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A STUDY OF MATH ANXIETY IN TEACHERS

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MATH ANXIETY IN TEACHERS

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This dissertation presents a mixed-data investigation aiming to comprehensively understand math anxiety in teachers. Math anxiety is defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and solving of mathematics problems in a variety of ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551). The study focuses on rural Nebraska district comparing practicing Elementary and Secondary teachers on the variable of Mathematics Anxiety. Employing both quantitative and qualitative methods, the research seeks to explore the correlations between teacher’s self-efficacy and Math Anxiety.

The quantitative process involved the use of the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) to measure teacher self-efficacy and the Math Anxiety Scale for Teachers (MAST) to measure Math Anxiety. Complementing these quantitative measures, a qualitative component utilizes a semi-structured interview process to uncover common experience of teachers with math. Previous studies on math anxiety in teachers often concentrated on elementary or pre-service teachers, emphasis teacher qualities rather than teacher’ experience with math influencing their instructional practices.

This study takes a distinctive approach, drawing on semi-structed interviews with eight (8) practicing teachers to gain deeper insights. By combining quantitative and qualitative data, the research provides a holistic understanding of the intricate relationship between teachers’ self-efficacy, math anxiety, and their instructional practices. The finding aims to contribute valuable insights for teacher training programs and cultivation of positive learning environment for mathematics education.

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Chapter 1: The Problem

Introduction

Teachers must have both content knowledge and pedagogical knowledge to educate students. Further, in subjects such as mathematics, teachers may struggle with both the content and pedagogy of mathematics because of issues related to anxiety about the difficult subject matter (Hunt & Sari, 2019; Yildirim & Gurbuz, 2017). While math anxiety is well understood and researched for students, the topic of math anxiety for teachers is less understood and tended to focus on pre-service and/or early-career elementary teachers (Bekdemir, 2010; Gresham, 2008; Gresham, 2009; Gresham, 2018; Gresham & Burleigh, 2019; Haciomeroglu, 2019; Isiksal, 2010; Tootoonchi, 2017). Therefore, the study contained herein will focus on exploring K-12 in-service teachers and their math anxiety levels in relation to their content and pedagogical knowledge.

Teachers can be affected by both General Math Anxiety and Anxiety Teaching Math (Hunt & Sari, 2019; Yildirim & Gurbuz, 2017).; research suggests that there is a difference between Anxiety Teaching Math (ATM), which is within the pedagogical realm, and General Math Anxiety (GMA), which relates specifically to the math content (Hunt & Sari, 2019; Yildirim & Gurbuz, 2017). Research also suggests that with training, interventions, and experience that math anxiety overall will decrease (Balogˇlu & Koçak, 2006; Hunt & Sari, 2019).General Math Anxiety is more prominent in pre-service and elementary teachers. Often the reason teachers go into elementary education is to avoid higher-level mathematics (Ganley et al., 2019). Though upper elementary teachers tend to have lower general math anxiety and higher anxiety teaching math because they lack depth of knowledge of mathematics and pedagogy to teach mathematics is limited to one

or two undergraduate methods courses. Very few studies have been done with secondary teachers to comprehend their level of content or pedagogical math anxieties.

Teachers who have higher math anxiety (content or pedagogy) tend to have less standard-based instruction in their classrooms. Lower elementary teachers (K, 1st, 2nd, 3rd-grade) tend to believe students should be taught as they were by memorizing facts and procedures, math lessons by reviewing, demonstrating, practice, and repeat (Hadley & Dorward, 2011a; Hunt & Sari, 2019; National Council of Teachers of Mathematics, (NCTM), 2000). Therefore, it is reasonable to consider that the math anxiety implication for classroom instructional practices influences students' math anxiety, attitudes, and achievements (Hughes et al., 2019).

According to the American Psychological Association (American Psychological Association, 2015), anxiety is emotionally characterized by feelings of tension, worries thoughts, and physical changes such as increased blood pressure. Symptoms of math anxiety are different for every person. Physically some people may experience sweaty hands, clinched fists, nauseated stomach, dry mouth, or a cold sweat. Psychologically they may feel panic, tension, helplessness, fear, distrust, shame, or an inability to think cognitively (Morris, 1981).

Math Anxiety is defined by Richardson and Suinn (1972) as "feelings of tension and anxiety that interfere with the manipulations of numbers and solving mathematical problems in a wide variety of ordinary life and academic situations" (p. 51). Researchers have repeatedly concluded that high anxiety negatively relates to performance (Ganley et al., 2019). Math Anxiety has also been defined as a feeling of apprehension and increase physiological reactivity when individuals must manipulate numbers, solve math

problems, or when they are exposed to an evaluation situation related to math (Ashcraft, Mark H., 2002; Hembree, 1990; Maldonado Moscoso et al., 2020).

These anxiety symptoms may affect instructional efficacy for experienced and pre-service teachers; therefore, more information about how math anxiety affects teachers is needed. The following section offers a framework of literature through which the study can be conceptualized.

Framework

The lens through which this study explores Math Anxiety in Teachers is threefold; Bandura's Self-Efficacy Theory, General Math Anxiety (content), and Math Teaching Anxiety (pedagogy). Math Anxiety Theory involves both General Anxiety of Mathematics and Anxiety Teaching Math. The difference between the two is General Math Anxiety is content related to the completion of math problems. Whereas Anxiety Teaching Math comes from the teaching and pedagogical aspects of math education. The phrase Anxiety Teaching Math (ATM) and Math Teaching Anxiety refer to the same concept- anxiety that occurs while teaching mathematics.

A study conducted by Gresham (2008) with 156 pre-service teachers to investigate: 1) the relationship between elementary pre-service teachers' mathematics anxiety and mathematics teacher efficacy, and 2) elementary pre-service teachers' perceptions towards their mathematics skills and abilities to teach elementary mathematics effectively. The instruments used in Gresham's (2009) study was the Math Anxiety Rating Scales (MARS), Mathematics Teaching Efficacy Beliefs Instrument, and pre-service teachers' interviews. The exploration contained herein is a modified and adapted version of Gresham's studies. The following model illustrates the links between

teachers' Self-Efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy).

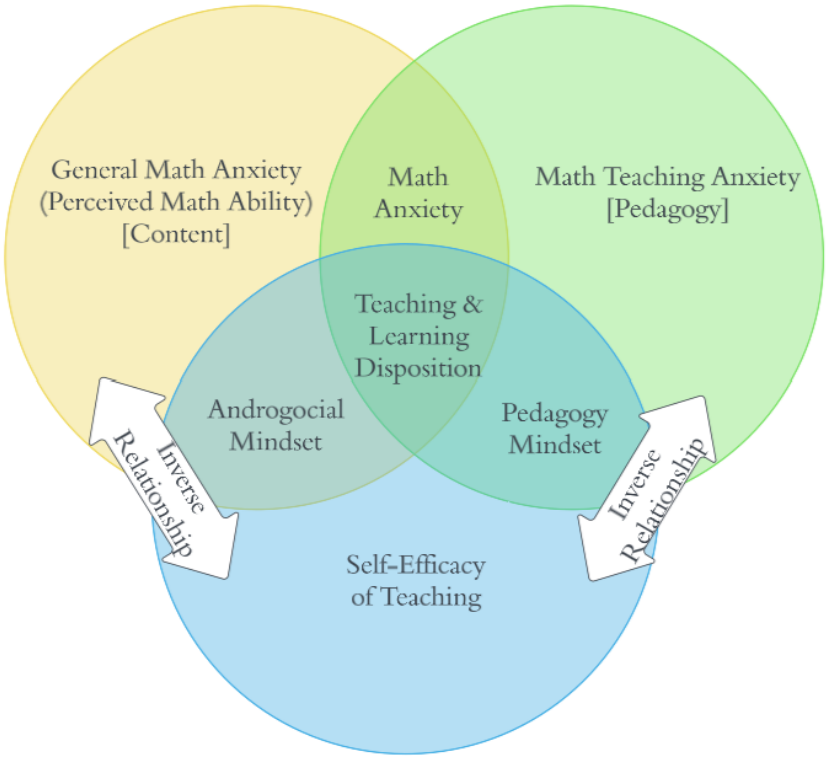

Figure 1 The Framework Model

Self-Efficacy of Teaching

One of the lenses this study looks through is the area of self-efficacy. Albert Bandura (1996) defined self-efficacy as beliefs in one's ability to succeed. The teacher's own self-efficacy and teaching efficacy beliefs affect their teaching style; "teachers who believe student learning can be influenced by effective teaching (outcomes expectancy beliefs) and who also have confidence in their own teaching abilities (self-efficacy beliefs) should persist longer, provide a greater academic focus in the classroom (Gibson & Dembo, 1984, p 570)" (Enochs, et al., 2000, p. 195).

The study herein uses the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) to measure a teacher's self-efficacy. The MTEBI consists of 21 items, 13 items

on the Personal Mathematics Teaching Efficacy (PMTE) subscale and eight items on the Mathematics Teaching Outcome Expectancy (MTOE) subscale (Enochs et al., 2000). This study will use the 13 items on the Personal Mathematics Teaching Efficacy (PMTE) subscale to measure the Teaching Efficacy of Teachers.

It is important to note that a teacher who scores higher on the PMTE has a strong self-efficacy or belief in their teaching. While a teacher with a lower score does not believe that their teaching is as effective as other teachers (Enochs et al., 2000).

General Math Anxiety (Content)

Someone who experiences General Math Anxiety is considered anxious about the math content, exhibiting fear of doing math-related problems or activities. For some, this General Math Anxiety is triggered by being forced to stand in front of the classroom unable to solve a problem or not knowing where to start. In extreme cases, General Math Anxiety stems from parents, siblings, or teachers calling them "stupid" or even people throwing or hitting students with their math work(papers) when the student could not solve or start the math problem(s) (Fiore, 1999). For other students, it was the timed math test from elementary or being called on without proper think/wait time before being required to answer a question. There is no clear universal explanation why some people develop Math Anxiety.

While it is possible that teachers' anxiety extends from experiences as a mathematics learner, teachers' Math Anxiety may also be present in various other forms. This may include a teacher having to solve math problems themselves, or because of the feeling of teaching challenging math problems. While the processes may not appear to be different, they represent different perspectives across the teaching-learning continuum.

There are four layers to Math Anxiety including General Anxiety which include emotional, worry and social anxiety and then the anxiety about teaching mathematics (Ganley et al., 2019; Looney et al., 2017; Ramirez, G. et al., 2013; Ramirez, Gerardo, 2016; Ramirez, Gerardo et al., 2018; Richardson & Suinn, 1972; Suinn, 2003). Ganley (2019) defined General Math Anxiety (GMA) as "anxiety about oneself doing math" (p. 2). Much of the success in measuring GMA came with the development of the MAST, which was the first questionnaire developed to measure practicing teachers' math anxiety. Surveys that were used to develop the MAST were the Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972), shortened version sMARS (Alexander & Martray, 1989) and the MARS-R were developed to measure students' math anxiety. Ganley completed a Construct Validation of the Math Anxiety Scale for Teachers study in 2019. This was the basis for use of the instrument in this study, as this study focuses on practicing teachers' math anxiety.

Adults must take concrete math concepts they learned in school and apply them to the world of life, which is often more abstract than what is common in educational settings and may have variables not previously known to exist. Some adults struggle to balance their checkbook, others do not understand how credit cards work, and yet there are others who are able to work the stock market to their fullest potential. Fiore (1999) described one student who was a police officer for 10-years and stated, "none of her experiences as a police officer frightened her as much as entering her first college-mathematics class (p. 404)." This demonstrates that General Math Anxiety affects people years later. With all these examples, it is not surprising that teachers who have high math self-efficacy and low math anxiety tend to teach science and mathematics, while teachers

with elevated levels of math anxiety are teachers who use math less frequently (Yildirim & Gurbuz, 2017).

General Math Anxiety is measured by the Math Anxiety Scale for Teachers, the subscale of perceived math ability for the study herein. This consists of twelve items on The Math Anxiety Scale for Teachers (MAST) and has two subscales: 1) teachers' own teaching practice and perceived math's ability and 2) teacher's anxiety concerning their pupils (Yildirim & Gurbuz, 2017). For this study, we use subscale one to measure the General Math Anxiety (GMA) of teachers and subscale two to measure the Anxiety Teaching Math (ATM) of teachers.

Math Teaching Anxiety (Pedagogy)

Math education has shifted methods in the last 20 years. The National Council of Teachers of Mathematics (NCTM) has provided guidance for teachers through Principles and Standards for School Mathematics (2000), Principles to Action (National Council of Teachers of Mathematics, (NCTM), 2014), and Catalyzing Change (National Council of Teachers of Mathematics, 2018). Parents, who were students before standard guidance, were taught more procedural or concrete mathematics while their students are taught a more conceptual or abstract math education. Both policy and parents make a significant difference in the education of students. "We recognized that we could not fully take into account the larger cultural environments affecting both parenting and policy making" (Heuveline et al., 2010), p.1365). Beatty (2013) also states that out-of-school factors have causal connections with academic success. As active teachers, educational policies, and communication with parents are an integral part of day-to-day life.

This research study extends to practicing teachers at the elementary and secondary school levels. Most research about Math Anxiety focuses on pre-service, early career and elementary teachers (Bekdemir, 2010; Gresham, 2009; Gresham, 2018; Gresham & Burleigh, 2019; Haciomeroglu, 2019; Hadley & Dorward, 2011b; Hughes et al., 2019; Isiksal, 2010; Tootoonchi, 2017), little research has been done on practicing in-service teachers, and even less has been completed on secondary teachers.

Anxiety Teaching Math for this study is measured by seven items on the Math Anxiety Scale for Teachers (MAST) has two subscales: 1) teachers' own teaching practice and perceived math's ability and 2) teacher's anxiety concerning their pupils (Yildirim & Gurbuz, 2017). For this study we use subscale one to measure the General Math Anxiety of teachers (GMA) and subscale two to measure the Anxiety Teaching Math of teachers (ATM).

Teachers need sustained support and often need additional training in basic strategies in language development and interventions. Early intervention is critical, although intervention that comes later in a student's academic careers is still beneficial (Beatty, 2013). Teachers who have taken additional method courses show lower Math Anxiety levels (Gresham, 2008).

Intersection of Self-Efficacy and Content (Mindset)

Teacher self-efficacy and mindset are related, though slightly different based on the teacher's levels of self-efficacy and if the teacher has a fixed or growth mindset. Students and teachers need both self-efficacy (belief in their ability to accomplish a task) along with a growth mindset (belief that with effort, their ability to accomplish that task will improve) (Bandura & Barbaranelli, 1996; Dweck, 2008). Which can be summarized

down to “belief in one's abilities to affect a successful outcome in any given situation” (Anderson & Schuh, 2021). Bandura (1977) found that efficacy was based on four sources: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal; each had different modes of treatment to operate that would increase self-efficacy. Bandura continues to state that self-efficacy can change based on motivational and behavior process as well as subject matter, format of the presentation and the type of audience that will be addressed. Teachers may have a high self-efficacy in their teaching strategies themselves and have low self-efficacy in mathematics or high General Math Anxiety which will affect their mindset as a teacher.

The ability to believe in oneself is also a form of mindset. There is a fixed or growth mindset (Dweck, 2008). There is also what can be considered a mathematical mindset (Boaler, Jo, 2016). Both mindsets focus on the ability to teach yourself or to push yourself through difficult situations- the “power of yet.” Adults who are learning to teach themselves are using andragogy skills. Teachers who develop methods and practices to teach themselves to be better teachers also use andragogy skills. Teachers are known for their life-long learning and willingness to learn new skills on their own.

Boaler’s Mathematical Mindset provides teachers with multiple ways to build students’ mindset into a growth mathematical mindset. Both Dweck’s (2008) and Boaler’s (2016) research established that learning occurs when we make a mistake, even if we are not aware of it, because when the brain is challenged is when the brain grows the most.

Intersection of Content and Pedagogy (Math Anxiety)

Is there a difference between knowing math and teaching math? Are teachers anxious about math content or math instruction/pedagogy? Yes, teachers can have anxiety about teaching mathematics called "Teaching Math Anxiety" and/or they can have "General Math Anxiety" which is anxiety about doing math (Yildirim & Gurbuz, 2017).

Teachers, as mentioned before, need the content knowledge to teach math and the pedagogical knowledge to know how to teach math. Just because a person is 'good' at math does not mean they will be a good math teacher- vice versa if a person were 'bad' at math does not mean they would be a bad math teacher either. The experiences shared by one who told the author they became at math teacher because their schoolteacher told them they were horrible at math as a student and became a math teacher because they understood that math was important and wanted to help others learn the content (Hadley & Dorward, 2011).

Teachers build relationships, make connections, and refine their pedagogical thinking continuously. Teachers develop action plans to address involvement, engagement, and participation from students. Teachers are expected to follow best practices for pedagogical instruction and are asked to re-examine the curriculum and policies searching for connections and ways to integrate vocabulary and real-world scenarios to provide opportunities for ALL students to learn whether this is through professional development or a guided book-study (White-Hood, 2017).

Intersection of Self-Efficacy and Pedagogy (Pedagogy Mindset)

One of the most significant problems teachers must compete with is the "misconception about mathematics that is pervasive and damaging—and wrong—is the idea that people who can do math are the smartest or cleverest people. This makes math failure particularly crushing for students, as they interpret it as meaning that they are not smart" (Boaler, Jo, 2016). Teachers who believe they are good at math and good at teaching tend to have more inclusive classroom settings. Whereas teachers who may have lower teaching self-efficacy and higher anxiety teaching math may use their growth mindset and strong teaching skills to reduce their anxiety. Teachers with higher anxiety about teaching could have a negative effect on their student's abilities to learn mathematics (Hadley & Dorward, 2011).

Pedagogy Mindset is be measured by the Mathematics Teaching Efficacy Believe Instrument (MTEBI) and the Math Anxiety Scale for Teachers (MAST) subscale of anxiety teaching mathematics to measure teacher's anxiety concerning their pupils and the semi-structured interview questions to determine teachers' perception of their own math ability impact their math instruction and if the experience teachers have with mathematics influencing their math instructional practices? This portion of the study herein compares the quantitative data from the MTEBI and MAST with qualitative data from the semi-structured interview to find commonality between teachers' abilities and experiences that influence their math instruction.

Math Anxiety in Teaching

This study will focus on PK-12 teachers who are actively teaching in the classroom. The teacher's math anxiety, self-efficacy, and experiences influence their math

instruction. There have been studies to measure a teacher's self-efficacy level, their math anxiety levels based on their General Math Anxiety or Teacher Math Anxiety, and teachers' pedagogy methods for instruction. For this specific study, we will focus on Math Anxiety in Teachers who are actively teaching (Gresham, 2008).

Several studies have been done to measure or determine relationships amongst Math Anxiety. There are several forms of the Math Anxiety Rating Scale (MARS). The four versions this researcher focused on were the Math Anxiety Scales for Teachers including the Turkish 33-Item (Yildirim & Gurbuz, 2017), the 19-item (Hunt & Sari, 2019) the 15-item (Ganley et al., 2019), and the single item rating scale (Núñez-Peña et al., 2014). Each rating scale was used with pre-service teachers and college students. The 19-item and 15-item rating scale had reliability and validity studies completed specifically for teachers (Ganley et al., 2019).

The survey for this study is the Math Anxiety Scale for Teachers (MAST). The MAST is a 19-survey scale, with one study reducing it down to 15-items. The Math Anxiety Scale for Teachers (MAST) was used for this study because it has been used in other research with in-service teachers and it collects on two points: the teachers perceived math anxiety and the teacher's math skill perceptions. More information about the instrumentation for this study will be in Chapter 3 in the instrument section.

Based on the framework and the problem outlined in the study herein, the following question(s) were developed for investigation.

Research Question(s)

The goal of this study is to determine the teacher's experiences that have caused math anxiety for them or how they mediate the factors of math anxiety. Based on the model above, the following questions are offered for exploration:

Research Question: What is the relationship between a teacher's self-efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy)?

Decomposition Question 1: How does a teacher's own teaching self-efficacy correlate to their general math anxiety (content)?

Decomposition Question 2: How does a teacher's own teaching self-efficacy correlate to their anxiety teaching math (pedagogy)?

Decomposition Question 3: How does teachers' perception of their own math ability relate to their math instruction?

Decomposition Question 4: How do the experiences teachers have with mathematics influence their math instructional practices?

Operational Definitions

Math Experiences are the description of experiences when participants explain how they manipulate numbers or solve problems in real-world situations. This is measured by comparing the qualitative data from the MTEBI and MAST with qualitative data from the semi-structured interview to find commonality between teachers' abilities and experiences that influence their math instruction (Gresham, 2008).

Self- Efficacy as defined by Bandura as a belief in one's ability to succeed. For this study, we measure using the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI**)-** The MTEBI consists of twenty-one items, 13 items on the Personal

Mathematics Teaching Efficacy (PMTE) subscale and eight items on the Mathematics Teaching Outcome Expectancy (MTOE) subscale (Enochs et al., 2000). For this study, we are using the Personal Mathematics Teaching Efficacy subscale to determine the teacher's self-efficacy level.

General Math Anxiety (GMA) is defined Teachers' own teaching practice and perceived math's ability as measured by subscale 1 of the Math Anxiety Scale for Teachers (MAST) (Yildirim & Gurbuz, 2017).

Perceived math ability can be closely related to test ability (Jansen et al., 2013). For the study herein, we use the Math Anxiety Scale for Teachers (MAST) to determine teachers' perceived math ability. This measures teachers' levels of General Math Anxiety-content anxiety (Hunt & Sari, 2019).

Anxiety Teaching Mathematics (ATM) is defined as a teacher's anxiety concerning their pupils and for this study is measured by seven (7) items on The Math Anxiety Scale for Teachers (MAST) subscale 2 (Yildirim & Gurbuz, 2017).

Influencing teacher math instruction from problem-solving instruction to more inquiry standard-based instruction, influences students' attitudes and achievements (Hughes et al., 2019). This is measured using a semi-structured interview protocol.

Purpose

The purpose of this study is to understand the relationship of math anxiety in teachers through their Self-Efficacy Theory, General Math Anxiety (Content), and Anxiety Teaching Math (pedagogy). The impact of this study may be on teachers who teach math and those that have created strategies to cope with their anxiety about math. The social impact of this study is to find strategies and practices that assist students to

develop math understanding with or without creating anxiety about math. This study may support advances in research exploring relationships among practicing teachers' math anxiety, pedagogy, and self-efficacy.

Have you heard people say "Oh, I don't do math" or "Math really isn't my thing." Statements like this have caused a phenomenon of math anxiety which has allowed people to believe only certain people are good or able to do math (Boaler, J., 2018). The "formal education system seems unsuccessful at educating students to an adequate level of 'numeracy,' the mathematical equivalent of literacy" (Ashcraft, Mark H., 2002), p. 181). However, the U.S. culture fosters math anxiety: Math is thought to be inherently difficult; aptitude is considered more important than effort and being good at math is unimportant, or optional (Ashcraft, Mark H., 2002).

Therefore, the purpose of this study will be to discover the factors of teachers' math anxiety. Determine if it is the perceived math ability(content) that led to the teachers' anxiety or is it teaching of math(pedagogy) that causes their teacher anxiety. Although the cause of math anxiety is not determined, there are teaching methods that are implicated as risk-factors. Teachers have a lot of power over students' success, especially in elementary grades. This power influences students' self-esteem and their belief in what they can do or accomplish. Preventing and overcoming math anxiety begins with teachers and strategies that develop a positive and realistic self-concept around mathematics (Fiore, 1999).

Chapter 2: Literature Review

Introduction

This literature review was structured first on what is math anxiety the definition, what math anxiety is that teachers have, what math anxiety is to teach mathematics, and how a teacher's self-efficacy in their math teaching ability. So, research on mathematics, as it relates to the preservice and in-service teachers, was a way to establish a foundation of how mathematics anxiety affects teacher practices (Gresham, 2018).

The Math Anxiety literature focuses on beliefs of teachers, elementary pre-service teachers, and teacher's' math ability. Based on the review of literature, the Math Anxiety Scale for Teachers included items to assess both General Math Anxiety and Anxiety of Teaching Mathematics. General Math Anxiety is defined as feelings of anxiety that happens when one is completing or thinking of math activities. Then, Anxiety of Teaching Mathematics is defined as feeling of anxiety while teaching math to others (DENİZ & ÜLDAŞ, 2008; Ganley et al., 2019).

This study will not focus much on the gender differences associated with mathematics or math anxiety, as that was not a primary focus in this study. This study's focus was the content and pedagogy of mathematics including the performance and instruction that teachers may have experienced with mathematics in relation to teachers' math anxiety.

What is Math Anxiety?

General Math Anxiety and Anxiety of Teaching Math are two distinct constructs that have been evaluated as found by researchers (Hadley & Dorward, 2011b; Liu, 2008; Pamuk & Peker, 2009; Peker, 2006) development instrument to measure anxiety of

teacher math, though these instruments were evaluated with pre-service teacher not practicing teachers (Ganley et al., 2019).

Math anxiety has three dimensions: environmental, mental, and personal. These dimensions are classified as situations, individualized, and reason for personal benefits. The negative effects of anxiety occur when there are family pressures, students, and teachers, who are not confident in their abilities and concerned with only success. General characteristics of anxiety can be measured by test and shown in cases of certain stimuli (DENİZ & ÜLDAŞ, 2008).

Ashcraft and Faust (1996) found that math anxiety differences between men and women were small, though may be more apparent in highly selected groups (e.g., college students). Though women score a slightly higher-level of math anxiety, this could be attributed to women's greater willingness to disclose personal attitudes (Ashcraft, Mark H., 2002; Ganley et al., 2019; Gresham, 2008; Maloney et al., 2013).

Justification of the Framework

Teaching experience seems to function as a buffer against anxiety and specific attention should be focused on the teacher's anxiety when there are concerns about student math understanding and performance (Hunt & Sari, 2019). Therefore, this study's purpose will be to discover the experiences of teacher's math anxiety to determine if it is the perceived math ability that led to the teachers' anxiety or is it the teaching of mathematics that causes their teacher anxiety. There are various perspectives about math anxiety: math content and teaching related. This study will focus on the teacher's perspective of teaching mathematics and the experiences teachers have while teaching math.

> Anxiety has been found to be one of the most prevalent and emotional problems associated with mathematics. Problems associated with mathematics have been studied intensely but there is still no clear answer as to the nature and causes of this anxiety (Balogˇlu & Koçak, 2006, p. 1331).

Mathematics anxiety is not a cut and dry topic. Researchers need to consider mathematics involvement and be careful with considering age and gender of participants (Balogˇlu & Koçak, 2006). There are multiple experiences which impact math anxiety in teachers and students.

The mean score for the Single Item Math Anxiety Scale (SIMA) with a sample of 279 college students was 5.18 (SD= 2.43), with a range from 1 to 10 for the data set. Women showed higher levels of anxiety, though not statistically significant compared to men ($t(277) = 0.778$; $p=0.437$) (Núñez-Peña et al., 2014).

The overlap of research suggests that a Venn Diagram best conceptualizes the research as a combination of these three parts: Self-Efficacy of Teaching, General Math Anxiety (content), and Math Teaching Anxiety (pedagogy).

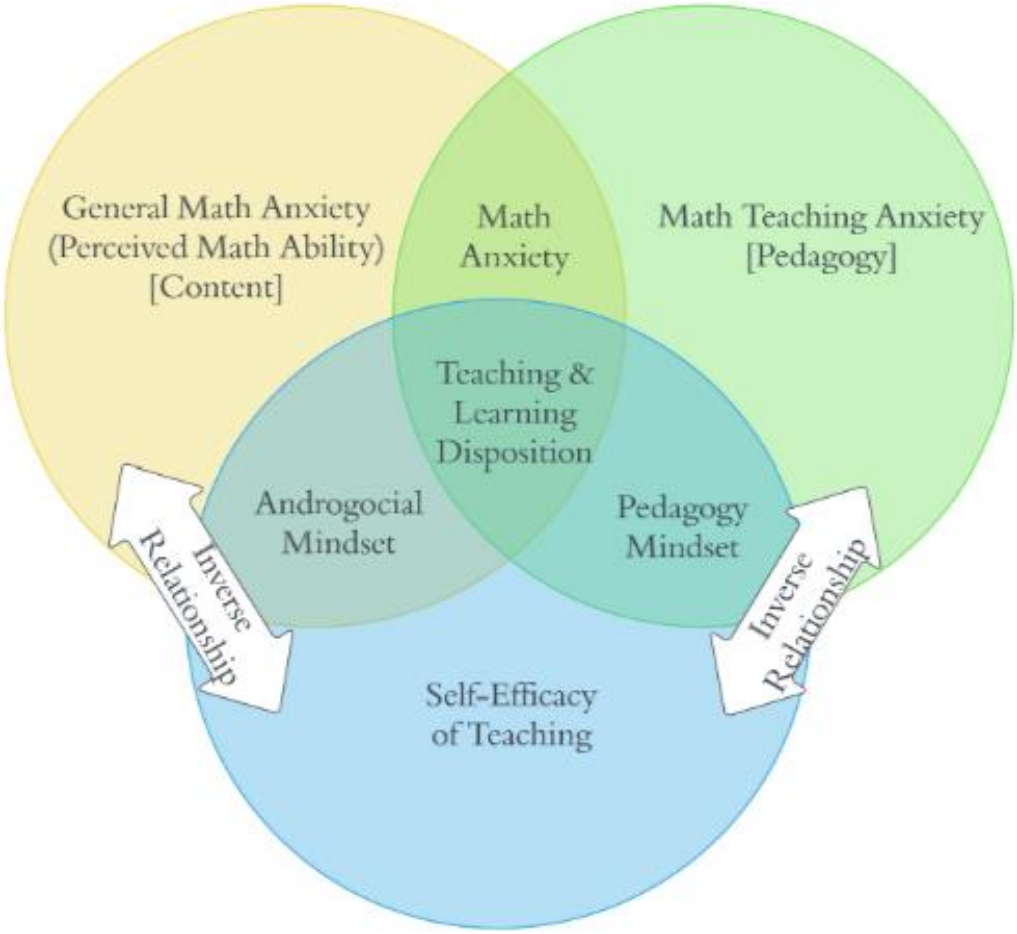

Figure 2 The Framework Model

Self-Efficacy of Teaching

The academic success and career preferences of the community are based on the impact of their anxiety (DENİZ & ÜLDAŞ, 2008). Perceived math ability and math performance is related to math anxiety studies (Hembree, 1990; Jansen et al., 2013). Teachers experience a range of positive and negative emotions while teaching including meeting students' needs, content they teach, and their ability to teach. Research shows that emotions matter related to teacher quality and students' emotions. Math anxiety is an important emotion to consider in teachers and students (Ganley et al., 2019; Xenofontos & Andrews, 2020).

General Math Anxiety (Perceived Math Ability) [Content]

In 1986, Shulman's notion of pedagogical content knowledge was developed suggesting that there is specific content knowledge unique to teaching. This content knowledge bridges the notion of content knowledge and practices of teaching (Ball, D. L. et al., 2008). Shulman refers to content knowledge as the "amount and organization of knowledge per se in the mind of the teachers…. represent content knowledge: Bloom's cognitive taxonomy" (p. 9) and content knowledge requires more than basic facts and concepts of the content. Content knowledge requires a conceptual understanding of the application of the content (Ball, D., 2005; Shulman, 1986) .

"Content knowledge is immensely important to teaching and its improvement" (Ball et al., 2008, p. 404). Improvement leads to increase student achievement, different teacher development, and informs the design of support materials for teacher education and professional development (Ball, D. L. et al., 2008; McMinn et al., 2021). Bandura (1993), states that those who have sense of efficacy visualize positive outcomes and supports, and those with lower efficacy has more self-doubt.

Perceived Math Ability is closely related to test anxiety. There is a relationship between perceived competence and academic performance. Though when students are given explicit instruction and practice math content overtime their general math anxiety decreases, and their perceived math ability improves. Though, researchers agree that failure in math content impedes students' ability to perceive themselves as successful. Perceived ability is related to self-efficacy and self-concept. It is debated whether anxiety and ability are related or independent constructs. Though studies, including the current study, demonstrate that there is some relationship between both Perceived Math Ability

and Math Anxiety (Faust, M. W. et al., 1996; Gresham, 2009; Hembree, 1990; Jansen et al., 2013; Lee, 2009). Positive attitudes towards math predicted perceived efficacy better than a person's actual ability to complete the math task, that there was also fluctuation in a person's self-efficacy based on their perceived ability (Bandura, 1993). Therefore, a teacher perceived math ability and General Math Anxiety may influence teachers' pedagogy and their teaching practices.

Math Teaching Anxiety [Pedagogy]

When describing pedagogy this study has a focus on math pedagogy, which implies math teaching. To become a teacher, there is a teaching education program and field experiences to 'teach' students how to become teachers (McDonnough & Matkins, 2010). Though it is important to note that just because you were once a student does not mean you know about teaching. Teaching is more than just lecturing students the content, the skill of sharing information in which students can recall and apply the information is a skill few people have, and there is an art to this skill.

Shulman (1986), reports that people know content and pedagogy is secondary or that one knows pedagogy and it not held accountable for content. Therefore, teacher development must decide what to teach, how to teach it and how to assist struggling students. Teacher preparation must focus on subject matter content knowledge, pedagogical content knowledge, and curriculum know (Smith, C. J., 2016).

Developing teaching mathematical and pedagogical content knowledge included knowing what concepts are easier or harder for students to grasp and how to connect topics together is vital for teacher preparation (Hill et al., 2004). While the curriculum knowledge is knowing what content is needed to be taught within the school year and

what material is susceptible to forgetting. The methodology between pedagogy and curriculum knowledge requires teachers to be prepared to the lesson with clear understanding of the content and the strategies that transform their knowledge into teaching (Hill & Lubienski, 2007; Lebak, 2023; McDonough, 2018; Shulman, 1986).

Math Anxiety in Teachers

Math education research has explored math anxiety in pre-service elementary teachers. Focused on emotions of math anxiety and feelings felt in assessment situations (Stoehr, Kathleen, 2017), the practice of teaching reflections and support of a knowledgeable mentor/peer have the ability to enhance students' knowledge (Jakopovic & Gomez-Johnson, 2021).

One way to quantify the difference between high and low math anxiety among teachers is to consider the raw data for emotionality for lower elementary teachers show that 22% of teachers have an average score at or about the midpoint (3), but this is for upper element(Ganley et al., 2019), this means elementary teachers who teach grade 4-6 tend to have lower math anxiety than elementary teachers who teach kindergarten or first grade.

There has been no work to explain the relation between math anxiety and belief of math teaching and learning among practicing teachers, though negative educational experiences in math correlate with math anxiety (Çenberci, 2019; Hembree, 1990; Hunt & Sari, 2019; Peker, 2006) and teachers with high math anxiety believe to have less math competence and lowers problem solving instruction (Ganley et al., 2019) which is Anxiety for Teaching math (Liu, 2008). Research also suggests that with training,

interventions, and experience, math anxiety overall will decrease (Balogˇlu & Koçak, 2006; Hunt & Sari, 2019).

Teachers have developed daily routines, use of cooperative learning groups, encourage students to write their understandings in the way they feel most comfortable. Using a variety of teaching methods and practices which are beneficial for all students, in one study the implementation of such practices made not only a difference in their math anxiety but also the teachers' math anxiety level (Schoen et al., 2019). Mostly the lack of math confidence in teachers and students made them resist trying math content, so confidence has a profound effect on math anxiety level (Gresham, 2018). Maloney, Schaeffer, and Beilock (2013) determined that math anxiety influenced math learning and blocked student learning. Math anxiety can be caused by a single humiliating experience, or it can be through the lack of understanding over time; this often leads to the avoidance of subjects involving math which creates negative self-confidence towards mathematics (Omoniyi Israel & Peter Olubunmi, 2014). Therefore, staff specific mathematics instruction and intervention helps students and teachers improve their mathematics performance, although no cause or explanation of math anxiety, it's believed that the parents and teachers' attitudes as it is transferred to students based on the non-standardized based instructional practices and focusing on how we were taught when we were students and creates a repetitive cycle.

The National Council of Teacher of Mathematics (NCTM) (2014) have strongly encouraged teachers to use mathematic understanding to make connections with students, in reality, teachers with math anxiety spend most of their time learning and practicing procedure knowledge and have little confidence in teaching mathematics. Therefore, it is

important for teachers to understand the curriculum and have methods courses that help them teach mathematics effectively. Manipulatives also help bridge that gap from a concrete understanding of 2 + 4 to the abstract of what it really means to have two things plus four things implementing various teaching practices that help build students' confidence and mathematics. Another commonality found among math programs is that the material was gone through very slowly and they did not use any prior knowledge, but students were not encouraged to share their learning and their thoughts on how they learned (Gresham, 2018).

Contemporary Findings

Studies with Pre-Service and Elementary Teachers

Anxiety for Teaching Mathematics is the same for grades 1-6, General Math Anxiety increases for lower elementary teachers. National Center for Education statistics 2017 indicated that less than 5% of Elementary teachers have strong math background. William Kelly (1985) believed that teachers with math certification had a lower level of Math Anxiety.

Elementary teachers with higher levels of math anxiety spend less time on math instructions and have classrooms with decreased participation of students in math activities (Ganley et al., 2019). Studies have shown that college students who study elementary education have higher levels of math anxiety (Hadley & Dorward, 2011a; Hembree, 1990; Kaasila et al., 2012; Kelly, 1985).

Gender Difference in Math Anxiety

While teaching is primarily a female profession, especially elementary teaching, women tend to have slightly higher math anxiety (Stoehr, Kathleen, 2017). Women tend

to have increased Math Anxiety. Multiple sources suggest Math Anxiety influences instructional practices and reported that female teacher predicted poor math performance of female students (Beilock, 2010; Ganley et al., 2019; Stoehr, K. J., 2016).

Miller and Bichsel (2004) explored the gender differences in relations between math anxiety and math performance. They found math anxiety impacts visual working memory and the gender differences were moderate. Males' math anxiety affected their basic math performance more than females, while males applied math performance was not affected.

While education is considered a teacher's job or primary a women's job. It is important to remember parents are students' first teachers in life. Parental involvement in students' education developed students who later become teachers.

Parental Involvement

The relationship between education-related parental practices and children's academic achievement is associated with student math anxiety. Though parental practices are associated with higher mathematics achievement at the end of 5^{th} grade. While families with higher poverty, higher unemployment, and lower- education neighborhoods showed positive effects when parents participated in students' education (Greenman et al., 2011).

Student's math self-concept and achievement increased when parents had an education and had a number of books in the household (Yoshino, 2012). Parents with higher education level had students with increased academic performance.

Math Anxiety as Students

Many student studies have focused on the fact that female students have higher math anxiety and lower math achievement scores as found in Hadley & Dorward (Hadley & Dorward, 2011b), also that elementary teachers tend to have a higher level of math anxiety. There are numerous studies (Bekdemir, 2010; Ganley et al., 2019; Gresham, 2008; Gresham, 2009; Mizala, 2015; Pamuk & Peker, 2009) stating that pre-service teachers tend to have higher math anxiety, which is normally due to lack of mathematical experience and education which leads to math anxiety. Most importantly negative teacher attitudes about math lead to mathematical anxiety.

Students' memory is subjective to emotions, like anxiety, and affects student recall of information and memories. Students' emotions while learning not only effect the present and past circumstances but also forecast the future of student learning if a student feels anxious about math as a middle school student that feeling will persist if there is not an intervention to negate these feelings of anxiousness. The anxiety a student has about math as a 12-year-old will perpetuate and grow as they age (Ashcraft, M. H. & Faust, 1994).

In Vukovic, Kieffer, and Bailey(2012), they studied 113 second grade students into third grade students and how math anxiety affected their math performance. Showing that math anxiety increases as students age up, especially in the area of math calculations. Showing that students need to be adequately supported in managing their math anxieties and building their mathematical application skills. It is imperative that intervening in early childhood before negative experiences with math content and repeated emotions of worry and tension towards math persist.

They found that math - anxious students participated less in class and avoided math majors (Faust, Michael W. et al., 1996; Hembree, 1990; Vukovic, 2012).

Negative Math Experiences as Students

Experiences as students deeply impact students and future teachers. Bekdemir (2010), Jansen (2013), and Stoehr (2017) found that negative experiences with math contribute to math anxiety. These negative experiences increase math anxiety in students and have a lasting impact into adulthood (Fiore, 1999; Mizala, 2015)(Fiore, 1999; Mizala, 2015).

As described earlier, Fiore had a student who was a police officer for 10-years and stated, "none of her experiences as a police officer frightened her as much as entering her first college-mathematics class (p. 404)." This student shared that in school they had multiple negative math experiences.

Bekdemir completed a study with pre-service teachers related to negative experiences in math classrooms while they were students. Showing math anxiety occurs initially in grades 3 and 4, grades 9-11 and first year of college, as people create a relationship between these negative experiences and their teachers from the past (Bekdemir, 2010; Hembree, 1990; Stoehr, K. J., 2016).

Developing a math anxiety cycle between teachers and students, the teacher exhibits anxiety about teaching mathematics, the student had negatived experience in mathematics and then become teachers who are not confident in their teaching of mathematics and the cycle of math anxiety is perpetuated (Bekdemir, 2010).

Teacher's Self-Efficacy on Their Math Teaching Ability

Math Anxiety and math performance are related (Ganley et al., 2019). "Math - anxious people also espouse negative attitudes toward math and hold negative self-perceptions about their math abilities. These correlations between math anxiety and variables such as motivation and self-confidence in math are strongly negative, ranging between -.47 (Ashcraft, Mark H., 2002) p. 182). Ashcraft focuses more on the cognitive components of math anxiety than the origin.

Research suggested that teacher math anxiety was malleable facet that explained variably in teaching practices and student outcomes. First, research needed a well-validated instrument like the MAST to measure this populations math anxiety, especially for practicing teachers (Ganley et al., 2019).

Teachers should also have positive disposition toward the subject. Their student' self-confidence and motivation can be impacted by the teacher's self-efficacy and their perspective on their teaching ability (DeWitt, 2022). The lack of collective teaching efficacy may be the cause of lack of teacher retention in the educational setting.

Teacher Retention

It would be remiss of this study to not mention the teacher shortage crisis the Unites States is currently in. The ability to develop and retain teachers has been difficult, the ability to develop and retain teachers of mathematics (STEM) teachers is significantly more difficult. While this study does not aim to assist in this area of need- the hope is that if we can assist in developing quality math educators and instructional practices, this will increase teacher retention over time. (Jakopovic & Gomez-Johnson, 2021).

The Standards of Preparing Teachers of Mathematics have some assumptions in chapter 1 about mathematics teacher preparation: 1) Ensuring success of every student required integrated focus on equity in every program, 2) Teaching mathematics requires careers-long learning, 3) Learning to teach mathematics requires focus on mathematics, 4) Multiple stakeholders must be responsible and invested in preparing teaching of mathematics, and 5) Those involved in math teacher preparation must be committed to improving their effectiveness in preparing future teachers of (Association of Mathematics Teacher Educators, 2020). While chapter 9 focuses on ensuring preparations for teachers of mathematics is cyclic in nature. First, there must be a vision, access to context, change in strategies, refine strategies, plan next steps, disseminate to teachers, and then ensure sustainability,(Association of Mathematics Teacher Educators, 2020). Which are similar to how teachers prepare students to learn mathematics through teaching. This has led to a reform in education in the last 20 years.

Reform in Mathematics Education

Since No Child Left Behind (2001) was revealed to the public, there had been a shift in the paradigm that was education. The spotlight was put on the educational system of the Unites States. It started with Sputnik and the realization that there was an "educational achievement gap" the NCLB legislation was an effort to relieve the tensions of historical inequalities caused by poverty and social factors on educational equality in the country (Ellis, 2008). The Secondary Education Act (ESEA) added reflections and adoptions to the modern perceptions of American Societal needs (Permuth & Dalzell, 2013).

Then came Common Core in 2009, with hopes of addressing the key issue of mathematics proficiency. President Obama gave a speech with statements that it would have incredible impacts of mathematics and science on American Life, that we "can't allow our nation for fall behind" (Permuth & Dalzell, 2013) thus the Common Core standard in mathematics emphasized both a practice need to understand mathematics computations and a conceptual need to understand why these manipulations were possible. While the role of mathematics education will continue full speed ahead, it is important to note the direction of history and the needs of society that will drive the desirable economics and education contest in which the educational institutions revolve (Permuth & Dalzell, 2013). When it comes to reform in mathematics education to reduce inequalities standardized testing and instruction should be addressed, there must be forms of assessments, instruction developed and allow students to make sense of mathematics in flexible, meaningful, and connected ways for themselves (Ellis, 2008).

Reform in mathematics education does not only occur through policies at the federal level, but also through the curriculum and support given at the district level. The infrastructure, teacher leadership, and school practices play a large role in redesigning and instructional reform in math classroom. Through professional development for teacher leaders and coaches, which facilitate teacher interactions about math instruction and lead teachers to increase beliefs which align with the district's mathematics (Hopkins et al., 2013).

Math education has changed over the last 20 years and NCLB, ESEA, and other policies were a driving force that led to NCTM developing Principles to Action to lead

math educators forward through the movement from procedural understanding to conceptual math understanding.

National Council of Teachers of Mathematics

In 2014, NCTM published Principles to Actions: Ensuring Mathematical Success for All which has eight mathematic practices. These include: 1) Establish mathematics goals to focus learning, 2) Implement task that promote reasoning and problem solving, 3) Use and connect mathematics representations, 4) Facilitate meaningful mathematic discourse, 5) Pose purposeful questions, 6) Build procedural fluency from conceptual understanding, 7) Support productive struggles in mathematics, and 8) Elicit and used evidence of student thinking. "Teachers' beliefs influence the decisions that they make about the manner in which they teach mathematics" (National Council of Teachers of Mathematics, (NCTM), 2014).

Then to support teachers further, NCTM published 5 Practices for Orchestrating Productive Mathematics Discussions which included: 1) Anticipating, 2) Monitoring, 3) Selecting, 4) Sequencing, and 5) Connecting. Anticipating focused on predicting student responses or questions they may have throughout a lesson. Monitoring students' actual responses while they work in small groups or pairs. Selecting focuses on having student share their learnings, which can be done in multiple ways, though the goal is to have some control over the conversation to be sure the discussion leads to productive understanding of the concepts that students are to be learning. Then sequencing student responses, much like sequencing tasks, is important. The order in which students share their responses leads to different discussions and teachers want to be mindful of their

objective as they facilitate these discussions. Finally, having students connect the responses with the main mathematical concept for the lesson (Smith, M. & Sherin, 2019).

Again, to foster conversation in the mathematics classroom, NCTM then published Catalyzing Change. The goal of Catalyzing Change is that students should leave high school with mathematics literacy and critical thinking skills to make decisions in their personal lives, not just to prepare them for postsecondary education or a career. The need for students and people in society to be mathematically literate has never been more relevant with polling and data mining in politics, to advertising algorithms on social media, to financial institutions and policies that affect million (National Council of Teachers of Mathematics, 2018).

These NCTM publications are beneficial to this study as they are the pedagogical foundation for which math teachers learn to educate students. These math teaching practices allow for students and teachers to discuss their understanding of mathematics concepts. An effort to reform math education with the NCTM standards the education system will continue to fail if the teachers' beliefs about math education do not align with the math education reform (Enochs et al., 2000). Therefore, it is imperative that teachers receive the professional development they want and need to reform math education.

Instrumentation Background

In 1972, Richardson and Suinn created the Mathematics Anxiety Rating Scale (MARS). A psychometric data which was a 98-item scale composed of behavior situations that were valued from 1-5 corresponding to level of anxiety: 1 assigned to "not at all" anxious and 5 reflecting "very much" anxious." The data from this 1972 study was

normed for the Missouri sample with a mean of 215.38 and a standard deviation of 65.29. The test-retest reliability coefficient using Pearson product-moment coefficient between the two set scores was 0.85. The internal consistency reliability coefficient was 0.97. This shows that the Math Anxiety Rating Scale (MARS) is reliable instrument (Richardson & Suinn, 1972) and is where the MAST was adapted from.

MARS-R used a large sample (*N*= 815), to construct validity of the revised Math Anxiety Rating Scale (MARS-R). The instrument was modified, resulting in the elimination of 12 items, and the fit of the two-factor model was improved considerably. Showing the revised internal consistency reliability coefficients were strong, and good validity was shown with the original MARS-R and other anxiety-related measures. (Hopko, 2003).

The Abbreviated Math Anxiety Scale (AMAS) was to validate this tool in a large sample of Italian primary school children, to confirm the factor structure of the AMAS and to develop standardized norms that can be used in the clinic (Caviola et al., 2017). The AMAS is a shortened version MARS with an internally reliable 25-item scale (Alexander & Martray, 1989; Hopko et al., 2003).The Modified Abbreviated Math Anxiety Scale (mAMAS) also has satisfactory reliability. Both the AMAS and mAMAS exhibited similar properties and respondents had a higher average math anxiety level for children (Carey et al., 2017; Milovanović & Branovački, 2021).

More information about the Single-Item Math Anxiety Scale (SIMA) and Math Anxiety Scale for Teachers (MAST) is discussed in chapter 3 as they are instruments used in this study and were created as reliable instrument for Math Anxiety and Teaching Math Anxiety.

Summary of Literature

The literature about Math Anxiety focused on pre-service/elementary teachers or students. There was little literature about in-service teachers and even less about secondary teachers. The guiding purpose of this study is to determine if there is a relationship between teachers' self-efficacy (Bandura, 2000; Gresham, 2008; Gresham, 2018; Hadley & Dorward, 2011b) and their math anxiety (content or pedagogical). To determine, we need to first understand their math anxiety as they were students and pre-service teachers first (Bekdemir, 2010; Gresham, 2008; Gresham, 2009; Gresham, 2018; Gresham & Burleigh, 2019; Sanders et al., 2019; Stoehr, K. J., 2016; Tootoonchi, 2017). This study is taking what is known about teacher self-efficacy, math anxiety and applying the principles to in-service teachers in a K-12 setting.

Chapter 3: Methodology

This study was completed in two phases. Phase One (1) was quantitative including a Demographic Survey, MTEBI and MAST. Phase Two (2) was qualitative based on the data received from Phase 1. Phase 2 included a semi-structured interview process.

In 2008, Gresham completed a study to investigate the relationship between mathematics anxiety and mathematics teacher efficacy. The investigation described herein was a modified and adapted version of Gresham's study. The key differences between this study and Gresham (2008) were the sample size of Gresham who used 156 Pre-Service Elementary Teachers, while this study used 36 active K-12 Teachers. This study used the Math Anxiety Scale for Teachers (MAST), and Gresham (2008) used the Math Anxiety Rating Scale (MARS). While both Gresham's and this study used a semi-structured interview process, the difference in the variety in those that are interviewed in this study; Gresham only interviewed pre-services elementary teachers, while this study interviewed elementary and secondary teachers.

In the present study, we looked at a whole K-12 district and explored teachers' math anxiety at different preparation and instructional levels. Furthermore, the study then took a closer look at eight (8) teachers, whose math anxiety levels were at both ends of the spectrum (high and low Math Anxiety, elementary and secondary teachers) as there were implications for teachers who have high math anxiety levels and student academic performance (Hughes et al., 2019).

The best way to analyze this information was through a mixed analytic model. The data collection occurred through both surveys and semi-structured interviews.

Quantitative analytics included a demographic survey, the MTEBI, and the MAST (Gresham, 2008; Richardson & Suinn, 1972).

Table 1 Schedule of Events

Action Steps	Timeline
Meet with superintended to get permission to use teachers in study.	Beginning of study
Digitize Phase 1 surveys to allow will-be participants to complete surveys online verse paper formatting.	Hours Completed while working on research for the study.
Meet with teachers to introduce study and administer Phase 1, provide overview of study, explain consent for study and access of surveys.	2 hours Once the study passes proposal and IRB check points.
Review and Analyze phase 1 data to determine which teachers to interview	2-weeks later
Schedule teachers to interview (Phase 2)	2-4 weeks
Interview Teachers	Over a 2-week period use Sign-up Genius for teachers to sign up for a time. Based on researcher and teacher time availability.
Transcribe interview data	2-3 weeks
Analyze Qualitatively- Identify themes and/or patterns (more specifics below)	1-2 months

Procedures

The researcher adapted the paper-pencil version of instruments to an electronic form of the instrument in Qualtrics. This was done to simplify and ease the distribution and data collection from participants to the researcher. The Demographic Survey, MTEBI, and MAST was provided through a QR code at a teacher in-service. Once educators had completed the electronic surveys, data was sorted by math anxiety level and grade level to determine the eight (8) teachers to be interviewed. The purpose of the present study is to investigate relations between experiences and mathematics anxiety after analyzing differences in math experiences (Balogˇlu & Koçak, 2006).

The setting for Phase 1 was during a teacher in-service day; the researcher had 1-hour to present the topic at hand. Participants choose to participate or not, without any repercussions. Participants from the whole district who consented to be participants completed the Demographic Survey, MTEBI, and MAST. Participants could have taken longer than 1-hour to finish, the researcher then analyzed the data before selecting the participants for Phase 2, the interview.

Once the researcher had collected all responses from Phase 1- they determined which eight (8) teachers to be invited to be interviewed for Phase 2. The researcher determined the 8-teachers to be interviewed using the overall composite scores from the MAST. The researcher interviewed these eight (8) teachers individually. The teachers were unknown to the interview until they were selected to be interviewed. The MAST data was collected semi-anonymously. The teachers used their staff ID#'s as identification, the researcher did not have the names to go with the IDs as the data was sorted. This school's administrator kept this information and once the MAST data was analyzed, it was determined who the eight (8) teachers to be interviewed by the researcher would use the staff ID#'s of those to be interviewed were put with their names, and then they received in email an invitation to participate in Phase 2. The interviewees were asked to use a "sign-up genius" to choose a date and time to be interviewed. The sign-up genius had time slots with different time slots for participants to choose from based on researcher availability. The dates available were in-service days, school breaks, and/or before/after school. The interviewees chose a date and time that worked best for their schedules. The researcher met the participant at a location of their choosing (ex. the teacher's classroom or zoom) to conduct the interview.

Phase 1 of Study

Subjects

In this study we looked at a whole district K-12 grades in rural Nebraska and compared their Math Anxiety and Self-Efficacy levels for the district. Then, the study took a closer look at eight (8) teachers, whose math anxiety levels were at both ends of the spectrum (High Math Anxiety vs Low Math Anxiety, Elementary Teachers vs Secondary Teachers).

For General Math Anxiety items, participants were asked to think about when they did math themselves, not in context of their teaching. Whereas as the Anxiety of Teaching Mathematics items, they were asked to think about the context of their pedagogy of the grade/content they were currently teaching in (Ganley et al., 2019).

The strength of claims demonstrated the power of this study was that through a whole district. Teachers at every level had experiences with math anxiety at some point in their education experience. The researcher separated teachers by level (high/low Math Anxiety and elementary/secondary) and saw whether there were patterns within their response to interview questions.

The sample for Phase 1 was the entire district in rural Southeast Nebraska, part of the Midwest in the United States. The district covers 23 square miles and 13 rural townships. In the 2022-2023 school year the district educated 497 students and employed 48 certified teachers and 23 classified staff. The average number of years of teaching experience was 18.76 years. There were 27.03 (56.29%) teachers who had their master's degree in the district. The district's student population includes: 4.36% English Language Learners, 47.48% Students eligible for Free Reduced Lunch, 4.79% qualify for High

Ability Learners, and 23.53% had a verified disability (Nebraska Department of Education, 2023).

Instrumentation

Phase 1 was the quantitative portion of this study. It included a Demographic Survey, the MTEBI and the MAST. In these explorations, the MAST was used to identify teachers perceived math anxiety and the MTEBI to identify teachers' self-efficacy to identify a relationship.

Demographic Survey

The demographic survey was to collect data on participants as to classify as: elementary or secondary educator, years of service, educational level (BS/BA, MS/MA, ED. S, ED. D/Ph.D.) and to determine if they were willing to participate in the interview phase (Phase 2) of this study. The Demographic Survey also asked teachers about what math courses they took in high school (Algebra/Geometry/Both), number of undergraduate math courses and method courses.

The final question on the Demographic Survey was the Single-Item Math Anxiety (SIMA) scale. "On a scale from 1 to 10, how math anxious are you?" (Núñez-Peña et al., 2014, p. 4). The anchors for the scale are 1 (not anxious) and 10 (very anxious) as developed by Ashcraft in 2002 as a more efficient way of measuring math anxiety. The evidence supporting the Single-Item Math Anxiety Scale (SIMA) validity was examined by assessing convergent and discriminate validity. The SIMA scale was a useful tool to gather valid and reliable data of math anxiety (Núñez-Peña et al., 2014).

There was a question about staff ID# as well so the researcher was able to determine who to interview. The list of names and ID#s were only put together once the

MAST composite scores were ranked. The researcher contacted the interviewees directly so the district would not know who was selected to participate in Phase 2 of the research.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) consists of 21 items, 13 items on the Personal Mathematics Teaching Efficacy (PMTE) subscale and eight items on the Mathematics Teaching Outcome Expectancy (MTOE) subscale (Enochs et al., 2000).

The MTEBI was developed for pre-service elementary teachers. The Personal Mathematics Teaching Efficacy (PMTE) has a reliability analysis with an alpha coefficient of 0.88. The PMTE was used as a measurement of teacher self-efficacy for this study. The Mathematics Teaching Outcome Expectancy (MTOE) is a subscale of the MTEBI. The MTOE has an alpha coefficient of 0.75 and is independent of the PMTE. Teachers will complete the MTOE subscale to measure Teacher Efficacy of the MTEBI; the MTOE subscale results were not used in this study.

In Drake (2006), there was a direct relationship between the perceived teacher's efficacy and attitudes towards reform practices. Then Drake (2009) found that having teachers write about their math stories helped teacher orientation and ability to describe their knowledge of beliefs, dispositions, values and actions toward their own learning and teaching. Teachers' perceptions framed the way in which the teacher interacted with students in their classrooms, and they acted upon their perceptions while instructing students. Then the teacher's knowledge of their mindset impacted their capacity to gain new knowledge of understandings (Drake, C., 2009).

The MTEBI was based on Bandura's theory of self-efficacy and applied to teachers. Teachers who believed student learning could be influenced by effective teaching and knew their own teaching abilities (self-efficacy beliefs) (Enochs et al., 2000).

There have been several efficacy belief instruments developed and modification to create the MTEBI. The Science Teaching Efficacy Believe: Elementary Inservice (STEBI-A) instrument has a 0.92 reliability; the Science Teaching Efficacy Beliefs: Elementary preservice (STEBI-B) instrument has a 0.90 reliability; and the Chemistry Teaching Self-Efficacy Beliefs: Middle School Inservice (STEBI-Chem) has a 0.88 reliability (Enochs et al., 2000).

Math Teacher Anxiety Scale (MAST)

The Math Anxiety Scale for Teachers (MAST) was used for this study because it had been used in other research with teachers. The MAST was chosen for this study because it collects on two points: the teachers perceived math anxiety (General Math Anxiety) and the teacher's math skill perceptions (Anxiety Teaching Mathematics). The MAST has a 0.96 reliability (Hunt & Sari, 2019) and has been shown to be a valid instrument.

The first MAST this researcher found was a 33-items version from Turkey and in Turkish, the researcher looked and could not find an English translated version. The researcher was able to find a 19-item MAST and research that reduced it down to 15-items. Items # 2, #5, #18 and #19 were removed from the 19-item MAST. Item # 2 ("I get butterflies in my stomach when I do math problems) for theoretical and interpretations reasons. Item #5 was removed because it had the lowest factors loading in its subscale.

Items 19 and 12 were considered redundant, since Item 19 was “interpreted by some as being a double-barreled” (Ganley et al., 2019), p. 9) and was so removed. Items 17 and 18 were also considered redundant of each other. Item 18 had the lower factor loading and was so removed. Research suggested that they removed the most redundancy in their model (Ganley et al., 2019).

With the 19-item MAST there are two factors: 1) Teachers’ own teachers’ practices (teacher math anxiety perception) and 2) Related to teacher’s anxiety pertaining to their students (teachers’ math skill perceptions). The 15-item MAST considered both of these fact(Hunt & Sari, 2019). There was a difference between Anxiety Teaching Math (ATM) and General Math Anxiety (GMA), and with training, interventions, and experience math anxiety (Balogˇlu & Koçak, 2006; Hunt & Sari, 2019).

The construct validity of the MAST instrument was obtained from over 500 undergraduate students. The MAST instrument was also compared with other math anxiety instruments and found that students who had positive attitudes towards mathematics experiences had less math anxiety (Balogˇlu & Koçak, 2006).

The 15-item MAST can be administered in large studies and can support research exploring relations among practicing teachers’ math anxiety, instruction, and student learning (Ganley et al., 2019) The MAST, a 15-item instrument consisting of Likert-type scales with lower scores indicating greater levels of mathematical anxiety. Cronbach’s’ alpha calculated to be a 0.96, an indication of high internal consistency, along with a determination of test-retest reliability of 0.90 (Suinn, 2003).

The MAST for this research was reduced from nineteen items to fifteen items based on the studies that showed both MAST had similar reliability and validity (Ganley

et al., 2019; Hunt & Sari, 2019). Due to time constraints, it was in the best interest of this study to have used the shorter instrument to use the time of the participants more wisely. It was believed that using the longer instrument, participants may not have given their best input because the length was taken away from their other duties as teachers. The instruments were adopted by the researcher to an online format to make administration of the instrument and data collection more efficient.

Data Collection and Analysis for Phase 1

Participants completed an online demographic survey, MTEBI, MAST, which includes questions about their grade/content taught, teacher certification, personal self-efficacy, general math anxiety and math teaching anxiety. Responses from the MAST determined which teachers are to be interviewed during Phase 2 of this study (Ganley et al., 2019).

The Demographic Survey had itemized scores for each teacher. The MTEBI gave an overall composite score and a subscale score for both subscales. The MAST also gave an overall composite score and then a composite subscale score for both subscales. Each teacher had their own composite scales. Teachers were then grouped into two groups: 1) Elementary and 2) Secondary.

Data was collected via an online survey that contained the Demographic Survey, the MTEBI, and the MAST. These instruments were chosen based on the relevance to the research questions and prominent levels of reliability and validity.

The quantitative surveys for teachers were given as part of the teacher in-service day. The superintendent for the school district emailed all teachers inviting them to the

in-service. Participants were asked to complete the demographic survey, MTEBI and MAST during the in-service day.

After the researcher collected the data and analyzed it by ranking MAST composite scores from low to high, the researcher informed eight (8) select participants on who will be interviewed. To remain unbiased towards the teachers the researcher did not use names; staff IDs were used so the researchers would not actually know who they were selecting for the interview. Then the researcher received the list of staff IDs from the district office assistant to then put the names with the numbers together, for the eight (8) ID#'s that were selected before having received the list of names.

Data was collected for all teachers who completed the quantitative surveys including the Demographic Survey, MTEBI and MAST. Table 2 and Table 3 illustrate the composite scores for the elementary and secondary teachers, respectively. Table 4 shows the composite scores for those who were interviewed. Analyzing the differences between Elementary and Secondary teachers who were interviewed in each of the scales shown in Table 5 helped determine if the level at which a teacher teaches is a factor of math anxiety. An overall average and standard deviations for all teachers, elementary teachers, and secondary teachers was determined once the data collection was completed as shown in Table 6.

Table 7 presents the correlations between elementary teachers' self-efficacy and their math anxiety and the sub-scales. Table 8 illustrates the correlations between secondary teachers' self-efficacy and their math anxiety and the sub-scales.

The connections shown in Table 9 were analyzed to determine if a teacher's self-efficacy is positively correlated with years of experience and if a teacher's anxiety about

teaching math anxiety is negatively correlated with their years of experience. Teachers' General Math Anxiety may change with time as well. While Table 10 illustrates how level of education can influence teachers' math anxiety and self-efficacy.

Determining the number of math classes a teacher took as an undergraduate or specifically methods courses does have an impact on their self-efficacy. Table 11 analyzed if the number of math courses influenced teacher's self-efficacy or math anxiety scores.

Phase 2 of Study

The sample for Phase 2, the semi-structured interview, was eight (8) certified teachers. There were four (4) Elementary teachers and four (4) Secondary teachers interviewed. Those selected and interviewed were based on the teachers' MAST score evaluations and Demographic Survey results, two of each will have scored the lowest and highest on the MAST for both Elementary and Secondary.

Data used multiple statistical measures and using math anxiety levels as the dependent variable to understand the experiences of math anxiety in teachers. Such analysis can estimate a set of independent variables (Creswell, 2006). The analysis identified two (2) groups (low & high math anxiety) and teachers according to years of experience. Math anxiety level and teaching experience were independent variables.

The reason for the split was for comparability. While most studies have been used on elementary teachers, the education sector needs to understand math anxiety at the secondary level as well. The education sector also needs to understand how math certified teachers and non-math certified teachers' math anxiety differs.

Delphi Group Process

The researcher attempted to create a focus group of experts in math education in Nebraska reaching out to 10 experts, returning with 8 willing to participate in a focus group. These experts were all leaders in math education either at the public-school level, state level or collegiate level. Since no common dates worked for 4+ members to meet as a collective focus group, the researcher transitioned from a focus group to a Delphi Group process where the experts worked independently on tasks and the researcher summarized information and shared back with the group for further information collection. The first Delphi Group invitation was sent to eight experts. Of these eight, four chose to participate in the Delphi Group process.

The Delphi Group process members were leaders in math education in Nebraska. The four participating members for the Delphi Group were three collegiate leaders at universities in the field of Mathematic Education: STEM (Science, Technology, Engineering, and Mathematics) Teacher Education; Early Mathematics Teacher Education; Science, Math & Computer Science Education. The fourth (4^{th}) member of the group was a Lifetime Achievement Award winner for the Nebraska Association of Teacher of Mathematics (NATM) which "honor mathematics educators for their contribution to the improvement of mathematics education in the state of Nebraska" (NATM, 2021). The diversity in their expertise in mathematics education and math experiences was vital in this study.

The overall task of the Delphi group process was to create a semi-structured interview instrument for Phase 2 of this study. The researcher first gave the Delphi Group the research questions for this study, Demographic Survey, and the task of brainstorming

interview questions that would gather information for the research questions as well as being sure questions proposed were open ended and experience-based questions for future participants. From these directions, the Delphi Group had two weeks to complete the task of brainstorming potential questions and adding comments to the Demographic Survey or any other thoughts on the study. The group was asked to limit their time to 90 minutes for the task to get their first instincts on the topic and questions. This was to get honest input from the Delphi Group. The researcher waited until all four (4) members had given feedback before reading their feedback, articles, and information they provided. This session returned 26+ unique interview questions, comments about structure of the Demographic Survey and articles that pertained to the "math stories" in which developed the directions of the semi-structured instrument.

The researcher typed up all the interview questions provided onto one document, then reshared the research questions, Demographic Survey, MAST, and the full list if questions provided, as well as "Primarily Math: Math Story Journal (Drake, Corey, 2006) document that explained how stories could be used as the structures of the interview. The group's task for this iteration was to determine which questions would best answer the research questions, allowed for math stories. The researcher also clarified the purpose of this study to the Delphi Group. Again, the group was asked to limit their time to an hour (or 90-minutes maximum)- as first instincts were important to the researcher. They were given three weeks, as they had conferences to present/attend and other time commitments, to review and share their thoughts.

Once feedback from all four members was received, the researcher sorted through the feedback and summarized the information. One member suggested taking the 26

questions and sorting them by research question, then eliminating those that were duplicates or did not pertain to any of the researcher questions. The researcher completed this suggestion and organized the questions for the interview instrument for each research question. After this process, there were 14 questions for the interview instrument which the group determined was still too long of an interview. Question #7 (Can you describe the practices/strategies you use to target/reduce students' [math] anxiety?) and #8 (What practices or strategies do you use in the classroom to reduce anxiety in your learning environment?) were very similar and were merged to become "Can you describe the practices or strategies you use in the classroom to target/reduce math anxiety in your student's?" As the group was split on whether #7 or #8 was better. The researcher took the input from the experts and merged them into one question that the experts could agree on.

The researcher worked with the instrument for two-weeks to review feedback about the MAST and Interview instrument to summarize the information from all group members and shared with the group one final time the interview instrument to get a collective and verified "OK" on the interview instrument from each group member. The experts were happy with the finalized 10-question instrument and thought it did well to get at the experiences of teachers have with math anxiety.

Semi-Structed Interview

The semi-structed interview instrument was developed by using the Delphi Group process made up of experts in mathematics and education as mentioned above. The researcher deemed this method to be a reliable means to develop questions for the interview to be completed with participants of the study.

With Gresham's 2008 study, they adapted questions from the Swars, Daane, and Giesen's 2006 interview protocol. Those questions were based off the MARS and the PMTE subscale of the MTEBI. These questions were:

> a) Do you believe or feel you can teach math effectively? b) What are your feelings towards mathematics? c) What is your level of understanding of K-6 math concepts? d) How comfortable do you feel using manipulatives to teach mathematics lessons to students? e) What would you do to help low and high achieving students? f) What are some ways you would try to motivate students to learn mathematics? Why did you choose these motivational strategies? (Gresham, 2008), p 175).

Which helped gather pre-service teachers' perceptions of their own skills and abilities to teach mathematics effectively- additional questions to follow-up or clarification to responses were asked. As Gresham's study and the study here, both aimed to look at teachers' perceptions of teaching-efficacy and math anxiety, it was important for the researcher to be cognizant of these questions as well as developing the interview instrumentation for this study.

The semi-structured interview was created with a group of experts that went through the Delphi process and brainstorm questions that answered the research questions and then all those questions were then sorted by research question then narrowed questions down to 14 questions after another feedback and it was narrowed down to 10 questions with some sub-questions so that there were some decent follow-up questions that would really get to answer the research questions of this research. The Demographic Survey that was given first to participants was composed of questions: what level they

teach, how long have they been teaching, what classes have they taken (content/ methods), and did they take Algebra, Geometry, or both in high school. Practicing teachers' time is valuable, and they are expected to do so much that the researcher wanted to be respectful of their time and get as much information as they could in the shortest amount of time.

The analysis of the semi-structures interview occurred once all interviews were conducted. The interviews were recorded and then transcribed by the researcher using Microsoft transcription function. The researcher then sent a copy of the transcription to the interviewee for clarification and verification of accuracy.

Once the verification of transcriptions was collected, the researcher analyzed the transcripts and identified key words or themes and organized data into themes and sub-themes as they emerged. The lens the researcher used was through the NCTM (National Council of Teachers of Mathematics) Principle to Actions Mathematical Teaching Practices and The 5 Practices in Practice (Smith, M. & Sherin, 2019). This was also the lens which the researcher also had experienced as a secondary math teacher.

While conducting the interview with teachers, I wanted to keep in mind that NCTM standards of communication problem solving connections representation and reasoning proof and how teachers used that in their classrooms as they share their stories of their experiences. While a semi-structured narrative interview was used, also known as a semi-structured interview, there was a formal discussion and clarifying follow-up questions to understand the experiences that the teachers have had with math anxiety and math anxiety teaching. The style of responses was in “math story” form, as to gather experiences from actual events that had occurred to the teachers. The interviewer

completed field notes and audio recordings of the interviews and discussions. These were used in analysis to contrast and looked for descriptive patterns and anecdotal evidence within the interviews. Participants may have been asked follow-up or clarification questions to responses as needed as noted in the field notes and audio recordings of the interviews and discussions. These were analyzed where data was broken down by asking questions and then comparing similar incidents which were grouped together and given the same conceptual label (Gresham, 2018).

The researcher retrieved the names of the eight (8) participants for the interviews and began scheduling interviews. Teachers were interviewed at a date/time of their choosing from the list of dates and times and at a location of their choice within the district.

Once the interviews were completed, the interviews were for themes based on the experiences and patterns. Once themes were identified and organized, the information was used to make assumptions about how or why Math Anxiety was more prevalent in teachers. Why math anxiety was higher in one teacher than it would be in another teacher. Were there distinct levels of math anxiety based on their content areas?

The goal of analyzing the qualitative data was to determine what had the biggest impact on teachers. The purpose of this study is to identify ways to increase teacher self-efficacy of them teaching mathematics and decrease their anxiety about mathematics content and teaching.

Analysis by Research Question

Research Question: What is the relationship between a teacher's self-efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy)?

To determine the answer to this research question, each decomposition was first measured and analyzed. Once those four were answered a statement about the relationship between a teacher's self-efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy) was determined based on this data. Granted the researcher was aware that the population of this study was not grand enough to make universal statements, but a conjecture can be made to move forward research on teacher math anxiety.

Decomposition Question 1: How does a teacher's own teaching self-efficacy correlate to their general math anxiety (Content)?

This study used the composite score of the 13-items on the Personal Mathematics Teaching Efficacy (PMTE) subscale to measure the Teaching Efficacy of Teachers. It was then correlated with the composite score of the 12-items on the General Math Anxiety subscale. Together a spearman correlation coefficient was determined to understand the correlation between teacher's self-efficacy and their general math anxiety.

Decomposition Question 2: How does a teacher's own teaching self-efficacy correlate to their anxiety teaching math (pedagogy)?

This study used the 13-items on the Personal Mathematics Teaching Efficacy (PMTE) subscale to measure the Teaching Efficacy of Teachers. It was then correlated with the seven (7) items on the MAST-ATM subscale. Together a spearman correlation coefficient was determined to understand the correlation between teacher's self-efficacy and their Anxiety Teaching Math.

Decomposition Question 3: How does teachers' perception of their own math ability relate to their math instruction?

This question was answered using the MAST. Finding the overall and subscales (GMA and ATM) averages, standard deviations, and a Pearson product moment correlation was discovered like the Gresham (2008) study. An analysis of variance was also found for elementary teachers, secondary teachers, low Math Anxiety group and high Math Anxiety group to see if there was a significant difference in the groups.

Decomposition Question 4: How do the experiences teachers have with mathematics influence their math instructional practices?

After completing the eight (8) interviews with teachers, transcripts of the interviews were summarized and sorted by teachers grade level (Elementary or Secondary) and math anxiety level (high or low). The researcher then looked at all four of the low Math Anxiety teachers and identified key words by creating word cloud and determined if there were any descriptive patterns among the four teachers and if there was a difference between the elementary or secondary teachers.

The researcher then analyzed all four of the high Math Anxiety teachers and theme and determined if there were any descriptive patterns among the four teachers and if there was a difference between the elementary or secondary teachers. The researcher then grouped the elementary teachers together and looked for anecdotal evidence or descriptive patterns and then grouped the secondary teachers and determined if there were anecdotal evidence or descriptive patterns that emerged. Also determined if there were patterns that emerged from elementary low or high math anxious teachers.

Once each group had been analyzed separately, the researcher then put all analysis together to see if there were common patterns among all four groups. Also

determining if there was evidence that emerged from secondary low or high math anxious teachers.

Concluding section

The methodology of this research project contained a mixed-data set. The Demographic Survey, MTEBI, and MAST contained quantitative data, while the semi-structured interview contained qualitative data. It was important for the researcher to understand how math anxiety affects all the diverse groups of teachers versus focusing on elementary school which was why the Math Anxiety Scale for Teachers (MAST) was used with the whole PK-12 school district. To really get to the root of the experiences of the teachers who had high math anxiety versus low math anxiety at both the elementary and secondary level, a semi-structured interview was completed.

The reason to find the relationships between teachers' self-efficacy and teachers' math anxiety was to determine what affects these factors. This leads to better professional development and better instruction for students. Allowing teachers to self-reflect on their teaching efficacy and math anxiety will help them determine alternative instructional practices.

Chapter 4: Data Analysis

This study was completed in two phases. Phase One (1) was quantitative data collection which included a Demographic Survey, MTEBI and MAST. Phase Two (2) was qualitative based on the data received from Phase 1, that was a semi-structured interview process. In the study herein, we looked at a whole K-12 district and explored teachers' math anxiety at different preparation and instructional levels. Furthermore, the study took a closer look at eight (8) teachers, whose math anxiety levels were at both ends of the spectrum (high vs low Math Anxiety, elementary and secondary teachers) as there were implications for teachers who had high math anxiety levels and student academic performance (Hughes et al., 2019).

The information was analyzed through a mixed analytic model. The data collection occurred through both surveys and semi-structured interviews. Quantitative analytics included a Demographic Survey, the MTEBI, and the MAST (Gresham, 2008; Richardson & Suinn, 1972). The purpose of the study contained herein was to investigate the relationship between the teachers' experiences and mathematics anxiety.

Data for Phase 1 was collected December 4th, 2023, during a teacher in-service day. The researcher presented on Teaching Conceptually and allowed participants time to complete the Quantitative Surveys via a QR code provided during the in-service sessions. There were 36 total participants that completed the surveys of the 51 certified employees of the district. There were 13 elementary teachers and 23 secondary teachers who completed the survey. Participant average time to complete survey was 22.8 minutes.

In this study we looked at a whole district, K-12 grades, in rural Nebraska. Where we compared their Math Anxiety and Self-Efficacy levels for the whole district and then

took a closer look at eight (8) teachers, whose math anxiety levels were at both ends of the spectrum (high Math Anxiety vs low Math Anxiety, elementary and secondary teachers).

Teachers' years of service were identified on the Demographic Survey illustrating that 23 teachers identified as having 16+ Years of Service, 8 teachers identified at 6-15 years of service, and 5 teachers identified as less than 5 years of service.

Also, the Demographic Survey showed that there was one elementary and five secondary teachers who were math certified. All teachers except one took Algebra and Geometry in high school. There was one teacher who did not have a math course in undergraduate studies. Ten teachers had one undergraduate math course, twelve teachers had two undergraduate math courses, and thirteen teachers had three or more undergraduate math courses. When data came to Mathematics Teaching or Methods courses: 13 teachers had no math methods courses, 10 teachers had one math method course, 9 teachers reported taking two math methods, and 4 teachers stated they had three or more math method courses.

The researcher collected all responses from Phase 1, then the researcher determined which eight (8) teachers to interview for Phase 2. The researcher determined the 8-teachers to be interviewed using the overall composite scores from the MAST. This was done by ranking all MAST scores from lowest to highest and identifying the two lowest and highest scores for elementary and secondary teachers. These were the 8 teachers who were invited to participate in the interview process: two elementary low Math Anxiety, two elementary high Math Anxiety, two secondary low Math Anxiety, and two secondary high Math Anxiety. Two invited participants declined to participate so the

researcher replaced that interviewee by going back to the MAST score and finding a suitable replacement (for example: if the person who declined was elementary low math anxiety the replacement was also an elementary low math anxiety). More details about the eight (8) interviewee participants will come during the Phase 2 analysis below.

The time each quantitative survey took teachers an average of 22.8 minutes. Though elementary teachers averaged 32.7 minutes and secondary teachers averaged 18 minutes. High Math Anxiety teachers (Score 61 or less on MAST) averaged 32.6 minutes on survey. Low Math Anxiety teachers (62 or higher on MAST) averaged 16.9 minutes.

The strength of claims demonstrated in this study were that through a whole district, teachers at every level had experiences with math anxiety at some time in their education experience. The researcher separated teachers by elementary or secondary level and determined if there are patterns in teachers' experiences.

The Demographic Survey was itemized for each teacher. The SIMA was a single score rating the teacher math anxiety. The MTEBI gave an overall composite score and a composite score for both subscales. The MAST also gave an overall composite score and a composite score for each subscale. Each teacher had their own composite score for each survey and subscale. The tables below represent composite scores for elementary teachers (Table 2) and secondary teachers (Table 3) and their average of composite scores, respectively.

Single-Item Math Anxiety (SIMA) Scale was a score from 1-10; 10 being high Math Anxiety. The average score for all teachers was 3.86, elementary teachers average was 3.85 and secondary teachers average was 3.87. As shown in Table 3, there were two secondary teachers who ranked themselves 10 or had extremely high math anxiety.

The Math Teacher Efficacy Beliefs Instrument (MTEBI) measured teacher self-efficacy in a higher score represents higher self-efficacy. The averages were 80.08 for elementary teachers and 79.3 for secondary teachers, which would allow us to believe that elementary teachers have stronger self-efficacy in their teaching abilities. The subsets for the MTEBI are the Personal Mathematics Teaching Efficacy (PMTE) and the Mathematics Teaching Outcome Expectancy (MTOE). The PMTE was used in further investigation for this study. The PMTE average was 50.85 for elementary teachers and 47.04 for secondary teachers, which shows that elementary teachers have a stronger belief in their teaching self-efficacy.

The Math Anxiety Scale for Teachers (MAST) was used to rank all teachers from high to low math anxiety. The score of 30 represents the highest recorded math anxiety in the district and the score of 75 represents the lowest math anxiety score for the district. Elementary teachers averaged 59.9 on the MAST and secondary teachers averaged 62.1. The MAST had two subscales, the General Math Anxiety (GMA) and the Anxiety Teaching Mathematics (ATM), which were used to measure the content math anxiety and their teaching anxiety. The GMA averaged 38.7 and 39.7 for elementary and secondary teachers respectively showing that secondary teachers have slightly lower general math anxiety due to this being all content area teachers surveyed. The average ATM for elementary and secondary teachers was 21.15 and 22.39, respectively. This shows that secondary teachers have lower anxiety for teaching math. This was possibly because secondary math teachers were confident in their own math abilities and have years of experience teaching their content.

Table 2 Elementary Teachers Composite Scores

	SIMA	MTEBI	MAST	ATM	GMA	PMTE	MTOE
	8	84	41	12	29	48	36
	5	72	48	14	34	43	29
	4	73	52	21	31	50	23
	1	81	59	22	37	51	30
	2	72	59	20	39	46	26
	7	83	59	22	37	54	29
	5	85	61	24	37	54	31
	5	74	62	20	42	45	29
	5	67	62	22	40	41	26
	1	94	66	25	41	61	33
	2	89	68	24	44	58	31
	2	83	70	24	46	53	30
	3	84	71	25	46	57	27
AVERAGE	3.85	80.08	59.85	21.15	38.69	50.85	29.23
STANDARD DEVIATION	2.230	7.826	8.668	4.018	5.298	6.067	3.320

Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite, MTOE= Moment Teacher Outcome Expectance subscale composite score.

Table 2 shows all composite scores for all qualitative surveys for the 13 elementary teachers. Table 3 shows all composite scores for all qualitative surveys for the 23 secondary teachers. You can see the range of MAST scores are smaller for elementary teachers than it is for secondary teachers. This is most likely because all elementary teachers teach math at some point in their day, while only specific secondary teachers teach math concepts in their content.

The MAST score was ranked lowest to highest to identify teachers for Phase 2 of the study herein. This will be explained in more detail below.

Table 3 Secondary Teachers Composite Scores

	SIMA	MTEBI	MAST	ATM	GMA	PMTE	MTOE
	6	76	30	10	20	40	36
	7	62	47	13	34	29	33
	10	59	52	20	32	40	19
	6	77	54	24	30	48	29
	6	77	57	21	36	47	30
	2	85	60	24	36	53	32
	1	95	61	24	37	59	36
	4	81	61	21	40	47	34
	1	79	62	25	37	54	25
	3	76	62	24	38	49	27
	1	85	63	25	38	56	29
	8	55	64	20	44	26	29
	2	80	64	23	41	50	30
	1	88	65	25	40	57	31
	3	68	65	24	41	39	29
	3	70	66	23	43	39	31
	10	84	67	23	44	55	29
	3	89	68	24	44	55	34
	3	87	68	23	45	55	32
	3	70	69	24	45	44	26
	1	86	73	25	48	59	27
	1	60	75	25	50	40	20
	4	66	75	25	50	41	25
AVERAGE	3.87	76.30	62.09	22.39	39.70	47.04	29.26
STANDARD DEVIATION	2.833	10.848	9.751	3.799	6.839	9.158	4.372

Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite, MTOE= Moment Teacher Outcome Expectance subscale composite score.

After the researcher read the data, analyzed it and then the researcher informed select participants who were interviewed. To remain unbiased towards the teachers the researcher did not use names, staff IDs were used so the researchers would not actually know who was selected for the interview. Then the researcher received a list of staff IDs from the district office assistant, then put the names together with the numbers and contacted the selected to be interviewed.

Table 4 Interviewee Composite Scores from Surveys

TEACHER	SIMA	MTEBI	MAST	ATM	GMA	PMTE	MTOE
			ELEMENTARY				
LMA.E1	2	89	68	24	44	58	31
LMA.E2	1	94	66	25	41	61	33
HMA.E1	5	72	48	14	34	43	29
HMA.E2	8	84	41	12	29	48	36
AVERAGE	4.00	84.75	55.75	18.75	37.00	52.50	32.25
STANDARD DEVIATION	3.162	9.430	13.326	6.702	6.782	8.426	2.986
			SECONDARY				
LMA.S1	1	86	73	25	48	59	27
LMA.S2	3	89	68	24	44	55	34
HMA.S1	6	77	54	24	30	48	29
HMA.S2	10	59	52	20	32	40	19
AVERAGE	5.00	77.75	61.75	23.25	38.50	50.50	27.25
STANDARD DEVIATION	3.916	13.500	10.340	2.217	8.851	8.347	6.238

Note: LMA= Low Math Anxiety, HMA= High Math Anxiety, E1/E2= Elementary Teacher, S1/S2= Secondary Teacher. There are 8 unique teachers.
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite, MTOE= Moment Teacher Outcome Expectance subscale composite score.

Table 4 illustrates the composite scores for the teachers who were interviewed. Data was collected for all teachers who completed the quantitative surveys. An overall average and standard deviations for all teachers, elementary teachers, and secondary teachers were completed.

Analyzing the differences between elementary and secondary teachers in each of the scales shown in Table 5 helped determine if the level at which a teacher teaches was a factor of math anxiety. The correlation was completed with Interviewee data and not all teacher data due to no equal number of participants in elementary and secondary. The correlations shown in Table 5 may be impacted due to the sample size being four to have equal matched pairs. Also, since they were pulled for being high and low, the correlation

will appear higher than if the sample size was larger and was randomly selected- that is not the case for the data in Table 5.

Table 5 Interviewee Correlations

	ELEM MTEBI	ELEM PMTE	ELEM SIMA	ELEM MAST	ELEM GMA	ELEM ATM
SEC MTEBI	0.426	0.681	-0.984	0.924	0.928	0.898
SEC PMTE	0.498	0.740	-0.947	0.972	0.995	0.927
SEC SIMA	-0.469	-0.717	0.942	-0.965	-0.992	-0.915
SEC MAST	0.724	0.890	-0.897	0.982	0.974	0.966
SEC GMA	0.817	0.934	-0.834	0.945	0.922	0.947
SEC ATM	0.892	0.419	-0.856	0.804	0.864	0.723

Note: SEC= Secondary, ELEM= Elementary. This table shows the correlations between Secondary and Elementary Teachers for each composite score.
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite.

Table 6 brings all the averages and standard deviations of composite scores together to show similarities. It is important to note that MAST (including the ATM and GMA) is reversed scored; meaning that a higher score implies lower math anxiety, and a lower score implies higher math anxiety.

Table 6 Averages and Standard Deviations

	SIMA	MTEBI	MAST	ATM	GMA	PMTE	MTOE
AVERAGE ALL TEACHERS	3.86	77.67	61.28	21.94	39.33	48.42	29.25
STANDARD DEVIATION (STDEV.P) ALL TEACHERS	2.562	9.778	9.182	3.815	6.178	8.176	3.918
AVERAGE ELEMENTARY TEACHERS	3.85	80.08	59.85	21.15	38.69	50.85	29.23
STANDARD DEVIATION (STDEV.S) ELEMENTARY TEACHERS	2.230	7.826	8.668	4.018	5.298	6.067	3.320
AVERAGE HS TEACHERS	3.87	76.30	62.09	22.39	39.70	47.04	29.26
STANDARD DEVIATION (STDEV.S) HS TEACHERS	2.833	10.848	9.751	3.799	6.839	9.158	4.372

Note: This table illustrates Average and Standard Deviation for each composite score, for each variable.

Tables 7 and 8 show the correlations between teachers' self-efficacy and their math anxiety and the sub-scales; elementary and secondary, respectively. Table 7 correlations may show stronger correlations due to the sample size (n=13) being smaller. The reason SIMA and MAST are negatively correlated to because SIMA is scores 1-10, 10 being high Math Anxiety and MAST scoring as larger numbers represent lower math anxiety. Though it is anticipated that the SIMA and MAST scores would have strong correlations no matter the sample size as these both measure math anxiety.

Table 7 Elementary Correlation

	ELEM MAST	**ELEM GMA**	**ELEM ATM**
ELEM MTEBI	0.340	0.260	0.392
ELEM PMTE	0.532	0.385	0.640
ELEM SIMA	-0.631	-0.569	-0.611

Note: ELEM= Elementary
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite

Secondary teachers' (n=23) correlations are more spread out as these were not all math teachers, this was every content area in the district. It was valid that the SEC SIMA and SEC ATM are most strongly correlated as these both measure the math anxiety, the research was surprised to see that the SEC SIMA and SEC ATM has a stronger correlation than that of the SEC SIMA and SEC MAST as these are the overall composite scores.

The low correlation between the MTEBI and MAST for secondary teachers is most likely due to the differences in content areas used. The higher correlation for elementary teachers is because elementary teachers teach across content areas.

Table 8 Secondary Correlation

	SEC MAST	SEC GMA	SEC ATM
SEC MTEBI	0.087	-0.054	0.320
SEC PMTE	0.283	0.097	0.553
SEC SIMA	-0.434	-0.316	-0.544

Note: SEC= Secondary
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite

These connections shown in Table 9 show that 1) Teacher's self-efficacy will increase with years of service and 2) Teacher's anxiety about teaching math anxiety should decrease with their years of service. Unknown teachers' general math anxiety may change with time.

Table 9 Years of Service, Average Composite Scores

	SIMA	MTEBI	MAST	ATM	GMA	PMTE
LESS THAN 5 YEARS	4.2	73	56	20	36	44
6-15 YEARS	3.4	77	62	22	40	48
16+ YEARS	4	79	62	22	40	49

Note: Years of Service are number of years teacher have taught.
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite

Level of education was a unique factor to witness as shown in Table 10 here. It was predicated that teachers with more education would have higher teaching efficacy. Math Anxiety was up and down depending on the level of education, this was most likely to what the graduate courses were.

Table 10 Level of Education

	NUMBER OF TEACHERS	AVG SIMA	AVG MTEBI	AVG MAST	AVG ATM	AVG GMA	AVG PMTE
BACHELORS	13	4.46	72.8	61.2	21.6	39.5	44.7
MASTER'S	8	3.63	81.5	54.6	19.1	35.5	49.9
MASTER'S + CREDITS	13	3.85	78.6	65.7	23.8	41.8	50.2
ED. S/ DOC	2	1	88	60	23	37	55

Note: Level of Education is highest level of degree earned.
Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite

Determining the number of math classes, a teacher took as an undergraduate or specifically methods courses did have an impact on their self-efficacy. Table 11 determined if the number of math courses influenced a teacher's self-efficacy or math anxiety scores. Only one participant had no math content courses as an undergraduate.

Table 11 Math Courses

	N	SIMA	MTEBI	MAST	ATM	GMA	PMTE
MATH CONTENT UNDERGRAD 0	0	3	84	71	25	46	57
MATH CONTENT UNDERGRAD 1	11	5	71.3	58.7	20.2	38.5	43.4
MATH CONTENT UNDERGRAD 2	12	3.667	75.917	60.917	21.25	39.667	46
MATH CONTENT UNDERGRAD 3+	13	3.231	83.692	62.846	23.692	39.154	53.846
MATH METHODS 0	13	3.769	74	61.462	21.385	40.077	44.077
MATH METHODS 1	10	4.7	76.4	58.6	21.1	37.5	48.1
MATH METHODS 2	9	3.222	81.667	63.778	22.778	41	52.222
MATH METHODS 3+	4	3.5	83.75	61.75	24	37.75	54.75

Note: N=number of respondents, UNDERGRAD= undergraduate course taken, SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite.

Phase 2 of Study

The sample for Phase 2, the semi-structured interview, was eight (8) certified teachers. There were four (4) elementary teachers and four (4) secondary teachers interviewed. Those selected to be interviewed were based on the teachers' MAST score

evaluations and Demographic Survey results, two of each scored the lowest and highest on the MAST for both elementary and secondary.

Data was used in multiple statistical measures and used math anxiety levels as the dependent variable to understand the experiences of math anxiety in teachers. Such analysis can estimate a set of independent variables (Creswell, 2006). The analysis identified two (2) groups (low & high Math Anxiety) and teachers according to years of experience. Math anxiety level and teaching experience were independent variables. This was how teachers were selected to be interviewed – based on their MAST scores (2-highest & 2- lowest scored for elementary and secondary).

The reason for the split was for comparability. While most studies have been used on elementary teachers, the sector needed to understand math anxiety at the secondary level as well. The education sector also needed to understand how math certified teachers and non-math certified teachers' math anxiety differ. Of the interviewees, one identified as a secondary math teacher, no surprise that this was the interviewee with the highest MAST score (lowest math anxiety score). Teachers had distinct levels of math anxiety based on their content areas because an English teacher doesn't teach specific math content. While Math and Science teachers have specific math content, they teach within their classroom curriculum.

Once the verification of transcriptions was collected the researcher analyzed each interview question which was sorted for themes based on experiences and pattern then organized data into themes and sub-themes as they emerge. The lens the researcher took was through the NCTM (National Council of Teachers of Mathematics) Principle to Actions mathematics teaching practices and The 5 Practices in Practice (Smith, M. &

Sherin, 2019). Then the information can be used to make assumptions about how or why Math Anxiety was prevalent in teachers. Why math anxiety may be higher in an art teacher than it would be a math teacher.

The goal of analyzing the qualitative data was to determine what has the biggest impact on teachers. The purpose of this study was to identify ways to increase teacher self-efficacy of them teaching mathematics and decrease their anxiety about mathematics content and teaching.

Analysis by Research Question

Research Question: What is the relationship between a teacher's self-efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy)?

To determine the answer to this research, question each decomposition was first measured and analyzed. Once those were answered a statement about the relationship between a teacher's self-efficacy, General Math Anxiety (Content), and Anxiety Teaching Math (Pedagogy) can be determined based on this data. Granted the researcher was aware that the population of this study was not grand enough to make universal statements, but a conjecture can be made to move research forward on teacher math anxiety.

Decomposition Question 1: How does a teacher's own teaching self-efficacy correlate to their general math anxiety (Content)?

This study used the 13-items on the Personal Mathematics Teaching Efficacy (PMTE) subscale of the MTEBI to measure the Teaching Efficacy of Teachers. It was then correlated with the 12-items on the MAST General Math Anxiety (GMA) subscale.

Together a spearman correlation coefficient was determined to understand the correlation between teacher's self-efficacy and their general math anxiety.

Table 12 Correlate PMTE and GMA

	SPEARMAN CORRELATION COEFFICIENT PMTE AND GMA
ELEMENTARY TEACHERS	-0.236
SECONDARY TEACHERS	0.085
ALL TEACHERS	0.162

The spearman correlation coefficient between the PMTE for elementary showed that there was a stronger correlation between teachers' self-efficacy and their General Math Anxiety.

Decomposition Question 2: How does a teacher's own teaching self-efficacy correlate to their anxiety teaching math (pedagogy)?

This study used the 13-items on the Personal Mathematics Teaching Efficacy (PMTE) subscale of the MTEBI to measure the Teaching Efficacy of Teachers. It was then correlated with the 7-items on the MAST Anxiety Teaching Math (ATM) subscale. Together a spearman correlation coefficient was determined to understand the correlation between teacher's self-efficacy and their Anxiety teaching math.

Table 13 Correlate PMTE and ATM

	SPEARMAN CORRELATION COEFFICIENT PMTE AND ATM
ELEMENTARY TEACHERS	0.806
SECONDARY TEACHERS	0.534
ALL TEACHERS	0.562

Remember that the ATM was an inverted score meaning a high school implies a lower math anxiety level, while the PMTE is scored as customary high score means high teacher efficacy. These all have a strong relationship due to teachers knowing what they are good at teaching and where their anxiety teaching mathematics level is. Though secondary teachers have the lowest correlation due to teacher at the level included every content area, so they don't know what they don't know about teaching mathematics and most likely chose to not teach math due to their math anxiety. Whereas some secondary teachers go into teaching their content area because they like the content more verse liking the act of teaching the content area. So, some teachers have strong self-efficacy and low anxiety because they understand the content and feel confident in their ability to explain it to others.

Decomposition Question 3: How does teachers' perception of their own math ability relate to their math instruction?

This question was answered using the MAST. Finding the overall and subscales (GMA and ATM) averages, standard deviations, and a Pearson product moment correlation was discovered like the Gresham (2008) study. An analysis of variance was also found for elementary teachers, secondary teachers, low Math Anxiety group and high Math Anxiety group to see if there was a significant difference in the groups.

The Pearson Correlation between the MAST and ATM is a 0.908, MAST and GMA are 0.848, ATM and GMA is 0.727 for elementary teachers. The Pearson Correlation between the MAST and ATM is a 0.847, MAST and GMA are 0.955, ATM and GMA is 0.652 for secondary teachers. For all teachers, the Pearson Correlation between the MAST and ATM is 0.866, MAST and GMA are 0.951, ATM and GMA are 0.670.

The average MAST score was 61.2. Therefore, scores less than or equal to 61 were considered high math anxiety; and scores 62 or higher were considered low math anxiety. Ranking the MAST Scores from low to high then separating these into two tables to determine the average, standard deviation and variance for each survey and subscale.

Table 14 High Math Anxiety

	SIMA	MTEBI	MAST	ATM	GMA	PMTE
	6	76	30	10	20	40
	8	84	41	12	29	48
	7	62	47	13	34	29
	5	72	48	14	34	43
	4	73	52	21	31	50
	10	59	52	20	32	40
	6	77	54	24	30	48
	6	77	57	21	36	47
	1	81	59	22	37	51
	2	72	59	20	39	46
	7	83	59	22	37	54
	2	85	60	24	36	53
	5	85	61	24	37	54
	1	95	61	24	37	59
	4	81	61	21	40	47
AVERAGE	4.933	77.467	53.400	19.467	33.933	47.267
STANDARD DEVIATION	2.631	9.187	8.862	4.779	5.035	7.285
VAR.S	6.922	84.410	78.543	22.838	25.352	53.067

Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite.

Note: This table determined the average, standard deviation, and variance for high math anxiety teachers.

Table 15 Low Math Anxiety

	SIMA	MTEBI	MAST	ATM	GMA	PMTE
	5	74	62	20	42	45
	5	67	62	22	40	41
	1	79	62	25	37	54
	3	76	62	24	38	49
	1	85	63	25	38	56
	8	55	64	20	44	26
	2	80	64	23	41	50
	1	88	65	25	40	57
	3	68	65	24	41	39
	1	94	66	25	41	61
	3	70	66	23	43	39
	10	84	67	23	44	55
	2	89	68	24	44	58
	3	89	68	24	44	55
	3	87	68	23	45	55
	3	70	69	24	45	44
	2	83	70	24	46	53
	3	84	71	25	46	57
	1	86	73	25	48	59
	1	60	75	25	50	40
	4	66	75	25	50	41
AVERAGE	3.095	77.810	66.905	23.714	43.190	49.238
STANDARD DEVIATION	2.343	10.628	4.130	1.521	3.669	9.027
VAR.S	5.490	112.962	16.990	2.314	13.462	81.490

Note: SIMA= Single Item Math Anxiety Scale, MTEBI= Math Teacher Efficacy Belief Instrument composite score, MAST= Math Anxiety Scale for Teachers Composite score, ATM= Anxiety Teaching Math subscale composite score, GMA= General Math Anxiety subscale composite score, PMTE= Personal Moment Teacher Efficacy subscale composite.

Note: This table determined the average, standard deviation, and variance for low math anxiety teachers.

The T-test estimated the true difference between the two groups. It states how significant the difference between the two-group means was and how likely it was to have occurred by chance. Given this information, the t-test should be low because it was very unlikely that teachers with low and high math anxiety would score the same. The reason while the t-test is higher for elementary and secondary Teachers was due to the

idea that all teachers were included, and some upper elementary teachers have lower math anxiety than secondary teachers due to the amount of math content they teach.

Table 16 T-Test

T-TEST, 1-TAIL, UNEQUAL VARIANCE	SIMA	MTEBI	MAST	ATM	GMA	PMTE
ELEMENTARY AND SECONDARY	0.489	0.119	0.241	0.187	0.314	0.072
LOW AND HIGH MATH ANXIETY	0.020	0.459	0.000	0.002	0.000	0.237

Decomposition Question 4: How do the experiences teachers have with mathematics influence their math instructional practices?

After completing the eight (8) interviews with teachers, transcripts of the interviews were summarized and sorted into themes. The researcher looked at all four of the low-math anxiety teachers first and key words and determined if there were any patterns among the four teachers and if there was a difference between the elementary or secondary teachers.

The researcher then analyzed all four of the high-math anxiety teachers and determined if there were any patterns among the four teachers and if there was a difference between the elementary or secondary teachers. The researcher then grouped the elementary teachers together and looked for common themes or patterns and then grouped the secondary teachers and determined if there were themes or patterns. Also, determined if there were themes that emerged from elementary low or high math anxious teachers.

Once each group had been analyzed separately, the researcher then put all analysis together to see the common themes amongst all four groups. Also determined if there were themes that emerged from secondary low or high math anxious teachers.

The Interviews

There were eight interviewees. As described above they were the two lowest elementary, two highest elementary, two lowest secondary, and two highest secondary teachers according to the composite score on the MAST. They all had over six (6) years of teaching experience and a master's degree. The two low secondary math anxiety teachers both had certification in math. All interviewees were female.

Low Math Anxiety teachers taught secondary special education, geometry, 5th-grade, and 4th-grade; while the high math anxiety teachers taught English (junior/senior), reading, Kindergarten and 1st-grade. The position they were employed in could have impacted their teaching self-efficacy and math anxiety.

The elementary teacher's math anxiety both general(content) and teaching(pedagogy) could have been influenced by the new math curriculum they were implementing at the time of this study. The teacher switched from Saxon Math curriculum to Savvas Envision Math curriculum.

Three out of the four teachers with low math anxiety took three math courses as undergraduates and two math method courses, they all took algebra and geometry in high school.

One interview took place via zoom, one interview took place in the hallway of the high school, one occurred at the home of the teacher, and the other 5 interviews took place in the teacher's classroom. Interviews ranged from 10-20 minutes in length.

Analysis by Interview Question

Interview questions were completed with an item analysis. Each item was divided between High Math Anxiety and Low Math Anxiety then separated by Elementary and Secondary Teachers. A key word analysis was completed for questions 1 through 4 and then a constant comparison analysis was completed to identify key themes. Questions 5 through 10 were completed through a constant comparison analysis and identified key themes and patterns throughout the question. Below are the results of the key word analysis and constant comparison analysis. The interpretation was completed by the researcher, who has experience as a secondary mathematics and special education teacher.

Interview Question 1: What are the first words or phrases that come to mind when I say "mathematics"?

The first look at question #1 was a key word analysis and continuous comparison of interview. Overall, when thinking of "math" teachers the most commonly used words they used were kids, think, know, long division, find out. Teachers with high math anxiety most frequently used words were number and equations, those with low math anxiety used kids, know, and think. Elementary teachers focused on kids, thinking and number sense, while secondary teachers focused on knowing mathematics, willing to try, and number sense.

High math anxiety teachers referred to understanding and how it challenged the 'head.' Low math anxiety teachers had more enthusiasm for the math content and referred to how they do math and acknowledged how some people or students may find it difficult.

Interview Question 2: What do you think it means to be "good" at math? Share a story.

Analyzed with a key word analysis which resulted in each group all, high, low, secondary, and elementary all stating the same thing: students could work through problems easily and knew different ways to do the work. Math was easy for students which made students good at math. After identifying descriptive patterns that emerged for high math anxiety teachers where students could use multiple methods or strategies. Teachers with low math anxiety focused on students whose math was easy or willing to persevere!

Interview Question 3: Please tell me what your understanding is of the definition of Math Anxiety? (Participant definition) Have you experienced this…where it was the worst? Describe your first memory of it. How did it make you feel?

Key word analysis showed that teachers acknowledged math anxiety showed in diverse ways for everyone it was usually appeared around story problems and/or algebra when they first experience it. Elementary teachers reference the timed math fact test and concepts which made them nervous.

The descriptive patterns showed higher math anxiety teachers first experience with math anxiety was during algebra (advance algebra or trigonometry). They stated they felt overwhelmed or didn't get it. They were not ready to remember all the steps or processes and therefore couldn't comprehend, which made them feel even more overwhelmed by the content.

Low math anxiety teachers also stated their first experience with math anxiety was during algebra (advanced algebra or linear algebra) or in elementary school. They all mentioned not understanding the math content. This resulted in them freaking out

mentally or a lack of confidence in their math experience, which was created by new perspective about math through assistance of a caring adult. Each of them either referred to a teacher that gave them extra support to boost their math confidence or a parent that gave extra support.

Interview Question 4: How do you see math anxiety present in students?

The key word analysis for question 4 showed that math anxiety presented in students as shutting down or a lack of confidence. The anecdotal analysis of the interview question showed that Math Anxiety presented in elementary students as students shut down (head down, holes in paper, scribbles, waiting for answers and sometimes physical stomach aches). Secondary students also exhibited avoidance behavior though all four secondary teachers reference students lack confidence and fear of being wrong was how students presented with math anxiety. Teachers referred to ways to help students was to have students verbalize their thoughts and do math together or nearby, so it was easier for students to ask questions of the teacher or peers. The teacher's math anxiety levels high or low did not affect there representation of students during the interview as they all experienced students with math anxiety.

Interview Question 5: What are ways you work to combat your own anxieties? Are there practices or strategies you use?

There was no keyword analysis done after this point as these last 5 questions were able to be themed. High math anxiety teachers in elementary focused on knowing the content and strategies before sharing with students while secondary high math anxiety teachers focused on creating space and times for students to learn the math contents even

working problems backwards or showing students how to ask others for help with the content.

Teachers with low math anxiety combat their math anxiety by being prepared thinking through how to solve problems either step-by-step or how to make connections and able to look at the math through alternative perspectives. This was likely due to teachers having the self-confidence to begin from wherever the student needs them, the low math anxiety teachers have higher confidence in their math content abilities.

Interview Question 6: If an administrator or another person observed your classroom, what would they say? What would they see you and/or students doing? What are the most effective teaching practices you model? What are you most nervous about getting feedback on?

Both secondary low math anxiety teachers had been teachers for a while so neither were worried about feedback or constructive criticism from administration, both frequently ask students for feedback to improve their teaching practices. They both also mentioned their best strategies were questioning and having students talk and show their thought process was something they would say people would see in their classrooms.

Secondary high math anxiety teachers tried to explain concepts multiple ways and allow students to talk and collaborate. They worry about doing it wrong or getting feedback on transitions between activities.

Elementary high anxiety teachers spoke of whole group instruction and multiple strategies for math content. They worried about how they used time and being able to get everything done within the amount of time they had.

Elementary low anxiety teachers took two different approaches to teaching: one used prior knowledge and explained why the learning was important (building the foundation) and used lots of manipulatives/pictures to create connections; while the other teachers used collaborative groupings, feedback after students had tried, focused on productive struggle for students. Both teachers were noticeably confident in their teaching practices. Neither were worried about administration coming into their classrooms because their administrator had no experience in the elementary classroom. Therefore, the teachers didn't think the administrator could give valuable feedback to them. Both really focused on students making connections with the math content.

Questions 6 and 7 focused on multiple strategies to help students work through math anxiety. Teachers stated remaining calm, positive, and showing they had confidence in the student's ability to be successful in the math content helped students. Teachers engaged students in multiple techniques and allowed for different sensory approaches to allow all students to learn the way they needed.

Interview Question 7: Can you describe the practices or strategies do you use in the classroom to target/reduce math anxiety in your students? What are you doing? What are students doing?

Secondary high math anxiety teachers both described the practice of students helping another period. Both of these teachers are secondary reading or English teachers, both stated they "can't help" students because of their content area but would try to help by asking other high achieving students to help the struggling student. Both mentioned making a community where it was safe to ask others for help. Elementary high math anxiety teachers both stated strategies that helped their student's lower math anxiety were

collaborating with partners or creating a community to work together. One mentioned that using our brain breaks and using hands-on (manipulative use) group work to help students explain math to their peers. Creating a community feel in a classroom helped students feel as though they were "all in it together" so they were willing to do what was good for the community. Also allowing students to process information and explain it to one another had greatly impacted students' performance.

All high math anxiety teachers stated that having peers explain content to students who maybe experienced math anxiety helped lower a student's math anxiety. In past experience this was due to hearing the same information in a different way helped students and hearing in from peer relieved anxiety from students and allowed the message to come through to their brain to better understand the information the teacher was giving the student.

Secondary low math anxiety teachers allowed students to use resources to help facilitate their learning, for example use of notes on quizzes or using a big white board to refresh their memory of learning the material. Both teachers would remain calm if students started to show signs of anxiety in math class and would help their students breathe and would ask questions of students to have, they student look at the math content from a different perspective or help guided them in a direction.

Elementary low math anxiety teachers' practices included remain positive, breaking and helping students remain calm. They helped by engaging students in different teaching techniques that help build students' confidence. They also tried different sensory approaches to teaching with interactive screens/online, iPads, fidgets,

and Velcro under their desk to help students work through their anxiety in a way that worked for them.

Interview Question 8: To what extent do you think students pick up/ notice on attitudes (including anxieties) of their teachers?

The interviewees were categorized as high math anxiety teachers agreed students can pick up on teachers' attitude and anxiety. The teachers talked to their students and connected with students on how math might be hard. They referred to the relationship they had with students. One elementary teacher model deep breathing when she gets overly anxious during a lesson with students. Understanding that students would feed off the energy around them. Therefore, creating a positive environment is particularly important in the realm of pedagogy.

The low math anxiety teachers stated if they feel a certain way then students so will their students. Therefore, they knew they needed to be aware of the attitude or emotions they were exhibiting when teaching a lesson, because the students would mirror those emotions back to them. One teacher pointed out if she acted like she was confident in the math content her students would be more likely to believe they could do it too. Overall, if the teacher had a positive mindset toward math, then the students would also have a positive mindset wards the math. The converse also being true, if the teacher had an anxious persona, then the students would also feel anxious about the math content.

Interview Question 9: What do you see as your responsibility as their teacher to address math anxiety in your students?

Every teacher who was interviewed acknowledges it as their responsibility as teachers to address students' math anxieties. Elementary teachers said they focused on 1-

1 conversations to make students comfortable, remain positive with students, and help students make corrections. The secondary teachers with low math anxiety focused on not comparing yourself to others, trying your best and being okay taking a break from the math work. High math anxiety teachers in the secondary level formed a community and worked to "just get through it" or "just don't give up" with students to address their student's anxiety.

The act of building relationships and community within the classroom was essential for creating positive educational experiences for students.

Interview Question 10: Describe a time/experience when teaching mathematics, can you think of a time when you were teaching a concept that you were not fully confident teaching?

Many teachers felt number sense and algebra was a concept they were not fully confident in. They all made a comment where it was their lack of confidence in themselves (lack of self-efficacy) to teach a concept. They all stated that working through the lesson before they did it in front of students helped build their confidence. Secondary teachers also mentioned to be honest with students, that this was new to them too and that even teachers make mistakes sometimes. Teachers would go to other teachers for assistance before teaching a lesson if they were not confident in the strategies they had for the content.

Elementary teachers focused on number sense with 10-blocks, measurement and regrouping as a concept they weren't feeling confident in their teaching practices. They also got a new curriculum this year, so the whole year has an added level of teaching anxiety- teacher stated they look over the next lesson the day or week ahead of time to

make sure they are comfortable with the content and tasks they are to do with students before doing it the first time with students.

Secondary teachers were more confident because they have taught the same material for years. Some secondary teachers teach the same lesson multiple times throughout the day and that helps them improve the lesson and teaching practices. When teachers have the opportunity to 'perfect' a lesson their confidence in the content and teaching practices grow. Some secondary teachers referred back to a time when they had to teach different content for a while and referred to riding a bike- you don't forget how to do it, it's just a little rusty and unbalanced for a while until you've done it again.

Interview Analysis

The interpretation of the interview questions was the researcher's own perspective; the statements are their own. The researcher is aware of their own their own Math Anxiety and Anxiety of Teaching Mathematics and teaching self-efficacy their viewpoint as an in-service teacher myself. Despite not being an overwhelming data set with eight participants, the analysis was done with my experiences as a teacher and knowledge of the research in mind. As in many professions, practice increases confidence in your ability to be successful in the skill set. The information gathered from the interviews was what the researcher expected for the majority of responses. The researcher was surprised by the number of times interviewees made comments about the foundation of mathematic content knowledge, having students work together, using hands-on learning, and creating a community of relationships in their classroom.

Teachers defined math anxiety as avoidance to math problems or lack of confidence to try, the fear of being wrong. Even in my experiences as a teacher, I have

seen many students exhibit these same factors and have seen students who are so afraid of being wrong or seen as ‘dumb’ or ‘stupid’ that they won’t even try or will exhibit inappropriate behaviors to avoid doing the math. I myself have worked hard to build relationships and community with students so that they understand we are all in this together to learn together and that we can help each other because we all have different strengths. The one method I was surprised teachers did not mention more was the inquiry-based learning, though the teachers did refer to having one-on-one conversations to guide students to new learnings, which could have led to teachers to inquiry-based learning. This method of productive struggle was put out by NCTM as a way to elicit student thinking, which allowed teachers to be more facilitators of students learning than the giver of information. The ability to allow students to learn on their own and assist or guide students is a level of pedagogical skill teachers need to practice using. There is a fine line between allowing a student to productive struggle through a problem and letting the student struggle with the content. This was where the relationship building in the classroom was essential – because only by knowing the students can you actually facilitate a discussion and productive struggle lesson with fidelity.

It was motivating to see how aware some teachers were aware of their own math anxieties and that of their students, while others understood why people may have math anxieties. The teachers that were interviewed were not innovative in their strategies but used methods that were simple and effective with students, there could be better ways which would need to be further determined in a different study.

After looking for anecdotal evidence from each question above- the research looked at only High Math Anxiety Teachers and found that these teachers focused more

on teaching practices and having students understand basic content and forming the foundation of students mathematical knowledge. Then looking for patterns with Low Math Anxiety focused on students being able to explain the math content and having student apply their learnings. Both High and Low Math Anxiety teachers focused on building community within their classrooms.

The elementary teachers in this district are implementing a new math curriculum the year this study took place. Therefore, the content and pedagogical practices are new to them and their students. The methodology and pedagogical strategies are shifting from concrete thinking to more abstract critical thinking skills.

Analysis of Quantitative and Qualitative

After analyzing the quantitative and qualitative data for this study it important to note that when all the data is combined it shows a picture of a district with K-8 teachers learning a new math curriculum and secondary teachers who build a community within their classroom. The researcher noticed themes of being prepared teachers and using multiple pedagogical strategies to help struggling students. It was interesting to notice the teacher's confidence change based on the content and pedagogy they were discussing in the interview and may have influence their quantitative scores.

Chapter 5: Results

Introduction

What we can infer from this study that there is a correlation between a teacher's self-efficacy of teachers and their teaching math anxiety. Overall findings can be connected back to literature and the framework created for this study. There are still multiple questions the researcher would like to propose for future research and to build of the study herein.

Connection to Literature

This study was an adaption for Gresham's 2008 study "Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers." Gresham, as stated before, used 156 pre-service teachers, and interviewed 10 pre-service elementary teachers. While study herein used 36 in-service teachers and interviewed 8 teachers. Gresham's study found "math anxiety is associated with efficaciousness towards mathematics teaching practices" as stated in the abstract of Gresham's study (Gresham, 2008).

Both the study herein and Gresham's, as well as other previous studies have shown that math method course have been effective in reducing teaching (Gresham, 2008) . It would be worth noting that teachers started having one math methods course in their undergraduate work as either an elementary or secondary teacher (Gresham, 2009; Stoehr, K. J., 2016; Swars et al., 2009). It would be conducive to further research to know if teacher preparation program included additional math method courses for teachers if the math anxiety level and academic performance would influence.

Multiple studies (Enochs et al., 2000; Hembree, 1990; National Council of Teachers of Mathematics, (NCTM), 2000; National Council of Teachers of Mathematics, (NCTM), 2014) have focused on teacher instruction. They have shown that instruction with teachers who have higher teaching anxiety will have more traditional teaching practices while those with lower math teaching anxiety will have more non-traditional practices. The study contained herein, found similar statements when interviewing teachers with higher math anxiety compared to teachers with lower math anxiety.

Framework Interpretation

The framework for this study was based on three pillars: self-efficacy, content math anxiety, and teaching math anxiety. What we know given this study is that these three are very much related, though given that each teacher had their own experiences and their own philosophy of teaching and learning- it was difficult to pinpoint exactly which ones has the largest impact on the teacher's teaching and learning disposition.

What we do know from research, including this study, is that teachers with positive teaching and learning dispositions will be more likely to have higher self-efficacy and lower math anxiety. Just because a teacher may have higher or lower content math anxiety doesn't dampen their self-efficacy or teaching beliefs.

Self-efficacy in teaching is the belief that your teaching makes a difference. Hattie says collective efficacy of teachers has a 1.36 effect size (Hattie, 2008). Teacher's collective efficacy has been imperative to students making progress academically. The belief in the district is that they do make a difference together and the community mindset within the district was developed and shared with students alike.

The content of mathematics is perceived to be difficult. Though the evidence showed that if there is a solid foundation of math content then the anxiety decreases. The mathematical mindset and development of productive struggle is still on the cusp of mathematic instruction and education.

The pedagogy of math education is based on NCTM standards of practice. As seen in chapter 2 of this study- there are several practices that develop within a math classroom. The act of sitting and getting instruction is not what happens in a math classroom. The interviews show how math instruction has changed by having multiple tasks for students to complete between working with hands-on manipulatives, pair-share and small group work, whole group discussion and one-on-one facilitation of student learning.

Mindset was found to be an important part of both teacher self-efficacy and their content knowledge because those with a fixed mindset continue to say “I can’t do math” while those with a growth mindset shifted to an “I can’t do this math, yet” mentality which led to decreased math anxiety in themselves as teachers and their students. It was fascinating to interpret the differences between teachers with higher teaching anxiety as their instructional strategies were very by the book and more rigid, than teachers with lower math anxiety were much more focused on developing strategies within their students and were able to use multiple strategies.

Elementary teachers, during the interview teachers spoke of different concepts you could hear what concepts they felt more confident because they’d share multiple ways to teach the concept, were as if they were less confident then they would share how the textbook would teach the concept and how they were still learning the concept.

While teachers experience math anxiety that led to their feelings of math anxiety are different. Every teacher experiences some anxiety with teaching math. It wasn't all the time; it wasn't always the same topic. The anxiety grew from the lack of confidence in themselves as teachers, or lack of confidence in themselves in their ability to meet students' needs to facilitate foundational teaching for students.

The mindset of pedagogy is more in the realm of collective efficacy which brings us full circle in the framework. To answer the question in this study YES, all teachers have some level of math anxiety in their teaching of the math content.

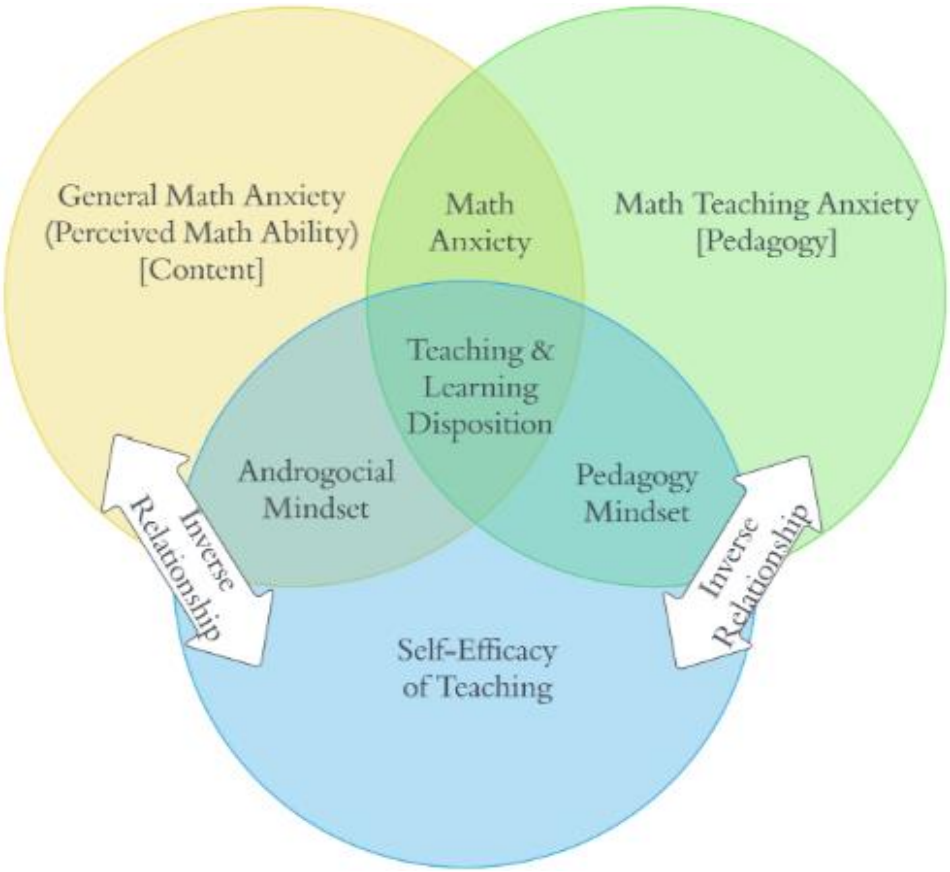

Figure 3 The Framework Model

Therefore, looking back at the framework model used for this study it is important to note that all teachers have varying levels of content anxiety, teaching anxiety and level

of self-efficacy in their teachings. The principles and practices outlined by NCTM enable teachers to increase their teaching self-efficacy, as well as their pedagogy in Math Content teaching. In this study, we interviewed teachers who illustrated all 8- principles given by NCTM. Not one teacher mentioned every principle though given the 8-teachers who were interviewed, each of the eight principles were mentioned in some part of the interview.

While each teacher had goals to focus on learning- the level of their general math anxiety and/or anxiety of teaching mathematics impacted which other principles from NCTM they used. For example, teachers with confidence in number families and how to teach number families were much more likely to pose purposeful questions and suppose productive struggle in their classroom, while a teacher who was less confident in their teaching ability focused more on using multiple mathematic representations and building from procedural fluency to the conceptual understanding of the number sense content.

Findings and Interpretations by Phase

Phase 1

The data analysis from chapter 4 shows that there is a relationship between a teacher's self-efficacy and math anxiety. The relationship between a teacher's self-efficacy and math anxiety was related more for elementary teachers than for secondary teachers. This is greatly impacted because of the way in which secondary schools are set up. Elementary teachers teach all content area in this district the K-3 teacher teach all content areas except PE, then elementary grades 4-5 compartmentalize where one 4^{th}-grade teacher teach ELA and the other teach Math to all 4^{th}-grade students, same with 5^{th}-grade. Secondary is based on content area; 6^{th}-grade is the exception as there is a 6^{th}-

grade teacher who teaches two content areas Math/Science for 6th grade only. Teachers grade 7-12 are content based meaning a math teacher only teaches math, English teacher only teaching English (and maybe journalism), Physical Education teacher teaches PE, Health, and/or strength training.

One relationship that was not a surprise was that the more education a teacher has the higher their teaching efficacy and lower their teaching anxiety.

Phase 2

The experiences teachers have had with mathematics influence their math instructional practices and greatly impact their teaching practices. Teachers with high math anxiety tend to avoid math or pass it off to others they perceive as better at math than they are. Teachers with lower math anxiety focus on giving students multiple strategies to work through the math content with. The teachers with high math anxiety are more community and relationship based.

Building a foundation of math content and a sense of community within the classroom where both large themes through the interview process when discussing how teachers' experiences influence their instructional practices.

Connecting Phase 1 Quantitative and Phase 2 Qualitative

The study herein was comparing the quantitative data from the MTEBI and MAST with qualitative data from the semi-structured interview to find commonality between teachers' abilities and experiences that influenced their math instruction. When you look at the quantitative data it was foreseeable or presumed it would show that elementary teachers would have higher math anxiety than that of secondary teachers. Although the closeness in scores between elementary and secondary teachers was

surprising, it was due to all content areas being used verse only secondary math teachers. Then relating the qualitative data though the interviews, it was interesting to see how teachers, no matter their level of content or pedagogical math anxiety, would use the same methods or tools with students.

All levels of teachers used relationships with students to foster a sense of community and working together to figure out problems to learn new content. They would use hands-on learning or would use peer conversations to build on prior knowledge which would build procedural fluences from conceptual understand of their peers. These instructional practices allowed students to go from concrete understanding to building abstract critical thinking skills in the math classroom.

Researcher Reflections

The researcher changed because of this study to understand that experience increases teacher self-efficacy and confidence. Also, teachers that are willing to learn new strategies and practice to help students will go out and find the information to become better at their skill and increase pedagogy practices.

Remaining on topic and on-task during the interview proved to be simpler than anticipated. Since several of the interviewees and the researcher knew each other before the interview process. Seven of the eight interviewees had worked or knew the researcher before the interview occurred, which made the interviews more personable and ability to by-pass- the get to know you and build trust, as this was established over years before this study came to be. It is why staff IDs were used to identify interviewees to eliminate bias of knowing who-was-who during the selection process. It was based purely off the MAST scores.

The researcher had the preconceived idea that the secondary math teachers would have the lowest math anxieties and while that is true for one of them, there was one secondary math teacher that was right on the cusp of having high math anxiety. It was assumed that lower elementary and non-math content teachers would have high math anxiety, and this was true for the majority of the data gathered.

Surprisingly, the sense of building a community was the biggest theme throughout the interview process to reduce math anxiety in themselves and students. The sense of we are all in this together and that learning is a process was referenced by all teachers that were interviewed.

Implications for Educational Leaders

Educational leaders through use of the NCTM resources and development of professional development that increases awareness to teachers' anxieties whether it be content or teaching related will increase teacher's self-efficacy in their teaching. While this study focused on practice teachers in the area of math anxiety- it would be inferred that any content area would have some level of anxiety and teaching of the content standards within that content. Identifying strategies and practices to help teachers experience less anxiety in their teaching and learning will benefit the educational environment.

Teacher experience increases their teacher self-efficacy and their confidence in their teaching, this is transferred to their student's confidence and student performance. Teacher who are willing to learn and gain theses experiences will find a way to better themselves. They will build a community to build themselves and their students'

confidence in the skills they are working to achieve. In the case of this study, the skill they worked on was to reduce math anxiety and to build math skills conceptually.

The impact of this study may be on teachers who teach math and those that have created strategies to cope with their anxiety about math. The social impact of this study is to find strategies and practices that assist students to develop math understanding with or without creating anxiety about math. Literature also states that Teachers need sustained support and often need additional training in basic strategies in language development and interventions. Early intervention is critical, although intervention that comes later in a student's academic careers is still beneficial (Beatty, 2013). Teachers who have taken additional method courses show lower Math Anxiety levels (Gresham, 2008).

It is important for educational leaders to understand that teachers, as well as students experience math anxiety. Educational leaders are responsible for improving teachers and education quality. Open communication between leadership and teachers about the needs of teachers is crucial to better the education system. Having educational leaders who are aware of content and pedagogical anxiety will better the professional development they offer to their teachers.

Recommendations for Future Research

It is recommended that additional research be done with in-service teachers, particularly secondary teachers, as there are still limited studies completed on this topic with those participants. It is important to note that elementary and non-math certified teachers don't know what they don't know when it comes to teaching of mathematic content or pedagogy. Secondary math teachers were more aware of their strengths and

weaknesses when it came to math content and pedagogy, which implies that there should be more research done with secondary teachers.

Additionally, research done what professional development and interventions are in place for teachers to increase their pedagogical knowledge while they are in-service and how we can leverage a school calendar to help both teachers and students learn about their math anxiety and strategies to alleviate the negative impact in has on the educational system. What if we could conquer teacher math anxiety (Gilreath, 2023)?

Questions yet to ponder…if this study had been done with larger population size, then more detailed statements could be made. With the smaller population (n=36) while we can determine that there is a relationship between teacher's years of service and education level and their self-efficacy and teaching anxiety levels. Taking a version of this study and scaling it up to state-wide or country wide would add a new element to the research in the area of math anxiety in teachers.

The researcher would like to dig deeper into secondary teacher math anxiety and their teacher efficacy- though given time constraints of the school year, it was not feasible to complete at this time- though would be a great next step in the research.

Questions That Could be Investigated

- How would secondary math teachers' math anxiety (content or Pedagogical) change over time, does it matter what math content they are teacher?
    - Could a comparison be made between teachers who always taught algebra vs those that have taught multiple math strands?
- Do teachers in grades 4-8 that departmentalize math, have similar teacher results?

  - How does the math anxiety levels differ for their students if they do or do not compartmentalize?

- Studying in-service teachers with their active students and determine if their awareness to math anxiety influenced their teaching and what strategies they developed to assist students or themselves as teachers.

Summary and Conclusion

This mixed analysis study explored the experiences and level of math anxiety of teachers. The framework illustrated in Chapter 2 demonstrated the connection between teacher's self-efficacy, general math anxiety(content), and anxiety of teaching math(pedagogy). The literature implies that the stronger a teacher's self-efficacy is the lower their teaching math anxiety would be. According to the 36 survey participants in this study, this was an accurate statement. Though, the 8 interviewees also brought about the point of building a community and building a solid foundation of mathematics content to lower general math anxiety amongst themselves and students. The literature also said that teachers with high math anxiety would use more concrete or procedural understanding this was illustrated through the interviews as teachers stated they used more manipulatives or hands-on learning, while teachers with lower math anxiety used more abstract teaching practices and allowed for productive struggle and peer-to-peer conversations to learn.

Chapter 4 illustrated the mixed-data analysis of quantitative data though a survey containing data on demographics, Math Teacher Efficacy Beliefs Instrument, and the Math Anxiety Scale for Teachers, which was used to determine the relationships between teacher self-efficacy, general math anxiety and anxiety teaching mathematics. While the

findings were not overwhelmingly surprising, there were some interesting findings, such as the community building and working together as a way to relieve math anxiety in teachers and students.

The interpretation in Chapter 5, showed how the data from Chapter 4 can be used to connect quantitative and qualitative data, literature, and research questions. The relationship between general math anxiety and anxiety teaching mathematics was found to be higher for teachers in lower elementary (in agreement with the literature) and in secondary teachers who do not teach math content specifically. Though this study determined that development of strong mathematic foundation, the ability to work hands-on with manipulative, and creating a community though relationships were all methods to lower both content and pedagogical math anxiety.

The recommendations, suggestions for future research, and questions to investigate above are further avenues of research that should be completed to further understand the Teaching Efficacy and Math Anxiety (content and pedagogical).

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Appendix

A. Demographic survey

1. What grade level do you currently teach (majority)
    a. Elementary PK-5
    c. Secondary 6-12
2. How many years have you been teaching?
    a. Less than 5 years
    b. 6-15 years
    c. 16+ years
3. Level of Education attainment
    a. Bachelors
    b. Masters
    c. Master's plus credits
    d. Educational Specialist/Doctorate
4. What area(s) are you certified to teacher (Select All that apply)
    a. Early Childhood
    b. Elementary
    c. Middle School
    d. High School
5. Do you have math certification (any level)?
    a. Yes
    b. No
6. Please list all content areas you are certified to teach. _____

7. Do you take Algebra or Geometry in high school?
    a. Yes, both.
    b. Yes, only Algebra.
    c. Yes, only Geometry.
    b. Neither
8. How many Math content course(s) were taken as an undergraduate? (rw163)
    a. 0
    b. 1
    c. 2
    d. 3 or more
9. How many Math methods (mathematics teaching/pedagogy) course(s) have you taken?
    a. 0
    b. 1
    c. 2
    d. 3 or more
10. Have you taken any Graduate level math courses?
    a. Yes
    b. No
11. Is there a team, colleague, or professional learning community (PLC) that you use to build your skills in helping students learn mathematics? Explain if so.

12. Have you held any leadership positions? If so what kind? (In your school or other organizations to which you belong?) For Example: SAT team lead, Committee Chair, Instructional Facilitator, Team Leader, etc. _____
13. On a scale from 1(not anxious) to 10(very anxious), how math anxious are you?
14. Would you be interested in being invited to participate in Phase 2 (semi-structured interview) for this research study? (dates/times TBD)
    a. Yes
    b. No
    c. Maybe
15. Staff ID # To keep information anonymous to researcher. The ID# will be used to identify those that will be interviewed at a later date.

B. Semi-Structured Interview Instrument

Directions: "*Frame the interview as having the teachers tell you stories. Math story questions (high point, low point, turning point). Connect this to have them then relate stories about themselves as mathematics teachers."* There are a few follow-up questions for some items, clarifying questions may be asked of participants.

1) What are the first words of phrases that come to mind when I say "mathematics"?
2) What do you think it means to be "good" at math? Can you share a story?
3) Please tell me what your understanding is of the definition of Math Anxiety? What is your definition of Math Anxiety?
    a) Have you experienced this? When and can you describe when it was the worst?
    b) Describe your first memory of it, how did it make you feel?
4) How do you see math anxiety present in students?
5) What are ways you work to combat your own anxieties? Are there any practices or strategies you use?
6) If an administrator or another person observed your classroom, what would they say?
    a) What would they see you doing? Student doing?
    b) What are the most effective teaching practices you model?
    c) What would you be more nervous about getting feedback on?
7) Can you describe the practices or strategies you use in the classroom to target/reduce math anxiety in your students?
    a) What are you doing? Student doing?
8) To what extent do you think students pick up/notice on the attitudes (including anxieties) of their teachers? How do you know?

9) What do you see as your responsibility as their teacher to address math anxiety in your students? What do you do?
10) When teaching mathematics, can you think of a time when you were teaching a concept you were not fulling confident teaching? Describe the experience.