felt they had too much time for collaboration. Perhaps this varied based on the agenda of their teams during the professional learning community time. Grace reflected on how her team was beginning to develop more trust and respect in order to

have deeper conversations during professional learning community time about student needs and questioning their own instructional methods:

> It's interesting to have a few teammates that are, like, "Why are you doing that?" and questioning those things. It's been good. I feel like I'm able to have a lot more conversation around what we are doing for these kids that don't get it. Or what. 50 plus 10. What are we going to do for these kids? Just having those conversations that maybe we didn't feel like we could have before. It's coming out more, not as often as we'd like, but it definitely comes around more. And we plan for it, so it's good. (1T:RM:2I:L2113-2120)

Grace knew that the trust and rapport were important in order to believe the verbal persuasion by her teammates about what method to use with students.

While Grace described the importance of developing trust with her team, Hannah had established trust with one of her colleagues, the occupational therapist. Hannah's colleague offered specific suggestions for helping students who had fine motor concerns relating to writing. Because Hannah believed in the colleague's competence, she tried the suggestions and became more confident with them.

Julia also mentioned her colleague's influence. When Julia first learned she was going to be teaching gifted mathematics, one of her school colleagues told her about using partner discussion as an instructional method. Julia reflected about the colleague: "She was so incredibly helpful. She gave me the quick version. 'Do this, have your kids work in partners,' so I just did that. And everything we do is partner work, and I make them talk" (GT:MM:2I:L1315-1317). Because Julia regarded the colleague as extremely knowledgeable, she felt confident to try the partner work and was successful.

Having a knowledgeable colleague with ideas for instructional methods was also something Kris explained. Kris learned from other colleagues: "They say, 'This is what's worked

for me.' So that builds my confidence. If this person can do it, I can do it, too" (4T:RM:3I:L2464-2465). With that statement, Kris was explaining how his colleagues verbally persuade him to try new instructional strategies.

Like Kris being verbally persuaded to try new strategies, Michelle was another teacher who said her professional learning community (including her teammates and instructional coaches) worked well together because they built on each other's strengths and were open to each other's ideas for other methods that would work well for students. Her team shared their thoughts about instructional methods and reflected on their success during the next team meeting. Michelle's colleagues verbally persuaded her to try different instructional methods they had succeeded in using. In order to be verbally persuaded, Michelle's team had worked hard to establish trust and rapport with each other.

Nora also had an experience in which a colleague persuaded her to try an instructional method. She mentioned how she relied on one of the assistants in her classroom: "I mean, I don't think there's anyone in the building more knowledgeable about mathematics" (Nora, 2T:MM:3I:L3842-3843). Nora considered herself as having similar competence as the instructional assistant. When the assistant suggested using an instructional method, Nora immediately tried it.

In addition to the seven teachers who described verbally persuasive comments as increasing their MTSE for instructional methods, Leah said she benefited when she observed colleagues. The observations were vicarious experiences. Because Leah was a special education teacher, she talked about supporting her students in the general education classroom and being able to observe the teachers:

> But they definitely help me because I jump around from all the different grade levels so much. It's really nice to hear how they [the classroom teachers] presented it. And then I can analyze it and try to use their language or their pieces. (ST:RM:3I:L2813-2816)

Leah watched a general education teacher use specific language to explain mathematics concepts, and then she replicated that with her students with special needs. In summary, all eight of the teachers felt as though their colleagues were a source of self-efficacy that increased their MTSE.

Colleagues who Inhibit Growth

While all eight of the teachers described colleagues as sources that increased their MTSE, there were also colleagues who decreased teachers' MTSE. Four of the teachers, including two with mathematics education master's degrees and two with reading education master's degrees, described how their interactions with colleagues led to decreased MTSE for instructional methods. The colleagues verbally persuaded the teachers that their instructional methods were not beneficial to students' success. Amber described one colleague who was "SO knowledgeable" about mathematics and made her feel "less confident in teaching" when they worked together (2T:RM:2I:L1794;1792). Perhaps Amber's colleague was intimidating because she was a mastery model who had more years of experience teaching mathematics, and Amber had lower MTSE before they met. While coteaching a lesson with her colleague, the colleague asked Amber about the purpose of the lesson and the way she was instructing it. The colleague's question made Amber rethink her decision about the main point of the lesson and her choice of instructional methods. She reflected that the colleague's question seemed to bring out her "old

mathematics anxieties" (Amber, 2T:RM:2I:L1897). The colleague seemed to verbally persuade Amber that she was using an incorrect method of teaching the concept, and Amber's MTSE decreased.

Grace also talked about how her team's pacing conversations impacted her MTSE for instructional methods. She said, "I think it's a little bit of pressure I feel with the team with, like, 'What lesson are you on?' which shouldn't really, you know, but there's a little bit of that going on" (Grace, 1T:RM:2I:L1345-1347). Like Grace and Nora who felt the pressure to stay with their team, Julia had teammates with very different teaching philosophies from hers. Julia reluctantly talked about her first teaching experience with colleagues who did not support each other to help the kids: "I didn't get any support from the team. And I tried to do some things that I knew were good, but you know" (GT:MM:1I:L752-757). Julia was explaining how it was difficult to go against her teammates' plans and have high MTSE for choosing her own instructional methods.

Nora had a team who seemed to negatively impact her MTSE because the team did not thoroughly examine the best mathematics instructional methods for teaching. She reflected on planning with her teammates and how they would not discuss the instructional methods for mathematics like they did for reading: "It [reading] required a lot more work to decide, like, if we're going to work on this strategy, pull these resources, pull these worksheets; where with mathematics, it was, like, it was here, you just did it" (Nora, 2T:MM:1I:L781-784). Nora continued to follow the planning of her team by using the book without much thought about the specific instructional methods. She began to think about using guided mathematics groups as an instructional method; however, she was too worried about her colleagues to try it. She explained,

> So I think when I was on the first-grade team, it was still, like, my first 4 years, and I was, like, "Well, I can't say I'm doing guided mathematics" because I think that would have been hard for the team because I think they would have felt, like, "Now what does that mean for us?" Because we literally would plan on Monday, everyone's doing this. On Tuesdays, everyone's doing this. (Nora, 2T:MM:3I:L3458-3463)

Nora continued to have doubts about all of her students learning the concepts, but she did not want to go against her team's decisions. Her teammates' doubts about changing their instructional methods made her question her MTSE.

Summary of School Colleagues

The teachers described their interactions with colleagues as verbal persuasion or vicarious experiences to increase or decrease MTSE for instructional methods. All eight of the teachers explained how their discussions with teammates or observations of colleagues increased their MTSE. The teachers described how their colleagues were very competent with mathematics instructional methods. This corresponds with Bandura's (1997) research on effective modeling because the teachers felt they were similar to their colleagues and could replicate what their colleagues were explaining or demonstrating. Four of the teachers had interactions with colleagues in which there was a lack of trust, rapport, or shared teaching philosophy which led to decreased MTSE. These teachers may have had low self-efficacy about changing their mathematics instructional methods, so the discussions with their colleagues led them to feel even less confident. Bandura (1997) suggested that people will continue their actions when they receive reinforcement for imitation. Several of the teachers thought about altering their instructional methods to better meet the students' needs, but they received verbal reinforcement

from their teammates to continue with the same instructional methods; therefore, they did not alter their methods.

Instructional Coaches and Mentors

Instructional Coaches

A relationship with strong trust and rapport was necessary not only for school colleagues but also for utilizing instructional coaches as a source of MTSE. In the district, there was one instructional coach at each elementary school. All teachers have the choice to work with the instructional coach in order to continue their professional growth opportunities. If a teacher decides to work with the instructional coach, he/she can observe and be observed, reflect on lessons, determine the best way to assess student progress, and plan for ways to meet students' needs. Two teachers with mathematics education master's degrees and two teachers with reading education master's degrees described how their work with instructional coaches increased their MTSE. These experiences became sources of verbal persuasion. For example, Amber talked about how she knew it was important to reach out to other professionals in the building to get different perspectives that would ultimately benefit her students. She said that when working with her instructional coach, she was able to implement a new instructional method of using small groups because the instructional coach "had more of an eye for that. Like teaching it this way or looking at this group for that" (Amber, 2T:RM:1I:L994-995). After working with the instructional coach, Amber was able to successfully continue to implement the mathematics groups.

Kris also talked about how his instructional coach created opportunities for staff members to discuss best research-based instructional methods. Kris said his instructional coach was "always looking to help and provide miniature professional development. Like a lunch bunch . . . or a book group" (4T:RM:3I:L2918-2919). Kris described the professional development sessions his instructional coach held:

> [The instructional coach] brings a bunch of teachers together about a specific topic. This is what we're doing already. Let's see what we can try. Let me hear something from a couple of other classes. Let me explore this part. Let me do it a little bit more. Go try it. Have that safety net of yep, that totally didn't work. What else can I try? (4T:RM:3I:L2926-2929)

Kris felt confident to try new instructional methods after his coach arranged for a forum for colleagues to discuss their ideas with each other. Michelle also implemented a new strategy of using differentiated integrated tasks after working with her instructional coach. To create the lessons, the instructional coach and Michelle planned an integrated task about decimals, "We try to make it as authentic as possible and just think where does that play in, what do we want the outcome to be" (5T:MM:2I:L1644-1646). Michelle's instructional coach was able to help her think about the student outcomes. She explained why she chose to work with her instructional coach: "I'm very much into pushing myself, and if someone's there and has this wealth of knowledge, how do you not tap into that?" (5T:MM:2I:L1606-1607). Michelle said she also pushed herself, with the instructional coach's help, to begin using an instructional method of using learning targets. The instructional coach provided books, articles, and discussion about why learning targets were important, and Michelle learned, "It makes sense to make your objective clear. The kids shouldn't have to guess, 'Wait, let me guess what I'm doing'" (5T:MM:2I:L2238-2239).

Another type of instructional coach in the district was a math specialist; five math specialists worked with teachers on improving mathematics instructional methods and taught students at risk of being unsuccessful with mathematics concepts. Nora talked about coteaching with her mathematics specialist in her fluency groups. She described how her mathematics specialist verbally encouraged her to continue using the successful instructional methods:

> I think, sometimes when you're in the midst of it, it's easy to see that kid's dancing around with cubes right now, and that kid's doing this rather than the 20 kids who are really engaged and having interesting conversations about this. So, [my mathematics specialist makes] sure I'm focusing on those positive things. (Nora, 2T:MM:3I:L2752-2756)

Nora said that by having validation from her very knowledgeable mathematics specialist, it helped her "feel more confident" (2T:MM:3I:L3809).

Mentors

While four of the teachers had experiences with their instructional coaches and mathematics specialists that increased their MTSE for instructional methods, two teachers also described how their mentors verbally persuaded them to use instructional methods. In the school district, mentors were assigned to teachers in their first 2 years of teaching and first year in the district. The mentors assigned to the teachers with 2 years of teaching experience or less were full-time mentors. In the examples below, Michelle was describing this type of mentor. Michelle's mentor was there for her to talk through all of the mathematics planning. Michelle described,

> [My mentor] was just calm and just sat at the back table with me, and he'd be, like, "Let me show you what I'd do. You start with these problems, and by the end, you'll do these

> problems. And you'll start with the fraction circles, and they'll each get two fraction circles." He's showing me all this stuff like how you know what methods [to use]. (5T:MM:1I:L750-754)

Michelle said that one specific instructional method her mentor shared was to "start with those easy questions" (5T:MM:1I:L757). Another tip from Michelle's mentor was to examine student work and look for the meaning behind the students' errors:

> He would make me make piles of got it, like the perfect ones; middle of the road; and the low ones. And then he would always challenge me: "This kid didn't get it. Why do you think he didn't get it?" [My mentor] was always really nice and had those conversations with me, so he started my reflective career. (5T:MM:1I:L883-887)

Because of her mentor's guidance, Michelle not only reflected on student errors but also reflected on which problems to present to students. By planning with her mentor, Michelle began to feel more confident in the instructional methods she was using.

For teachers who moved into the district, there was another type of mentor, a colleague in the same grade level who held a meeting before each trimester in order to clarify upcoming curriculum needs. Grace described how her grade-level mentor, a mentor who had been teaching first grade for years, helped her learn more about how to teach mathematics. When Grace went to the first-grade meetings, she thought, "Whoa, she [the mentor] really knows what she's talking about" (1T:RM:2I:L1488-1489). Grace reflected on what she learned:

> I did not understand number sense. I thought it was automatic. I thought it was, like, everybody had number sense. I couldn't understand why someone would not have number sense. But the more that I learned about it, I'm, like, "Well, of course. Yea. That makes sense." Some kids are missing that number sense. And that's why, you know, 24 plus 8 doesn't make sense. (1T:RM:2I:L1496-1500)

Her grade-level mentor helped Grace learn that students' number sense varies and helped her to become "excited" about how to "meet kids at their level" (1T:RM:2I:L1518;1520).

Summary of Instructional Coaches and Mentors

Instructional coaches and mentors used verbal persuasion to encourage the teachers to consider the best mathematics instructional methods to meet students' needs. These professionals helped increased the teachers' MTSE for instructional methods because they encouraged, motivated, and discussed instructional methods. It seemed as though the teachers with mathematics education master's degrees and the teachers with reading education master's degrees were fairly similar in their description of how their instructional methods improved due to their work with instructional coaches and mentors. The teachers described the processes of attention, retention, production, and motivation that Bandura (1997) described in his social cognitive theory about when people become effective models. The teachers were motivated to seek other professionals to improve their instructional methods. By attending to the models' instructions, asking questions to retain the information, trying out the methods, and then reflecting on how they worked, the teachers increased their MTSE.

Students' Individual Experiences

One of the sources of self-efficacy the teachers described was their mastery experience of teaching mathematics lessons to their students. They described students experiencing success or being engaged in learning mathematics as increasing their MTSE and students experiencing failure or frustration as decreasing their MTSE.

Students' Engagement

Six of the teachers, all four teachers with mathematics education master's degrees and two teachers with reading education master's degrees, described how students who were engaged in their mathematics learning impacted the instructional methods. Hannah simply stated, "Early numeracy and multiplication and division are the ones [mathematics topics] I really enjoy the most. Just because I feel like I can make it more engaging with the students" (ST:MM:2I:L1777-1778). When Hannah's students were engaged, she felt more confident with the instructional methods she chose. Like Hannah, Julia described a time when her students were engaged in an integrated task: "I could give my kids a TOUGH mathematics problem, and I could get high engagement out of them just because I've taught them how to talk and think and work together" (GT:MM:2I:L1804-1806). The students were immersed in their integrated tasks, and Julia realized the students were learning.

Michelle also experienced increased MTSE when her students were engaged in their learning. One of the practices she used was to have her students use homework as their gauge of their learning: "If you [students] attempted [homework] and you circled it, you know that's your question for the next day. So I kind of always liked that because I felt like we were making mathematics less threatening" (Michelle, 5T:MM:1I:L850-852). Michelle wanted her students to interact with the subject of mathematics and feel successful when they were doing their homework. When the students had the opportunities to ask their questions, they engaged in their mathematics learning. Then Michelle felt more confident in her choice of instructional methods.

Like Michelle, Nora reflected on her confidence when the students were engaged and enjoyed their mathematics lessons. Nora talked about how one time, the students enjoyed the

place value unit they were doing: “All the kids are really enjoying it, whether they’re in my highest mathematics group or my lowest mathematics group. They’re all finding something. They’re all making connections. They’re all enjoying what we’re doing” (2T:MM:3I:L3191-3194). Nora continued to teach the student-centered place value unit based on her students’ engagement. When the students in the teachers’ classes were engaged in their mathematics learning, the teachers experienced increased self-efficacy with those instructional methods.

While Nora described her students’ learning during integrated tasks, Grace described using several instructional methods in order to engage her students. She described her students’ mathematics experiences in her classroom:

> But, like, in general, it’s a very positive experience. It’s not memorization. It’s not worksheets. It’s not timed tests. . . . It’s like more of a holistic experience, where there’s music, and there’s movement, and there’s problem solving, and there’s so many components to it that it doesn’t look like one thing. (1T:RM:3I:L2499-2503)

Grace continued to explain why she created the holistic mathematics experiences for her students:

> It should be much more than just a worksheet. So, again, I want it to be such a positive, fun experience where the kids really remember it . . . years later. As much collaborative experiences. As much discovery as possible. I think that’s what’s going to make or break their experience. So I definitely think I teach differently than the way I was taught because I don’t want them to have that neutral experience. (1T:RM:3I:L2913-2918)

By using a variety of instructional methods, Grace was able to engage students with various learning styles in her classroom.

For Grace and the other teachers, engagement was very important to build their MTSE for instructional methods. Representative of the teachers’ experiences, Kris talked about why high engagement was so important to him:

> How do I make it so the kids are going to remember it? Because obviously, I don't remember very much of my elementary school mathematics. . . . How can they get it ingrained into them without feeling like drill and kill because that's never something that I've ever, ever been a fan of is just assigning work for the sake of assigning it. (4T:RM:1I:L671-676)

When Kris created experiences in which the students were engaged in mathematics, his MTSE increased. The students' high levels of engagement confirmed the teachers' choices of instructional methods.

Students' Lack of Engagement

The above descriptions focus on the students' engagement or successful learning experiences. On the other hand, two teachers with mathematics education master's degrees and three teachers with reading education master's degrees described how their MTSE decreased as a result of a lack of student engagement. Hannah believed students should have some struggle, but her confidence waivered when the students started to struggle. Hannah summed up her thoughts about how to instruct when she wanted to encourage productive struggle: "That's hard because it's kind of, like, a fine line. It's, like, are they struggling, but are they still engaged? Are they still working within it? Or are they starting to slip and like they're checking out?" (ST:MM:2I:L2064-2066). When she saw students start to disengage from their learning, she started to question her instructional methods.

Like Hannah, Nora talked about how it was challenging for her when students felt unsuccessful during mathematics. When asked about students who struggled, Nora said, "I wanted to fix it. I wanted to make it easier for them. . . . I wanted them to feel successful"

(2T:MM:1I:L1175-1776). If Nora's students felt like the work was too hard, her MTSE for the instructional methods she was using decreased.

One specific instructional method that Grace and Leah questioned was the use of integrated tasks. Grace described her feelings about what happened when her students attempted integrated tasks:

> They don't like to linger on difficult problems. So getting them to really talk about, getting those conversations out of them, probing them with difficult questions, it's hard for me, too, because I see kids shut down. I see the kids not really want to engage in that. (1T:RM:3I:L2872-2875)

Grace did not see the students engage in the complex problems and began to lose MTSE that the problems were valuable. Like Grace, Leah reflected on students doing integrated tasks and how it was difficult for her to continue to push students if they were not ready:

> So I think a lot of times where I do actually encourage a struggle, or I don't let them give up on themselves. But I do struggle with actually giving things that I know are, I don't want to say that they have no chance of figuring out, but that they haven't figured out what the processes are yet. Or they're not strong enough on the processes to attack it. I think that's sometimes hard. (ST:RM:3I:L2713-2717)

Leah's words reflected her internal battle with knowing when to keep encouraging students to persevere and when to provide support. Amber also talked about her low level of confidence for letting students struggle: "That's hard because you want to help the kids right away. Again, I feel like that's not something that you're taught. You're taught that if they don't know how to do it, you teach them" (2T:RM:2I:L2165-2167).

Students' Success

While student engagement was a source of MTSE, all eight of the teachers also described their students' success with learning mathematics concepts. An instructional method in which students experienced success and the success increased the teachers' MTSE was using integrated tasks. Although Grace described how she was not as confident at first using integrated tasks in her classroom when her students were disengaged, she then had an experience in which she used a challenging task and realized how much the students gained. Grace explained,

> Yea, I thought I would have to guide them [the students] more. I thought I would have to break it down more, but a couple of them really surprised me. And it really made me think, "I should be doing this more often." . . . Maybe I don't have to limit myself to once a unit because they loved it. (1T:RM:2I:L1373-1376)

Although Grace was hesitant to use the task to instruct the mathematics concept, it turned out that the students' success encouraged her to continue to use the task in the future.

Hannah talked about how instructing various computational methods produced student success, "I think my confidence with the alternate methods of multiplication is getting a lot stronger just because I see how it works, and I've seen so many kids be like, "Oooh. That makes sense. I can do this" (ST:MM:3I:L3152-3155). Once Hannah's students understood how the process of multiplication worked, she knew that it was important to teach various methods to approach the problems.

Julia also knew the importance of teaching multiple methods to approach mathematics problems and was able to view her students' success in the future because she had the opportunity to see her students' academic growth while teaching them for 3 years. She used the instructional method of listening with understanding and asking questions if something didn't

make sense. While, at first, the third-graders had difficulty with this skill, by the time they reached fifth grade, they had shown growth. Julia stated, "They're now in fifth grade, and I'm looking at the growth that they have experienced since third grade. It just keeps me going because I realize I remember how bad it was with them" (GT:MM:2I:L1346-1348). She realized how challenging students in a positive manner could produce positive results.

Like Julia, Kris also had a student who demonstrated success, and it increased his MTSE for his instructional strategy of recognizing patterns. Kris expounded,

> One of my biggest successes was a young lady who just didn't do the mathematics and wasn't very careful with it. She just didn't think about the math. So she came to me, and she's, like, "I was thinking about eights last night, and I learned. I realized." And she told me some crazy pattern. . . . The confidence to come in and share that. That self-discovery for mathematics to come in and share that is a success. (4T:RM:2I:L1813-1819)

From examples like that one, Kris felt as though self-discovery was helping his students reach their targets. He explained that it took many experiences in which the students figured out patterns themselves for him to have the confidence in letting the students come to their own conclusions rather than reciting his procedures.

Leah persevered in teaching her students a different method for a standard computation problem. The students told her the mathematics was much easier when she taught it to them. Leah stated, "So I think those pieces [successful student experiences], they are definitely things that made me start to raise my confidence. I feed off kids getting it, so I'm going to keep trying" (ST:RM:1I:L1087-1089). That student success, in turn, convinced her that she was using the appropriate instructional methods.

Leah, like Grace, Hannah, Julia, and Kris, watched her students experience success. However, student success took another form for Amber and Michelle. They described how

students' test scores helped to increase their MTSE for instructional methods. Amber mentioned her students' scores increasing: "I think just seeing the students mastering the skills I was teaching. I think, even though I wasn't confident in my own mathematics abilities, like, my confidence grew because I was able to teach them" (2T:RM:1I:L716-718). Michelle also talked about keeping track of students' scores and seeing growth after using learning targets: "I take the 2 days, and the thing is last year, I had great test results with my IEP [individualized education plan] kids" so "I kind of have some numbers to prove it's [learning targets] going to help" (5T:MM:3I:L3178-3180).

The teachers felt they were using the appropriate instructional methods when their students were experiencing success at learning the mathematics concepts. Representative of all eight teachers, Nora summed up the idea of having students experiencing success. She said that even if there was a lesson that didn't go well,

> I think there was always some glimmer or something like, at least, like, one kid would get it or have some kind of ah-ha, and it was, like, "Okay, how did I, or what worked for him?" because I want everyone, I want everyone to feel that way. (Nora, 2T:MM:2I:L1939-1942)

Nora, like the other seven teachers, had higher MTSE when her students experienced success.

Students' Struggles

All four teachers with reading education master's degrees reflected on mastery experiences when they were unsure which instructional methods to use with struggling mathematics learners. Amber, a teacher with a reading education master's degree, described how she was more confident helping struggling readers as opposed to struggling mathematicians.

Amber described her love of reading impacted her confidence to teach reading and how she knew more about choosing reading instructional methods than mathematics: "But, again, I'm generally more comfortable teaching reading, so I innately had more [instructional methods]. I just innately knew more what to do, if that makes sense" (2T:RM:1I:L970-973). Amber continued to explain,

> I think, yea, I just loved it [reading] myself, so it was easier for me. And I still do, to kind of pinpoint in a student, "Oh, you need to work on this, this, and this." Not because at that time, any formalized training I had ever seen, but it kind of stood out to me, and I could tell that they were struggling with this or that, with their decoding or their fluency or their, um. Where in mathematics, it's not as apparent. (2T:RM:1I:L987-991)

Amber felt more confident in her ability to work with struggling readers and had lower MTSE for instructing students struggling with mathematics. Just as Amber felt higher self-efficacy for teaching reading and lower self-efficacy for teaching mathematics, Grace experienced decreased MTSE when she had difficulty explaining algebra to her first-graders. Grace described her experience with students not understanding the missing addend:

> It's hard for kids to learn. And sometimes, I feel at a loss to kids who don't pick up on it because I feel, like, oh, most kids will just pick up on it. But there are kids who just never do, and I get frustrated because I want to move them further, but they're just missing that. And I don't know outside of, like, grabbing them the counters and hiding something, you know, if there [are] other strategies out there. (1T:RM:2I:L2189-2195)

Grace's confidence in how she taught algebra was affected by her students' struggles. As she looked for different methods to teach, she decided to tell the students the procedure rather than continue to try to develop the concept. Grace said,

> Sometimes it's easier to say, "Just do it this way." You know? And I have to stop myself from doing that because that's not going to necessarily help the child move forward. It's going to teach them how to do something without the number sense to know why. (1T:RM:3I:L2269-2272)

Even though Grace did not want to use the method of telling the student what to do, she did not know what else to do. Grace continued to describe the challenges she faced with pinpointing students' weaknesses in mathematics compared to the confidence she felt with pinpointing students' reading needs:

> I don't feel as confident pinpointing specific weaknesses. Whereas I'm, like, "Oh, that's fluency." . . . Like, I feel like it just comes so quickly to me for reading. And with mathematics, I'm, like, "What is this? What is it that he's not getting?" And it's more like a mystery that I have to solve. Um, yea. And it's just as important, but, um, I, I don't feel like I have as many tools, and I don't feel as confident. (1T:RM:3I:L3102-3107)

Grace even considered obtaining a master's degree in mathematics education in order to gain confidence with various instructional methods: "Maybe if I did take the mathematics master's [degree program]. Maybe I would feel a little more confident. I don't know" (1T:RM:3I:L3251-3252).

Kris described that he felt the pressure to have his students succeed and what happened when he tried to hold a student accountable for the objectives and realized the student was not understanding: "It just made me slow down and realize and reinforce the idea that I have to do a better job, or I have to make sure that kids truly understand our targets and our objectives" (4T:RM:2I:L1891-1893). Not knowing which method to choose to help his students understand the targets decreased his MTSE.

Leah, the fourth teacher with a reading education master's degree described in this section, also experienced low MTSE when assisting students struggling with mathematics. She worked with many students who did not understand the objectives, and she found it difficult to choose when to focus instruction on filling in gaps or when to continue with the grade-level skills. Leah described,

> Every day [it's a challenge]. Do I work on what the class is working on, or do I work on the deficit that I know is there? And how do you bridge those two so they don't fall further behind, but also fill in gaps? (ST:RM:2I:L1262-1264)

Leah's struggle to determine which methods to focus on was a continuous internal dialogue for her. Leah's internal dialogue was similar to that of the other three teachers with reading education master's degrees because they had low MTSE as a result of instructing students with mathematics deficiencies.

Summary of Students' Individual Experiences

The teachers' MTSE for instructional methods increased or decreased depending on the mastery experiences they had with students' engagement and success in learning mathematics as well as students' disengagement and struggles. As the teachers reflected on their early and current teaching experiences, they focused more on student engagement later in their teaching careers, similar to the research conducted by Tschannen-Moran and Woolfolk Hoy (2007). Perhaps novice teachers are focused much more on the task rather than the students' engagement because they are still learning how to balance all the demands of teaching. All eight of the teachers explained how their MTSE increased when students were successful learning mathematics or engaged in the process. The four teachers with reading education master's degrees described how their MTSE decreased when students struggled or were not successful in learning mathematics. Perhaps the teachers with mathematics education master's degrees felt more confident with their knowledge of instructional methods in order to help the struggling learners so the students' unsuccessful experiences did not decrease their MTSE.

Students' Group Experiences

Students have many individual learning experiences, but they also experience learning in groups. The teachers talked about how using small learning groups and student discussion were sources of MTSE for instructional methods.

Successful Differentiated Groups

Three teachers with reading education master's degrees described the mastery experiences of teaching differentiated groups of students. Kris simply stated, "When you do it in a small group, it really is powerful" (4T:RM:3I:L2432-2433). Kris said his confidence was higher when he was able to truly tailor his instructional methods to the students in a group rather than the whole class of students. Amber echoed that she also felt more confident when she worked with students in a small group: "I feel like, if it's a small group, probably more confident, because they're all using the same tool" (2T:RM:2I:L2196-2197). Amber was expressing her confidence about being able to use different instructional methods in a small group when it was more challenging in a whole class.

Grace also reflected on her move from whole-class mathematics instruction to differentiated small groups. Although Grace said it was difficult to begin differentiating her mathematics instruction into small-group learning, she also said she "started seeing the success of it" and "could never go back" (1T:RM:3I:L2821-2822). Using the instructional method of small-group instruction was challenging for Grace, but the successful mastery experiences increased her confidence to continue to use it.

Promoting Student Discussion

In addition, the teachers' MTSE increased when they had mastery experiences in which they promoted student discussion. All four of the teachers with mathematics education master's degrees talked about setting up integrated tasks or mathematics discussions for their students. Hannah said, "It's fun just hearing the students talk about it because there isn't one known right answer. But just to find that. 'How did you know that?' And see if they can go deeper in their justification" (ST:MM:2I:L1751-1753). When Hannah heard her students discussing their mathematics thinking with each other, she experienced increased MTSE. Michelle echoed the idea of students discussing mathematics: "I would say I didn't realize it was mathematics talk at the time, but as I got more confident. . . When I started figuring out, 'Oh, they gain more from talking to each other than me,' I valued that" (5T:MM:1I:L1119-1121). Michelle realized the value of students talking with each other and not just hearing lectures from their teachers. During these student discussions, Michelle promoted the understanding of the Standards for Mathematical Practice. Julia specifically described her high level of confidence in using student discussion to integrate the SMP:

> I mean, everything that I have done since I started teaching gifted math has been nothing but the math practice standards. So, you know, I don't often say "Oh, now we're going to use Math Practice Standard 8, it's just woven into and embedded into everything I do. (GT:MM:2I:L969-972)

Julia embedded the SMP, and the students experienced success, which led to Julia's MTSE to continue embedding the SMP into other mathematics lessons. It was a circular process of Julia using the SMP, students experiencing success, Julia's confidence increasing, and then Julia embedding more of the SMP into her mathematics lessons.

Nora also had the powerful experience of integrating student-led discussion into her instruction. She described her confidence about having the students work on integrated tasks together:

> I feel like they're working in groups, and then we're [the teachers] going around and having a chance to talk to them. And seeing them make connections and work together. I'm, like, this is what mathematics should be like every day. (Nora, 2T:MM:3I:L2704-2707)

While Nora was listening to her students, she realized the student-led discussion helped them develop their mathematics skills. She wanted to find more ways to embed time for student discussion into her mathematics class.

Doubting Student Discussion

All four teachers with mathematics education master's degrees expressed high MTSE for using integrated tasks and student discussions, whereas all four teachers with reading education master's degrees described their uncertainty about these instructional methods because they had mastery experiences where their students were unsuccessful. Amber described how she was "not confident" in the area of using integrated tasks with her students because her team didn't "talk about" them (2T:RM:2I:L1933).

Just as Amber felt unconfident for using integrated tasks, Grace also experienced that feeling. Grace expressed her discomfort. She tried to incorporate more student discussion, even though it was uncomfortable for her at first. She explained her thoughts: "I think I'm so concerned with everybody getting it at the same time, and I know that with mathematics talk

[student discussion], it's not going to happen" (Grace, 1T:RM:3I:L2406-2410). She further explained,

> I still think it's one of the hardest things to prepare for because you don't know where the conversation's going to go, and you don't know exactly where students are at. You might have an idea, but you never know when someone's going to say something brilliant or something that's totally off and you have to redirect them. So I think it's the hardest thing to plan for. You can have a list of questions that you thought of beforehand. It doesn't mean -- I rarely actually use all the questions that I had planned, you know. So I think because it's such a constructive process that it's harder to plan for. But it's exciting, too, because you -- yea. I always feel, like, wow, that was really good when we have those conversations because I feel like somewhere light bulbs went off. Yea. I think with first grade, one of the goals I have for myself is not trying to assume that they don't know it. Trying not to assume that it's going to be too hard because I think I get afraid of frustration. I don't like when kids are frustrated, and kids hate it, you know. They're not used to it. (Grace, 1T:RM:3I:L2370-2383)

Grace wanted to give her students the time to construct their knowledge, but she sometimes felt the pressure of time constraints and making sure students learned all the concepts they needed to learn.

Like Amber and Grace, Kris also expressed his lack of confidence with using integrated tasks. When asked about using inquiry-based learning opportunities for his students, Kris stated, "That's still pretty hard for me" (4T:RM:3I:L1936). Leah had a similar internal struggle about wanting her students to be able to discuss mathematics problems but fighting against the time factor: "I'd say almost all my kids have struggled with collaboration in some way, either because they don't get it or because they don't know how to explain their thinking" (ST:RM:3I:L2733-2735). Many of Leah's students with special needs had communication challenges, and that made it more difficult for her to teach the social skills and mathematics skills at the same time. But it was also Leah's lack of confidence that impacted her choice to try a new instructional method:

> But until you've set up that procedure in your classroom, and until as a teacher, you're comfortable with it, it's a lot of -- You have to kind of be courageous, and you have to be willing to do it. And then, once you do, you can do it more often. And you can incorporate more easily with less effort on your end. But until you do it, it takes a lot of effort, and I think that's scary. (ST:RM:2I:L1825-1828)

Leah was expressing low MTSE for new instructional methods such as allowing more student discussion. While the teachers with reading education master's degrees wanted to use the instructional methods of student discussion or integrated tasks, they did not feel confident with those methods of teaching because their students experienced failure.

Summary of Students' Group Experiences

The teachers described mastery experiences of students working in groups. For three teachers with reading education master's degrees, simply moving from whole-group instruction to small groups was a source of increasing MTSE for instructional methods. This may be because the teachers with reading education master's degrees felt they could differentiate their instruction to better meet their students' needs when the students were in homogeneous-ability groups. They may have also felt they could focus on one instructional method at a time when they were working with students in small groups.

As for using the instructional strategies of integrated tasks and student discussion, all four teachers with mathematics education master's degrees described student success that further increased their MTSE. The four teachers with reading education master's degrees were not as confident to try the more student-centered mathematics instructional methods and described how they were trying to become better equipped to facilitate more quality student discussions. This

finding supports the research of Czerniak (1990) who found that highly self-efficacious teachers were more likely to use student-centered teaching strategies. It also supports the research by Riggs and Enochs (1990) who found that teachers with higher self-efficacy use a wider variety of instructional methods as compared to teachers with lower self-efficacy. Because the teachers with mathematics education master's degrees had higher MTSE, they may have experimented with a wider variety of instructional methods.

Professional Development

Workshops

Teachers described professional development as another source of MTSE for instructional methods through workshops, professional books, and institute days. Three of the teachers mentioned being verbally persuaded by presenters to attempt new instructional methods. Two teachers with reading education master's degrees, Leah and Grace, described how Greg Tang, a renowned mathematics author and speaker, persuaded teachers to use instructional strategies to make students think more deeply about mathematics concepts. Leah said,

> I did see Greg Tang speak. . . And I learned more about subitizing and how important that is because it actually provides structure to what they're [the students] looking at and allows them to see patterns and allows them to organize all those different abstract things. So I think once I heard more affirmation on those massive things that kids NEED, that was kind of what I based my own teaching and curriculum off of. (ST:RM:2I:L1618-1625)

Leah felt affirmed when Greg Tang spoke about assisting students with identifying mathematics patterns. Like Leah, Grace talked about how Greg Tang inspired her. However, she learned a

different instructional method from him: to use more literature in mathematics: “It was totally brand-new to me, but this guy came in and did some professional development on mathematics and literature, Greg Tang, and I just thought that was the greatest idea” (Grace, 1T:RM:3I:L2554-2557). After hearing the idea of integrating literature into mathematics instruction, Grace began seeking appropriate books to connect the two. Because her passion was for reading, his idea helped Grace connect her passion with her mathematics instruction.

Like Grace, Nora heard a presenter discuss an instructional method that matched Nora’s mathematics philosophy. Nora mentioned a mathematics author, Connie Kamii, who presented at one of the national mathematics conferences. Before going to that conference, Nora said, “I had heard about it [differentiated mathematics grouping of students] and wanted to do it, but I did not have the confidence to start it for a while” because “it seemed like so much. . . I was not sure how to manage all of it” (2T:MM:3I:L3423-3424;3428). After going to that conference, Nora said she was able to implement “things about small groups and differentiation” that she had wanted to try (2T:MM:1I:L428-429). Nora’s confidence increased to try a new instructional method after hearing more information from a renowned mathematics author.

Professional Books

One teacher with a mathematics education master’s degree and one teacher with a reading education master’s degree did not go and hear authors present, but they read professional books that increased their MTSE for instructional methods. Reading about other teachers using the methods may have become indirect teaching models for the teachers. Kris talked about one book called *Comprehending Math* by Art Hyde:

> Fantastic book where it takes those reading strategies and really connects it to how we use it in mathematics. I started to do that a lot more in my classroom. You know, building that background knowledge and beginning to think about other subjects or other ways they've used mathematics. . . . All those reading skills transfer over, and then that *Comprehending Math* book kind of solidified it for me. (4T:RM:2I:L1316-1324)

Kris found that book connected mathematics and reading instruction, and it made sense to him. By reading about how Art Hyde made the connections, his confidence to do the same thing increased. Michelle also read a book that assisted her in asking questions to provoke her students' mathematical thinking. She said she learned from the book, "I think what's helped me is just asking the right questions when they're struggling because I never would have thought of that, like, even a year ago. Like, asking the questions and kind of guiding them there" (Michelle, 5T:MM:2I:L2328-2331). Both Kris and Michelle were able to read about how to use an instructional method, increase their MTSE for specific instructional methods, and implement them within their classrooms.

Institute Days

The professional development did not only come from outside authors, but one teacher with a mathematics education master's degree and one teacher with a reading education master's degree mentioned district-sponsored institute days. For Amber, the institute day was a vicarious experience because she had the opportunity to watch presenters describe how to instruct mathematics. She explained how it was helpful that the whole school staff learned together to develop instructional methods to reach the standards:

> There was still a lot of training because a lot of elements were new and then the Common Core edition. I think that helped build my confidence because everyone was at the same

> point that I was. Everyone was learning it. It was new to everyone. So I think that definitely helped me as a teacher because we were all at the same point. (Amber, 2T:RM:1I:L885-889)

Amber's MTSE increased because she listened to the presenters instruct and learned about how to teach her students. Hannah also mentioned an institute day at which she had an experience, however it was a mastery experience, when all staff members were learning together and talking about integrated tasks:

> The one [institute day] I'm thinking about is when we got to practice a task, and it was a task that I hadn't seen previously. So it was kind of like in the moment as a student, and you were kind of trying to solve it. And so, kind of having everyone's different perspective about how they want to tackle it. (ST:MM:3I:L2956-2959)

Because Hannah had the opportunity to solve the problems during the institute days and then plan for student learning, the mastery experience increased her MTSE for using the integrated tasks with her students.

Summary of Professional Development

The teachers described workshops, professional books, and institute days as ways they engaged in professional development. They experienced mastery experiences, verbal persuasion, vicarious experiences, and indirect modeling. The teachers with mathematics education master's degrees and reading education master's degrees were similarly mentioned how these experiences increased their MTSE.

Master's Degree Classwork About Instructional Methods

Mathematics Education Master's Degree Classwork About Instructional Methods

When describing their master's degree class experiences, the teachers reflected on how they learned about instructional methods and how that increased their MTSE. All four teachers with mathematics education master's degrees described their class discussions about integrated tasks. The master's degree classwork seemed to combine mastery experiences and verbal persuasion. Hannah mentioned how she and her mathematics education master's degree classmates would talk about "thinking aloud, talking aloud, hearing the students' thinking, and how that gives you so much insight" (ST:MM:2I:L2055-2057). Hannah also described how she learned new methods for using integrated tasks with struggling students. She and her classmates would attempt to complete an integrated task, and then they would discuss how to help a student through the struggle of attempting such a challenging task. Hannah said the professor would "ask for ideas" and then if she and her classmates did not know which one was the best, he offered some possibilities (ST:MM:2I:L1433). She continued to explain that if she had not had her mathematics education classes, she would "still be that struggling" teacher who was trying to figure out "how else to help or how else to look at the problem or why else is the student struggling" (Hannah, ST:MM:3I:L3367-3368). Hannah had the time to learn about how to use integrated tasks in her classroom so that her students would experience success.

Hannah had the time to learn about how to use integrated tasks, and so did Julia. Julia's MTSE for using integrated tasks increased, but her experience was through verbal persuasion. She described how one of her professors verbally persuaded his master's degree students to use

integrated tasks to demonstrate that all mathematics concepts are interrelated: "Well, all you need is a couple of classes with [professor], and you realize you've got to get some good problems, and you need to know what you're teaching. And you're not just teaching things in isolation" (Julia, GT:MM:2I:L1606-1608). Listening to the professor's discussion about how to choose appropriate integrated tasks increased Julia's confidence that she could select complex problems for her students as well.

Michelle's comments represent the teachers' thinking about the importance of integrated tasks:

> I just think that's more exploratory, more hands-on, more buy-in instead of saying . . . "Okay, guys, we're going to be dividing fractions today." Like, I just think there'd be more authentic buy-in and for those students who they just don't like math, and they're already bringing that into the class, I just think it'd be wonderful if it was messier, like a messier process. (5T:MM:2I:L1681-1685)

Michelle, like the other three teachers with mathematics education master's degrees, wanted to use integrated tasks more often because she believed the students were then more engaged in mathematics work and understood more about how the mathematics concepts worked together.

Nora also reflected on how she had not attempted mathematics integrated tasks before her mathematics education master's degree classes: "It wasn't until my mathematics master's degree that we talked about them, and I remember being, like, 'Oh, I can't wait to do them'" (2T:MM:1I:L1019-1020). After her mathematics education master's degree program, she used "different games" in her teaching to encourage deep mathematical reflection (Nora, 2T:MM:1I:L926). Her mastery experiences of doing the integrated tasks and games increased her confidence in using those methods with her students. All four teachers with mathematics education master's degrees developed increased MTSE for using integrated tasks.

Reading Education Master's Degree Classwork About Instructional Methods

Although Kris and Leah, two teachers with reading education master's degrees, did not spend time in their master's degree classes learning the specific method of using integrated tasks, they used the information from their master's degree classes to address students' reading needs within the discipline of mathematics. Kris described the connection between his reading education master's degree classwork and mathematics instruction:

> And actually, honestly, the reading of mathematics comes into [how] I view how kids read mathematics and interpret mathematics problems, especially word problems, or lengthy situations. . . I really have to analyze a lot of times, am I penalizing kids because it's a reading issue or a mathematics issue? So you have to look at the difference between if that's a reading or a mathematics issue. And my reading master's [degree] helped me be focused on or understand that they might be able to do the mathematics if you say it a different way. The mathematics that's holding them back; sometimes, it's the reading. (4T:RM:2I:L1286-1292)

Kris' reading education master's degree classes assisted him in having the confidence to choose the appropriate instructional methods if students were struggling to learn mathematics concepts because of their reading skills.

Like Kris, Leah also saw the connection between the instructional methods she learned in her reading education master's degree classes and mathematics instruction. She explained,

> Even, like, emphasizing finding evidence in reading, and everything had to be defended. And I think that in mathematics, too. And don't just tell me this is the answer. Tell me why you thought it was. What strategy did you use? How did you do that? And I think those pieces and reasons [of] evidence of what your brain is doing to get it from that to the paper. I think that was emphasized so much in literacy that I carried that over. I kind of simultaneously emphasized that in mathematics, too. So I think that kind of helped. (Leah, ST:RM:2I:L1636-1642)

Leah was describing how she could see the importance of explanations in mathematics and reading. Neither subject should be about only giving the answers; it is about the thinking behind the answers.

Summary of Master's Degree Classwork About Instructional Methods

The mathematics education master's degree classwork increased teachers' MTSE for instructional methods through mastery experiences of doing the integrated tasks themselves as well as verbal persuasion by professors and classmates. All four teachers with mathematics education master's degrees were able to immediately apply the instructional methods they learned in their mathematics education master's degree classes to their classrooms. Although two teachers described how their reading education master's degree classes assisted them in improving their mathematics instruction, their MTSE for specific instructional methods did not seem to increase as much as the teachers with mathematics education master's degrees.

Comparison of Teachers' Self-Efficacy Beliefs by Degree Type

With regard to MTSE for instructional methods, there were a few differences in the teachers' self-efficacy and sources of that self-efficacy. Curriculum resources were indirect models, and the teachers with mathematics education master's degrees seemed to use the curriculum resources more as resources than scripts to be followed. Verbal persuasion by teammates, school colleagues, instructional coaches, and mentors seemed to be equally important

across teachers with mathematics education master's degrees and reading education master's degrees.

All four teachers with mathematics education master's degrees expressed increased MTSE when they had mastery experiences of students experiencing engagement and success. All four teachers with reading education master's degrees had decreased MTSE when they had mastery experiences of students experiencing disengagement and struggles. Because the teachers with mathematics education master's degrees had more mastery experiences and verbal persuasion during their master's degree classwork about research-based instructional methods, their confidence seemed to help them experience more successful student learning. In addition, the students' struggles did not seem to decrease their self-efficacy. Perhaps the teachers with mathematics education master's degrees had high MTSE that remained high because they felt they had instructional methods to increase the students' success.

Summary of MTSE Beliefs for Instructional Methods

The most salient source of MTSE for instructional methods seemed to be verbal persuasion. The teachers' professors and colleagues verbally persuaded them to use or not use specific instructional methods. Bandura (1997) theorized that people could become sources of verbal persuasion when they were credible and trustworthy, and the present study's teachers described the importance of these qualities in their colleagues and professors. The mathematics education master's degree professors persuaded the teachers about instructional strategies to use when students struggled. This finding supported the study conducted by Tschannen-Moran et al.

(1998) that found that verbal persuasion includes specific strategy suggestions for overcoming student struggles.

While teachers described different types of mastery experiences for their MTSE for instructional methods, verbal persuasion seemed to be the most salient. In the next chapter, mastery experiences seemed to be the most salient source of self-efficacy for assessment techniques.

CHAPTER 6

DESCRIPTION AND SOURCES OF MATHEMATICS TEACHING SELF-EFFICACY BELIEFS FOR ASSESSMENT TECHNIQUES

This chapter describes the teachers' descriptions of their sources of MTSE for assessment techniques. The themes that emerged resulted from the teachers' experiences as students and as inservice teachers. The teachers' sources of MTSE for assessment techniques emerged in narratives surrounding four themes: standardized assessments, district assessments, formative assessments, and master's degree classwork.

Mathematics Teaching Self-Efficacy in the Area of Assessment Techniques: Participant as Teacher

Standardized Assessments

Past Test Anxiety

MTSE for using standardized assessments may have started for two teachers with their physiological states when they were students taking standardized assessments. One teacher with a mathematics education master's degree and one teacher with a reading education master's degree described the anxiety they experienced, and that seemed to decrease their MTSE for using

standardized assessments with their students. For example, Amber expressed her sense of failure when taking the American College Test (ACT) in high school. She explained her experience: "I was very, even, like, on the ACT, VERY stressed on the mathematics part because I knew I had to do well, and, um, just not knowing how I would do" (Amber, 2T:RM:1I:L546-547). She said that she tried to take the ACT several times to improve her mathematics score, but her "score got worse every single time" (Amber, 2T:RM:3I:L3027). Amber's experiences decreased her MTSE, and she explained how she then questioned the use of standardized assessments with her students.

During the school year of this study, the state standardized assessment was being changed to the Partnership for Assessment of Readiness for College and Careers (2014) assessment, so Amber reflected on using the new computer-adapted test: "I guess it would be hard to say if I would be confident in their ability because I'm not confident in their computer skills and their ability to navigate" (2T:RM:3I:L3262-3264). She questioned the validity of the results from the test.

Just as Amber's experiences as a student taking standardized tests impacted her MTSE for giving her students standardized assessments, Michelle also described how her anxiety impacted her MTSE. Michelle reflected on her anxiety when taking mathematics tests as a student:

> My parents always said they saw, like, a disconnect between the homework and the test. So they were always wondering . . . [if I had] some sort of testing anxiety type of thing. And, I was just, like, "I just get so anxious because I don't know." I understood the homework, but then it was, like, turning it into the test. (5T:MM:1I:L232-236)

Michelle remembered her testing anxiety when she was a teacher and had the opportunity to practice a PARCC test. She described her feelings:

> When I'm sitting there doing that test, it, like, all came back to us [her teammates and her]. Our hearts started racing, and it -- I'm, like, second-guessing everything I did. I wrote everything down. It was a mess, and you know, my attention was, like, "Oh, my gosh. There's so much to read on this page for mathematics. I don't want to do it." (Michelle, 5T:MM:2I:L1919-1922)

Michelle's experience of taking the practice PARCC test made her feel the same anxiety she felt when she took standardized tests as a student. After experiencing her own stress while taking the test, Michelle explained how she felt about using the test with her students:

> I'm always worried. I'm a perfectionist, and, like, I'm always worried that it won't. It's just that it's not transferring, and I'm willing to change whatever I need to change as long as it's realistic. And I can't teach to a PARCC test. There's just that. So my anxiety would be in that area. (5T:MM:2I:L1928-1931)

Michelle was worried that her students would have anxiety about the PARCC tests as she did as a student. She did not want their anxiety to influence their performances.

Tests Differ From Instruction

Three teachers with mathematics education master's degrees described the use of the previous state standardized tests and how the tests made them doubt their mathematics teaching confidence. These were experiences of preparing for the assessments and modifying instruction, which made the teachers feel like they were failing their students. The pressure of tests came from many sources, such as administrators. Julia talked about how administrators told her to stop instruction on mathematics concepts and teach test skills immediately before the state standardized test. Julia reflected on how she felt about the mathematics test preparation: "I just

felt like it was all wrong that we were preparing and teaching to a test. It was just dismal. Everything about it was dismal" (GT:MM:1I:L774-775).

Another teacher who talked about preparing for the state test was Michelle. She explained,

> I remember you would, like, pull out the old state test book. We would -- This is what my team did. We would, like, pull out some of the first multiple choice ones and just add that in for a month or whatever, and then we would add in the short answer. And then [we] gave into the extended response. And I remember I struggled with that, and that was the first thing I think I was brave enough to question. (Michelle, 5T:MM:1I:L1216-1223)

Michelle seemed concerned by the test preparation as well as the format of the test.

Hannah also reflected on how the format of the previous state standardized test was so different than the mathematics instruction the students received. She explained how some of her students were so confused about the state tests because they were allowed to use calculators when they did not use them in class: "I had some kids that were adamant that they could do -- I think it was, like, fractions or something. We never used the fraction button [on the calculator]" (Hannah, ST:MM:3I:L3348-3349). Because the standardized test was different from district assessments, Hannah was confused as to the best way to prepare her students. Hannah, like Julia and Michelle, saw the disconnection between the standardized tests and the content being taught in their classrooms. This disconnection led to decreased MTSE.

Students' Poor Test Scores

Two teachers with mathematics education master's degrees and one teacher with a reading education master's degree described how the students' poor performances on

standardized tests led them to question the validity of the assessment and their confidence in preparing the students to meet the assessment demands. These experiences of analyzing the students' low test scores led to decreased MTSE. Hannah reflected on whether one of the standardized assessments was valid due to the mathematics content in the classrooms being different than what was reflected on the test:

> Maybe half to a third of these questions really match what's happening in the grade level at that time. So should we be using that measure? Like, so I think just that frustration of what tool should I be using to assess and to get my data? You know, this is my tool. Does it really make sense? (ST:MM:3I:L2847-2851)

Because the tool did not match the content the students were learning, Hannah was not sure how to interpret the data.

Like Hannah, Leah experienced decreased MTSE for using standardized assessments to measure student learning because her students would sometimes not demonstrate growth. Leah said that when students would not perform well on the state standardized tests, she felt like "a failure" (ST:RM:3I:L3279). She went on to explain that if she modified her instruction, other skills would appear as weak on the standardized assessments:

> I would see, like, the discrepancy or the other skills that the classroom was hitting that I didn't really touch. . . . So then, like, I would incorporate that, but then if I would incorporate that too soon, I would see decline in what I just taught them and, like, the progress I had just made because I went away from my repetition. (Leah, ST:RM:2I:L1241-1247)

Leah felt as though the standardized assessments were moving targets, and she could not continue to try to teach to the test. These moving targets made her question the use of the standardized assessments.

The moving targets made another teacher, Michelle, question the standardized assessments. Michelle described the state test results: "With the state tests, when we didn't make our yearly growth, it kind of labeled the school, and that was heart-wrenching because you know we were working hard" (5T:MM:3I:L3313-3316). Michelle did not feel as though the tests represented her students' true skills, so her MTSE decreased for using the standardized assessments. Hannah, Leah, and Michelle experienced decreased MTSE for giving standardized assessments because they questioned tests' validity.

Summary of Standardized Assessments

Not one teacher commented about the standardized assessments being a source that increased their MTSE for assessment techniques. Two of the teachers described how their previous test-anxiety affect negatively impacted their MTSE. The teachers questioned the format, the validity of the questions, and the negative student results. Those questions seemed to become mastery experiences that decreased their MTSE.

District Assessments

The district mathematics committee, composed of teachers representing each grade level, created district assessments that were given to all students. For example, the second-grade mathematics committee team created summative assessments to be given at specific times to all second-graders across the district. By giving these assessments, there were some teachers who

felt the district assessments provided important information and others who questioned their validity.

Informing Instruction

One teacher with a mathematics education master's degree and two teachers with reading education master's degrees described how using the district information provided them with the summative information they needed about their students. These were mastery experiences because the teachers were finding success in being able to use the assessments to inform their instruction. For example, Hannah talked about how the district assessments assisted teachers in determining evidence of student thinking:

> I think the teachers have been really good at pulling out a district assessment and saying, "We have evidence." You know, "Here's the evidence," and also talking about . . . [the students'] errors. Was the error with the division or the subtraction? (ST:MM:3I:L2827-2830)

The district assessments led to discussions about error analysis, and being able to analyze the errors helped Hannah increase her confidence for accurately assessing students. Kris also described his mastery experience of being able to use the district assessments to assign mathematics grades to his students. Kris said, "Oh, I'm fairly confident in it. I think our district assessments give me the summative information that I need because they do target what we're supposed to be teaching those kids" (4T:RM:2I:L2166-2168). Kris was also confident in using district assessments because he felt they increased his knowledge of his students' mathematical understanding.

Like Kris, Leah said she used the district assessments to plan for her student learning.

She explained how she worked backwards to decide which parts to explain to the students:

> I've tried to look at assessments, and what actually is going to be on the test, and what skills are they going to need. And what is a method I think they are actually going to be able to get there. (Leah, ST:RM:2I:L2113-2116)

For Leah, the district assessments accurately measured the students' progress towards the CCSSM, so she experienced increased MTSE for using them. Hannah, Kris, and Leah were confident in using the district assessments to measure their students' growth and areas for future instruction.

Accommodations for Students

Both of the special education teachers described the challenges of giving the district assessments to students who struggled. These experiences of their students underperforming seemed to lead to decreased MTSE. Leah talked about how the district mathematics assessments presented challenges for her students who needed accommodations:

> [The student's] making mistakes on the writing portion, not on the mathematics portion. So for her, just that accommodation [of using manipulatives] showed that she does have a lot of that [mathematics] sense. But when you ask her straight out or you ask her to write it out, she'd still make a lot more mistakes because it has a lot more mental processes to it. (ST:RM:3I:L2914-2918)

Leah was explaining how her student could not fully demonstrate her knowledge through one format such as the district assessment. Hannah added more information about the experience of trying to modify the test to make it relevant for her students with special needs. She said,

> Now that we have those district assessments, we e-mailed to the district at the beginning of the year and said these are rich, these are meaty, these are above several kids' heads. Can we modify it? You know, it's a district assessment. Can we modify it? The answer is

> nope. "You can provide accommodations like read it out loud, [give] extended time, but we need these scores." Which was hard because we knew the students struggled so much. (Hannah, ST:MM:2I:L2315-2321)

Leah and Hannah both had doubts about the district assessment expectations and the students' true mathematical knowledge. They wanted to ensure that the students had fair opportunities to show that knowledge.

Assessment Windows

In addition to making accommodations to the district assessments, three teachers with mathematics education master's degrees and two teachers with reading education master's degrees discussed how the district assessments were a source of anxiety, a physiological response that lowered their MTSE. During the school year in which this study took place, the district had established assessment windows, a period of days that all grade-level teachers had in which to give the district assessments. Amber reflected on how the assessment windows impacted her instruction: "They [assessment windows] shouldn't drive instruction, but I feel like they do. If they close and you don't have anything scanned, you're out of luck" (2T:RM:2I:L2016-2017). The assessment windows were making Amber questioned her confidence in the instructional path she had arranged to meet the standards.

Grace described how she would feel if there were no district assessments: "That would be my dream" because "then I feel like I'd have the freedom to teach them what they really need" (1T:RM:2I:L2315;2319). One of the reasons Grace said she felt this way was because she was

trying to differentiate to meet all of her students' needs; however, she did not feel that giving the same assessment to all students was true differentiation. Grace said,

> I don't feel like it's true differentiation when, in the end, it's the same assessment and it's the same expectation for everyone. You know, because then there will always be kids with gaps, and there will always be kids who hate mathematics. (1T:RM:2I:L2332-2335)

The assessment windows caused Grace to feel less confident in using the district assessments to measure students' progress because the students were all at different levels, but they had to take the same test. For example, if a student had already mastered the concepts on the district assessment, there was not another assessment that could measure additional growth.

The district assessment windows also decreased teachers' confidence because the growth that was being measured may have been more procedural than conceptual. Three teachers with mathematics education master's degrees, Hannah, Michelle, and Nora, described how their instruction changed to match the assessment windows. Nora felt bound by the assessment windows and talked about rushing students' learning: "We had to finish the unit because of the assessment window. We had to have all of our tests scanned in. It was hard. It was hard to get it all in" (2T:MM:3I:L2970-2971). The pressure of conducting the assessments also made Hannah experience decreased MTSE:

> That's where I struggle because you know the district assessment is x number of days away, and you have to get through all of this so that they will have seen it, but you know you're just flying through it. And they're kind of, like, "Oh, okay." So it's hard. Do you slow it down but then make them sit through something you've not gotten to? Or do you say, "Let's slow it down. Let's have you gain your skills in this area." You know, because they're a child, because when they sit down to a test, they're going to be, like, "Oh, it's a test I have to do. I have to get it right. I don't understand it. Why don't I understand it?" (ST:MM:3I:L2598-2605)

When Hannah knew she had to administer the district assessments, she began to teach the concepts quickly so the students would be exposed to them before taking the test. However, this made Hannah question the assessment and the instruction needed to take it.

Like Hannah, Michelle also changed her instruction to meet the demands of the district assessments after she had a battle within herself about teaching mathematical concepts versus teaching procedures:

> I value so much the concept. It's just myself. I just beat myself over it, but it's the constant. I know that if they understand the concept, it will stick longer than if I teach a one, two, three, and they'll get through a test. So it's like, I know for the better good, I need to stay with the concept. (5T:MM:2I:L1962-1965)

While Michelle realized that deeper learning about the mathematics concepts was her preferred way to teach, she sometimes taught the procedure explicitly when she felt the anxiety of the assessment window approaching.

Summary of District Assessments

Three teachers described how the district assessments were mastery experiences because they were able to use the assessments to understand students' learning needs. However, both special education teachers reflected decreased MTSE for giving the district assessments because the tests did not always accommodate students with special needs. Five of the teachers, including three teachers with mathematics education master's degrees, described the physiological feeling of anxiety they experienced when they needed to complete the district assessments by a specific time.

Formative Assessments

Seven of the teachers mentioned how using formative assessments strengthened their MTSE to elicit students' true mathematical knowledge. The teachers' experiences seemed to be mastery experiences in which they were in control of choosing the assessment techniques, creating the assessments, and determining how to use the assessments to plan for instruction. Two formative assessments that were mentioned as increasing MTSE were pretests and exit slips.

Pretests

One example of a formative assessment technique that two teachers with mathematics education master's degrees and two teachers with reading education master's degrees mentioned as increasing their MTSE was pretesting students to determine levels of knowledge before beginning instruction. Amber implemented mathematics pretests because she made it an evaluation goal for herself. She stated that she learned the value of pretests, "It really proved the importance of the pre and the post and how valuable that can be if it's used correctly" (Amber, 2T:RM:2I:L1321-1323). Kris also described his experience with pretesting students: "So I believe heartily in pretesting kids to see what they already know. And if they already know it, I don't have to teach it again. They've proven it to me" (4T:RM:2I:L1650-1652). He further described how pretesting led to accurate informal assessments:

> I do a lot of informal assessments. Are they getting it? Are they paying attention? Can they explain it? That's not necessarily formal. It's informal, but it's informal to the nth degree. . . . But because I feel like I know who the kids are when we start a unit or when

> we're doing something, I can pretty quickly see who gets it and who doesn't [get] it. (Kris, 4T:RM:2I:L2092-2096)

Kris said the mastery experience of giving the pretests and posttests to students improved his confidence for that assessment technique because he could show his students' their growth.

Nora also talked about how creating her own formative pretests increased her MTSE for assessment. She and her mathematics specialist worked together: "We're just creating preassessments, so . . . we're looking through the book and the postassessment, what do we want them to learn? What do we want to see if they already know?" (Nora, 2T:MM:3I:L2835-2837). Nora was able to create a formative assessment that was going to give her the information she wanted to know about her students.

Just as Nora chose to create pretests, Hannah used pretests and posttests to show student growth. Hannah described her experience: "I remember [the students] journaling and looking through the journals," and noticing how much better the students were able to articulate their mathematical thinking (ST:MM:1I:L918-919). Giving the pretest helped Hannah strengthen her confidence in using that assessment technique as an accurate measure of students' strengths and weaknesses.

The teachers became more confident about the pretests and also were better able to see their students' growth by comparing pretests and posttests. These mastery experiences served to increase the teachers' MTSE.

Exit Slips

Another informal assessment technique that two teachers with mathematics education master's degrees and one teacher with a reading education master's degree mentioned was exit slips. Exit slips are short assessments given at the end of lessons to evaluate the students' understanding of the lessons.

For example, Amber used exit slips to plan for her small group instruction. She and her teammate worked together to create the exit slips for every lesson. She said, "having someone else to talk about those exit slips with and to have common ones between everyone at the grade, I think, has been really helpful, so we're able to really pinpoint what our kids need grade-level wise" (Amber, 2T:RM:1I:L1085-1087).

Michelle also mentioned using exit slips to assess students' strengths and weaknesses. She said she learned about using the exit slips by taking an assessment class at a local college. After taking the class, Michelle worked to create exit slips for every lesson. She explained what she learned:

> I've learned I don't want just one problem to show it. I want the formative [assessment] to be almost as rigorous as I need it to be. I think I, in the past, and my teammates in the past, we've both made it too easy. "What's 40 x 50? Let's go. Oh, they got it. Hallelujah!" Because, like when we're doing it this year, we're re-evaluating the formatives we had from last year, and we changed some. (Michelle, 5T:MM:3I:L3208-3214)

By continuing to create the exit slips and then revising them, Michelle's confidence for assessing her students seemed to increase. Like Michelle, Nora's confidence also increased when she used exit slips. Nora explained how the exit slips gave her important information about her students' needs: "I do an exit slip almost every lesson that tells me a lot of information and helps me do

my groupings in those small groups" (2T:MM:3I:L3783-3785). The exit slips provided Nora, and the other teachers, with accurate information about their students. Perhaps because the teachers could control the use of the exit slips and their content, they experienced increased MTSE.

Challenges with Formative Assessments

Although the teachers above explained how they felt confident in assessing students' needs, two teachers described how they did not feel comfortable using formative assessments to determine students' needs due to their lack of mastery experiences. Grace said, "So maybe that's where I don't feel as comfortable. I don't feel as comfortable diagnosing students, like. exactly pinpointing what they don't have" (1T:RM:2I:L2248-2250). She was searching for specific assessment techniques to be able to pinpoint students' mathematics needs. Like Grace, Kris also talked about his challenging experience in assessing students' written mathematical communication:

> Especially when I've gotten later in my teaching [career], I've struggled with assessing written work in mathematics. . . . [The state test], even though it is on its way out, we still have that reflective piece [of communicating about mathematics thinking in an assessment]. And I think it's a very integral piece because I actually think it's more important than some of the other things we do. But not that, not only did you get the answer, but did you explain it adequately? I've never felt super confident on those middle kids, not necessarily. I know when they don't get it, and I know when they really, really get it. But am I assessing their writing, or am I assessing their mathematical ability? It's that mathematical communication piece that's really challenging for a lot of kids. So that's one that I always struggle with. (4T:RM:1I:L808-817)

Kris' experience examining his fourth-graders' written mathematical communication led him to doubt his confidence in being able to accurately determine his students' quality of mathematics work.

Summary of Formative Assessments

By creating, implementing, and revising their formative assessments including pretests, quizzes, and exit slips, seven of the teachers reflected on how those assessment techniques increased their MTSE. These experiences were mastery experiences for the teachers. However, two teachers with reading education master's degrees had doubts about the type of information they were assessing in order to determine students' mathematical needs. Perhaps the teachers with reading education master's degrees did not feel as confident with formative assessments because they did not learn about specific mathematics formative assessments within their master's degree classwork. Another reason for their low MTSE with formative assessments may have been because they did not have as many mastery experiences with giving the formative assessments.

Master's Degree Classwork About Assessment Techniques

Teachers with mathematics education master's degrees and reading education master's degrees described how their master's degree classes assisted them in developing a deeper understanding of how to assess students and use the data to make instructional decisions. These

experiences became mastery experiences, verbal persuasion, and vicarious experiences sources of self-efficacy.

Mathematics Education Master's Degree Classwork About Assessment Techniques

Two of the teachers with mathematics education master's degrees described how their master's degree classwork and conversations about assessments increased their MTSE. Hannah remembered that two of her mathematics education master's degree professors explained their beliefs about assessment:

> Both [of the professors] have the perspective of, an assessment shouldn't just be at the end, but it should be a tool that you can use as your next step. Because they were, like, "Oh, if it's at the end of the unit, and the student flunks, what are you going to do with that? Just move on, or are you going to do something ahead of time to make sure you know where your student is, to better gauge where your student is, and know where your student's learning should go?" (ST:MM:2I:L1695-1701)

The professors seemed to verbally persuade Hannah to use formative assessments more often in class. In order to determine how to use the assessments to make instructional decisions, Hannah's professors encouraged her classmates and her to discuss their ideas with each other, so she gained a deeper understanding of how to effectively use assessments.

Nora's professor and classmates also verbally persuaded her about the importance of informal assessments. Nora reflected on her experience of learning about students' mathematical thinking after her master's degree professor gave an assignment to conduct the informal assessments: "One of the assignments in those early numeracy classes was to give this early numeracy assessment, and that was definitely an interesting experience because it was like an

hour-long assessment. It was intensive" (2T:MM:2I:L1679-1682). Then, Nora also had the opportunity to discuss her assessment results with a classmate and reflect on next steps:

> But it was really important in giving that assessment, being able to level students and talk about now they're at this level, what do I do to get them to the next level? And we had some really good conversations about that, both about how that was really important and insightful about students who we had preconceptions about. Like, oh, I think the student is a really good math student, or a struggling math student, or my middle-of-the-road math student, and, like, giving this really in-depth math assessment. We found interesting holes or strengths. That was a really eye-opening experience. (2T:MM:2I:L1691-1699)

Nora's reflection on her assessment experience made her examine her preconceived notions about what kids could do and realize their true mathematics thinking after conducting the informal assessments.

Nora also had a vicarious experience of self-modeling by watching a video of herself conduct informal assessments. She said that videotaping herself giving the assessment was an important part of her learning process:

> You had to turn in the video of you giving the assessment . . . with the assessment and your write-up about where the child was. How do you know that? What are your next steps? And it was very stressful, like, okay, I am on videotape, and I have to make sure I say everything right and do everything right. And, like, I'd take all the right notes, so that was a little stressful the first time. Then we gave a second one, and I remember then, I focused more on, like, my conversation with the student, trying to ignore that, because there was so much great data and like really trying to focus. (Nora, 2T:MM:2I:L1715-1722)

Both Hannah and Nora used their verbal persuasion and vicarious experience to increase their MTSE for giving informal mathematics assessments.

Reading Education Master's Degree Classwork About Assessment Techniques

Two of the teachers with reading education master's degrees talked about the discussions they had during their master's degree classes about the purpose of assessments. Even though Grace took her master's degree classes in reading education, she described how some of the information she learned about assessment techniques transferred to the other academic disciplines:

> I guess, going back to that assessment class, I do feel, like, in every subject, we've been asked to conduct more assessments, and I definitely feel more comfortable doing that, even in terms of mathematics, as a holistic experience. And it's not just calculating, it's not just problem solving, it's not just math talk. It's being able to take all those pieces of data and being able to, you know, form my comprehensive view of that learner. So I just feel like that helped me kind of think of learners in that way. (1T:RM:2I:L1942-1948)

Grace's mastery experiences of giving assessments and analyzing the data increased her MTSE. After describing assessment purposes, Grace also had to conduct the assessments and do case studies. She described how she had to study a great deal before doing a scripted assessment called the Basic Reading Inventory (BRI):

> I didn't feel comfortable, like it was part of me. But then, towards the end, I felt, like, "Oh my gosh, I can see the triangulation of data, and, like, it's all making sense, and it is useful." Um, so, yea, I definitely feel like that was a very USEFUL class. And although we don't use some of those assessments, I still feel like it was good information, and I feel like it's helped me in terms of now assessing my students, taking formative data. I feel like I'm able to do that. (Grace, 1T:RM:2I:L1760-1771)

Amber also described the mastery experience of tutoring and doing a case study as a part of her reading education master's degree requirements:

> I mean, I think it definitely made me feel more . . . confident. . . . Because I was actually having to decide what assessment to administer once I saw where they [the students she was tutoring], what area they were deficient in. Then it was up to me, once you, you

> know, give the one assessment, and you can see, "Okay, here's the gaps here, here, and here." So then, let's pull [decide on] this assessment with my professor. (2T:RM:2I:L1406-1411)

Tutoring the student during the class time and being able to reflect on the assessments with the professor before or after the tutoring sessions seemed to impact Amber's confidence with selecting the most beneficial assessments to obtain the whole picture of the student's needs. Amber later reflected that the case study experience in her reading education master's degree class "really helped" her "critically look and examine and think more about what data" she was collecting, even when giving mathematics assessments (2T:RM:2I:L1703-1704). "So I feel like while I'm able to see that and to look through that and to feel confident giving this assessment, and making those calls, and communicating that with my [student's] parents" (Amber, 2T:RM:2I:L1726-1728). The mastery experiences seemed to increase Amber's confidence for giving and using assessment information in mathematics and reading.

Summary of Master's Degree Classwork About Assessment Techniques

Teachers with mathematics education master's degrees and reading education master's degrees reflected on how their master's degree classwork was a source of MTSE for assessment techniques. These experiences were mastery experiences, verbal persuasion, and vicarious experiences sources of self-efficacy. Teachers learned about assessment purposes from their professors, conducted assessments that were new to them, wrote about how to change instruction based on the assessment data, and discussed their observations with classmates. The most salient

sources seemed to be the mastery experiences of giving the informal assessments and analyzing the results.

Comparison of Teachers' Self-Efficacy Beliefs by Degree Type

Overall, the teachers with reading education master's degrees reported lower MTSE for assessment techniques than the teachers with mathematics education master's degrees. They did not feel as though they knew different assessment techniques to evaluate students' mathematical understanding, and they were unsure about how to utilize the data they obtained about students to inform their instructional methods.

However, the teachers with mathematics education master's degrees and teachers with reading education master's degrees were fairly similar in describing standardized assessments as mastery experiences that lowered their MTSE because the assessments did not always match the content or instruction. The district's summative assessments also caused concern for both types of teachers because the requirements made the teachers change their instruction in order for the students to be able to master the test rather than the content.

For both teachers with mathematics education master's degrees and reading education master's degrees, their master's degree classes provided them with mastery experiences, verbal persuasion, and vicarious experiences in order to learn more about assessments in general and then how to conduct subject-specific assessments. Although the general information about assessments seemed to transfer to other subjects, the reading education master's degree teachers did not have the mastery experiences with the specific mathematics assessments.

Summary of MTSE Beliefs for Assessment Techniques

The most salient source of self-efficacy for MTSE was mastery experiences because the teachers described students' successes or failures with the assessments. When the teachers felt the assessments provided them with accurate information about students' needs, the teachers' MTSE increased.

The master's degree classwork for mathematics and reading helped increase the teachers' self-efficacy with using informal assessments, and these formative assessments seemed to provide the teachers with the most accurate information about students' learning.

CHAPTER 7

DISCUSSION AND CONCLUSION

Salient Sources of Self-Efficacy for MTSE

Chapters 4, 5, and 6 detailed the themes that emerged from the teachers' interviews about their sources of mathematics self-efficacy and MTSE for content knowledge, instructional methods, and assessment techniques. These 20 themes were discussed as to how they related to Bandura's (1997) sources of self-efficacy theory. See Table 5 for a summary of the discussion to view how each theme connected the four sources of self-efficacy: mastery experiences, verbal persuasion, vicarious experiences, and physiological state.

After connecting each of the themes to the sources of self-efficacy, I examined which one appeared as the most salient within each of the research areas: content knowledge, instructional methods, and assessment techniques. Appendix G shows the final 20 themes and how the initial 72 themes were combined. The final column in the table in Appendix G shows the total number of pieces of data for each of the themes. Although each theme included teacher descriptions that perhaps applied to more than one source of self-efficacy, I examined the source that was the most prevalent throughout the theme. For example, the theme of family included descriptions of experiences that related to all four sources of self-efficacy, but the most prominent theme was physiological state. After determining the most prominent source for each theme, I then added together the total pieces of data for each of the four sources. For example, in the area of content

Table 5

Themes Connected to Sources of Self-Efficacy

	Mastery experiences	Verbal persuasion	Vicarious experiences	Physiological state
Content knowledge	• Family • Teaching assignment • Standards • Master's degree classwork	• Family • Standards • Master's degree classwork	• Family • Learning experiences • Master's degree classwork	• Family • Affect towards mathematics • Peers • Learning experiences
Instructional methods	• Methods classes • Preservice experiences • Students' individual experiences • Students' group experiences • Professional development • Master's degree classwork	• School colleagues • Instructional coaches and mentors • Professional development • Master's degree classwork	• Methods classes • Preservice experiences • School colleagues • Professional development	
Assessment techniques	• Standardized assessments • District assessments • Formative assessments • Master's degree classwork	• Master's degree classwork	• Master's degree classwork	• Standardized assessments • District assessments

knowledge, to determine the most salient source, I added family, affect towards mathematics, learning experiences, and peers. This added up to 246 pieces of data for the source of physiological state. Then, I added up the teaching assignment, standards, and master's degree classwork for the source of mastery experience, and it totaled 128 pieces of data. Therefore, the most salient source of MTSE for content knowledge was physiological state. I used the same method for the other two areas of instructional methods and assessment techniques. The most salient source of MTSE for instructional methods was verbal persuasion, and the most salient source of MTSE for assessment techniques was mastery experiences.

Although each area had a different salient source of self-efficacy, the overarching theme of relationships seemed to be the most influential experience that contributed to all four sources of self-efficacy for the teachers. Instead of focusing on Bandura's (1997) four identified sources of self-efficacy as independent phenomena, the interpretation of the extensive interview data collected in the present study focuses on the influential nature of relationships with family members, teachers, peers, students, colleagues, classmates, and professors. These relationships contributed to all four sources of self-efficacy. Previous research has also postulated that mastery experiences, verbal persuasion, and physiological state are interrelated sources of self-efficacy (Lent, Lopez, & Bieschke, 1991; Lopez & Lent, 1992). Consistent with these findings, I found that particular relationships with others often provided multiple sources of self-efficacy for the teachers in this study. The emphasis on social relationships in the interpretation of these data is consistent with social cognitive theory in that it represents teachers as forming interpretations of the world based on observation of and interaction with others (Bandura, 1986).

Understanding vicarious experiences as a source of self-efficacy presented unique challenges in the interpretation of the data because the teachers discussed social comparisons and

indirect modeling, but there were not as many experiences of watching a model directly and trying to replicate the model. This may be because there is simply not enough time in schools to teach and observe. Thus, teachers' explanations of vicarious experiences seemed less tied to relationships with specific people. Lent, Lopez, Brown, and Gore (1996) also found vicarious experiences to be a more complicated source to explain because the experiences were different based on relationships with peers or adults.

While salient sources of self-efficacy emerged for each of the content areas, the idea of relationships building teachers' MTSE was the most important piece of information. One of the crucial relationships to improve a teacher's MTSE is fostering a productive relationship with students. In the literature review in Chapter 2, I examined the specific suggestions by the NCTM (2014) as to how to use the most effective instructional methods in order for students to experience success in the mathematics classrooms, and these recommendations focus on the teachers building relationships with students in which the students take ownership for their learning.

The NCTM Recommendations

As discussed in Chapters 1 and 2, the National Council of Teachers of Mathematics (2014) created a document detailing recommendations for teaching and learning in mathematics classrooms. See Table 2 for a description of each of these eight practices. The teaching practices outlined are also closely related to the Standards for Mathematical Practice within the CCSSM. These recommendations guided several of the present study's interview questions in order to probe about the teachers' MTSE for specific instructional methods and assessment techniques.

See the semistructured interview guides in Appendix D and Appendix E. The teachers' MTSE for instructional methods revealed practices in which the teachers had high and low levels of self-efficacy. The teachers described high levels of self-efficacy for the two instructional methods of "establishing mathematics goals" and "facilitating mathematical discourse" (National Council of Teachers of Mathematics, 2014, p. 10). One of the reasons the teachers had higher MTSE for goal setting was because the instructional coaches and professional development workshops had encouraged the teachers to read articles about the success of using learning targets.

The teachers described low levels of MTSE for the two instructional methods of "implementing integrated tasks" and "supporting productive struggle" (National Council of Teachers of Mathematics, 2014, p. 10) because they had mastery experiences in which the students struggled in solving the problems and communicating their findings. These teachers reflected on the challenge of giving up control to the students and attempting to help all students master the mathematical procedures at the same time. The teachers' descriptions support the research by Czerniak (1990) that found that teachers with lower self-efficacy tended to use more traditional methods of teaching rather than promoting student ownership and discussion. Although student struggle decreased the teachers' MTSE, Kapur (2010) found that students who had instruction with productive struggle outperformed students who had traditional lecture. The teachers described how they struggled to find the correct balance of telling the students the procedures and providing the time for students to reason through the mathematics problems.

In addition to suggestions for instructional methods, the NCTM (2014) made recommendations for assessment techniques. The teachers reported high levels of MTSE for the technique of "eliciting and using evidence of student thinking" (National Council of Teachers of

Mathematics, 2014, p. 10) when they used formative assessments such as pretests, quizzes, and exit slips. Along with that technique, the teachers expressed high levels of MTSE for "posing purposeful questions" (National Council of Teachers of Mathematics, 2014, p. 10), especially after gaining practice with various assessments from their master's degree classes. The teachers also expressed high levels of MTSE for the assessment technique of "using and connecting mathematical representations" (National Council of Teachers of Mathematics, 2014, p. 10) because they felt they had enough resources to provide them with examples of how to help students represent their mathematical thinking.

Even though the teachers expressed MTSE for assisting students in connecting the mathematical representations during specific times, the teachers expressed low MTSE for the assessment technique of "building procedural fluency from conceptual understanding" (National Council of Teachers of Mathematics, 2014, p. 10). Research such as Baroody's (2006) found that students' fluency should develop after solid conceptual understanding in order for students to be able to synthesize the information and apply it to new mathematical problems. Although several teachers described how they knew it was better for students to develop conceptual understanding before procedural fluency, the pressure of district and state assessments made them doubt their decisions to take more instructional time to build conceptual understanding.

Implications for Enhancing MTSE

The teachers' descriptions of their sources of mathematics teaching self-efficacy provides information for several groups to consider including parents, elementary and secondary teachers,

undergraduate professors, graduate professors, school district leaders, and standardized test writers.

Parents and Teachers

The teachers' mathematical experiences as students impacted their mathematics self-efficacy. The two sources of mathematics self-efficacy that the teachers described the most often were family members and relationships with elementary and secondary teachers. Because teachers develop mathematics self-efficacy before they develop mathematics teaching self-efficacy, an implication is for parents and teachers to examine their methods for providing feedback in order to increase children's joyful feelings during mathematics experiences. Parents and teachers may want to evaluate the use of feedback on students' performances early in their academic career and give positive feedback about their abilities to do mathematical problems while attributing failures to effort (Schunk & Lilly, 1984). The feedback needs to match the learners' needs and be given at the appropriate times for the appropriate situations (Shute, 2008).

Elementary and secondary teachers may want to consider the use of peers as a way to increase students' self-efficacy in mathematics. The present study's teachers described how their self- comparisons to peers influenced their self-efficacy. To create verbal persuasion and physiological state that increases students' self-efficacy, teachers may consider the use of peer tutors so students have the opportunity to communicate about mathematical content and to teach each other (Fuchs et al., 1997).

Professors

Professors who teach undergraduate education programs have the opportunity to create mathematics methods classes that support preservice teachers' understanding of the best instructional methods to use for student success. By verbally describing the instructional methods, the professors can contribute to one source of self-efficacy; however, they can also connect the methods classes to preservice teachers' experiences. When teachers can immediately apply the instructional methods they are learning in their courses to classroom experiences, the teachers' self-efficacy can increase through the source of mastery experiences (Tschannen-Moran et al., 1998). The undergraduate professors may also want to consider having the students engage in authentic complex mathematical tasks in order to impact their mathematics self-efficacy and mathematics teaching self-efficacy. When the teachers with mathematics education master's degrees had the opportunity to engage in integrated tasks, it increased their MTSE for content knowledge, even if they had previous low mathematics self-efficacy.

Another implication is for graduate professors to examine the content of their master's degree programs. Currently, there are many more master's degree programs in reading education compared to mathematics education master's degree programs in Illinois (Illinois Board of Higher Education, 2012). One possibility is to create programs with a combination of mathematics education and reading education master's degree classes specifically for elementary teachers. Because elementary teachers need to teach all academic disciplines, it might be helpful to have the opportunity to be exposed to more content, instructional methods, and assessment techniques in the two primary subjects of mathematics education and reading education. Although some universities offer master's degree programs in curriculum and instruction, these

general classes could be transferred into subject-specific classes. A hybrid master's degree program might offer teachers the type of professional learning that may increase elementary teachers' self-efficacy in both content areas.

School District Leaders

One of the implications of verbal persuasion as an influential source for teachers' MTSE is for school district leaders to consider creating opportunities for elementary teachers to plan and discuss content, instruction, and assessment with their teammates and instructional coaches. One form of professional development that allows teachers to have deep discussion about instructional methods is professional learning communities (DuFour, DuFour, Eaker, & Many, 2010). Within professional learning communities, teammates discuss student outcomes, instructional methods, and content standards. The challenge with instituting professional learning communities is finding the time to implement them; however, based on the teachers' narratives, the time discussing student outcomes with teammates may make the most impact on teachers' MTSE.

Another form of professional development that school district leaders may want to consider is instructional coaching because the traditional format of presenting a topic at an institute day and expecting teachers to implement the changes is not effective in changing teacher practice (Joyce & Showers, 2002). Instructional coaching, on the other hand, involves working with a teacher to learn new instructional methods through planning for the student outcomes, observation of the coach, coteaching new instructional methods, reflection of the practices, and discussion about how to assess students' needs (Knight, 2007). Instructional

coaching can lead to increased teacher self-efficacy by verbally persuading teachers to try the best instructional methods. When the teachers try the methods with the support of the instructional coaches, they may also have more mastery experiences to continue to increase the teachers' self-efficacy (Tschannen-Moran & McMaster, 2009). A recent study by Campbell and Malkus (2011) found that using mathematics coaches was correlated with increased student achievement as measured by standardized tests. Finally, using mentors provides powerful verbal persuasion because they can help teachers reflect on teaching practices and learn about instructional methods. The mentors are unique teacher supporters because teachers do not have to worry about impressing the mentors or following a team's plans. The mentors are simply there to discuss ideas and be empathetic about the teachers' experiences. Each mentor provides individual attention to teachers and can provide direction and support for new teachers (Danielson, 1999).

School district leaders should also consider their incentives for elementary teachers to complete master's degrees in mathematics education. By taking coursework in mathematics education, the present study's teachers were able to increase their mathematics self-efficacy as well as their MTSE for using research-based instructional methods. The teachers in this study with reading education master's degrees had lower MTSE because they were seeking more instructional methods to assist students struggling with mathematics concepts. The last time these teachers had coursework about mathematics instructional methods was in their one or two undergraduate classes. Therefore, the school district leaders should find ways to increase teachers' time learning how to teach mathematics, and one way to do this is through incentives for master's degree classwork in mathematics education. If elementary teachers have master's degrees in other subjects, they would also be able to learn from each other about the content

knowledge, instructional methods, and assessment techniques to meet students' mathematics needs.

School district leaders may also want to consider placing less emphasis on standardized tests because giving these tests decreased the present study's teachers' MTSE. As the PARCC committee has given its first assessments for evaluating students' progress towards the CCSSM, the question is how standardized tests are truly impacting instruction. The teachers in this study described low MTSE for giving standardized assessments because they did not see the benefits to students. They administered the standardized assessments because they were obliged to do so, but many did not see results that were reflective of the students' levels of learning. If the teachers' self-efficacy for obtaining valid results from these assessments is low, the students may feel that impact which may lead to results that provide little value in helping students succeed. Therefore, school district leaders could help teachers spend more time examining the content of the standardized tests and how the content matches the instruction in the classroom. The school district leaders should spend less time using standardized assessments to measure teachers' effectiveness. The teachers in this study had high MTSE for giving formative assessments. Therefore, school district leaders should consider how to value the formative assessments for providing feedback about students' learning.

Study Limitations

The study sought to explore the mathematics teaching self-efficacy about content knowledge, instructional methods, and assessments techniques. Personal characteristics such as gender (Usher & Pajares, 2006), cultural background (Stevens et al., 2004), and years of

experience (Tschannen-Moran & Woolfolk Hoy, 2007), may influence teachers' perceptions of sources of self-efficacy. One limitation of the study was the sample included an unequal distribution of gender, cultural background, and years of experience. Therefore, I was unable to consider, in a systematic way, the influence of personal characteristics on teachers' perceptions of their sources of self-efficacy. Another factor that may influence teachers' perceptions of sources of self-efficacy is the contextual variable of school climate (Hoy and Woolfolk, 1993; Tschannen-Moran and Woolfolk Hoy, 2007). Because the teachers in the study were from the same school district, there was a limited amount of differences in the school climate. However, three participants discussed the lack of support they felt in their previous school districts.

Another limitation to this study was that the teachers self-reported about their experiences, relying on their memories. The teachers may not have remembered all of the specific details of events, and there may have been other experiences that influenced their MTSE that they did not recall. In addition, teachers may have embellished some of their experiences in order to have a complete story to share.

The type of exposure to different graduate classes was another challenge to this study. One of the research questions was about whether there were differences between teachers with mathematics education master's degrees and reading education master's degrees. The four teachers with mathematics education master's degrees participated in the same program, whereas the four teachers with reading education master's degrees participated in different reading education programs. Therefore, the types of instruction the reading education master's degree teachers received was varied and could have impacted the teachers' MTSE.

Future Research

Teachers' self-efficacy is a complex construct and could benefit from more qualitative studies so teachers at different grade levels and across various academic disciplines have the opportunity to explain their perceptions of its sources. These studies should also focus on how personal characteristics and contextual factors impact teachers' perceptions of their sources of self-efficacy. Due to the limited scope of this study, there were some instances that suggested these factors influenced the teachers' descriptions. Future research should continue to examine these factors. For example, cultural background may be a factor in exposure to verbal persuasion and vicarious experiences. Stevens et al.'s (2004) study found that White students had more exposure to those sources of self-efficacy that led to increased mathematics self-efficacy compared to Latino students. In the present study, all eight of the teachers were White or Asian and described their childhood experiences of their family members verbally persuading them to continue to practice their mathematics skills.

Another personal characteristic that may influence the perceptions of sources of self-efficacy is gender. Usher and Pajares (2006) found that verbal persuasion influenced females' self-efficacy more than it influenced males'. In the present study, there was only one male teacher and seven female teachers, so no substantial conclusions about how gender influenced the teachers' interpretations of sources of self-efficacy can be made. However, the male participant had colleagues who attempted to discourage him from using specific instructional methods or assessment techniques, and this discouragement did not decrease his MTSE. On the other hand, three female teachers from the study described how their colleagues verbally persuaded them to not use newer instructional methods, and this discouragement decreased their

MTSE. Future research should investigate whether verbal persuasion is a factor that leads to different female and male interpretations.

A third personal characteristic that may be a factor in the interpretation of sources of self-efficacy is years of teaching experience. Tschannen-Moran and Woolfolk Hoy (2007) found that experienced teachers tended to have higher self-efficacy levels than novice teachers. The present study agrees with this research because all eight of the teachers reported higher MTSE after their first 2 years of teaching. The teachers' mastery experiences, specifically when students experienced success and engagement, increased their MTSE. As novice teachers, they did not have those experiences to draw upon.

Tschannen-Moran and Woolfolk Hoy's (2007) research also found that teachers had higher self-efficacy when they perceived a positive school climate. Therefore, school climate may be a contextual variable that influences teachers' perceptions of sources of self-efficacy. The teachers in the study described how the support they felt from their teammates and administrators impacted their MTSE. Three teachers reported working in very unsupportive environments during the early parts of their careers and in very supportive environments in later years. One of the teachers experienced a great deal of stress when she started talking about her first year of teaching. This stress and the unsupportive environments could have led to the low self-efficacy the three teachers experienced. Future research should continue to investigate how school climate influences teachers' MTSE.

In addition to researching how the personal characteristics and contextual factors influence teachers' MTSE, the present study also reveals a need to explore how subject-specific graduate education programs impact teachers' self-efficacy in that subject as well as across content areas. Because elementary teachers instruct in all disciplines, it is important to

investigate how their self-efficacy impact their decisions about graduate work and, in turn, how the graduate work influences their self-efficacy.

Another area for future research is to do longitudinal studies of teacher self-efficacy to see how it changes over time similar to the study by Woolfolk Hoy and Burke-Spero (2005). In the present study, teachers took one moment in time to look back on the sources of their teaching self-efficacy, but it would be helpful to have them reflect on the sources as they occur and change. If studies could capture teachers' sources of self-efficacy in childhood, during preservice experiences, and inservice experiences, memories would be less likely to be distorted. Studies such as the qualitative investigation by Usher (2009) would examine how students describe their sources of mathematics self-efficacy. Studies like these could be used to determine more about students' mathematics self-efficacy and then later follow the students who choose to enter the teaching profession. Because longitudinal studies may not always be possible, future research should continue to explore teachers' self-efficacy in different contexts and grade levels. Guskey and Passaro (1994) described how self-efficacy can vary across contexts and depend on a global or specific definition.

Future research should also include more studies focusing on how teachers' mathematics teaching self-efficacy impacts students' self-efficacy and learning. Although a few studies have already found those connections such as the study by Midgley et al. (1989) that found that students' mathematics self-efficacy was positively correlated with teachers' MTSE. Therefore, it is important to continue to explore how teachers can increase their self-efficacy in order to support their students, especially in the area of mathematics.

Conclusion

This study sought to explore the sources of mathematics teaching self-efficacy in the areas of content knowledge, instructional methods, and assessment techniques. There was a variety of themes that emerged from the teachers' descriptions of the sources of their self-efficacy. In this qualitative study, the teachers were able to describe these sources in their own words, which led to the idea that relationships with parents, peers, teachers, colleagues, and professors made the greatest impact on their self-efficacy. The study also highlighted how a teacher's mathematics self-efficacy contributes to MTSE. At all levels of education, there are ways to increase teachers' MTSE so the ultimate impact becomes the students' successful mathematics experiences.

REFERENCES

Anderson, R., Greene, M., & Loewen, P. (1988). Relationships among teachers' and students' thinking skills, sense of efficacy, and student achievement. *Alberta Journal of Educational Research*, *34*(2), 148-165.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 181-185.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York, NY: Longman.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389-407.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1994). Self-efficacy. In R. J. Corsini (Ed.), *Encyclopedia of psychology* (2nd ed., Vol. 3, pp. 368-369). New York, NY: Wiley.

Bandura, A. (Ed.). (1995). *Self-efficacy in changing societies*. New York, NY: Cambridge University Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Baroody, A. J. (2006). Mastering the basic number combinations. *Teaching Children Mathematics*, *13*(1), 23-31.

Bates, A. B., Kim, J., & Latham, N. (2011). Linking preservice teachers' mathematics self-efficacy and mathematics teaching efficacy to their mathematical performance. *School Science and Mathematics*, *111*(7), 325-333.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010, February 2). Female teachers' mathematics anxiety affects girls' mathematics achievement. *Proceedings of the National Academy of Sciences*, *107*(5), 1860-1863.

Boaler, J. (2012, July 3). Timed tests and the development of mathematics anxiety. *Education Week*. Retrieved from http://www.edweek.org/ew/articles/2012/07/03/36boaler.h31.html?tkn=LWYFuHPKJvfvRYmd7q7LM1%2BVra4sq8JCnFt6&print=1

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *Teachers College Record*, *110*(3), 608-645.

Bogdan, R. C., & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods* (5th ed.). Boston, MA: Pearson Education.

Bouffard-Bouchard, T., Parent, S., & Larivee, S. (1991). Influence of self-efficacy on self-regulation and performance among junior and senior high school age students. *International Journal of Behavioral Development*, *14*, 153-164.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching*, *43*(5), 485-499.

Burns, M. (1998). *Math: Facing an American phobia*. Sausalito, CA: Math Solutions Publications.

Campbell, P. F., & Malkus, N. N. (2011). The impact of elementary mathematics coaches on student achievement. *The Elementary School Journal*, *111*(3), 430-454.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Thousand Oaks, CA: Sage.

Coladarci, T. (1992). Teachers' sense of efficacy and commitment to teaching. *The Journal of Experimental Education*, *60*(4), 323-337.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

Czerniak, C. M. (1990, April 8-11). *A study of self-efficacy, anxiety, and science knowledge in preservice elementary teachers*. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Atlanta, GA.

Danielson, C. (1999). Mentoring beginning teachers: The case for mentoring. *Teaching and Change, 6*(3), 251-257.

DuFour, R., DuFour, R., Eaker, R., & Many, T. (2010). *Learning by doing: A handbook for professional learning communities at work* (2nd ed.). Bloomington, IN: Solution Tree Press.

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics, 100*(4), 194-202.

Fischer, C. T. (2009). Bracketing in qualitative research: Conceptual and practical matters. *Psychotherapy Research*, *19*(4-5), 583-590.

Fives, H., & Buehl, M. M. (2011). Spring cleaning for the messy construct of teachers' beliefs: What are they? Which have been examined? What can they tell us? In K. R. Harris, S. Graham, T. Urdan, S. Graham, J. M. Royer, & M. Zeidner (Eds.), *APA educational psychology handbook*, *Volume 2*(pp. 471-499). Washington, DC: American Psychological Association.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., Phillips, N. B., Karns, K., & Dutka, S. (1997). Enhancing students' helping behavior during peer tutoring with conceptual mathematical explanations. *Elementary School Journal*, *97*(3), 223-250.

Geist, E. (2010). The anti-anxiety curriculum: Combating mathematics anxiety in the classroom. *Journal of Instructional Psychology*, *37*(1), 24-31.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, *76*(4), 569-582.

Green, E. (2014, July 27). New mathematics minus new teaching equals failure. *The New York Times Magazine*, pp. 22-27, 40-41.

Gregorie, M. (2003, June). Is it a challenge or a threat? A dual-process model of teachers' cognition and appraisal processes during conceptual change. *Educational Psychology Review*, *15*(2), 147-179.

Guo, Y., Connor, C. M., Yang, Y., Roehrig, A. D., & Morrison, F. J. (2012). The effects of teacher qualification, teacher self-efficacy, and classroom practices on fifth graders' literacy outcomes. *Elementary School Journal*, *113*(1), 3-24.

Guskey, T. R. (1987). Context variables that affect measures of teacher efficacy. *The Journal of Educational Research*, *81*(1), 41-47.

Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher Education*, *4*, 63-69.

Hattie, J. (2012). Know thy impact. *Educational Leadership*, *70*(1), 18-23.

Henson, R. K. (2001, January). *Teacher self-efficacy: Substantive implications and measurement dilemmas*. Paper presented at the meeting of the Educational Research Exchange, College Station, TX.

Hill, C., Corbett, C., & St. Rose, E. (2010). *Why so few? Women in science, technology, engineering and mathematics*. Washington, DC: American Association of University Women.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371-406.

Hoy, W. K., & Woolfolk, A. E. (1993). Teachers' sense of efficacy and the organizational health of schools. *Elementary School Journal*, *93*, 356-372.

Illinois Board of Higher Education. (2012). *Illinois Board of Higher Education degree program inventory*. Retrieved from http://www.ibhe.org/BHEProgramInventory/Search.aspx

Jourden, F. (1992). *The influence of feedback framing on self-regulatory mechanisms: A glass half full or half empty*. Retrieved from http://hdl.handle.net/2142/29902

Joyce, B., & Showers, B. (2002). *Designing training and peer coaching: Our needs for learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

Kapur, M. (2010). Productive failure in mathematical problem solving. *Instructional Science*, *6*, 523-550.

Knight, J. (2007). *Instructional coaching: A partnership to improving instruction.* Thousand Oaks, CA: Corwin Press.

Krupa, E. (2011). A summary report from the conference "Moving forward together: Curriculum & assessment and the common core state standards for mathematics." Retrieved from http://www.mathismore.net/resources/MovingForward/MFT_Final_Report.pdf

Lent, R. W., Brown, S. D., Gover, M. R., & Nijjer, S. K. (1996). Cognitive assessment of the sources of mathematics self-efficacy: A thought-listing analysis. *Journal of Career Assessment*, *49*(3), 292-308.

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*, *38*, 424-430.

Lent, R. W., Lopez, F. G., Brown, S. D., & Gore, P. A. (1996). Latent structure of the source of mathematics self-efficacy. *Journal of Vocational Behavior*, *49*, 292-308.

Lopez, F. G., & Lent, R. W. (1992). Sources of mathematics self-efficacy in high school students. *Career Development Quarterly, 41,* 3-12.

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage.

Mercer, J. (2007). The challenges of insider research in educational institutions: Wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education*, *33*(1), 1-17.

Michaels, S., O'Connor, M. C., & Resnick, L. (2008). Deliberative discourse idealized and realized: Accountable talk in the classroom and in civic life. *Studies in Philosophy and Education*, *27*(4), 283-297.

Midgley, C., Feldlaufer, H., & Eccles, J. S. (1989). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *Journal of Educational Psychology*, *81*(2), 247-258.

Mongeau, L. (2014). *Common core standards to bring dramatic changes to elementary school mathematics*. Retrieved from http://edsource.org/2014/common-core-standards-bring-dramatic-changes-to-elementary-school-mathematics-2/63665#.VAfL7EtN3wI

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Retrieved from http://www.nctm.org/PrinciplestoActions/

National Council of Teachers of Mathematics Research Committee. (2013). New assessments for new standards: The transformation of mathematics education and its research implications. *Journal for Research in Mathematics Education*, *44*(2), 340-352.

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGA Center & CCSSO). (2010). *Common core state standards for mathematics. Common core state standards (College- and career-readiness standards and K-12 standards in English language arts and math)*. Washington, DC: Author. Retrieved from http://www.corestandards.org

Olander, E. K., Fletcher, H., Williams, S., Atkinson, L., Turner, A., & French, D. P. (2013). What are the most effective techniques in changing obese teachers' physical activity self-efficacy and behavior: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *10*. Retrieved From http://www.ijbnpa.org/content/10/1/29

Organisation for Economic Co-Operation and Development. (2013). *Skilled for life? Key findings from the survey of adult skills*. Retrieved from http://skills.oecd.org/documents/SkillsOutlook_2013_KeyFindings.pdf

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578.

Partnership for Assessment of Readiness for College and Careers. (2014). *About PARCC*. Retrieved from http://www.parcconline.org/about-parcc

Patton, M. (1990). *Qualitative evaluation and research methods*. Beverly Hills, CA: Sage.

Popham, W. J. (2008). *Transformative assessment.* Alexandria, VA: Association for Supervision and Curriculum Development.

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, *74*, 625-637.

Ross, J. A., & Bruce, C. D. (2007). Professional development effects on teacher efficacy: Results of a randomized field trial. *Journal of Educational Research*, *101*(1), 50-60.

Saldaña, J. (2013). *The coding manual for qualitative researchers.* Los Angeles, CA: Sage.

Schmidt, J. A., & Shumow, L. (2014). *Enhancing adolescents' motivation for science: Research-based strategies for teaching male and female students*. Thousand Oaks, CA: Corwin.

Schunk, D. H. (1989). Self-efficacy and achievement behaviors. *Educational Psychology Review*, *1*, 173-208.

Schunk, D. H., & Lilly, M. W. (1984). Sex differences in self-efficacy and attributions: Influence of performance feedback. *Journal of Early Adolescence*, *4*, 203-213.

Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. New York, NY: Teachers College Press.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153-189.

Stevens, T., Olivarez A., Lan, W. Y., & Tallent-Runnels, M. K. (2004). Role of mathematics self-efficacy and motivation in mathematics performance. *The Journal of Educational Research*, *97*(4), 208-221.

Swars, S. L. (2005). Examining perceptions of mathematics teaching effectiveness among elementary preservice teachers with differing levels of mathematics teacher efficacy. *Journal of Instructional Psychology*, *32*, 139-147.

Swars, S. L., Daane, C. J., & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? *School Science and Mathematics*, *106*(7), 306-315.

Swars, S. L., Hart, L. C., Smith, S. Z., Smith, E. M., & Tolar, T. (2007). A longitudinal study of elementary preservice teachers' mathematics beliefs and content knowledge. *School Science and Mathematics*, *10*, 325-335.

Tobias, S. (1995). *Overcoming mathematics anxiety.* New York, NY: W. W. Norton.

Tschannen-Moran, M., & McMaster, P. (2009). Sources of self-efficacy: Four professional development formats and their relationship to self-efficacy and implementation of a new teacher strategy. *The Elementary School Journal*, *110*(2), 228-245.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*, 783-805.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2007). The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and Teacher Education*, *23*, 944-956.

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, *68*(2), 202-248.

U.S. Department of Education. (2010). *Blueprint for reform: The reauthorization of the elementary and secondary education act.* Retrieved from http://www2.ed.gov/policy/elsec/leg/blueprint/blueprint.pdf

Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Educational Research Journal*, *46*, 275-314.

Usher, E. L., & Pajares, F. (2006). Sources of academic and self-regulatory efficacy beliefs of entering middle school students. *Contemporary Educational Psychology*, *31*, 125-141.

Weiss, R. S. (1994). *Learning from strangers: The art and method of qualitative interview studies.* New York, NY: Free Press.

Wolcott, H. F. (1994). *Transforming qualitative data: Description, analysis, and interpretation.* Thousand Oaks, CA: Sage.

Woolfolk, A. E., & Hoy, W. K. (1990). Context variables that affect measures of teacher efficacy. *Journal of Educational Psychology*, *82*(1), 81-91.

Woolfolk Hoy, A., & Burke-Spero, R. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teaching and Teacher Education*, *21*, 343-356.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, *37*(1), 215-246.

APPENDICES

APPENDIX A

PARTICIPANT INFORMATION SUMMARY

AN EXPLORATION OF ELEMENTARY TEACHERS' SELF-EFFICACY BELIEFS ABOUT TEACHING MATHEMATICS AMONG TEACHERS WITH ADVANCED DEGREES

By: Kelly Talaga

Purpose

This research study will focus specifically on teacher self-efficacy for teaching mathematics in the areas of content knowledge, instructional methods, and assessment techniques. The research study will explore participants' life experiences that lead to feelings of teacher self-efficacy in an effort to determine the influences that can lead to higher self-efficacy for teachers.

Definition of Teacher Self-Efficacy

Teacher self-efficacy is the belief a teacher has in his own abilities to execute a teaching task in order for students to be successful in learning (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). For the purpose of this study, teacher self-efficacy will include those pertaining to the three areas of teaching mathematics including content knowledge, instructional strategies, and assessment techniques.

Research Questions

The study will address the following research questions:

1. How do elementary teachers describe the nature and sources of their self-efficacy for teaching mathematics in the areas of content knowledge, instructional methods, and assessment techniques?
2. Do these descriptions differ depending on whether participants have earned an advanced degree in mathematics education or reading education?

Importance

Teachers' self-efficacy beliefs have been shown to be predictive of teacher practice, students' self-efficacy, and student achievement (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2007, Woolfolk & Hoy, 1990).

Because the Common Core State Standards for Mathematics (2010) has changed some of the student learning objectives, there is a need to determine how teachers' increase self-efficacy for mathematics content. The National Council of Teachers of Mathematics (2014) also published *Principles to Actions* outlining the mathematics teaching practices each successful mathematics classroom should implement. This study will utilize both documents as discussion points during the interviews.

This qualitative research study will add to the literature about specific sources of teacher self-efficacy for teaching mathematics. By interviewing teachers and allowing them to have the opportunity to make meaning about their process of developing teacher self-efficacy for teaching mathematics, school staff members will be able to create professional development experiences to continue to increase teacher self-efficacy. By increasing teacher self-efficacy for teaching mathematics, student self-efficacy for mathematics and students' mathematics achievement may also improve.

Procedures

The researcher will contact elementary teachers with mathematics education master's degrees and elementary teachers with reading education master's degrees. Each member who agrees to participate will have the opportunity to discuss their confidence sources in teaching mathematics at the beginning of their careers during the first interview, their confidence sources after their advanced degree completion during the second interview, and their own meaning about the experiences during the third interview. Each interview will last approximately 90 minutes and will be conducted after the school day at a neutral location.

APPENDIX B

PARTICIPANT CONSENT FORM

I agree to participate in the research project entitled "An Exploration of Elementary Teachers' Self-Efficacy Beliefs About Teaching Mathematics Among Teachers with Advanced Degrees" being conducted by Kelly Talaga, doctoral graduate student in Educational Psychology at Northern Illinois University.

The purpose of the study is to explore the sources of teacher self-efficacy beliefs for teaching mathematics. The research will focus specifically on mathematics content knowledge, instructional methods, and assessment techniques.

I understand that if I agree to participate in this study, I will participate in a three-part interview set, which will be audiotaped. Each of the three interviews will last approximately 90 minutes.

I am aware that participation is voluntary and may be withdrawn at any time without penalty or prejudice. If I have any additional questions concerning this study, I may contact Dr. Jennifer Schmidt at (815) 753-8425. I understand that if I wish further information regarding my rights as a research subject, I may contact the Office of Research Compliance at Northern Illinois University at (815) 753-8588.

I understand that the intended benefits of this study include reflection on my practice of teaching mathematics and a deeper understanding of the current best practices in mathematics education.

I have been informed that risks and/or discomforts I could experience during this study include disclosing personal information. I understand that all information gathered during this research study will be kept confidential by using pseudonyms for the district, the schools, and the teachers involved. In addition, the utmost care will be taken by the researcher to secure the audiotapes of interviews by using a personal device that will be locked when not in direct possession of the researcher.

I understand that my consent to participate in this project does not constitute a waiver of any legal rights or redress I might have as a result of my participation, and I acknowledge that I have received a copy of this consent form.

Signature of Participant: _____ Date: _____

I agree to participate in the audiotaped interviews and acknowledge that only the researcher will transcribe the audiotapes. The audiotapes will be destroyed one year after the completion of the research.

Signature of Participant: _____ Date: _____

APPENDIX C

PARTICIPANT DEMOGRAPHIC QUESTIONS

Demographic Profile Sheet

What grade do you teach?	
How many students do you currently teach?	
How many years have you taught total?	
How many years have you taught in this district?	
How many years have you taught in this school?	
What teaching certifications do you hold?	
What academic degrees do you have?	
How many minutes per day do you teach mathematics?	
How would you describe the climate of your school?	

APPENDIX D

GUIDING QUESTIONS FOR INTERVIEW #1

Interview Guide #1: Teaching Experiences Before Graduate Work

1. As a student in elementary through high school, describe your mathematical experiences.
    a. Talk me through one lesson you remember in elementary school.
    b. Talk me through a mathematical experience you had at home.
2. Imagine I was your high school friend. What would you say to me about mathematics?
3. Tell me about the mathematics content you taught during your first 2 years of teaching.
    a. Which of the grade-level standards did you feel the most confident to teach? What led you to feel that way?
    b. Which of the grade-level standards did you feel the least confident to teach? What led you to feel that way?
4. Tell me about your lesson planning process for mathematics during your first 2 years of teaching.
    a. In what areas did you feel most confident? What led you to feel that way?
    b. In what areas did you feel least confident? What led you to feel that way?
5. Describe the instructional methods you used in your mathematics classroom during the first 2 years of teaching.
    a. Talk me through a lesson in which you felt confident using the instructional method. What led you to feel that way?
    b. Talk me through a lesson in which you did not feel confident using the instructional method. What led you to feel that way?
6. There are many instructional methods involved in teaching mathematics. Can you talk about your confidence in using the following practices during the first 2 years of teaching and what led you to feel that way?
    a. Establish mathematics goals to focus learning.
    b. Implement tasks that promote reasoning and problem solving.
    c. Facilitate meaningful mathematical discourse.
    d. Support productive struggle in learning mathematics.
7. Tell me about how you assessed students in your mathematics classroom during the first 2 years of teaching.
    a. What forms of assessment did you feel most confident in using? What led you to feel that way?
    b. What forms of assessment did you feel least confident in using? What led you to feel that way?
8. There are many assessment techniques involved in teaching mathematics. Can you talk about your confidence in using the following practices during the first 2 years of teaching and what led you to feel that way?
    a. Use and connect mathematical representations.
    b. Pose purposeful questions.
    c. Build procedural fluency from conceptual understanding.
    d. Elicit and use evidence of student thinking.

APPENDIX E

GUIDING QUESTIONS FOR INTERVIEW #2

Interview Guide #2: Teaching Experiences After Graduate Work

1. How did you come to the decision to pursue your specific master's degree?
2. Describe your experiences in graduate classes.
    a. What is something you learned from class that you currently use a teacher?
3. Tell me about the mathematics content you currently teach.
    a. Which of the grade-level standards do you feel the most confident to teach? What led you to feel that way?
    b. Which of the grade-level standards do you feel the least confident to teach? What led you to feel that way?
4. Tell me about your current lesson planning process for mathematics.
    a. In what areas do you feel most confident? What led you to feel that way?
    b. In what areas do you feel least confident? What led you to feel that way?
5. Describe the instructional methods you currently use in your mathematics classroom.
    a. Talk me through a lesson in which you recently felt confident using the instructional method. What led you to feel that way?
    b. Talk me through a lesson in which you recently did not feel confident using the instructional method. What led you to feel that way?
6. There are many instructional methods involved in teaching mathematics. Can you talk about your confidence in using the following practices and what led you to feel that way?
    a. Establish mathematics goals to focus learning.
    b. Implement tasks that promote reasoning and problem solving.
    c. Facilitate meaningful mathematical discourse.
    d. Support productive struggle in learning mathematics.
7. Tell me about how you assess students in your current mathematics classroom.
    a. What forms of assessment do you feel most confident in using? What led you to feel that way?
    b. What forms of assessment do you feel least confident in using? What led you to feel that way?
8. There are many assessment techniques involved in teaching mathematics. Can you talk about your confidence in using the following practices and what led you to feel that way?
    a. Use and connect mathematical representations.
    b. Pose purposeful questions.
    c. Build procedural fluency from conceptual understanding.
    d. Elicit and use evidence of student thinking.

APPENDIX F

DESCRIPTIVE CODING: INITIAL CODES

Code #	Category Name	Number of Pieces of Data	Code #	Category Name	Number of Pieces of Data
1	Facts	9	37	Learning style	3
2	Math person	7	38	Student engagement	10
3	Parent influence	58	39	Student and teaching views	22
4	Siblings	17	40	Planning	14
5	Feelings toward math	37	41	Relationship with students	9
6	Empathy for students	1	42	Current family members	16
7	Learning experiences	26	43	External pressure	1
8	Relationship with teacher	30	44	Student outcomes	9
9	Peers	44	45	Routine	1
10	Grades	14	46	Standards/Content	24
11	Work ethic	5	47	Students' parents	7
12	Taking tests	16	48	Feelings about school	2
13	Advanced math	9	49	Teaching philosophy	18
14	Math purpose	6	50	Math committee	12
15	Math teaching content	1	51	Internet ideas	4
16	Teaching position	30	52	Assessing through discussion	5
17	Colleagues	103	53	National Board	1
18	Math methods classes	15	54	Small groups	6
19	Preservice experiences	19	55	Time	1
20	Student success	31	56	Formative assessments	23
21	Teaching affect	15	57	District assessments	26
22	Training	5	58	Standardized assessments	20
23	Instructional strategies	36	59	Integrated tasks	9
24	Differentiation	15	60	Tutoring	1
25	Reading comparison	22	61	Creating curriculum	3
26	Curriculum resources	74	62	New content	3
27	Supportive people	1	63	Evaluation	3
28	Master’s class work	52	64	Math talk	9
29	Master’s class colleagues	26	65	Tutor	6
30	Master’s class professors	31	66	Other job experiences	2
31	Student struggles	54	67	Mentor	9
32	Tracking	7	68	Additional classes	5
33	Professional reading	6	69	Coaches	17
34	Pacing	5	70	School improvement goal	1
35	District communication	10	71	Math club	1
36	Institute days	5	72	Teacher leader	1

APPENDIX G

FREQUENCY OF SOURCES OF SELF-EFFICACY

	Theme	Primary source of self-efficacy	Code(s) #	Total pieces of data
Content knowledge	Family	Physiological state	#3, #4	75
	Affect towards mathematics	Physiological state	#2, #5, #14	50
	Learning experiences	Physiological state	#7, #8	56
	Peers	Physiological state	#9, #10, #32	65
	Teaching assignment	Mastery experience	#16, #39	52
	Standards	Mastery experience	#46	24
	Master's degree classwork	Mastery experience	#28	52
Instructional methods	Methods classes	Vicarious experience	#18	15
	Preservice experiences	Mastery experience	#19	19
	Curriculum resources	Indirect modeling	#26	74
	School colleagues	Verbal persuasion	#17	103
	Instructional coaches and mentors	Verbal persuasion	#67, #69	26
	Students' individual experiences	Mastery experience	#20, #31, #38	27
	Students' group experiences	Mastery experience	#24, #54, #59, #64	39
	Professional development	Verbal persuasion	#22, #33, #36	16
	Master's degree classwork	Verbal persuasion	#29, #30	57
Assessment techniques	Standardized assessments	Mastery experience	#12, #58	36
	District assessments	Mastery experience	#34, #35, #57	41
	Formative assessments	Mastery experience	#56	23
	Master's degree classwork	Verbal persuasion	#28	52