

ELEMENTARY PRE-SERVICE TEACHERS: CAN THEY EXPERIENCE MATHEMATICS TEACHING ANXIETY WITHOUT HAVING MATHEMATICS ANXIETY?

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Abstract

Elementary pre-service teachers report high levels of mathematics anxiety (MA), but the construct less widely addressed is their mathematics teaching anxiety (MTA). This study investigated the frequency with which MA stemming from prior experiences leads to MTA. Fifty-three elementary pre-service teachers' written reflections were analyzed, using a Framework for MA and MTA. The results showed that one-third of the pre-service teachers reported high prior mathematics anxiety but did not experience MTA, suggesting the relationship between MA and MTA is not always linked. Teacher educators must address this relationship to support successful mathematics teaching experiences for pre-service teachers.

Introduction

For decades, research has documented the mathematics anxieties of pre-service elementary teachers. The findings from this research have focused on a variety of factors that contribute to pre-service teachers' mathematics anxieties and ways to address those anxieties in preparation for teaching elementary mathematics. An underlying assumption of this research is that pre-service teachers with high levels of mathematics anxiety are likely to become elementary teachers who do not enjoy teaching mathematics and who will not teach mathematics well. In concert with this assumption is the notion that pre-service teachers who have not experienced prior mathematics anxiety are likely to become elementary teachers who enjoy teaching mathematics and who will teach mathematics well. This body of research focuses on pre-service teachers' prior experiences with mathematics. In contrast, less is known about pre-service teachers' anxieties as a result of their mathematics pre-teaching experiences, and in particular, a lesser known phenomenon labeled: *mathematics teaching anxiety* (Levine, 1993; Peker, 2009).

The purpose of this study was to examine the assumption that high levels of mathematics anxiety from prior experiences are related to anxiety about mathematics teaching. In particular, we were interested in investigating how frequently pre-service teachers who brought prior mathematics anxiety experiences to their teacher education programs also had mathematics anxiety for teaching; and, the frequency of pre-service teachers who had little or no prior mathematics anxiety experiences who also had little or no mathematics anxiety for teaching. To understand pre-service teachers' experiences, we examined their descriptions of prior mathematics experiences and their reflections after teaching mathematics in elementary schools during a field-based experience.

What We Know About Mathematics Anxiety

The term mathematics anxiety is often credited to the work of Sheila Tobias (1978), who described an insurmountable feeling of sudden death for people stricken with mathematics anxiety. Since then, mathematics anxiety has been studied by researchers in many contexts, and has been described as a “complex phenomenon that has been defined in a number of ways” (Brady & Bowd, 2005, p. 37). For example, mathematics anxiety has been studied in terms of test anxiety (Hembree, 1990), fear toward mathematics coursework, and a desire to avoid mathematics at all costs (Bessant, 1995). Richardson and Suinn (1972) created an instrument to measure mathematics anxiety, called the *Mathematics Anxiety Rating Scale* (MARS), and more recently researchers have created an abbreviated instrument called the MARS-Revised (Alexander & Martray, 1989). This instrument has been used widely with elementary pre-service teachers, often revealing higher levels of mathematics anxiety in pre-service teachers when compared with the general undergraduate population (Bursal & Paznokas, 2006; Harper & Daane, 1998, Hembree, 1990).

The onset of mathematics anxiety can begin as early as elementary school (Harper & Daane, 1998). Jackson and Leffingwell (1999) found that 16% of students, in the transition between elementary and secondary school, stated that their first negative mathematics experience occurred by third or fourth grade, and 26% of respondents recalled negative mathematics experiences in secondary education classrooms. These negative experiences included: memories of struggling with particular concepts, such as fractions or long division; embarrassing moments of making mathematics errors in front of peers; past teachers that were viewed as hostile or uncaring; and gender-biased issues of mathematics schooling (Brady & Bowd, 2005). Cornell (1999) found similar results when studying the impetus for mathematics anxiety for teachers; participants who reported mathematics anxiety cited unsympathetic teachers in their past, who assumed that a mathematics concept or procedure was simple and self-explanatory, when the participant did not understand (Uusamaki & Nason, 2004). While some research has traced feelings of mathematics anxiety as far back as elementary school, other researchers have found that mathematics anxiety most often begins at the secondary level (Brown, McNamara, Hanley, & Jones, 1999; Nicol, Gooya & Martin, 2002; Trujillo, & Hadfield, 1999). Of note is that, “this results in a considerable proportion of students entering primary teacher education programs with negative beliefs and attitudes towards mathematics” (Uusamaki & Nason, 2004, p. 370). Therefore, understanding the relationship between mathematics anxiety in pre-service teachers and how mathematics anxiety influences field-based mathematics pre-teaching experiences, is worthy of investigation.

The Construct of Mathematics Teaching Anxiety

According to Peker (2009, p. 336), “Mathematics teaching anxiety can be defined as pre- and in-service teachers’ feelings of tension and anxiety that occurs during teaching mathematical concepts, theories, and formulas or during problem solving.” This type of anxiety is different from the more commonly used term, mathematics anxiety, because it is based on an individual’s anxiety about their ability to *teach* mathematics. Conversely, mathematics anxiety tends to focus on an individual’s anxiety regarding their lack of mathematics content knowledge or mathematics confidence. Mathematics anxiety is more internally focused and reflects how the individual views their own ability to interact with the mathematics; on the other hand, mathematics teaching anxiety is more externally focused and reflects how the individual views their ability to engage children in an interaction with the mathematics. Mathematics teaching anxiety can be independent of an individual’s weak mathematics history or background. Therefore, a person may not experience *mathematics anxiety* and may be very confident

about their mathematics knowledge, but they may experience *mathematics teaching anxiety* because they are not confident about their ability to teach the mathematics that they know to children.

Currently, research regarding mathematics teaching anxiety (MTA), can be difficult to isolate within the larger context of mathematics anxiety (MA). However, a Turkish researcher recently developed an instrument titled the “Mathematics Teaching Anxiety Scale” (MATAS) (Peker, 2009). In his research, Peker investigated interactions between scores on the MATAS and different learning styles, as well as differences in MATAS scores between elementary and secondary teachers. While Peker’s work is valuable in terms of isolating MTA from the larger umbrella of MA, there still appears to be a research gap in applying MTA to pre-service teachers in the United States and specifically to study MTA in the context of field-based mathematics teaching experiences.

Is there a Relationship between Mathematics Anxiety and Mathematics Teaching Anxiety?

We propose that there is an important distinction between mathematics anxiety and mathematics teaching anxiety that is important for pre-service teacher education. Pre-service teacher education programs may treat much of pre-service teachers’ anxieties about mathematics teaching by addressing the phenomenon as a pre-existing condition. In fact, some pre-service teachers may have confidence in their own abilities in mathematics, and therefore, do not experience mathematics anxiety (MA); while at the same time, they may be uncomfortable communicating mathematical ideas to children, and experience mathematics teaching anxiety (MTA). In these instances, pre-service teachers with mathematics anxiety may receive support while pre-service teachers with no mathematics anxiety may not receive support, and yet they too may need support for teaching.

A review of the literature on elementary pre-service teachers’ mathematics anxiety often refers to weak mathematical backgrounds, histories, and experiences for this population; it seems intuitive that teachers who have negative feelings and abilities in any subject area, such as mathematics, would then have difficulty teaching the subject of mathematics to students. In many studies, mathematics anxiety can be considered a pre-existing condition, or a negative mathematics attribute that elementary pre-service teachers bring with them as they enter teacher preparation programs. However, this focus on mathematics anxiety as a pre-existing condition overlooks the anxiety that may develop as a result of teaching mathematics, or *mathematics teaching anxiety*.

Much of the research conducted in the area of linking mathematics anxiety to mathematics teaching anxiety has used similar instruments to measure these constructs. Several studies have administered a mathematics anxiety instrument (such as the aforementioned MARS) to pre-service teachers, followed by administering a different instrument to measure mathematics teacher efficacy, the *Mathematics Teaching Efficacy Beliefs Instrument* (MTEBI) (Enochs, Smith & Huinker, 2000). Bursal and Paznokas (2006) found that pre-service teachers’ mathematics anxiety scores, as measured by the *Revised-Mathematics Anxiety Survey* (R-MANX), were negatively correlated with their levels of mathematics efficacy beliefs as measured by the MTEBI (high anxiety scores correlated with low efficacy scores). Gresham (2008) implemented a similar study using the MARS and MTEBI instruments with pre-service teachers and found that, “the preservice teachers with the lowest degree of mathematics anxiety had the highest levels of mathematics teacher efficacy” (p. 171). Swars, Daane & Giesen (2006) found similar results implementing the MARS and the MTEBI with clinical interviews and report, “findings revealed a significant, moderate negative relationship between mathematics anxiety and mathematics teacher efficacy” (p. 306). All three of these studies were conducted within a mathematics methods course semester which included some form of field experience.

In the three previous studies that all investigated mathematics anxiety and mathematics teaching efficacy, the latter two studies (Gresham, 2008; Swars et al, 2006) also implemented structured interviews following the scores rendered from the mathematics anxiety and efficacy instruments. In both studies, researchers only interviewed pre-service teachers that fell into the “highest” or “lowest” mathematics anxiety spectrums, based on MARS scores; the Gresham (2008) study interviewed twenty out of 156 pre-service teacher participants (ten with high mathematics anxiety, and ten with low mathematics anxiety) and the Swars et al (2006) study interviewed four pre-service teachers out of the 28 study participants. An interesting finding stemming from the interview portion in both of these studies was that pre-service teachers in both the high and low mathematics anxiety categories expressed some form of positive feeling when asked about teaching mathematics to students. Swars et al (2006) wrote, “All four of the preservice teachers, regardless of level of mathematics anxiety, indicated that they believed they could teach mathematics effectively” (p. 310); while Gresham stated, “Of the 20 pre-service teachers interviewed, 18 revealed that they believed they could teach mathematics effectively” (2008, p. 179). What these two studies reveal is that pre-service teachers in both the high and low groups of mathematics anxiety all expressed some level of efficacy, or confidence, toward teaching mathematics to elementary students. What these studies do not present is information on the pre-service teachers who are between these two extremes and their explanations of how mathematics anxiety, or lack thereof, has influenced their mathematics teaching. The studies also raise questions as to why some pre-service teachers’ mathematics anxiety scores may correlate with their mathematics efficacy beliefs, yet their own verbal explanations of mathematics teaching offer different perspectives.

Purpose of the Study

This study questions the assumption that pre-service elementary teachers with high levels of mathematics anxiety from prior experiences automatically leads to high levels of mathematics teaching anxiety; and pre-service elementary teachers with low levels or no mathematics anxiety from prior experiences automatically leads to low levels or no mathematics teaching anxiety. To unpack this assumption, we determined the frequency of the relationship between pre-service elementary teachers’ reported prior mathematics anxiety (those with prior mathematics anxiety and those with little or no prior mathematics anxiety) and pre-service elementary teachers’ reported mathematics teaching anxiety experiences (those with mathematics teaching anxiety experiences and those with little or no mathematics teaching anxiety experiences) during a field-based placement in an elementary school.

Research Questions

This study examined the following research questions: 1. What is the frequency of the relationship between pre-service elementary teachers’ prior mathematics anxiety (MA) and their mathematics teaching anxiety (MTA)? 2. With what frequency do pre-service teachers’ prior experiences with mathematics impact their mathematics teaching anxieties (MTA)?

Methods

Participants.

Fifty-three pre-service elementary teachers in a Bachelor’s degree program in Elementary Education participated in this study. The participants were undergraduates in their senior year of a four-year program that included elementary teacher licensure. Most participants were female. All were enrolled in three different sections of a mathematics methods course taught by three different faculty members at two different campus sites.

Instrument.

The participants provided self-report data as part of a common *Teaching Reflection Assignment* after they taught a minimum of three elementary mathematics lessons in local elementary schools. The data that were analyzed for this study were only one portion of the entire course assignment. This portion of the assignment was open-ended and narrative allowing pre-service teachers to “free write” and be descriptive of their experiences. There were several prompts in the assignment that encouraged the pre-service teachers to describe their own mathematics backgrounds, to talk about their teaching experiences with children, and to discuss their confidence and comfort level during their teaching of mathematics and other subject areas. These written narrative documents were our primary source of data.

Procedures.

The three course instructors explained the common *Teaching Reflection Assignment* to the pre-service teachers in each course section at the beginning of the semester. During the semester, the pre-service teachers attended classes on the university campus for nine weeks, and participated in a five-week elementary school field-based teaching experience. As part of the course requirements, each pre-service teacher was required to teach at least three mathematics lessons, although many of them had the opportunity to teach more than three lessons. After the conclusion of the semester, the course instructors solicited the participation of the pre-service teachers through email communication. This communication asked the pre-service teachers to submit only the open-ended and narrative portion of the assignment that focused on their background experiences and classroom experiences teaching mathematics. Fifty-five of the 62 pre-service teachers enrolled in the courses submitted the requested data. These documents were obtained from participants as electronic email attachments in Word format.

Data analysis.

To begin the coding process, the three instructors combined the documents from the 55 participants into one large file. Each participant file was treated as one case. Each participant case was coded in two categories along two dimensions. The first category was *prior mathematics anxiety* (MA) experiences. The two dimensions of this category were pre-service teachers who reported several experiences in their background which caused them to have prior mathematics anxiety (e.g., I have always felt stupid in math) and those that did not report these types of experiences (e.g., Math has always been

easy for me). The second category was *mathematics teaching anxiety* (MTA) experienced in the field-based teaching practicum. The two dimensions of this category were pre-service teachers who reported several experiences during their field-based teaching practicum that reduced their confidence in their ability to teach mathematics (e.g., I was upset that I didn’t reach the students) and those that did not report these types of experiences (e.g., I felt very confident while teaching mathematics).

Two readers independently coded and classified each of the 55 cases using the two categories and their dimensions (Stake, 1995; Strauss & Corbin, 1998); 2 cases did not provide enough information to be classified and were removed from further analysis, resulting in 53 cases presented in the results. The result of this coding process was that the two readers agreed on the coding of 45 of the 53 cases (85% agreement). A third reader conducted an independent analysis of the eight discrepant codes to reach agreement on the eight cases using the code given by two of the three readers. The 53 cases were clustered in four groups: A) NO-prior mathematics anxiety (MA), NO-mathematics teaching anxiety (MTA); B) YES-prior mathematics anxiety (MA), NO-mathematics teaching anxiety (MTA); C) NO-prior mathematics anxiety (MA), YES-mathematics teaching anxiety (MTA); and, D) YES-prior mathematics anxiety (MA), YES-mathematics teaching anxiety (MTA).

Results

The results from the 53 pre-service teacher cases are organized in a 2 x 2 matrix framework. (See Table 1.) Table 1 reveals the results regarding the interaction of mathematics anxiety and mathematics teaching anxiety for pre-service teachers. The horizontal dimension of this framework groups cases into pre-service teachers with prior mathematics anxiety and those with little or no prior mathematics anxiety. The vertical dimension of this framework groups cases into pre-service teachers with little or no mathematics teaching anxiety, and those with mathematics teaching anxiety. Each participant was assigned a case number (1-53) and each pre-service teacher's position in the framework was determined based on their reflection responses following their practice teaching experiences. The table indicates the number and percentage of pre-service teachers categorized in each of the four quadrants within the framework. There were 21 (39.6%) pre-service teachers in Quadrant A (no mathematics anxiety, NO-MA; no mathematics teaching anxiety, NO-MTA); 10 (18.9%) pre-service teachers in Quadrant B (yes mathematics anxiety, YES-MA; no mathematics teaching anxiety, NO-MTA); 9 (17%) pre-service teachers in Quadrant C (no mathematics anxiety, NO-MA; yes mathematics teaching anxiety, YES-MTA); and 11 (20.8%) pre-service teachers in Quadrant D (yes mathematics anxiety, YES-MA; yes mathematics teaching anxiety, YES-MTA). There were two cases (3.8%) within the data set where all readers agreed that the evidence provided in the pre-service teachers' reflections was so mixed that they did not fit the dichotomous framework (Cases: 23, 53).

Table 1: Framework of MA and MTA Results

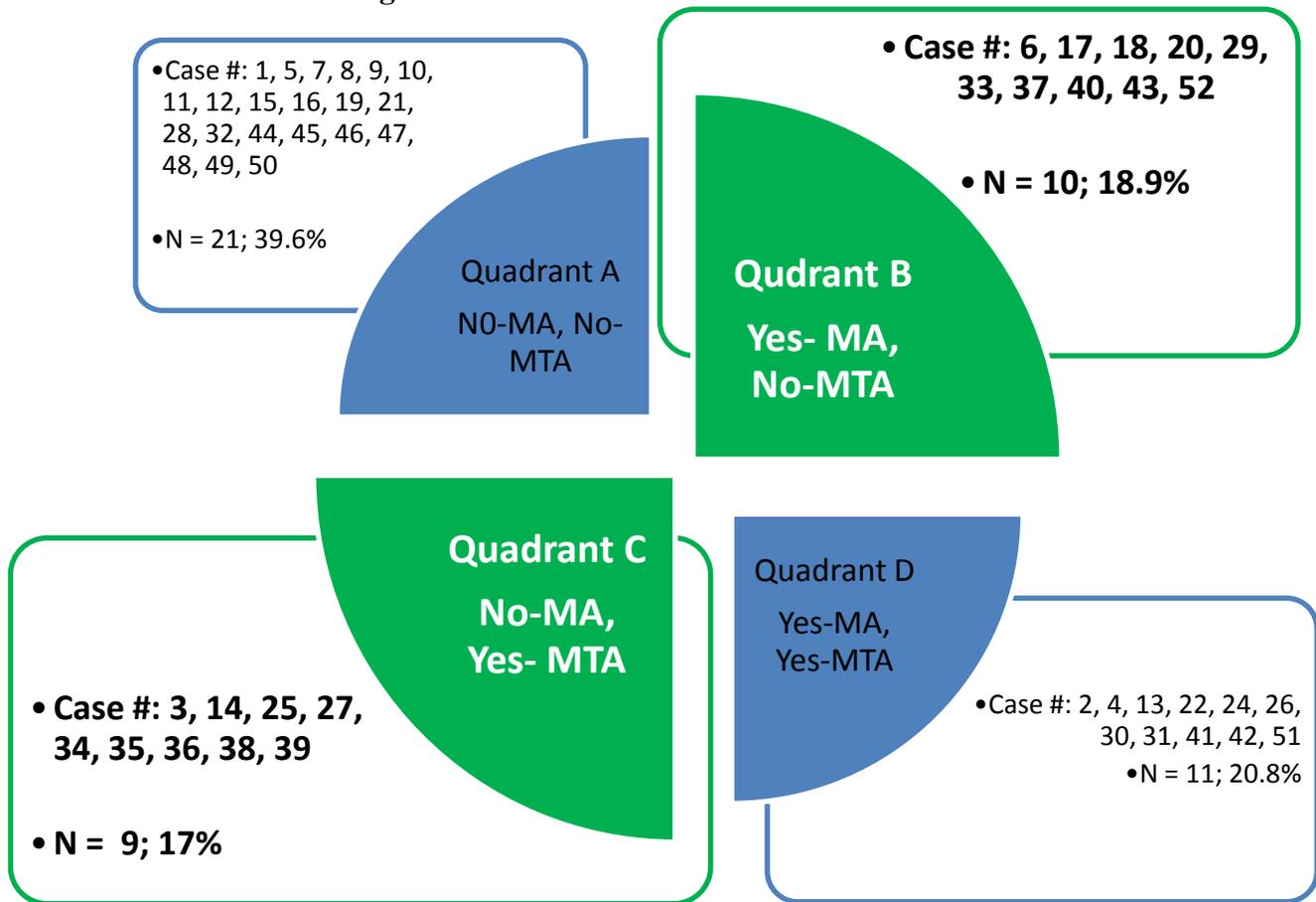
	NO-MA No: Prior Mathematics Anxiety (MA)	YES- MA Yes: Prior Mathematics Anxiety (MA)
NO-MTA No: Mathematics Teaching Anxiety (MTA)	Quadrant A: No-MA, No-MTA Case #: 1, 5, 7, 8, 9, 10, 11, 12, 15, 16, 19, 21, 28, 32, 44, 45, 46, 47, 48, 49, 50 N = 21; 39.6%	Quadrant B: Yes-MA, No-MTA Case #: 6, 17, 18, 20, 29, 33, 37, 40, 43, 52 N = 10; 18.9%
YES-MTA Yes: Mathematics Teaching Anxiety (MTA)	Quadrant C: No-MA, Yes-MTA Case #: 3, 14, 25, 27, 34, 35, 36, 38, 39 N = 9; 17%	Quadrant D: Yes-MA, Yes-MTA Case #: 2, 4, 13, 22, 24, 26, 30, 31, 41, 42, 51 N = 11; 20.8%

Not enough evidence for Case #s: 23, 53

In order to visually demonstrate the differences between the pre-service teachers that support or challenge prior assumptions regarding the relationship between MA and MTA, Figure 1 was created to show the quadrants with different emphases. These emphases are not based on mathematical proportions, but instead are based on the quadrants that contribute new insights to the literature on MTA. Quadrants B and C represent those pre-service teachers that challenge prior assumptions, and therefore are emphasized by appearing larger than the other quadrants in Figure 1. The results will be presented in

terms of quadrants of pre-service teachers that fit, or challenge, prior assumptions regarding MA and MTA.

Figure 1: Framework of MA and MTA Results



Not enough evidence for Case #s: 23, 53

Cases that fit prior assumptions of MA and MTA.

The pre-service teachers categorized in Quadrants A (No-MA, No-MTA) and D (Yes-MA, Yes-MTA) fit assumptions about pre-service teachers’ prior mathematics anxiety leading to mathematics teaching anxiety. This assumption is that pre-service teachers with prior mathematics anxiety will have mathematics teaching anxiety and that pre-service teachers without mathematics anxiety will not have mathematics teaching anxiety. Examples of written responses from pre-service teachers in Quadrants A and D are presented below. The following quotes are taken directly from pre-service teachers’ reflection data in order to provide examples of typical pre-service teachers in these quadrants. These are the pre-service teachers that most closely follow the assumption that negative previous mathematics experiences will lead to mathematics teaching anxiety, and that positive mathematics experiences will lead to positive mathematics teaching experiences.

Quadrant A: No-MA, No-MTA.

Quadrant A represents pre-service teachers who reported no prior mathematics anxiety as well as no anxieties about teaching mathematics in the practicum classroom (n = 21; 39.6%).

Case # 16 writes:

I always liked math and did well, so my attitude toward math is generally positive. I think that has definitely influenced my mathematics teaching in my practicum placement. Since I enjoy math, I am excited to teach them.

Additionally, Case # 19 writes:

I have always done pretty good [sic] in math and I have had really good teachers so I have a positive attitude about math. I think that this affected how I taught math because I went into each math lesson with the attitude that math is just as fun as any of the other subjects.

The statements shared by these two cases represent the pre-service teachers in Quadrant A; these are pre-service teachers who enjoy and have been successful with mathematics themselves, and they had positive experiences teaching mathematics to students during the field placement.

Quadrant D: Yes-MA, Yes-MTA.

The pre-service teachers in Quadrant D fit the assumption that having negative, prior personal experiences and anxieties about mathematics will lead to negative mathematics teaching experiences with students. These pre-service teachers described prior mathematics anxieties (MA), as well as anxiety while teaching mathematics (MTA) to students in the field-based classroom (n = 11; 20.8%).

Case # 26 writes:

As a student I struggled with math...I haven't had much exposure to techniques of teaching math, and I wasn't sure that I was going to be very good at it...I found myself praying for the lesson to be over. It seemed to last forever. The students were confused and I had to start completely over.

This pre-service teacher's statements reflected the comments from all of the pre-service teachers in Quadrant D. For the eleven cases in this quadrant, there were consistently negative statements about their personal abilities and experiences with mathematics (MA), and these mathematics anxieties influenced their mathematics teaching in the field-based classroom (MTA).

Cases that challenge prior assumptions about MA leading to MTA.

Unlike the pre-service teachers previously described in Quadrants A and D, the following pre-service teachers break from the traditional assumptions that mathematics anxiety will lead to poor mathematics teaching experiences for pre-service teachers. These pre-service teachers experienced mathematics anxiety in their backgrounds but did *not* report experiencing mathematics teaching anxiety (Quadrant B); or, they did not report mathematics anxiety in past experiences, yet revealed anxiety about teaching mathematics to students during their field-based teaching experiences (Quadrant C).

Quadrant B: Yes-MA, No-MTA.

The pre-service teachers in Quadrant B wrote about personal mathematics anxieties in their backgrounds (MA), but did not describe mathematics teaching anxiety (MTA) in the elementary classroom (n = 10; 18.9%). These pre-service teachers challenge assumptions regarding how prior mathematics anxiety will lead to negative mathematics teaching experiences in the classroom. One common notion from these pre-service teachers (six out of 10) was related to shifts in thinking about mathematics; they admitted having negative feelings about mathematics previously, but those feelings

changed to become more positive about teaching mathematics during their teaching experiences. Case # 29 writes:

Math now makes sense to me because my brain can wrap itself around the concepts and relate them to other aspects of my experience. Hopefully, I'm passing this on to the students I work with so that math is not a lesson in frustration for them.

And Case #43:

I also remember that I was taught mainly by me memorizing facts. I don't really ever remember using any manipulatives or seeing all the different ways to do math problems. Since entering the program, I have been exposed to all the different manipulatives and computer programs used to help students get a true understanding of math. It excited me because it makes sense! It's not just about memorization anymore. There are really cool ways to show students how to add, subtract, multiply, and divide.

Another sentiment shared by pre-service teachers in Quadrant B (seven out of 10) showed that because they were anxious about mathematics, they prepared their lessons with more diligence than in other subjects, which resulted in more positive views regarding their teaching of mathematics to students.

Case #17:

Mathematics was never the easiest subject for me when I was in elementary school so I was eager to teach the math lessons. I wanted to be as explicit as possible so that I could help those students who struggled with math like I did. I was actually quite confident in my teaching.

And Case #40:

I think that since I usually do not feel confident teaching math, I over-prepared so I always felt very confident when teaching my math lessons. Because of that, I really enjoyed teaching math almost more than [sic] I liked teaching the other subjects.

One more notion that was shared by five of the pre-service teachers in this quadrant was that, because they were anxious themselves about prior mathematics experiences, they realized the importance of hiding their personal anxiety through enthusiasm and excitement for mathematics, which ended up decreasing their mathematics teaching anxiety with students. Case # 18:

I am not good at math but if I understand it I enjoy it. Because of this I was enthusiastic about teaching it. I feel that by being enthusiastic about it the students will want to learn because they can see that you are enjoying it as well.

And Case # 37:

I wish that I had had a more positive attitude toward math as I grew up and realize that as a teacher I need to show a positive attitude toward it so my students can hopefully gain that as well.

The pre-service teachers in Quadrant B present an interesting dichotomy; they express their personal mathematics anxiety when asked about prior experiences, yet they found ways to have positive teaching experiences that led them to avoid feeling mathematics teaching anxiety when teaching students in the classroom.

Quadrant C: No-MA, Yes-MTA.

The pre-service teachers in Quadrant C (n = 9; 17%) revealed no mathematics anxieties in their personal backgrounds, yet still wrote about high levels of MTA when teaching mathematics in their elementary practicum classroom. Similar to the pre-service teachers in Quadrant B, these cases challenge assumptions that pre-service teachers with positive mathematics backgrounds will also be confident and experience no mathematics teaching anxiety when teaching mathematics in the classroom.

In describing causes of their mathematics teaching anxiety, eight of the nine pre-service teachers in this quadrant described issues related to their abilities to give clear instructions and explanations to children. They feared that either the students would not be able to understand the concepts or that management or assignment completion would be diminished as a result of students being frustrated or not being able to understand how to complete the mathematical tasks. Case # 34 writes:

I know I can do the problem but when asked to explain it to a nine year old I was having a hard time feeling like I was getting the point across to all of the students.

And Case #25:

I think math is the hardest thing to teach. It's especially hard when you know how to do the problem perfectly, but just can't explain it to the students. I feel comfortable in knowing all the problems; I just don't feel as confident in teaching it.

Another concern cited by over half (five out of nine) of the pre-service teachers in this quadrant was anxiety related to planning for and effectively developing with students the required mathematical concepts, especially in the earlier grades. As explained in the following quote, pre-service teachers viewed the nature of early mathematics concepts as difficult to plan for in the elementary classroom. Case # 35:

I found that I am a deep, abstract-type thinker and that I came up with ideas for lessons that were too far above the level achievable by 1st graders. I found that 1st graders need much more hands-on manipulatives (as you showed us in class) to make the concepts understandable and concrete. I fear I failed to demonstrate my love of math in my practicum this semester.

And Case #39:

At the beginning of my practicum, I would have felt that I was more comfortable teaching math, but towards the middle of my practicum, I lost a lot of my confidence in any of my teaching skills, especially math. I think a lot of attributes [sic] to the fact that it is first grade, so it is very basic math skills. I have never taught such basic math skills, and that has been difficult.

Closely related to difficulties of age-appropriate instructional methods for teaching mathematics concepts was the pre-service teachers' concerns about the difficulty of differentiating instruction for the

wide range of abilities they observed among their students. Six of the pre-service teachers in Quadrant C ($n = 9$) expressed concern about being able to effectively help struggling students. Case # 38:

I really liked Math as a student because I was really good at it. It affected my teaching because I figured that everybody would understand what I was trying to teach because I understood it. I should've tried differentiating instruction during that last lesson and explaining it more thoroughly than I thought necessary.

And Case #36:

I suppose the greatest shock to me in my last few years of teaching math and other subjects to students is that they don't all have the same love for numbers, challenges, or subjects as I did. What seems like a simple concept to me can actually be extremely difficult for others to master and they need a lot more experience in different ways than I did.

Many pre-service teachers in Quadrant C (seven out of nine) expressed mathematics teaching anxiety related to keeping students engaged and on-task during mathematics teaching. Case #14 writes:

I was always confident in my ability to do math. However, my management skills during teaching math were very difficult to master and they still need some polishing.

And Case # 27:

I like math and I am good at it, but I have never been a fan of math worksheets and book work math.... I believe this is why I struggled while teaching math during my practicum. I felt confined when I had to use the scripted lesson and worksheet. I didn't feel that the students were really getting math in a positive engaging way.

The pre-service teachers in Quadrant C ($n = 9$; 17%) are unique because they do not conform to assumptions regarding the connection between mathematics anxiety and mathematics teaching anxiety. These are pre-service teachers, who confidently state that they are good at mathematics and have had positive mathematics experiences in their backgrounds, are now facing mathematics teaching anxiety when it comes to teaching elementary school students. When Quadrant C is combined with Quadrant B ($n = 10 + 9$; 18.9% + 17%), these two groups of pre-service teachers represent 36% of our students, over one-third of our pre-service teachers whose prior experiences with mathematics and current mathematics teaching experiences seem to be disconnected in terms of assumptions about how prior experiences with mathematics influence mathematics teaching.

Implications and Future Research

The results of this study demonstrate that the relationship between mathematics anxiety and mathematics teaching anxiety is not always the same for all pre-service teachers, and in fact, is difficult to predict. Pre-service teachers with low or no mathematics anxiety in their prior experiences can still possess mathematics teaching anxiety when teaching mathematics to students, and vice versa for pre-service teachers with high levels of mathematics anxiety in their backgrounds. This result, revealing various relationships about the experiences of pre-service teachers with mathematics anxiety and

mathematics teaching anxiety, could contribute to the teaching of mathematics methods courses in several ways. By learning more about the attitudes, beliefs and practices of pre-service teachers who do not exhibit mathematics teaching anxiety in Quadrants A (No-MA, No-MTA) and C (Yes-MA, No-MTA) it may be possible to identify interventions which could help pre-service teachers be more prepared for the anxiety-inducing experiences that contribute to their mathematics teaching anxiety. For example, one pre-service teacher described how positive self-talk helped her to be able to project a positive attitude about mathematics. Several pre-service teachers suggested that the practice of creating very detailed lesson plans made them more confident when teaching mathematics. Sharing these ideas with pre-service teachers may help them overcome mathematics teaching anxiety.

Many of the pre-service teachers in Quadrant D (Yes-MA, Yes, MTA) described how their lack of confidence in their mathematics abilities translated very quickly to mathematics teaching anxiety when they realized they had made an error while teaching. Mathematics educators might intervene with pre-service teachers who have MA by spending some class time discussing what to do when making a mathematics error when working with children, and encourage pre-service teachers that an entire lesson is not lost if a teacher makes one mistake. Video clips and role-playing could be beneficial in accomplishing this kind of intervention.

Awareness of the four quadrants could aide mathematics educators in identifying and supporting the needs of their pre-service teachers. One concern frequently expressed by pre-service teachers of Quadrant C (No-MA, Yes-MTA) was their anxiety of describing mathematics so that it was clear and understandable to younger students. These pre-service teachers might gain confidence through practice presenting concepts in the safe environment of the mathematics methods course. Another intervention for pre-service teachers in Quadrant C (No=MA, Yes- MTA) could include the use of video vignettes that show children's thinking while struggling with mathematics problems, and observing the interaction between students and an experienced teacher in order to support pre-service teachers' understanding of children's mathematics thinking and how to use discourse effectively in mathematics teaching.

The framework presented in this study may lead to further research on the effects of specific strategies for pre-service teachers during methods courses. Some strategies may have positive effects for pre-service teachers in one quadrant but have negative effects for those in another quadrant. A student in Quadrant C (No-MA, Yes-MTA) may find role playing to be beneficial because of the opportunity to practice presenting concepts in a friendly environment, yet a pre-service teacher in Quadrant B (Yes-MA, No-MTA) may find the same activity to be very intimidating because they must demonstrate their mathematics ability in front of their peers.

Even the interpretation of activities such as viewing teaching films may be found to differ among quadrants. Pre-service teachers in Quadrant A (No-MA, No-MTA) could focus more on students' conceptual development while those in Quadrant C (No-MA, Yes-MTA) focus on teacher practices. Another mathematics methods activity that may produce different results amongst pre-service teachers is the removal of the "algebra crutch" during mathematics problem-solving activities; this experience could be challenging for pre-service teachers who only know algebraic formulas as a problem-solving strategy, but could boost pre-service teachers' confidence who tend to use more intuitive strategies such as guess and check or draw a picture.

Conclusion

Research related to elementary pre-service teachers' mathematics anxieties has consistently shown that elementary pre-service teachers have higher levels of mathematics anxiety than the general college population, which has prompted concern in the mathematics education community for decades. This

study examined mathematics teaching anxieties more closely, in order to understand the frequency of the relationship between mathematics teaching anxiety and the traditional notion of mathematics anxiety. The *Framework for MA and MTA* revealed that for some pre-service teachers, the relationship between MA and MTA did fit the assumption that mathematics anxiety and negative prior experiences with mathematics would indeed result in mathematics teaching anxiety, and vice versa for pre-service teachers without mathematics anxiety. Over one-third of the pre-service teachers in this study challenged the assumptions of the relationship between MA and MTA, and revealed that the anxieties experienced through the actual teaching of mathematics with children were not always related to pre-service teachers' previous mathematics anxiety.

Early mathematics teaching experiences are crucial to the future mathematics teaching experiences of novice in-service teachers. Research shows that the reform-based mathematics strategies learned in undergraduate methods courses can easily revert to traditional, lecture-based teaching styles during the first few years of in-service teaching (Ebby, 2000). Therefore, any progress that mathematics educators can make toward ensuring that early mathematics teaching experiences do not result in mathematics teaching anxiety is important. The pre-service teachers that are represented in the four quadrants of the *Framework for MA and MTA* provide an opportunity to consider strategies and activities within mathematics methods courses that may benefit elementary pre-service teachers in different ways, in order to prepare elementary pre-service teachers for positive, early mathematics teaching experiences regardless of their prior mathematics anxieties.

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