

9-25-2015

# Building the wall brick by brick: One woman prospective teacher's experiences with mathematics anxiety

Kathleen Jablon Stoehr  
Santa Clara University, [kstoehr@scu.edu](mailto:kstoehr@scu.edu)

Follow this and additional works at: <http://scholarcommons.scu.edu/tepas>

 Part of the [Education Commons](#)

---

## Recommended Citation

Stoehr, K. (2015). Building the wall brick by brick: One woman prospective teacher's experiences with mathematics anxiety. *Journal of Mathematics Teacher Education*.

The final publication is available at Springer via <http://dx.doi.org/10.1007/s10857-015-9322-y>

This Article is brought to you for free and open access by the School of Education & Counseling Psychology at Scholar Commons. It has been accepted for inclusion in Teacher Education by an authorized administrator of Scholar Commons. For more information, please contact [rscroggin@scu.edu](mailto:rscroggin@scu.edu).

**Building the Wall Brick by Brick: One Woman Prospective Teacher's Experiences  
With Mathematics Anxiety**

## **Abstract**

Mathematics education researchers have investigated mathematics anxiety in prospective elementary teachers. While many of these studies have focused on the bodily sensations and emotions of mathematics anxiety, particularly those felt in assessment situations, opportunities remain to investigate how prospective elementary teachers interpret their experiences with mathematics anxiety and connect them over time to compose personal histories of mathematics anxiety. Currently, over 90% of elementary teachers in U.S. schools are women, and women have been shown to suffer more from mathematics anxiety than do men. In this article, I analyze how one woman prospective elementary teacher described, explained, and related her experiences of mathematics anxiety across her personal narratives of learning mathematics as a K-12 student and of learning to teach mathematics as a college student in a teacher-preparation program. My research demonstrates that experiences of mathematics anxiety may persist beyond assessment situations to influence women prospective elementary teachers' larger mathematical histories. I also show that women prospective elementary teachers may interpret mathematics anxiety as specific fears (e.g., loss of opportunities for social participation) and may develop particular coping strategies related to those fears. Finally, I point out that while a coping strategy may be used consistently across K-12 mathematics learning and undergraduate teacher preparation, and may even offer a woman prospective elementary teacher some relief from mathematics anxiety, it may also limit her mathematics learning and professional development. To conclude, I present implications of my research for mathematics teacher educators.

**Key Words:** Mathematics anxiety, narratives, confidence, prospective teachers, coping strategy

## **Introduction**

Mathematics anxiety in women who are entering the elementary teaching field is a subject that for decades has captured the interest of education researchers. Mathematics anxiety has been defined as “a feeling of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002, p.181). Previous studies have focused on the sensations that accompany mathematics anxiety (Brady & Bowd, 2005; Luo, Wang, & Luo, 2009). However, research remains to be done on how women prospective elementary teachers interpret their experiences of mathematics anxiety and make connections among these experiences. In particular, relationships between experiences of mathematics anxiety while learning mathematics and experiences of mathematics anxiety while learning to teach mathematics merit further investigation. In this article, I will pursue this inquiry by examining one woman prospective teacher’s narratives of learning mathematics as a K-12 student, and while learning to teach mathematics during her university based teacher preparation program.

Research on women who pursue elementary teaching careers reveals that they have often experienced mathematics anxiety during their own K-12 experiences (Ball, 1988; Brady & Bowd, 2005; Brown, Westenskow, & Moyer-Packenham, 2012; McGlynn-Stewart, 2010; Sloan, 2010). Presently over 90% of all elementary teachers in the U.S. are women (Beilock, Gunderson, Ramirez & Levine, 2010). In addition, Beilock et al. (2010) report that elementary education candidates have the highest levels of mathematics anxiety of all college majors. However, many elementary teacher

preparation programs require their prospective teacher candidates to take minimal mathematics courses (Beilock et al., 2010). Indeed, these reduced requirements may account for why some women who experience mathematics anxiety choose to pursue an elementary education major (Olson, 2014). Consequently, women prospective elementary teachers may be exiting university based teacher preparation programs less prepared to teach mathematics and burdened with mathematics anxiety.

Women with mathematics anxiety is an important topic to study, as such anxiety can have significant implications for how teachers approach mathematics instruction in their own classroom (Ball, 1988; Bursal & Paznokas, 2006; Mizala, Martinez, & Martinez, 2015). In fact, there is deep concern about whether teachers who experience mathematics anxiety can be successful in teaching mathematics (Beilock et al., 2010; Bursal & Paznokas, 2006). Elementary teachers who have encountered mathematics anxiety may have lower expectations for their students' mathematical achievement (Mizala et al., 2015). There is also great concern that teachers who have mathematics anxiety may pass their anxiety onto their students (Beilock et al., 2010; Mizala, et al., 2015; Sloan, 2010). Indeed, teachers may "take cover" and protect themselves from struggling with mathematical teaching situations that create anxiety for them. Across the literature base, there is a growing consensus that a confident and competent mathematics teacher is a vital necessity in the classroom (Ball, Hill, & Bass, 2005; Beilock et al., 2010, Gavin & Reis, 2003; Huebner, 2009; Marx & Roman, 2002; Mizala et al., 2015, Oswald, 2008).

## **Mathematics Anxiety in Women Prospective Elementary Teachers**

Multiple studies have examined mathematics anxiety in women elementary teacher candidates (Brady & Bowd, 2005; Brown, Westenskow, & Moyer-Packenham, 2011; Bursal & Paznokas, 2006; Gresham, 2007; McGlynn-Stewart, 2010). Bursal and Paznokas (2006) conducted a study of predominantly women prospective elementary teachers (56 out of 65 participants so no attempt was made to report the results by gender) and investigated their mathematics anxiety and confidence levels. Participants were given the Revised-Mathematics Anxiety Survey (R-MANX) to complete as well nine key statements from the Math Teaching Efficacy Belief Instrument (MTEB: Enochs, Smith, & Hunter, 2000) to assess their beliefs about teaching mathematics. These key statements focused on participants' responses about such things as believing they could teach mathematics effectively, have the necessary skills to teach mathematics, and welcome students' questions about math. The participants were asked to estimate the amount of anxiety they believed they would experience in hypothetical situations that involved everyday life and academics that required mathematical thoughts or tasks.

The results of the study revealed that more than two-thirds of the prospective teachers had moderate or high mathematics anxiety. In addition, the moderate and higher anxiety level participants had less confident responses in regards to teaching mathematics. The results of Bursal and Paznokas's (2006) study supported previous studies that report prospective elementary teachers' lack of confidence is attributed to their mathematics anxiety (Harper & Daane, 1998; Hembree, 1990; Sloan, Daane, & Giesen, 2002). Bursal & Paznokas's (2006) also pointed out that although a significant number of women who are prospective elementary teachers have great anxiety about

mathematics, they will still be expected to teach mathematics in their own classrooms. Collectively, this research documents the role that mathematics anxiety may play in women prospective elementary teachers' learning and teaching of mathematics.

### **Prospective Elementary Teachers Experiences with Learning Mathematics**

Brady and Bowd (2005) explored the connection between how prospective teachers learned mathematics and how those experiences influenced their attitudes about mathematics and their confidence towards teaching mathematics. Participants were asked to answer questions about mathematics courses they had taken, their mathematics experiences and perceptions, and their level of confidence in teaching as well as in teaching mathematics. Participants were also given the Mathematics Anxiety Rating Scale (MARS) to assess mathematics anxiety in academic and nonacademic settings. The results of the study revealed that the prospective teachers who were women had significantly higher MARS scores than the men, suggesting comparatively higher levels of anxiety. Open-ended comments made by women in the study identified specific themes regarding their mathematics anxiety. These themes included enjoying mathematics in elementary school but finding success in mathematics to be out of reach in the higher grades, finding mathematics to be distressing and often humiliating, feeling extreme pressure when confronted with mathematics tests, and having teachers that did not believe they were capable of doing well in mathematics.

Data from this study revealed another important outcome: many of the participants in Brady and Bowd's (2005) study who encountered negative mathematical experiences as K-12 students opted out of taking more than the necessary mathematics classes to meet university admission requirements. Some participants stated that as a

result, they felt unprepared to teach mathematics with confidence to their own students. These findings indicate that the mathematics anxiety that some women have experienced as students may follow them into the classroom as teachers. Indeed, this study raises the importance of addressing mathematic anxiety that some women prospective elementary teachers experience so they can feel more confident about teaching mathematics.

### **Narrative Research on Women Prospective Elementary Teachers'**

#### **Mathematical Experiences**

One way to study issues of mathematics anxiety is to investigate the experiences that women prospective elementary teachers have had in mathematics classrooms, as reported in their personal narratives (Drake, 2006; Drake & Sherin, 2006; Drake, Spillane, Hufferd-Ackles, 2001; Stoehr & Carter, 2011; Stoehr, 2012). Some women prospective elementary teachers have positive mathematics stories to share that exude confidence in and an enjoyment of the subject. However, many other mathematics stories that women prospective elementary teachers recall are steeped in feelings of mathematics anxiety that often arise from operating in a personal safe zone in mathematics in which they take few risks. For example, struggles to understand mathematical content, feelings of embarrassment, dealing with continuous competition with others (especially boys), and dealing with self-fulfilling prophecies of being unable to be successful in mathematics (Carter & Stoehr, 2012; 2011, Drake & Sherin, 2006; Drake, Spillane, Hufferd-Ackles, 2001). In addition, prospective teachers have recalled incidents where they felt like other people such as teachers, parents, and their peers did not view them as being strong mathematics students. Based on these experiences, prospective teachers often concluded that they would never be good in mathematics.



Although previous narrative research provides a snapshot of a single or isolated mathematics experience that prospective teachers recall, what still remains to be studied is how women prospective elementary teachers understand and connect experiences of mathematics anxiety that occur across their K-12 years as well as their experiences of learning to teach mathematics.

### **Theoretical Framework**

Two distinct frames provide both the background and impetus for this work: (1) research on women and mathematics anxiety/low confidence and (2) narrative research in teacher education on the mathematics experiences of women prospective elementary teachers. I begin by examining the scholarly definitions of mathematics anxiety. I then look at narrative research in teacher education as a means to understand the mathematics experiences of women prospective elementary teachers.

### **Mathematics Anxiety**

Education researchers have defined mathematics anxiety in multiple ways (Brady & Bowd, 2005). Swars, Daane, and Giesen (2006) refer to Vinson's (2001) definition of mathematics anxiety as being more than just not liking mathematics. Bursal and Paznokas (2006) explain mathematics anxiety by using Trujillo and Hadfield's (1999) definition as "a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem" (p.173). Some researchers push further arguing that mathematics anxiety can be viewed as a disease (Hembree, 1990; Luo et al., 2009). "Mathematics anxiety refers to such unhealthy mood responses which occur when some students come upon mathematics problems and manifest themselves as being panicky and losing one's head, depressed and helpless,

nervous and fearful, and so on” (Luo et al., 2009, pp. 12-13). Physiological reactions such as sweaty palms, tight fists, being sick, vomiting, having dry lips, and a pale face can also occur which can result in students losing not only their interest in mathematics but their confidence in their ability to learn mathematics (Luo et al., 2009). A lack of confidence can then lead to more feelings of mathematics anxiety. This in turn can then lead to dodging mathematics, which reinforces mathematics anxiety (McGlynn-Stewart, 2010).

This article moves beyond the momentary sensations and emotions (i.e. sweaty palms, dry lips, helpless, nervous, fearful), associated with mathematics anxiety as well as a passing unease when confronted with performing a mathematics task. I address this gap in the literature, as there is great importance in understanding how women prospective elementary teachers’ stories of anxiety shape their thinking about teaching mathematics. This is important because as they take on the role of elementary teachers, mathematics anxiety can affect how they teach this content area (Bursal & Paznokas, 2006).

### **Narrative Interpretations of Mathematical Experiences**

For the past 20 years, scholars have successfully used narratives as a research framework to provide a clear focus of how new teachers make sense of teaching, including how it relates to their own school experiences (see, for example, Atkinson, 2007; Carter, 2008, 2003, 1994, 1993; Clandinin, 1989; Clandinin & Connelly, 1990; Connelly & Clandinin, 1990; Drake, 2006; Drake, Spillane, & Hufferd-Ackles, 2001; Doyle & Carter, 2003; Goodson & Sikes, 2001; Hollingsworth & Dybdahl, 2007; LoPresto & Drake, 2005; Stoehr & Carter, 2011; Stoehr, 2012). Narrative inquiry provides a research tool for education researchers to go beyond explanations of standards,

percentages, skills, strategies, and exit and entrance criteria (Atkinson, 2007; Carter, 1993; Clandinin and Connelly, 2000; Drake, 2006; Hollingsworth & Dybdahl, 2007; Seidman, 1991). It creates avenues for teachers to talk and write about their storied lives while making connections to teaching (Carter, 1993).

Recently scholars have examined the utility of examining anxiety and confidence in mathematics from a narrative perspective (see for example Drake & Sherin, 2006; Drake, Spillane, Hufferd-Ackles, 2001; LoPresto & Drake, 2004; Stoehr & Carter, 2011; Stoehr, 2012). This follows the groundbreaking work of several feminist scholars whose work suggests collaborative conversations among women can be a powerful means to reflect on issues important to women when told from their point of view (Belenky, Clinchy, Goldberger, Tarule, 1986; Gilligan, 1982). Engaging women in conversations of specific topics of study affords opportunities for themes to emerge that can either propel them forward or move them backwards (Belenky et al., 1986).

However, in the existing body of work on narratives, little is known about the stories and experiences of women prospective elementary teachers who feel anxious about mathematics. Stoehr and Carter (2011) and Stoehr (2012) have done studies that focus on prospective teachers' understanding of a single mathematics "well-remembered event," which is defined by Carter (1994) as "an incident or episode that a student observes in a school situation and considers for his or her reasons as especially salient or memorable" (p.236). Drake's (2006) work has examined mathematics turning points, which she defined as "events that led to substantial change" (p.584). What remains missing in the literature is how women prospective elementary teachers make sense or interpret their experiences of mathematics anxiety across time as they learn mathematics

and learn to teach mathematics. It is not enough to examine episode by episode of mathematics anxiety, as experiences of mathematics anxiety become related to one another in personal narratives. Narrative research offers the tool to link the stories or episodes that women prospective elementary teachers have to tell that surround their experiences of learning mathematics and learning to teach mathematics. Moreover, narratives also provide a means for prospective teachers to interpret their experiences of mathematics anxiety.

In this article, I examine the narrated mathematical experiences of one woman prospective elementary teacher (Estelle) who identified herself as having anxiety in learning and teaching mathematics in order to answer the following questions:

1. How did Estelle interpret her experiences of mathematics anxiety?
2. How did Estelle relate her experiences with learning mathematics to her experiences of learning to teach mathematics?

### **Methodology**

This study was part of a larger longitudinal project called xxxx.<sup>1</sup> The study reported here focused on one White woman prospective elementary teacher who attended a large public Research 1 University located in the southwestern United States region. The participant (Estelle) was part of a cohort of fourteen women prospective elementary teachers whose fieldwork and student teaching experiences took place in schools that served low socioeconomic and culturally diverse communities. Estelle was in her early twenties and spoke only English.

Estelle was initially selected to participate in my study as her mathematics autobiography (a math methods course assignment) spoke clearly and powerfully about

---

<sup>1</sup> The larger xxxx includes six university sites. Data for this study was drawn from one of the sites.

feelings of mathematics anxiety. These feelings of anxiety in mathematics included descriptions and thoughts of an intense dislike and dread of mathematics time at school, assumptions of not being “math smart,” scars created from continuous low test scores, and not understanding the relevance of mathematics.

This study encompassed data collection from three different timeframes. The data collection for this study began when Estelle was a college junior (age twenty-one) in January 2011 and ended when she graduated with her Bachelor’s degree in Elementary Education in May 2012. I used specific types of interviews (i.e. individual and group) and semi-structured prompts to direct Estelle to narrate mathematics stories as both a student and student teacher. Audio and/or video recordings were used in each narrative generation in this study, with the exception of the mathematics autobiography. Collecting data over eighteen months allowed me to theorize the mathematics experiences that Estelle encountered as she made the shift from student to teacher. Table 1 outlines when each data collection instrument was compiled and how each one addressed my research questions.

Table 1: Data Collection Strategy

<b>Data Collection Strategy</b>								
	<i>Spring 2011</i>		<i>Fall 2011</i>	<i>Spring 2012</i>				
Research Question	Math Autobio- graphy	Methods Pre/Post Interviews	Focus Group Interview	Student Teaching Interview & End of Semester Interview	Student Teaching Pre/Post Lesson Interviews	Reader’s Theatre	Conver- sations that Matter	Timeline Activity
How did Estelle interpret her experiences of mathematics anxiety?	<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
How did Estelle relate her experiences with								

learning mathematics to her experiences of learning to teach mathematics?	X	X	X	X	X	X	X	X
---	---	---	---	---	---	---	---	---

### **Narrative Analysis**

#### **Phase 1: demarcating narratives.**

After multiple readings of Estelle’s mathematics autobiography and transcripts, I began an iterative analysis (Bogdan & Biklen, 2006) by demarcating the narratives that pertained specifically to mathematics anxiety as well as issues of confidence in learning and teaching mathematics. I identified a narrative to be an individual’s lived experiences and their interpretations of their experiences (Connelly & Clandinin, 1990). I identified narratives within text passages that included key words specific to mathematics anxiety and issues of mathematics confidence that emerged from Estelle’s narratives. Some examples of these words include confused, embarrassed, fumbled, nervous, not confident, not taking anything in, stressed me out, struggled, tensed up, and worried. If a transcript or text passage from Estelle’s autobiography or interviews included one or more of the key words, I identified the passage as a narrative related to mathematics anxiety. I repeated this demarcation procedure as a means to ensure reliability.

Next, I divided the narratives that pertained to issues of mathematics anxiety and confidence into two categories, stories and reflections. I defined a story as a having a basic structure that included an event or a sequence of events with at least one character, a plot, a setting, a theme, and a pattern of action (Carter, 1993). I defined a reflection as thinking back on one’s experiences as a means to understand what had occurred (Schon, 1991). At times, these reflections spontaneously arose from Estelle’s revisiting of the stories of mathematics anxiety she told. At other times, Estelle was specifically asked to reflect upon mathematics anxiety.

Estelle's mathematics autobiography included stories and reflections of mathematics anxiety. In addition, each of the fifteen data collection instruments contained stories and reflections of mathematics anxiety. Estelle had stories and/or reflections that were told more than once across the three semesters. However, each story or reflection was counted only once. Each narrative is presented by how Estelle interpreted or made sense of these experiences in relation to mathematics anxiety.

### **Phase 2: analysis of narratives and case development**

Via a careful analysis of Estelle's narratives, I created a case study. I chose to present my findings through the case study approach, as case studies offer a method of exploration of a particular time period that focuses on specific situations where a series of detailed information is collected in a variety of ways (Sykes & Bird, 1992). This methodological device allowed me to present Estelle's narratives of mathematics anxiety as a substantive and distinct case of mathematics anxiety.

I began the case development of Estelle by utilizing an emergent coding scheme (Marshall & Rossman, 2006) to organize and sort her stories and reflections. I first sorted the stories and reflections as being either positive or negative mathematics experiences. I then highlighted and labeled particular phrases or sentences that identified how a particular story or reflection seemed to create or reduce mathematics anxiety, or seemed to reflect confidence or lack of confidence relative to mathematics anxiety. I separately recoded the stories and reflections for consistency (or a lack thereof) after a passage of at least a week's time. This allowed me to evaluate the stability of emerging themes and/or consider alternative interpretations of the data. I then wrote analytic memos (Maxwell, 1996) to summarize key patterns across the stories and reflections that Estelle told. I

utilized analytic memos to construct Estelle's case while arranging her stories and reflections in chronological order. I have titled each story or reflection using a composite of Estelle's own words to encapsulate the essence of her narratives. Estelle's case highlights how experiences of mathematics anxiety can be differentiated. In other words, all women who experience mathematics anxiety may not interpret it in the same manner as Estelle.

## **Findings**

### **Learning Mathematics in Elementary School**

Estelle began her mathematics journey as a young child feeling mathematically confident and competent. According to Estelle, during her early years elementary school, her teachers held high expectations for her to achieve in mathematics, which she embraced. Moreover Estelle believed they were able to teach her in a manner that complemented her visual learning style. Estelle viewed herself as someone who did well in mathematics but admitted that she had to work hard not only to achieve good grades but also to understand the mathematical content expected of her.

#### **I wished I could have been one of “the smarties.”**

As Estelle progressed through her elementary years of schooling, her hard working nature did not earn her a place in the top tier of her mathematics classrooms. Estelle began to feel partitioned or separated from the “smart students”, equating her status as a “regular” student to mean she was less valued than her peers in the higher-level mathematics group. This public comparison in which she could not hide nor conceal her status of being classified as a “regular student” led Estelle to believe that she was not good in mathematics. She perceived that her teachers were less interested in her



mathematical thinking and less attentive to her mathematical questions and concerns. Estelle's confidence waned, leaving behind a trail of mathematics anxiety for her to attend to. She recalled the following story:

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?"

Estelle added:

I really feel like classmates can have a big affect on your perceptions of math and I really think experiences, you know, from my own personal experiences, being separated at a young age, even in fourth grade you know you're advanced in math yet I'm stuck in the regular class. It always made me feel like I'm just regular but you guys are awesome cause you get to go in a different classroom. Man, I really wished I could be in there! Oh math, I don't like you cause I'm not good at it.

Estelle's two narratives spoke of the sense of defeat she felt in mathematics as well as being partitioned or separated from the students who were seen as the competent and smart kids. In other words, she believed she was being walled in the "regular classroom." This separation or partition seemed to accentuate Estelle's belief that she was inferior in mathematics and perhaps unable to be as successful as the "smart kids" in mathematics.

Moreover, as part of the “regular class,” Estelle could not hide from the fact that she had not been labeled as one of the smart kids.

As Estelle looked back at this experience, she imagined the excitement her classmates must have felt to be selected in the advanced mathematics groups. She revisited the stigma she felt for not being chosen and stated, “I don’t know, it’s always stuck in my head that wow, they’re really good at math. I must not be that good if I’m just in the regular classroom with everybody else.” Estelle seemed to think she had been corralled behind a wall that was comprised of the less accomplished mathematics students in the class. In this way, the ability grouping experiences that Estelle encountered prompted her to create a coping strategy that led her to invent an imaginary protective wall.

### **Learning Mathematics in Secondary School**

#### **Brick by brick I built “the mathematics wall.”**

By the time Estelle reached middle and high school, her mathematics experiences were fraught with anxiety. She began to believe even more firmly that not only was she not good at mathematics, she did not understand this content area as well. It was at this point in time she spoke openly and clearly about “the wall” she built to protect herself from the shame and humiliation she encountered while learning mathematics.

When Estelle entered middle and high school, her mathematics test scores confirmed to her that she had low mathematics ability. She shared the following memory:

During middle and high school, I know my attitude towards math was 100% affected by my low test scores. I began to build a wall towards math and it was, and it still is sometimes tough for me to open up and soak up information.

Sometimes teachers would want to talk to me in private about how I was doing in math and they usually were not positive talks. I began to get embarrassed and started to over think even the simplest math equations.

Estelle recounted having erected a psychological “wall” to protect herself from others’ negative evaluations of her mathematical performances in school. Initially, “low test scores” represented unfavorable feedback. Then, the “not positive talks” with mathematics teachers about her work became experiences to avoid. As the negative feedback accumulated, Estelle reinforced her wall, which increasingly interfered with her capacities to “open up and soak up information” and to think through the “simplest math equations.” In other words, a negative cycle emerged in which the psychological wall, meant to shield Estelle from others’ criticism of her mathematical performances, blocked her mathematics learning. Unfortunately, while Estelle’s mathematics teachers, in meeting privately with her to discuss her work, may have attempted to mitigate Estelle’s “embarrassment,” the very seclusion of these conversations may have strengthened Estelle’s belief that she deserved to be sequestered from more successful mathematics students in her classes, and that she needed to conceal what she did not know about the mathematics content from others. In effect, Estelle’s preferred strategy of separating herself from the mathematics as a means to cope with her anxiety appear to have made learning mathematics even more difficult.

Estelle recalled that by the time she reached high school she had seriously doubts about being able to learn mathematics. In an effort to cope with the anxiety associated with her not comprehending mathematics she said the following:

Math is everywhere and it's like you can't get away from it. ... A big factor of that is maybe a confidence issue. Maybe from like past experience. ... Sometimes I think maybe children can put up a wall against math, I don't know, that's what I did in high school when a teacher would start talking about math and I'd be like, I'm looking at the board, but I am not taking anything in.

Estelle's narratives suggest that she may have enlisted the wall to ward off the anxiety she experienced in the moments when mathematics lessons were being taught. By her own account, the wall blocked her momentarily from the anxiety associated with not understanding the content but the wall also appeared to distance her even more from learning the content. Moreover, the wall helped her to conceal the fact that she was not "taking anything in" even as she appeared to be looking at the board and listening to her teacher talk about mathematics.

There were times when Estelle remembered being in her mathematics class unable to comprehend the content being presented by her teacher. She explained how she tried to cope with this situation:

And I just know from my own personal experiences that especially in high school, when I couldn't grasp a concept, and a teacher would just move on and on, I was lost. And you kind of build up this wall like well I don't get it and so I don't know what else to do cause the teacher's already moving on.

Estelle sought shelter from the wall as a way in which to handle the anxiety of being lost or cut off from the mathematics content. The wall appeared to have given her some relief from the anxiety of not knowing what to do when she was confronted with mathematics that she did not understand. In addition, the wall offered her temporary respite from

teachers she believed left her behind. However, the wall could not provide a long-term solution for accessing the mathematical content knowledge that Estelle needed.

Nevertheless, Estelle continued to utilize the wall to hide from the mathematical content she did not know.

### **Learning to Teach Mathematics During Math Methods and Classroom Internship**

#### **I made a vow of never leaving a student behind.**

When Estelle thought seriously about becoming an elementary teacher, she was concerned that her mathematics anxiety might be a stumbling block to her chosen profession. As she entered the teacher education program she vowed that she would provide her future students with a positive mathematics experience that would promote their understanding as well as instill in them a sense of confidence. Moreover as a caring person, she wanted to ensure that none of her students got left behind, an experience that she encountered many times in her own learning of mathematics. In addition, Estelle wanted to be seen by her students as a capable and competent mathematics teacher, a label that was not associated with herself as a student. She envisioned that her mathematics class would be one in which she would:

break down methods and lessons for them because that's something I felt that like I didn't get in elementary school. And I want it to be a very talkative class in a way that we can communicate back and forth about math. Where it's not just the teacher talking and the children doing like I don't get this in my head, where they feel comfortable and ask questions that they're feeling. ... I just want to be that awesome math teacher that children remember.

Estelle also explained that she planned to create a classroom environment that would be built on trust. She stated that her classroom would be a place where her students could share their mathematical thoughts and ideas and come to her with any questions they might have without feeling scared or ashamed. She reported that she wanted to create confident mathematics students who viewed making mistakes as part of the learning process. Estelle imagined a classroom in which she would be decentralized as the sole authority in mathematics. She envisioned a classroom in which she would not be expected to know everything about mathematics and could let her guard down. In other words, Estelle vowed to create a classroom culture in which she and her students would be able to “break down” the psych-social walls that both protected and prevented them from participating in mathematics. In addition, by creating a classroom environment that did not require Estelle to be the sole mathematics knowledge provider, she could potentially conceal the areas of mathematics that created anxiety for her.

As Estelle neared the end of her math methods semester she acknowledged that she learned many important things about teaching mathematics. However she shared that of utmost importance was her responsibility to ensure that her students understood the concepts she would be teaching them. Her confidence seemed to surge as she shared the following observation at the end of her math methods course:

I’m really excited about teaching math and I think this semester really helped me build my own confidence with math... It was really about understanding how to teach these concepts to children. And I think that I can, all of my good and bad experiences in math, I really think I can bring a positive attitude to my students and knowing. ... you may go through a hard time sometimes in math but you will

get through it and I just, I want to see my students get that “Ah hah I get it moment.”

Estelle had a great desire to provide an environment conducive to learning the mathematics she believed was important for her future students to know and understand. In imagining her ideal mathematics classroom, Estelle positioned herself as one of her students—equal to them in social status but also in responsibilities. In this vision, Estelle excused herself from being the sole authority on mathematics. However, while she vowed to “bring a positive attitude” and encourage her mathematics students to “communicate,” it is unclear which “concepts” Estelle hoped her students would learn, other than to “get through it.” Indeed, it seemed that within Estelle’s ideal mathematics classroom, both she and her students would engage mathematics only insofar as to *survive* it. At this point in her teacher preparation program, Estelle did not specify how she and her students would *thrive* as mathematics learners. In this way, Estelle projected her own past as a mathematics student onto her future mathematics class and onto the mathematics teacher-learner she would be.

**I have nagging notions of necessary mathematics knowledge.**

Upon completing her math methods course and her accompanying classroom internship semester, Estelle talked about some concerns about teaching mathematics that were on her mind. She shared that with her student teaching semester looming ahead, she worried about how she would teach mathematics content areas that she did not feel confident in such as decimals and fractions. Estelle said:

I am going to have to almost reteach myself those things again. I want to become a confident math teacher and confident in those lessons so my children, so yeah, this teacher knows what she's talking about, we can do this.”

In addition, Estelle felt anxious as she thought about the following scenario:

When I think about teaching older grades, I get a little nervous sometimes, thinking about, gosh, you know, when they ask me questions, how, what if I can't answer them? What if I don't know these, the answers right on the spot? ... How am I going to handle that? I don't want my future students to get stuck or not know what they need to know.

Estelle acknowledged that teaching children to understand mathematics is “one of the top things a math teacher should be doing.” Yet before embarking upon her student teaching semester she asked herself:

How am I going to be a good math teacher?” *[Chuckling]* “What if I can't reach and teach all of my students?” I kept thinking, “I have to understand what I'm teaching for myself before I can teach it to anybody else.” I kept thinking, “This is scary.” Math is the one subject that gives me anxiety. At the end I just told myself, I wanted to be the math teacher that I always wanted, which was having a teacher who was supportive, encouraging, and understands where my students are coming from, so they can be successful in math.

Despite her vow of wanting to be the mathematics teacher that she wished she had, Estelle worried about how she would be able to do so. As Estelle gained a broader understanding of what it meant to teach mathematics, she questioned herself as to how she would be able to attend to all of the different facets that teaching mathematics



successfully required. As she entered her student teaching semester she kept in her mind her goal of being “a confident math teacher” despite feeling that “math is the one subject that gives me anxiety.” In other words, as Estelle thought deeply about teaching mathematics she could not conceal her own mathematics anxiety.

### **Learning to Teach Mathematics During Student Teaching**

#### **Will I flourish or crumble in Ms. C’s classroom?**

Estelle reported that she entered her student teaching semester feeling somewhat anxious, having been reassigned to Ms. C’s third grade class (where she had spent time during her internship semester). Although Estelle respected Ms. C and knew that she would benefit greatly from Ms. C’s expertise, she reported that Ms. C could be overly critical and harsh at times. Although Estelle was a hardworking and caring person, these qualities did not save her from being embarrassed by Ms. C in front of the students.

Estelle remembered on several occasions during the previous semester feeling publicly exposed and shamed for mistakes she made while working with students. She revealed that she felt nervous when Ms. C was critiquing her, pointing out the things she was doing wrong as well as the things Ms. C thought she should have been doing. However, Estelle reported that being mentored by Ms. C, especially in the area of mathematics, would be invaluable as she was learning to teach and accepted the placement.

Estelle made the decision that she would “just really try to soak up everything I could” by learning the strategies Ms. C used in teaching mathematics to the students while managing the class at the same time. In fact, Estelle said that she asked Ms. C at the beginning of her student teaching semester if she could start teaching mathematics

earlier than planned. Estelle believed by gaining as much experience as she could teaching mathematics, especially under the watchful eye of Ms. C, then the more comfortable she might become with mathematics. She stated that her hope was that her experience in teaching mathematics in Ms. C's classroom would lead her to feel more mathematically confident. Perhaps then Estelle could let down her wall and not have to conceal the mathematics she did not know that appeared to cause her mathematics anxiety.

### **Working to minimize mathematics mistakes.**

When Estelle began to teach mathematics, she discovered that teaching this content area seemed to be as challenging as her student experiences of learning mathematics. Her experiences of learning to teach mathematics, especially as it related to understanding her students' thinking, often mirrored her experiences of the feelings she had of "being lost" in this content area as a child. The wall that Estelle built as a student learning mathematics continued to be utilized as she was learning to teach in an effort to ward off the mathematics anxiety she encountered. While preparing for her mathematics lessons, Estelle tried to conceal what she did not know about the mathematics content by trying to anticipate every possible strategy a student might utilize. However, while Estelle was teaching her carefully prepared lessons, her students would often arrive at an answer using a strategy that she had not planned for. As Estelle was trying to figure out her students' mathematical thinking, her mathematics anxiety would ignite and she would become confused. While teaching a multiplication and division lesson she recalled:

I guess going into this lesson I didn't really pin point where they might get confused. I guess I was just kinda more worried ab- of the parts where I always

get confused and I didn't want to confuse the students. But I don't think I really was surprised, cause I just feel like that every time I teach a lesson there's just something new that comes up that, which I wasn't expecting.

In other instances, Estelle would teach from behind the wall as a means to hide what she did not know about the different mathematical content areas. She accomplished this by having her students explain particular mathematics terms that caused her confusion or by sharing their explanations about strategies they utilized that she did not understand. Estelle seemed to almost be holding her breath in anticipation while she waited and hoped that her students could offer the explanations that she herself could not provide. While teaching a fractions lesson, she related the following story:

I anticipated, you know, some students getting confused on certain....certain parts that I think, I was mostly concerned with the numerator and denominators, but at, at the beginning of the class I had asked students if they knew which number was the numerator and which number was the denominator and I had students who raised their hand to tell me what a denominator was and what it stood for and what a numerator was and what it stood for. So that was just great that I didn't, I didn't have to explain it to them. They explained it to the entire class. They knew exactly what it was so....um....I was just confused, I wasn't confused, I was afraid that the students would be confused on that topic of the lesson.

Despite spending a considerable amount of time preparing a definition of the two mathematical terms she would be using in her fractions lesson, Estelle's own confusion and anxiety took precedence. Estelle was able to teach from behind the wall as her students shielded her from her confusion of how to explain the two mathematical terms.

Their explanations led to the class' understanding of the two words without a contribution from Estelle. By teaching from behind the wall, Estelle was able to conceal her inability of how to explain the two mathematical terms. Her students were able to define the terms for her, protecting her from her own anxiety. Moreover, by teaching from behind the wall, Estelle may have been able to escape her feelings of failure while simultaneously preserving her own sense of worth.

### **Can I create mathematical understanding for my students?**

As Estelle neared the end of her student teaching semester she admitted that overall, she still felt nervous about teaching mathematics. When asked what specifically made her feel anxious about teaching mathematics she said:

I think just again delivering it and saying the right things to my students... I tend to have a hard time using math, I guess math vocabulary or saying the, the right words and just getting jumbled up in my thoughts and that all goes into delivering the lesson... I, lately I've been having just a few, like a handful of students who say "I don't get it" so I go into a deeper break down of instructions for them and they eventually get it. But I guess when students, when I hear students automatically say, "I don't get it" it makes me nervous because I feel like I'm not doing a good job teaching. That they're obviously not understanding what I'm saying. That's just probably the biggest thing I'm worried about is not getting the point across to the students.

Estelle's vow to teach in a manner that left nobody behind was put to the test when her students voiced their lack of mathematical understanding. Challenges associated with

creating understanding for all her students made Estelle feel nervous about whether she was doing a good job teaching.

The strategy that Estelle utilized as a student learning mathematics was to conceal or hide what she did not know about the mathematics content she was supposed to be learning. While this strategy may have offered Estelle temporary relief from feeling incompetent in mathematics and anxious about this content area, this strategy failed repeatedly. However, Estelle continued to employ this strategy as a prospective teacher, even though it did not always work.

### **Discussion**

I begin my discussion by describing the patterns of mathematics anxiety experienced by Estelle. I have identified key ideas within the patterns that occurred and titled them according to their content. While synthesizing the experiences of mathematics anxiety for Estelle, I also look back to past research in the areas of mathematics anxiety and mathematics teacher education.

#### **Mathematics Anxiety May Be Persistent and Varied**

Estelle reported experiencing mathematics anxiety while learning mathematics as a K-12 student, while learning to teach mathematics as a college student enrolled in a teacher preparation program, while imagining herself as a future mathematics teacher, and while engaging in her early attempts to teach mathematics during her student-teaching internship. Thus, my research suggests that experiences of mathematics anxiety may not be limited to formal testing situations as indicated by prior research (Bursal & Paznokas, 2006; Luo, Wang, & Luo, 2009; Mc-Glynn-Stewart, 2010) but, instead, may arise in response to a range of experiences with mathematics, both enacted and imagined,

across a lifetime. While I do not argue that all individuals who experience mathematics anxiety will find that it pervades their mathematical histories, Estelle's narratives suggest that a generalized experience of mathematics anxiety can occur.

Estelle's narratives spoke of experiences with mathematics anxiety that occurred throughout her K-12 years of learning mathematics and during her time in her teacher preparation program. Estelle often felt "jumbled up" as she sought to learn and teach mathematics. She dreaded the criticism that would follow from her K-12 teachers as well as her mentor teacher, as she attempted to make sense of mathematics. Based on these findings, my study indicates that mathematics anxiety may be an issue or concern for women prospective elementary teachers that may recur for decades. Previous research has demonstrated that negative experiences with learning mathematics may affect how future teachers think and feel about this content area (Ball, 1988; Brady & Bowd, 2005; McGlynn-Stewart, 2010). My work extends this research by examining how the legacy of anxiety-producing experiences with mathematics education may continue overtime and be cumulative in nature.

Additionally, most researchers interested in mathematics anxiety have focused on the arousal in response to assessment situations (Bursal & Paznokas, 2006; Luo et al., 2009; McGlynn-Stewart, 2010). For example, Bursal and Paznokas (2006) define mathematics anxiety as "a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem" (p.173). My study extends this work by expanding the boundaries of "assessment" and "mathematical tasks" to encompass the diverse range of activities, which prospective teachers understand to be mathematical: for example, Estelle's attempts to define

mathematical vocabulary for students and anticipate students' strategies for solving mathematical problems.

As an example of the range of activities that prompted mathematics anxiety for Estelle, she reported having felt her earliest experiences with mathematics anxiety in relation to what she perceived as “ability” grouping. When Estelle was separated or partitioned from the advanced students in her childhood elementary mathematics class, she felt anxiety and in response created her own “Wall” to conceal what she did not know about this content area. Thus my research indicates that the strategies for coping with mathematics anxiety that individuals seemingly create on their own may, in fact, be tightly related to their experiences with ability grouping and may even have been suggested to them by those situations. Previous research confirms how harmful and misguided ability grouping in mathematics can be, especially when the sorting of the groups is done at a young age when vast developmental differences are likely (Boaler, 2008). My study adds to the conversation on ability grouping by showing not only that experiences of mathematics anxiety may arise from ability grouping but also that ability grouping itself may shape the coping strategies that individuals invent in response to those experiences.

### **Mathematics Anxiety May Present As Unique Fears and Coping Strategies**

Additionally, I have shown that Estelle experienced mathematics anxiety as a specific and distinct fear. Estelle described the dreaded consequence of failing to exhibit mathematical competency as the loss of *social belonging*, or opportunities to participate. Moreover, as I have elaborated in Estelle's case, she developed a related coping strategy, which she used repeatedly across her mathematical experiences, even when the strategy

failed to protect her from stress, embarrassment, and demoralization. Estelle concealed from others behind "the Wall" what she understood to be her lack of mathematical knowledge and skills. Previous studies of mathematics anxiety have attended primarily to the physiological and psychological feelings of mathematics anxiety. For example, Luo et al., (2009) investigated affective responses to mathematics tests like panic, helplessness, confusion, depression, nervousness, fear, and dissociation. My study adds to this work by considering how individuals might make sense of their feelings of mathematics anxiety and attempt to diminish its effects on their lives. Thus, my study challenges "one size fits all" orientations towards mathematics anxiety. I argue that researchers should consider patterns in individuals' interpretations of, and responses to, experiences of mathematics anxiety: that is, their specific fear and coping strategy. This is important because the identification of specific fears and strategies relative to mathematics anxiety is an initial step in being able to address them.

### **Coping Strategies for Mathematics Anxiety that Offer Relief But May Limit**

#### **Learning**

Estelle's case also demonstrated that when she confronted situations in which she felt expected to know mathematical content that she did not understand, she used her specific strategies for coping with mathematics anxiety rather than seriously attempting to learn that content. For example, during her math methods semester, Estelle realized that there were several key mathematics topics that she did not fully understand. In an effort to conceal what she did not know about the topics, Estelle focused on projecting the qualities of a supportive, encouraging, and empathetic mathematics teacher who would model a positive attitude about this content area. In other words, she hid behind



her smile. During her student teaching semester Estelle taught from behind the wall when she was able to rely on her students to explain mathematical vocabulary terms that confused her. Therefore my research demonstrates that prospective teachers' use of certain strategies for coping with mathematics anxiety may ultimately impede mathematics learning. Previous studies of mathematics anxiety have addressed how affective responses, in the immediate term, may hinder mathematical performances (Bursal & Paznokas 2006; Luo et al., 2009). My study adds to this research by arguing that coping strategies such as concealment behind a "wall" developed in response to fears of mathematical participation and evaluation of mathematical performances may hamper mathematics learning.

I have also demonstrated that while Estelle's specific strategy repeatedly broke down, there were instances when the strategy provided some relief (albeit temporary relief) from mathematics anxiety. For example, while teaching a fractions lesson, Estelle struggled to explain the difference between a denominator and a numerator to her class. When several students were able to explain the two mathematical terms to the class without Estelle's input, she was able to conceal her inability to do so in that teaching moment, though her relief was only momentary. Although Estelle could not rely on her coping strategies to protect her from mathematics anxiety at all times (e.g. Estelle did not always have students who could provide mathematical explanations on her behalf), her coping strategy nevertheless temporarily protected her from completely avoiding mathematics or not participating in mathematics at all. Thus, my research provided evidence that strategies for coping with mathematics anxiety may be reused by individuals because at times, these strategies may work to temper the anxiety. My study

also suggests that in reusing strategies for coping with mathematics anxiety, individuals may develop familiarity with them and derive comfort from these strategies, even when they don't always work. Moreover, strategies for coping with mathematics anxiety may allow individuals to continue to move forward in their work as prospective teachers.

Previous research conducted on mathematics anxiety has provided evidence that many prospective teachers experience mathematics anxiety, especially when faced with the expectation of teaching mathematics (Brady & Bowd, 2005; Bursal & Paznokas, 2006; Harper & Daane, 1998; Hembree, 1990). However, these studies have presented experiences of mathematics anxiety as momentary states rather than as recurring experiences. Moreover, prior research has not considered the coping strategies that individuals develop in response to experiences of mathematics anxiety or examined how these strategies may be used repeatedly over time. My study adds to this literature by considering individuals' long histories not only with mathematics anxiety but also with particular strategies for coping with mathematics anxiety.

### **Visions of Successful Mathematics Teaching Despite Mathematics Anxiety**

Estelle's case also reveals that despite repeated experiences of mathematics anxiety as a K-12 student and as prospective teacher, she clung to the hope that when she stepped into her own classroom, she would be able to successfully teach elementary mathematics. Estelle believed that by establishing a classroom where the mathematics discussions would be shared between herself and her students, mathematics could be learned. In this way, she imagined herself having the "ah ha" moments of mathematics understanding alongside her students. Thus, my research indicates that although some prospective teachers experience mathematics anxiety across the various junctures of

learning mathematics and learning to teach mathematics, their strategies to cope with mathematics anxiety may serve as a means for them to continue to pursue their goal of becoming a competent and successful elementary teacher. Estelle spoke of the confidence and strengths she possessed in the other content areas she would be expected to teach as elementary teachers (such as language arts and social studies) as well as her strong desire to work with children. Previous research has shown that prospective teachers who battle mathematics anxiety both while learning mathematics and while learning to teach mathematics nevertheless often believe they will be able to teach mathematics (Swars, Daane, Giesen, 2006). My research suggests a possible, if partial, explanation for this surprising trend by demonstrating the power of prospective teachers' strategies for coping with mathematics anxiety in helping them to pursue careers as teachers, despite long-term experiences with mathematics anxiety.

### **Implications**

My findings revealed that experiences of mathematics anxiety might go beyond formal testing situations. Mathematics anxiety may emerge as a response to mathematics experiences, both enacted and imagined, that occur across a lifetime. While I do not claim that all individuals who experience mathematics anxiety will find that mathematics anxiety pervades their mathematical histories, I do suggest that a generalized experience of mathematics anxiety can occur. This study focused on the experiences of mathematics anxiety that one woman prospective elementary teacher experienced while learning mathematics and while learning to teach mathematics in the U.S. Therefore future research might interview and/or survey a larger sample of this population (including men) regarding the frequency and duration of their experiences with mathematics anxiety.

Further study is important because the findings related to the frequency and duration of mathematics anxiety of a much larger sample of participants might elicit a greater understanding of mathematics anxiety. Moreover, a study that investigates mathematics anxiety beyond the boundaries of the U.S. educational context as a means to gain a better understanding of this serious issue may be warranted as well.

Estelle's narratives about mathematics anxiety also suggest the need for future scholarly inquiry to include prospective teachers' individual interpretations of, and responses to, experiences of mathematics anxiety: that is, their specific fears and coping strategies. There may be more to know about the individual patterns and fears that some prospective teachers encounter in learning mathematics and learning to teach mathematics. Continued research in this area of inquiry may reveal additional patterns and interpretations that women elementary prospective teachers utilize to cope with experiences of mathematics anxiety. This is important to know in order to gain a more complete picture of the various patterns and interpretations of mathematics anxiety.

I have also argued that although Estelle experienced mathematics anxiety across the various junctures of learning mathematics and learning to teach mathematics, her strategy for coping with mathematics anxiety was a sort of double-edged sword that seemed to enable her to continue to pursue her goal of becoming an elementary teacher yet appeared to prevent her from engaging in important learning activities. This is significant for teacher educators, as they seek to create teacher preparation programs that equip prospective teachers with the skills, abilities, and knowledge they need to know in order to take on the responsibilities of an elementary teacher. Work remains to be done through the use of narrative inquiry to gain a deeper insight into the strategies that

prospective teachers employ for coping with mathematics anxiety. Perhaps then the strategies for coping with mathematics anxiety can be replaced by strategies that create more confidence in teaching mathematics.

Additionally, I have made the claim that mathematics anxiety may be an issue or concern for prospective teachers that may recur for decades. In fact, it may be that some individuals may never stop experiencing mathematics anxiety. Future research might address how mathematics educators can work with prospective teachers' histories of experiences with mathematics anxiety, keeping in mind that their efforts might primarily serve to raise awareness and provide options rather than to prevent mathematics anxiety. Future research may provide mathematics teacher educators with a more in-depth view of how pervasive mathematics anxiety is for some women prospective elementary teachers.

### **Acknowledgments**

This material is partially supported by the National Science Foundation under Grant Number [1228034]. Any opinions, findings, conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the National Science Foundation.

## References

- Ashcraft, M. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, 11(5), 181–185.
- Atkinson, R. (2007). The life story interview as a bridge in narrative inquiry. In D. J. Clandinin (ed.), *Handbook of Narrative Inquiry* (1st ed., pp. 224–246). Thousand Oaks, CA: Sage.
- Ball, D. (1988). Unlearning to teach mathematics. *For the Learning of Mathematics*, 8(1), 40–48.
- Ball, D. L., Hill, H.C, & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator*, 29(1), pp. 14–17, 20–22, 43–46 .
- Beilock, S., Gunderson, E., Ramirez, G., & Levine, S. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences of the United States of America*, 107(5), 1860–1863.
- Belenky, M., Clinchy, B., Goldberger, N., & Tarule, J. (1986). *Women's way of knowing*. New York, NY: Basic Books, Inc.
- Boaler, A. (2008). *What's math got to do with it?* New York, NY: Penguin Group.
- Bogdan, R.C, & Biklen, S. K. (2006). *Qualitative research for education: An introduction to theories and methods* (5th ed.). New York, NY: Pearson.
- Brady, P. & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching: Theory and Practice*, 11(1), 37–46.

- Brown, A., Westenskow, A., & Moyer-Packenham, P. (2012). Teaching anxieties revealed: Preservice elementary teachers' reflections on their mathematics teaching experiences. *Teaching Education, 23*(4), 365–385.
- Bursal, M., & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics, 106*(4), 173–180.
- Carter, K. (1993). The place of story in the study of teaching and teacher education. *Educational Researcher, 22*(1), 5–12.
- Carter, K. (1994). Preservice teachers' well-remembered events and the acquisition of event-structured knowledge. *Journal of Curriculum Studies, 26*(3), 235–252.
- Carter, K. (2003). Narratives and learning to teach: Implications for teacher-education curriculum. *Journal of Curriculum Studies, 35*, 129–137.
- Carter, K. (2008). Spontaneous story spaces: Understanding narrative knowledge in teaching and teacher education. *Proceedings of the 6th Annual Hawaii International Conference on Education*, Honolulu, HI.
- Clandinin, D. J. (1989). Developing rhythm in teaching: The narrative study of a beginning teacher's personal practical knowledge of classrooms. *Curriculum Inquiry, 19*(2), 121–141.
- Clandinin, D. J., & Connelly, F. M. (1990). Narrative, experience, and the study of curriculum. *Cambridge Journal of Education, 20*(3), 241–253.
- Connelly, F. M. & Clandinin, D. J. (1990). Stories of experience and narrative inquiry. *Educational Researcher, 19*(5), 2–14.

- Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. San Francisco, CA: Jossey-Bass, Inc.
- Connelly, F. M., & Clandinin, D. J. (2006). Narrative inquiry. In J. L. Green, G. Camilli, & P. B. Elmore, (Eds.), *Handbook of complementary methods in educational research* (pp. 477-487). Mahwah, NJ: Lawrence Erlbaum.
- Doyle, W., & Carter, K. (2003). Narrative and learning to teach: Implications for teacher-education curriculum. *Journal of Curriculum Studies*, 35(2), 129–137.
- Drake, C. (2006). Turning points: Using teachers' mathematics life stories to understand the implementation of mathematics education reform. *Journal of Mathematics Teacher Education*, 9, 579–608.
- Drake, C., & Sherin, M. (2006). Practicing change: Curriculum adaptation and teacher narrative in the context of mathematics education reform. *Curriculum Inquiry*, 36(2), 153–187.
- Drake, C., Spillane, J., & Hufferd-Ackles, K. (2001). Storied identities: teacher learning and subject-matter context. *Journal of Curriculum Studies*, 33(1), 1–23.
- Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the Mathematics Teaching Efficacy Beliefs Instrument. *School Science and Mathematics*, 100(4), 194–202.
- Gavin, M. & Reis, S. (2003). Helping teachers to encourage talented girls in mathematics. *Gifted Child Today*, 26, 32–45.
- Gilligan, C. (1982). *In a different voice*. Cambridge, MA: Harvard University Press.
- Goodson, I., & Sikes, P. (2001). *Life history research in educational settings: Learning from lives*. Philadelphia, PA: Open University Press.



- Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. *Early Childhood Education Journal*, 35(2), 181–188.
- Harper, N. W., & Daane, C. J. (1998). Causes and reductions of math anxiety in preservice elementary teachers. *Action in Teacher Education*, 19(4), 29–38.
- Hembree, (1990). Nature, effects and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, 21(1), 33–46.
- Hollingsworth, S., & Dybdahl, M. (2007). Talking to learn: The critical role of conversation in narrative inquiry. In D. J. Clandinin (ed.), *Handbook of Narrative Inquiry* (1st ed., pp. 146–176). Thousand Oaks, CA: Sage.
- Huebner, T. (2009). Encouraging girls to pursue math and science. *Educational Leadership*, 67(1), 90–91.
- LoPresto, K., & Drake, C. (2004). What’s your mathematics story? *Teaching Children Mathematics*, 11(5), 266–271.
- Luo, X., Wang, F., & Luo, Z. (2009). Investigation and analysis of mathematics anxiety in middle school students, *Journal of Mathematics Education*, 2(2), 12–19.
- Marshall, C. & Rossman, G. (2006). *Designing qualitative research*. Thousand Oaks, CA: Sage.
- Marx, D. & Roman, J. (2002). Female role models: Protecting women’s math test performance. *Personality and Social Psychology Bulletin*, 28(9), 1183–1193.
- Maxwell, J. A. (1996). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage.

- McGlynn-Stewart, M. (2010). Listening to students, listening to myself: Addressing pre-service teachers' fears of mathematics and teaching mathematics. *Studying Teacher Education, 6*(2), 175–186.
- Mizala, A., Martinez, F., & Martinez, S. (2015). Pre-service elementary school teachers' expectations about student performance: How their beliefs are affected by their mathematics anxiety and student's gender. *Teaching and Teacher Education, 50*, 70–78.
- Olson, A. M. (2014). *Teacher education students: Their experience of mathematics anxiety, self-efficacy, and teacher professional development*. Retrieved from The University of Arizona Open Repository, Tucson, AZ.
- Oswald, D. (2008). Gender stereotypes and women's reports of liking and ability in traditionally masculine and feminine occupations. *Psychology of Women Quarterly, 32*, 196–203.
- Schon, D. (1991). *The reflective turn: Case studies in and on educational practice*. New York, NY: Teachers College Press.
- Seidman, I. *Interviewing as Qualitative Research: A guide for researchers in education and the social sciences*. (2006). New York, NY: Teachers College Press.
- Sloan, T. (2010). A quantitative and qualitative study of math anxiety among preservice teachers. *The Educational Forum, 74*(3), 242–256.
- Sloan, T., Daane, C. J., & Giesen, J. (2002). Mathematics anxiety and learning styles: What is the relationship in elementary preservice teachers? *School Science and Mathematics, 102*(2), 84–87.

- Stoehr, K. (2012). Mathematical conversations that matter. Paper presented at the annual meeting of the *American Educational Research Association*, San Francisco, CA.
- Stoehr, K., & Carter, C. (2011). Stories and statistics: A mixed picture of gender equity in mathematics. Paper presented at the annual meeting of the *American Educational Research Association*, New Orleans, LA.
- Swars, S. L., Daane, C. J., & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? *School Science and Mathematics*, *106*(7), 306-315.
- Sykes, G., & Bird, T. (1992). Teacher education and the case study. *Review of Research in Education*, *18*, 457–521.
- Trujillo, K. & Hadfield, O. (1999). Tracing the roots of mathematics anxiety through in-depth interviews with preservice elementary teachers. *College Student Journal*, *33*(2), 219–233.
- Vinson, B. M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal*, *29*, 89–94.