1-22-2019

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Recommended Citation

Olson, A., & Stoehr, K. (2019). From numbers to narratives: Preservice teachers' experiences with mathematics anxiety and mathematics teaching anxiety. School Science and Mathematics, 119(2), 72–82. https://doi.org/10.1111/ssm.12320

From Numbers to Narratives: Preservice Teachers Experiences' with Mathematics Anxiety and Mathematics Teaching Anxiety

Amy M. Olson & Kathleen Jablon Stoehr

Abstract

This paper presents qualitative and quantitative approaches to exploring teachers' experiences of mathematics anxiety (for learning and doing mathematics) and mathematics teaching anxiety (for instructing others in mathematics), the relationship between these types of anxiety and test/evaluation anxiety, and the impacts of anxiety on experiences in teacher education. Findings indicate that mathematics anxiety and mathematics teaching anxiety may be similar (i.e., that preservice teachers perceive a logical continuity and cumulative effect of their experiences of mathematics anxiety as learners in K–12 classrooms that impacts their work as teachers in future K–12classrooms). Further, anxiety is not limited to occurring in evaluative settings, but when anxiety is triggered by thoughts of evaluation, preservice teachers may be affected by worrying about their own as well as their students' performances. The implications for preservice experiences within a teacher education program and for impacting future students are discussed.

Literature Review

Mathematics anxiety (anxiety when asked to learn or perform mathematics) and mathematics teaching anxiety (anxiety when asked to teach mathematics) are an ongoing concern for preservice teacher (PST) education. However, little is known about how the two types of anxiety relate and whether they differentially or collaboratively impact PSTs. In fact, the distinction between MA and MTA is relatively recent. Accordingly, this paper brings together qualitative and quantitative work to begin exploring PSTs' experiences of both types of anxiety and the effects of those experiences on teacher education.

Mathematics Anxiety (MA)

MA is more than dislike for mathematics (Swars, Daane, & Giesen, 2006; Vinson, 2001), and is better described as a stress response, supported by negative physiological reactions (e.g., sweaty palms, racing heart rate, dry lips, pale face, nausea) when engaged in mathematical tasks (Luo, Wang, & Luo, 2009) or when even thinking about engaging in mathematics (Hembree, 1990). The physiological response is supported by an emotional response (e.g., fear, panic, hatred) to mathematical stimuli and contexts (Tobias, 1978; Trujillo & Hadfield, 1999). Meta-analyses indicate significant inverse relationships between MA and achievement (Hembree, 1990; Ma, 1999). Moreover, anxious students are less likely to take advanced mathematics courses or to be successful in the courses they do take (Beilock, Gunderson, Ramirez, & Levine, 2010; Brady & Bowd, 2005).

Research and measures of MA often associate the experience with test and evaluation anxiety (e.g., Brady & Bowd, 2005; Bursal & Paznokas, 2006; Luo et al., 2009; McGlynn-Stewart, 2010) and the impact that failure in these settings has on self-beliefs (Lee, 2009). However, it is unclear whether initial experiences of failure lead to anxiety or whether mathematics anxiety leads to a history of poorer performances in evaluative settings (Dowker, Sarkar, & Yen Looi, 2016). Anxious individuals report that the negative emotional response occurs prior to mathematical performance, but is most severe when poor performance is evaluated, resulting in loss of self-esteem (Bursal & Paznokas, 2006), confidence (McGlynn-Stewart, 2010), or self-efficacy (Stoehr & Olson, 2015). These feelings are associated with a tendency to avoid mathematics generally (Hembree, 1990), but especially where one's performance will be evaluated. Repeated experiences of real or perceived failure may lead to identification of oneself as "not a math person" (Stoehr, Carter, & Sugimoto, 2014).

Evidence in K-12 settings suggests that for some students MA increases significantly between elementary and secondary school (Brown, McNamara, Hanley, & Jones, 1999; Jackson & Leffingwell, 1999). This increase is associated with exposure to negative stereotypes about mathematics as well as humiliating experiences with mathematics and with a perception that mathematics teachers at later grades become uncaring and hostile towards students who struggle to learn (Brady & Bowd, 2005; Dowker et al., 2016; Stoehr, Carter, & Sugimoto, 2014; Uusimaki & Nason, 2004).

Mathematics Teaching Anxiety (MTA)

MTA is defined as anxiety associated with real or perceived deficits in teaching mathematics (Peker, 2009). It is marked by high levels of concern about being able to teach correctly and fear that instructional efforts will confuse students. MA potentially exacerbates the experience of MTA, as PSTs struggle to learn content and pedagogy (Bursal & Paznokas, 2006; McGlynn-Stewart, 2010).

Research has shown that the two types of anxiety can be distinguished by those who experience them. For example, Brown, Westenkow, and Moyer-Packenham (2011) found that 36% of PSTs experienced only one type of anxiety, while 21% experienced both. Hadley and Dorward's (2011) sample of inservice teachers reported both types of anxiety but indicated that they experienced higher levels of MA than MTA.

Effects on Inservice Teaching and Student Outcomes

Most existing studies use measures of MA rather than the newer construct of MTA to describe impacts on classroom teaching, student outcomes, and teacher education. MA has been linked to less-skilled teaching (Gresham, 2007; McGlynn-Stewart, 2010; Swars, Smith, Smith, & Hart, 2009; Vinson, 2001) and lower student achievement (Mizala, Martinez, & Martinez, 2015).

Moreover, teachers who feel uncomfortable with mathematics may model their anxiety to students. Beilock et al. (2010) found that first and second grade elementary teachers unintentionally communicated their anxiety resulting in an increased likelihood that girls (but not boys) in these classes would endorse gender stereotypes that boys are better at mathematics. Such negative and stereotyped mathematics messages have been shown to have detrimental effects on academic achievement (Boaler, 2008; Gavin & Reis, 2003).

Effects on PST Education

Researchers have also demonstrated that PSTs, especially women preparing to teach in elementary classrooms, experience consistently high levels of MA across studies (e.g., Brady & Bowd, 2005; Bursal & Paznokas, 2006; Brown et al., 1999; Gresham, 2007; Harper & Daane, 1998; Hembree, 1990; McGlynn-Stewart, 2010; Peker, 2009; Sloan, Daane, & Geisen, 2002). The anxiety and concomitant weak understanding of mathematics may cause PSTs to prefer teaching at earlier grade levels or in non-mathematical subject areas (Stoehr, 2017).

Further, the experience of MA disrupts PSTs' ability to process information, thus inhibiting learning and performance in mathematics methods and content courses (Gresham, 2007). Teachers must make sense of students' mathematical thinking (Sherin, Jacobs, & Philipp, 2011), which means that as PSTs, they must develop strong mathematics content knowledge (Ball & Forzani, 2010) and rich conceptual understanding of mathematical pedagogy (Ma, 1999). Yet, MA may inhibit them from learning mathematical content and developing instructional skills.

PSTs who experience MA are also more likely to have negative attitudes about mathematics and required mathematics courses, lower performance in mathematics methods courses, and preferences for focusing on traditional algorithms and direct instruction rather than

conceptual development and student-centered instruction (Brady & Bowd, 2005; Grootenboer, 2008; Rayner, Pitsolantis, & Osana, 2009). Thus, while studied as MA, the literature suggests potential impacts that are conceivably due to either or both MA and MTA. It is within this context of developing understandings of what it means for PSTs to experience MA and MTA that these current exploratory studies were grounded.

Research has begun to focus on the role of teacher preparation programs to ameliorate mathematics-type anxieties and their effects on PSTs (e.g., Gresham, 2007; McGlynn-Stewart, 2010). Although these studies do not regularly distinguish between the two types of anxiety, they suggest generally that it is possible to reduce anxiety during teacher education when clear and collaborative opportunities are given to PSTs to think, talk, and reflect on their anxieties about learning and teaching mathematics. The two present studies were guided by interest in better framing these opportunities for PSTs.

Research Questions

The studies reported in this paper are exploratory in nature, with the intention of further understanding and distinguishing between MA and MTA to inform teacher preparation interventions. The research questions are as follows:

1. How do PSTs experience MA and MTA in evaluative and non-evaluative contexts?
2. How are experiences of MA and MTA related to each other?
3. How do experiences of MA shape PSTs' beliefs about their future mathematics teaching?

This paper reports on both a qualitative and quantitative study that explored MA and MTA of PSTs enrolled in a teacher education program at a southwestern university. The participants came from successive cohorts of students and the designs of the studies differed. We report these studies together as they provide insights into traditional survey methodology for

measuring anxiety as well as more qualitative approaches for understanding the narratives that PSTs use to make sense of their experiences with anxiety. Thus, the findings across the two designs offer implications for the study of MA and MTA in addition to the impacts on teacher preparation programs. We begin with the qualitative study.

Qualitative Methods

Participants

The qualitative study focused on three White women elementary PSTs (Estelle, Phoebe, and Roxanne), who were in the third year of their elementary teacher preparation program. The women were all in their early twenties and were part of a larger study (TEACH Math). They were recruited on the basis of an initial course assignment in mathematics methods in which they were asked to write a "mathematics autobiography." The three women wrote clearly and powerfully about feelings of MA throughout K-12 schooling.

Data Collection

While a small sample, this group of women shared many extended personal narratives over 18 months, enabling rich portraits of mathematics anxiety to be examined through long-term interactions during key phases of their teacher preparation program. This design allowed for the researcher to collect data over three semesters of coursework and student teaching. Individual and group interviews and semi-structured prompts were used to direct the participants to narrate mathematics stories as learners and as future teachers. A total of eleven individual interviews, with all three women asked the same questions, and three focus group interviews were conducted (See Appendices A - C for sample individual and focus group interview questions). The individual interviews were 15 - 60 minutes in duration. The focus group interviews were

between one and two hours long. Data from both the focus group interviews and individual interviews contributed to the findings in this study.

Analysis

During multiple subsequent readings of the data, an iterative analysis (Bogdan & Biklen, 2006) of the data was performed to demarcate the narratives that pertained specifically to mathematics anxiety in learning and teaching mathematics. A narrative was defined as an individual's lived experiences and/or their interpretation of their experiences (Connelly & Clandinin, 1990). For each PST, narratives were identified within transcript and text passages that included key words specific to MA and MTA (See Figure 1). If a transcript or text passage included one or more of the key words, the passage was identified as a narrative related to mathematics anxiety. The demarcation procedure was repeated to ensure reliability.

An emergent coding scheme (Marshall & Rossman, 2006) was utilized to organize and sort each participant's narratives. Particular phrases or sentences that identified how a particular narrative seemed to create mathematics anxiety were highlighted and labeled. The narratives were recoded for consistency (or a lack thereof) after a passage of at least a week's time. This allowed evaluation of the stability of emerging themes and/or consideration of alternative interpretations of the data. Analytic memos (Maxwell, 1996) were then written to summarize key patterns across narratives.

Narrative Findings: Estelle, Phoebe and Roxanne

Given that these PSTs were chosen based on their autobiographies detailing anxious mathematics experiences, it was not surprising that they would experience high levels of MA. However, they also experienced high levels of MTA, with clear overlap between the ways they described both types of anxiety (See Figure 1).

MA in Evaluative (Testing) Contexts

All three women described emotional responses consistent with a test anxiety framing of MA during their K-12 years, such as feeling "uncertain," "ashamed," "panicky" or "fearful" by their performance on mathematics tests. This appeared to lead to their changing beliefs about themselves and their abilities to learn mathematics. For example, Estelle vividly reported a fourth grade experience in which she began to feel "inadequate" because she had not been identified as one of the "smart kids" based on a mathematics test. She shared the following narrative:

> Fourth grade math is when, right at the beginning of the year, we all took a math test. I don't remember if it was just multiplication or what. The people who got one hundred percent on their math test were in the advanced group. Everyday we would see them leave the class and go to a different classroom. I just always remember that, thinking, "Why can't I be in that group? Or "Is it because I didn't finish my test in a certain amount of time?" (Student Teaching Interview, March 26, 2012)

Phoebe remembered feeling frustrated because she "could not get" mathematics like so many of her classmates, and her feelings of "not being good enough" intensified when she compared her performance to that of her peers. She reported:

> In high school when I would get like a D on the test or something and the kids would just, no problem, get As and Bs and it just made sense. I just remember thinking, I just remember not understanding how it made sense to them and not to me (Student Teaching Interview, March 22, 2012).

Both Phoebe and Estelle described their MA within the context of tests, which they believed provided the evidence that they *could not learn* mathematics, creating their self-identification as math-anxious.

MA in Non-Evaluative Contexts

A counter-narrative was put forth by Roxanne. Rather than speak about her test performance, Roxanne explained that her anxiety was grounded in her feelings of *uncertainty* about her classwork. She stated that she never knew how she was really doing in high school mathematics so she consistently second-guessed herself, withholding judgment until her work was graded and returned to her. She stated:

> I didn't have a full understanding when I was younger. … When I was in school, it was, here are the problems, do the work, and then turn it in. I never understood if I did it right until I got my paper back (Mathematics Autobiography, January 18, 2011).

For Roxanne, the anxiety appeared to be driven by not knowing how to evaluate her own mathematical performance and needing to rely on the feedback she received from teachers.

MTA in the Evaluative Context of Student Tests

All three women revealed feelings of MTA that arose when they thought about preparing their students for tests. For example, Phoebe shared how teaching of a geometry lesson, a content area in which she already experienced MA, could also have a negative effect on her students. She reported:

> With this geometry lesson I just would go home at night thinking, "I don't know what to do tomorrow!" I think I just feel so responsible for their learning that I think if I don't know what to do, how are they gonna learn? And how are they gonna be successful? With [the state standardized test] coming up, that kind of makes me nervous too, because

> I don't want to, as a preservice and as a student teacher, I don't want them to lose out because I'm spending my time learning (Student Teaching Interview, March 22, 2012).

In this interview, Phoebe expressed how unprepared she felt to be teaching a geometry lesson that students needed to master in order to be successful on the state test. Similar themes were shared by Estelle in reflecting on a multiplication and division lesson and by Roxanne, who worried about how her students would be able to learn when she was still struggling to understand the curriculum. For all three, the experience of MTA was elicited when they felt unprepared to help students perform well on tests.

MTA in Non-Evaluative Contexts

The three women also described contexts that were non-evaluative but still anxiety provoking. For example, Estelle described intense feelings of MTA when teaching students vocabulary related to fractions. Similarly, Phoebe, recalled feeling MTA when preparing a lesson on three dimensional shapes. In relaying these experiences, the women focused on content, but they did not connect to a testing or evaluative context.

In contrast, Roxanne described MTA in relation to aspects of the teaching other than the content, such as being able to use an interactive whiteboard to deliver mathematics lessons. She recalled a lesson on equivalent fractions where she attempted to use the smart board.

> We get to a problem and I made this really cool plan on the smart board and the technology fails. …Because you plan this really great interactive thing and then you kind of lose the whole idea of your lesson and the message that you're trying to send the kids. Because everyone's trying to fix the smart board, you know? I feel unsure about math when they're trying to get all of us to start teaching through this technology and everybody should be using technology. It's like okay but did I just lose the whole class

> because it didn't work? … Most of the time I use the board for math and so it's always like please just do it for me. (Conversations that Matter, March 31, 2012)

When the technology failed, Roxanne's already high MTA caused her to "lose the whole idea of the lesson" and the content she was trying teach.

Perceived Relationship between MA and MTA

Estelle, Phoebe, and Roxanne perceived their MTA to be a logical extension of their experiences of MA as students. In their narratives, this continuity between the anxiety they experienced while learning mathematics as children and learning to teach mathematics as adults, imagining themselves as future mathematics teachers, and engaging in their early attempts to teach mathematics during their student-teaching internships was clear and cumulative. For example, Estelle described a cognitive aspect of her experience of both MA and MTA. She often felt "jumbled up" as she sought to learn and teach mathematics. This feeling of confusion and disorganization was emphasized by an ongoing, emotional response to mathematics, namely a "dread" that the criticism she recalled from her K-12 teachers would be replicated by her mentor teacher when she attempted to teach.

Like Estelle, Phoebe's description of her MA in childhood was firmly grounded in poor performance on tests and concerns that her poor performance would result in criticism from teachers and peers. This cumulative history of poor performance had left Phoebe with a sense that she could not learn enough content to teach well:

> Math, I've always shied away from it so I think that's a part of it. … I am worried that I am not going to be able to do it. I'm not going to get the information or knowledge I need to bring it to my students. … I am worried that I am not going to know enough. I won't

> have a deep enough knowledge to help my students learn (Methods Post Interview, May 11, 2011).

When Phoebe tried to envision herself as the one responsible for teaching her future students mathematics, the doubts about her own fragile relationship with mathematics made her wonder if she would be able to do so.

Roxanne also spoke of struggling to understand the mathematical concepts that she would be expected to teach. She stated:

> How do you teach something if you don't know it? There were projects and little problem solving things that we did in [methods] class with Dr. T, and if I didn't know it I felt dumb, so I kept saying, "Well how can I be a teacher if I don't even know how to do this stuff myself," so I just kind of lost a little bit of confidence there. (Timeline Activity, April 25, 2012).

When faced with teaching mathematics, Roxanne questioned her mathematical confidence, leading her to question if she was "dumb."

MA/MTA and Future Mathematics Teaching

All three women described strategies they used during their teacher preparation program to moderate their MA and MTA. Roxanne who responded to mathematics learning and learning to teach mathematics with feelings of uncertainty, spoke of teaching strategies (rather than content) in hopes they might "get her through" her future teaching of mathematics. Phoebe suggested that her tendency was to "shy away" from mathematics learning, consistent with her tendency toward avoidance behaviors in teaching mathematics. Estelle stated that she would focus on being "a teacher who was supportive, encouraging, and understands where my students are coming from" (Timeline Activity, May 2, 2012). In this way, she had hoped that perhaps her

own MA and MTA would not be so apparent to her future students. Thus, the MA and MTA that all three of the women experiences throughout their student learning days and their teacher preparation program contributed to their beliefs regarding their future mathematics teaching.

[INSERT FIGURE 1 HERE]

Quantitative Study Methods

Participants

The sample of participants in the quantitative study were representative of the range of PSTs in the elementary education program (91% women, 85% interested in teaching at K-4 grade levels). The participants included 53 PSTs recruited as sophomores (just prior to their mathematics methods courses). The participants were recruited as part of a larger study (Algebra Ready) focused on creating and evaluating online professional development for elementary and middle school mathematics teachers. As elementary teachers, the participants were expecting to teach all core subjects, including mathematics.

Data Collection

In addition to rating the degree to which they believed each core subject area would be an area they would prefer to teach on a four-point Likert-like scale, they also completed two 12-item anxiety measures. These included the MA measure (MARS-R, Hopko, 2003) and the MTA measure written to align with the MARS-R (Hadley & Dorward, 2011). The MARS-R is a revision of the original Mathematics Anxiety Rating Scale (MARS, Richardson & Suinn, 1972). Several revisions of the scale have been proposed, but the Hopko (2003) revision was used because it features a two-factor solution of 8 items related to learning (e.g., “Picking up a math textbook to begin working on an assignment”) and four items related to test/evaluation contexts (e.g., “Thinking about an upcoming math test one day before”), consistent with the narrative

design. It has also been used in prior research with PSTs (e.g., Rayner et al., 2009) and served as a basis for the creation of the Hadley and Dorward (2011) MTA survey, again resulting in 8 items assessing anxiety about teaching mathematics and 4 items referencing tests/evaluations. Although the two sets of measures are consistent in design, they differ in whether anxiety occurs in learning or teaching contexts. For example, the Hopko (2003) measure asks about preparing a homework assignment while the parallel item from the Hadley & Dorward (2011) measure asks about preparing a lesson. Both measures use a five-point Likert-type scale in which participants rate the level of their anxiety from 1 ("not at all") to 5 ("very much").

Survey Findings

Descriptives were explored to examine the average level of anxiety PSTs reported for MA and MTA, and for the learning/teaching and evaluation components of each anxiety type. In Table 1, average PST responses are provided for the learning or teaching and evaluation items. In general, participants responded with modal item scores suggesting that items elicited between "not at all" and "a fair amount" of anxiety, with higher levels of anxiety in response to evaluative items.

[INSERT TABLE 1 HERE]

In answering the first research question about PSTs' experience of MA and MTA in evaluative and non-evaluative contexts, paired t-tests were used to determine whether participants' mean responses of MA differed between learning and evaluation and whether MTA differed between teaching and evaluation. Cohen's *d* is reported here as an effect size measure used to indicate the practical difference between two means. Cohen's $d = .01$ is considered a very small effect, $d = .20$ is a small effect, $d = .50$ is a medium effect, $d = .80$ is a large effect, and $d = 1.20$ is a very large effect (Cohen, 1988, Sawilowsky, 2009).

MA in Evaluative and Non-Evaluative Contexts

The survey responses indicated PSTs felt significantly higher levels of anxiety in test (M = 3.26, SD = 1.14) than in learning (M = 1.98, SD = .79) contexts [($t(52) = 10.85$, $p < .001$, d = 1.31]. For example, the highest levels of anxiety were recorded for the items: "Being given a 'pop' quiz in math class" (M = 3.49, SD = 1.23), "Taking an examination (quiz) in a math course" (M = 3.21, SD = 1.26), "Thinking about an upcoming math test one day before" (M = 3.19, SD = 1.29), and "Waiting to get a math test returned in which you expected to do well" (M = 3.15, SD = 1.34).

In contrast, non-evaluative items, such as "Having to use the tables in the back of a math book" (M = 1.45, SD = .77), "Looking through the pages in a math text" (M = 1.64, SD = .98), "Watching a teacher work an algebraic equation on the black board" (M = 1.81, SD = 1.09), and "Picking up a math textbook to begin working on an assignment" (M = 1.85, SD = .98) elicited relatively lower levels of anxiety.

MTA in Evaluative and Non-Evaluative Contexts

Similar to the MA findings, participants responded with significantly more anxiety to MTA items set in evaluative (M = 3.26, SD = 1.01) than in non-evaluative (M = 2.22, SD = .88) teaching settings [$t(52) = 9.73$, $p < .001$, d = 1.09]. For example, participants indicated some of the highest levels of anxiety for items that explicitly mentioned testing, despite the fact that these items indicated their students would be tested and not themselves: "Waiting for the results of your students' year-end math tests" (M = 3.19, SD = 1.14) and "Preparing students for a 'standardized' math test throughout the week before" (M = 3.13, SD = 1.18). The highest level of anxiety was triggered by an item that explicitly indicated the *teacher* would be evaluated:

"Having a surprise evaluation by an administrator during a math lesson you are teaching" (M = 3.45, SD = 1.17).

In contrast, the lowest levels of anxiety occurred in non-evaluative preparation and teaching contexts: "Talking to a student who wanted to use a different way to solve a math problem than the way you taught in class" (M = 1.83, SD = 1.11), "Looking through the pages in your math series teachers' manual" (M = 1.89, SD = .99), and "Teaching students how to use and interpret tables, graphs, and charts" (M = 1.96, SD = .96) all elicited low levels of anxiety.

Relationship between MA and MTA

To answer the second research question about whether a relationship existed between participants' reported experiences of MA and MTA, a paired t-test compared participants' responses on the MA and MTA surveys and a Pearson correlation between the two surveys was calculated. For PSTs in this study, there was no significant difference (p = .282) between levels of MA (M = 2.40, SD = .83) and MTA (M = 2.50, SD = .85). Thus, consistent with the narrative findings, PSTs who were highly anxious about learning mathematics were also highly anxious about teaching mathematics and those with lower levels of anxiety for learning were also less anxious about teaching. However, MA and MTA were significant, but not perfectly, correlated (r = .688, $p < .001$).

MA/MTA and Future Mathematics Teaching

A one-way analysis of variance was used to explore the third research question concerning impact of MA and MTA on future teaching. Findings indicated that there were significant differences in both MA ($F(3, 48) = 7.54$, $p < .001$) and MTA ($F(3, 48) = 6.55$, p = .001) based on preference to teach mathematics as rated on the four-point scale. Post hoc analyses indicated that those PSTs who strongly disagreed (M_{MA} = 3.26, SD_{MA} = .70, M_{MTA} =

3.36, SD_{MTA} = .91) to preferring teaching mathematics scored significantly higher on both types of anxiety than participants who disagreed (M_{MA} = 2.03, SD_{MA} = .56, M_{MTA} = 2.28, SD_{MTA} = .70), agreed (M_{MA} = 2.39, SD_{MA} = .89, M_{MTA} = 2.27, SD_{MTA} = .77), or strongly agreed (M_{MA} = 2.02, SD_{MA} = .56, M_{MTA} = 2.22, SD_{MTA} = .58).

Discussion

Tests, Evaluations, and Uncertainty

The findings presented here indicate that tests play an important, but not exclusive role in eliciting anxiety. In the survey data, tests that PSTs take (MA) or tests they will be required to prepare their students to take (MTA) provoked high levels of anxiety. Test anxiety was also salient for two of the three narrative participants (Estelle and Phoebe), who recalled specific tests and patterns of test performance as the "evidence" that they could not learn mathematics. All three of the narrative participants were likewise concerned that their lack of mathematical knowledge would prevent them from adequately preparing students to do well on tests.

It is interesting that the *uncertainty* of performance acted much like evidence of poor performance. Even when the survey item specifically stated that the participant believed she had done well ("Waiting to get a math test returned in which you expected to do well"), the mere possibility that she had not been successful triggered anxiety. This uncertainty is consistent with the findings in the qualitative study, in which the third narrative participant, Roxanne, also described "second guessing" her performance, and never knowing "if I did it right until I got my paper back."

However, findings indicate that neither MTA nor MA are limited to test and traditional evaluation settings as previous studies suggest (Brady & Bowd, 2005; Bursal & Paznokas, 2006; Luo et al., 2009; McGlynn-Stewart, 2010). Instead, this study suggests that a diverse range of

performances, some of which are not even inherently mathematical, can become the focus of anxiety for math-anxious PSTs (e.g., using the available technology productively in a mathematics lesson). These findings are consistent with Dowker et al.'s (2016) assertion that mathematics anxiety needs to be studied both as an issue of anxiety and as one of mathematics. In particular, future work needs to do more to explore additional learning and teaching performances that may elicit anxiety. In fact, the focus on test items in existing anxiety surveys, despite their tendency to be highly reliable and elicit high levels of anxiety, may prove to be a weakness in predicting when and if individuals will become anxious in learning (or teaching) mathematics content or even other content areas.

A related concern arises from the responses to both survey items and narrative prompts in this study, which suggest that PSTs experience high levels of anxiety *on behalf of their students*. For example, survey participants reported feeling anxious when preparing to teach a lesson they thought their students would find challenging. Both survey and narrative participants also reported feeling anxious in situations in which their students would be tested (i.e., in preparing students for tests or waiting for their students' test results). This finding could be interpreted in two ways: 1) PSTs empathize with their students when students are put in situations that they connect to their own anxiety, or 2) PSTs are aware that situations in which their students struggle may serve as evidence of their own inability to appropriately teach mathematics and/or their own lack of mathematical knowledge. In the second case, the anxiety remains within the teacher and is consistent with previous evaluative understandings. What differs is that the actual performance (teaching) can be quite distant from the potential evaluative evidence (student performance on a math test not given until the end of the school year).

However, the first explanation is also potentially problematic. This interpretation suggests that teachers' empathy may cause them to act consistently with a need to protect or reduce anxiety for their students. They may downplay evaluative or difficult components of mathematics learning in order to "soften" the learning experience and protect their students' self-beliefs. This was the plan Estelle outlined for herself by becoming an encouraging, supportive, but not necessarily confident mathematics teacher.

Clearly, more research is needed to understand whether teachers' anxiety is due to potential evaluation of their teaching (generally or specific to a content area) or empathy for their students when struggling with difficult content. However, the implications are troubling either way. Whether a teacher acts anxious of her own performance or on behalf of students, her teaching may communicate negative expectations for learning and performance, while trying to protect students from challenge will certainly reduce academic rigor and opportunities to learn.

Distinguishing MA from MTA

Both the narrative and survey results indicate a great deal of continuity and overlap between the experiences of MA and MTA. Although some researchers have found utility in measuring both constructs (Brown et al., 2011; Peker, 2009; Hadley & Dorward, 2011; Swars et al., 2009) the findings here suggest the distinction may not be important for math-anxious PSTs. Instead, it may be helpful for teacher educators to provide opportunities for PSTs to explore their histories of MA. Perhaps then the cumulative effects of MA experiences may be mitigated as PSTs move forward in their role as mathematics teachers.

Coping with Anxiety in a PST Program

Previous research has demonstrated that PSTs who are preparing to teach elementary mathematics may be likely experience mathematics anxiety (Brady & Bowd, 2005; Bursal &

Paznokas, 2006; Brown et al., 1999; Gresham, 2007; Harper & Daane, 1998; Hembree, 1990; McGlynn-Stewart, 2010; Peker, 2009; Sloan et al., 2002). The qualitative findings in this study reveal the importance of uncovering an individual's narratives about their experience with anxiety in order to gain a deeper understanding of how they cope as they learn to teach. Both Estelle and Phoebe believed that their history of poor performance was proof that they could not learn mathematics content. Their MTA was aroused whenever they were required to demonstrate content knowledge, and they feared being unable to appear sufficiently expert in front of mentor teachers and students. As a result, they both engaged in avoidance behaviors. In contrast, Roxanne's narrative was primarily marked by uncertainty about performance. Rather than avoid mathematics entirely, she had a tendency to focus on mastering procedures over developing reasoning. Although the coping strategies differed, all three women entered methods classes already defending against anxiety and attempting to find ways to "get through" teaching mathematics, thus indicating there is a real need for teacher educators to address anxiety and coping strategies in methods courses.

Finally, a startling finding was the degree to which the math-anxious PSTs in these studies downplayed the importance of mathematics in their future professions. Previous research has confirmed that teachers need to have a strong understanding of the mathematics content they will be expected to teach as well as be able to make sense of their students' mathematical thinking (Ball & Forzani, 2010; Sherin et al., 2011). In this study, more than 85% of the surveyed PSTs indicated that they planned to teach mathematics as part of their careers. Yet less than 20% were looking forward to doing so. Similarly, the narrative participants self-described with such phrases such as "Not a math person," and "Math is not my thing," indicating a similar

lack of enthusiasm for the subject. These findings emphasize an urgent need to address MA and MTA in elementary teacher preparation programs.

Conclusion

Although these studies draw from a relatively small sample of PSTs within a single teacher education program, the findings from both surveys and narratives indicate MA and MTA are present and have effects in teacher education programs. We found little evidence that MA and MTA are usefully distinguished; individuals who experience MA as students may bring that history of anxiety to their teaching. What seems more important, however, is that elementary teacher preparation programs help PSTs to understand their own personal histories of MA and how that may impact their learning to teach mathematics.

Author Note

The authors also wish to acknowledge that support for this work is due in part to a grant from the Helios Education Foundation and the Algebra Ready Project. This material is also supported in part by the National Science Foundation under Grant Nos. 1228034. Any opinions, findings, conclusions, or recommendations expressed here are those of the authors and do not necessarily reflect the views of the NSF.

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