

Toward an Understanding of Graduate Preservice Elementary Teachers as Adult Learners of Mathematics

Rachael M. Welder

Hunter College, The City University of New York
New York, United States
rwelder@hunter.cuny.edu

Joe Champion

Texas A&M, Corpus Christi
Texas, United States
joechampion@gmail.com

Abstract

Career-switchers who are returning to university for training as future elementary school teachers join an important and increasing group of adult learners of mathematics. These graduate preservice elementary teachers often place a high value on learning mathematics because of its prominent role in their prospective careers, but their learning often requires overcoming histories of personal struggles with mathematics. This inquiry used a mixed methods designed and focused on ten participants' perceptions of their experiences as learners of mathematics, anxiety regarding mathematics, and graduate mathematics coursework. All of the participants left professional careers to join a full-time graduate teacher preparation program in New York City. Bridging research from adult education and teacher education, we analysed interview transcripts, mathematics anxiety measures, and survey data using mixed methods both qualitative and quantitative research approaches. The findings show that, starting in adolescence, and continuing into adulthood, participants described negative experiences with exam performance, tracking, and instruction during formal school mathematics. Participants perceived these struggles as contributing to patterns of avoiding mathematics coursework and experiencing moderate-to-high levels of test mathematics anxiety. In spite of, or perhaps partly because of, their personal struggles with mathematics, the participants described urgently wanting additional high-quality mathematics preparation focused on upper-elementary content, manipulative-based pedagogy, and current elementary mathematics curricula.

Key words: mathematics; preservice elementary teachers; graduate education.

Introduction

Non-traditional teacher preparation programs were initially established in the United States during the 1980s in response to projected teacher shortages and have steadily grown to become

an important source of teachers in the U.S. (Humphrey, Wechsler, & Hough, 2005). For instance, non-traditional programs produce nearly a third (6,590 of 20,839) of the newly certified teachers in New York City, or about 20% of the approximately 33,000 new U.S. teachers prepared through non-traditional programs annually (United States Department of Education, 2009).

Around the world, education faculty employ standards for mathematical competency to selectively admit students into teaching programs (Burton, 1987). However, because of the immense need for teachers in inner city and under-served schools, teachers are often recruited without an acceptable level of mathematics competency and are expected to develop this knowledge through their teacher preparation program (Ashun & Reinink, 2009). Yet, in non-traditional programs like those in New York City, the mathematical preparation of elementary teachers is particularly challenging because typically students are only required to complete one mathematics course of any kind; and, analyses of syllabi have revealed huge variation in the content covered across these single mathematics courses (Boyd, et al., 2008).

Improving the mathematical preparation of elementary teachers is a major concern of policy makers and educational researchers (Adler, Ball, Krainer, Lin, & Novotna, 2005). This concern extends to a need to better understand better the beliefs preservice elementary teachers have about their own K-12 mathematics instruction, together with potential anxiety the teachers experience around mathematics, because these beliefs have been linked to their future instructional practices (Fang, 1996; Thompson, 1984). Consequently, “an important goal of every teacher education program should be to help pre-service teachers develop beliefs and dispositions that are consistent with current educational reforms and to assist them in addressing their mathematics anxiety” (Gresham, 2008, pp. 171-172).

In contrast to the strong track-record of success and high self-efficacy experienced by most preservice secondary mathematics teachers (Champion, 2010), many preservice elementary teachers are tasked with learning to teach mathematics in spite of long personal histories of struggling to learn mathematics. Ashun and Reinink (2009) underscore the global scale of the typical nature of this phenomenon:

Casual conversation with these adults reveal that many do not fondly recall learning mathematics when they were younger. Many of these adults are now choosing to start second careers as elementary teachers who must, by virtue of the Ontario classroom system, teach mathematics as part of their core curriculum. ... [T]here is no doubt that [adult preservice elementary teachers’] inability to block out previously held (and inherently erroneous) beliefs in mathematics education is a contradiction in terms (Wedge, 1999) since these learners bring a wealth of experience and common sense competence from their everyday lives. (Ashun & Reinink, 2009, p. 33)

With a multitude of factors potentially impacting the mathematical content preparation of adults switching to careers in elementary education, it is vital that graduate elementary teacher preparation programs address the unique needs of this population. Concomitantly, basic research into the mathematical experiences and perspectives of these prospective teachers is needed to (1) better understand the mathematical preparation and beliefs of preservice elementary teachers, and (2) inform the design and delivery of graduate mathematics courses which are offered to preservice elementary teachers. Our study specifically addresses adult preservice teachers’ affect towards, and beliefs about, mathematics by exploring their prior learning experiences and mathematical preparation in the context of a graduate teacher education

program.

Review of Literature

One aim of our study was to explore potential bridges between two areas of mathematics education research - the mathematical preparation of preservice elementary teachers and the mathematical experiences of adult learners. Besides a few recent exceptions (Ashun & Reinink, 2009; Wheeler, 2009), there has been limited research into the important subpopulation of adult preservice elementary teachers. Consequently, our review of literature constructs a conceptual framework by synthesizing two often separate lines of research relating to the mathematics preparation of graduate preservice elementary teachers. First, we summarize the literature regarding the mathematical beliefs, motivations, and obstacles to success that often face adult learners of mathematics. Second, we describe several themes within the large body of research into the mathematical beliefs and mathematics anxiety of preservice elementary teachers. To better contextualize our findings, we reserve additional research into sources of math anxiety and as well as coping mechanisms among preservice elementary teachers for the discussion following our results.

Adult Learners of Mathematics

As career-changers, who in most cases have been previously active in non-teaching careers, graduate preservice elementary teachers often approach their mathematics training with a unique set of challenges. According to Schloglmann's (2006) survey study of adult career-changers, it is important to distinguish between the larger group of career-changers who choose to participate in adult education and the smaller group who report feeling compelled to participate in adult education because of, for instance, losing their job. While Schloglmann found adults in the larger group were often highly motivated to learn mathematics and saw their courses as an opportunity for personal and financial improvement, those who felt compelled to take mathematics often viewed mathematics as a threat to completing their education. In many cases, these adult education participants perceived multiple reasons to fear mathematics as an obstacle to their educational attainment:

[Adult students] often feel unable to learn, because their learning processes have occurred over a long time, whereas they recognize that mathematics learning requires intense processes of abstraction and generalization. A frequent consequence of this is a students' fear that his or her memory is unable to hold all the abstract concepts required. Formal learning often brings back memories of mathematics learning in school and it is generally accepted that for many adults these memories are bad. (Schloglmann, 2006, pp. 14-15)

Though many face a unique set of challenges to learning formal mathematics, there is substantial evidence that adults are able to succeed in learning postsecondary mathematics. Elliott (1990) found that non-traditional students (ages 25 and older) scored at the same level as traditional students (ages 18-24) on a test of basic mathematics skills. Interestingly, Elliott discovered a negative association between non-traditional female students' beliefs that luck played a role in mathematics achievement and their subsequent course grades, further underscoring the idiosyncratic ways in which personal beliefs and affect can influence mathematics performance among adult learners of mathematics. Similarly, Richardson's (1994) synthesis of research on non-traditional students suggests that older students typically have the

basic skills to productively study and progress in higher education, but often contend with increased personal and financial concerns that can cause them to withdraw from school.

Although enrolment by adults over the age of 24 in higher education grew in the U.S. by nearly 150% from 1970 to 2000, these non-traditional students remain less likely than traditionally aged (18-24) students to complete degree programs; while approximately 54% of all traditionally aged U.S. college students complete a bachelor's degree in six years, only 41% of non-traditional males and 35% of non-traditional females tend to reach that goal (Taniguchi & Kaufman, 2005). Bean and Metzner's (1985) conceptual model for non-traditional student attrition identified four primary factors influencing the decision to drop out of a program of higher education: (1) current academic performance (e.g., GPA), (2) intent to leave, (3) past educational performance, and (4) environmental factors like family commitments. In highlighting the effects of the external environment on non-traditional student attrition, the authors contrasted the demands on adults' time outside of school to the prominent role that adolescent variables, such as identity formation and social integration, have in traditional student attrition. Some of the external demands faced by adult learners include employment, commute time (Schuetze & Slowey, 2002), financial aid, childcare, and remedial coursework (Bundy & Smith, 2004).

Adult learners certainly face challenges to succeeding in higher education, but many of the external factors influencing their lives (e.g., family, career) can be seen as sources of motivation. For example, Chao and Good (2004) found many adult students drew motivation from support provided by friends, family, and faculty, and from a more mature understanding of the financial investment associated with higher education and the prospects for career development. Similarly, Blair, McPake, and Munn (1995) found myriad reasons supporting adults' choices to return to school, including "gaining qualifications or skills to secure a better job, enjoyment, learning for its own sake, getting out of the house, making new friends, and gaining a place on a more advanced course" (p. 637). Their study participants mentioned grants, student loans, and support systems as necessary aids in returning to school. Jane, one of the participants, shared her reasons for returning to school that included bettering her children's future and socializing:

This is me trying to get back. [I wanted] to provide my youngest son with some type of nursery education and give myself something to take my mind off everything...It gives me the chance to meet other people—otherwise I would be totally isolated...I was given encouragement and support...It helped me get myself sorted out and it's given support for me and my children. (Blair, et al., 1995, pp. 644)

The Mathematical Knowledge and Beliefs of Preservice Elementary Teachers

Ball, Thames, and Phelps (2008) have recently claimed that there may be nothing more fundamental to teacher competency than how well teachers know the subjects they teach. Relying on the rationale that "improving the mathematics learning of every child depends on making central the learning opportunities of our teachers" (Ball, 2003, p. 9), many elementary education teacher preparation programs emphasize building content-specific understanding of foundational mathematics such as representations of numbers and arithmetic operations (Lee, Meadows, & Lee, 2003; Welder, 2007). This has been a challenging goal, because preservice elementary teachers tend to enter their coursework less mathematically proficient and express more negative views of mathematics than the general population of college students (Rech,

Hartzell, & Stephens, 1993). With limited opportunity (sometimes as little as a single mathematics course) to experience change in their beliefs and understanding of mathematics, many U.S. elementary teachers work with a persistent lack of the profound understanding of mathematics that serves as the base for successful mathematics teaching (Ball, Hill, & Bass, 2005; Ma, 1999)

Learning mathematics is not solely a cognitive activity (Schloglmann, 2006). Beliefs about the purposes for and underlying structures of mathematics, combined with emotional and physiological responses to encountering mathematics, can have a profound influence on the mathematical development of preservice elementary teachers (Wheeler, 2009) and the teaching practices of elementary teachers (Thompson, 1984). Not surprisingly, researchers have identified links between prospective teachers' beliefs and attitudes about mathematics and their mathematics performance (Harding-DeKam, 2005). Preservice elementary teachers' affective reactions to mathematics, especially reports of mathematics anxiety, are particularly prominent as potential sources for poor performance in the foundational mathematics courses offered in teacher preparation programs.

In his seminal meta-analysis of math anxiety literature, Hembree (1990) identified math anxiety as a profound barrier to people's ability to perform well in math and to continue their formal math education. People with math anxiety experience fear "when they are called on to do math—whether it is working through a problem at the chalk board as an entire class looks on, taking a math test, or even calculating a restaurant bill" that can "prevent them from using the math knowledge they possess to show what they know" (Ashcraft & Kirk, 2001 as cited in; Beilock, Gunderson, Ramirez, & Levine, 2010, p. 1). People with math anxiety may exhibit intense worries and self-doubt that can compromise their mathematical thinking and reasoning (Beilock, 2008); and therefore, math anxious students tend to "perform more poorly than their abilities would suggest when they are exposed to math" (Beilock, et al., 2010, p. 1).

Not surprisingly, Hembree (1990) found increases in math anxiety correlate to lower achievement in mathematics across grade levels. However, among college students, those who majored in elementary education had the highest levels of math anxiety, compounding the obstacles already faced by preservice elementary teachers. Math anxiety is especially concerning among preservice elementary teachers because it has negatively associated with content knowledge for teaching mathematics (Gleason, 2008) and because it can result in:

- (a) a potential on the part of mathematics anxious teachers to pass their anxiety on to their students thus inhibiting their future mathematics attainment; and (b) engagement, on the part of teachers, in mathematics avoidance behaviours and the use of less than effective instructional techniques. (Brady & Bowd, 2005, p. 44).

Background

Setting

All of the study participants were enrolled in a non-traditional childhood education program at a large, public, urban university in New York City. This university offers an accredited and nationally recognized graduate program in childhood education leading to initial certification in childhood education (grades 1-6) in the state of New York. As a graduate program specifically designed for career-switchers, it is comprised of students with varying educational backgrounds and work experiences. Most adults enter the program having had substantial work experience

after the completion of their undergraduate programs, but they typically start the program with very little or no prior teaching experience. During this one and a half to two-year program, participants take a pre-planned sequence of courses, which includes one required course in the teaching and learning of mathematics in the elementary school. This three-credit, semester-long course meets face-to-face during 15 weekly 150-minute sessions. In addition, the students are required to spend at least ten hours observing mathematics instruction at a public New York City elementary school of their choice.

According to the syllabus prepared by the course coordinator, the elementary mathematics course is designed to provide students an opportunity to (1) become knowledgeable of fundamental skills and concepts related to the elementary school mathematics curriculum, (2) develop teaching strategies and appropriate assessment techniques related to elementary school mathematics instruction, and (3) discover and/or enrich an enjoyment of learning and teaching mathematics. Several sections of the course are offered every term, including summer sessions, and the sections are taught by a small set of mathematics education professors (including the primary author) and a rotating set of adjunct instructors.

Research Questions

Within the context of the conceptual framework and prior findings identified by the review of literature, our study addresses two research questions:

1. In what ways do graduate preservice elementary teachers perceive prior learning experiences as influencing their beliefs and anxiety about mathematics?
2. To what extent do graduate preservice elementary teachers perceive their childhood education program as adequately preparing them to teach elementary mathematics?

Methods

Research Design

We used a mixed-methods design with special emphasis on qualitative methods because we believed a focus-group methodology afforded opportunities to develop detailed views of participants' experiences with and perceptions of their preparation to teach mathematics. Our interview protocol incorporated open-ended questions in an effort to limit potential to bias students' responses and allow for themes and variations to emerge from the participants' responses during the analysis of transcripts.

Two semi-structured interviews (Merriam, 1998) allowed us to tailor questions to session participants and to gather data on similar aspects of the participants' experiences while leaving room for dynamic questioning to probe the participants' unanticipated responses during the interview (Creswell, 2009). In addition to limiting the potential for constrained responses due to participants' feeling intimidated by discussing their mathematics experiences with a mathematics educator in their program, we believed the focus-groups would give study participants a chance to openly discuss their mathematics experiences within a group of their peers and to learn from one another. The design also allowed us to compare and contrast responses in the two interviews and to better understand the contexts and scope of emerging themes.

Our research design has several limitations that are important to acknowledge. First, the inquiry included a small sample of graduate preservice elementary teachers at a single urban

alternative teacher education program. Secondly, seven of the ten interview participants had previously completed a section of the mathematics course taught by the primary researcher. Though this increased familiarity of the interview participants with the interviewer afforded opportunities, it also may have subtly influenced participants' interview responses. Third, the exploratory nature of our study and relatively limited duration provided for to construct only preliminary conclusions regarding the research questions. As in most studies of this scale, we invite readers to consider the context surrounding our study and characteristics of the participants when considering the potential transferability of the findings to other settings (Patton, 2002).

Data Collection and Analysis

The data sources for our study were records from two extended group interviews and three surveys. The interviews included ten participants divided into two focus groups of five, based on their availability. The interviews lasted two hours each and were audio and video recorded, transcribed verbatim by the research team, and analyzed using the professional qualitative data analysis software program NVivo 8 (QSR International, 2008).

In addition to the focus group interview data, we collected participants' responses to three surveys. First, a background survey asked participants to provide demographic and contextual personal data. Background variables collected included age, years since completing secondary school, undergraduate major, sex, race/ethnicity, and employment history. In addition, participants were asked to describe their prior secondary and university-level mathematics experience as well as plans for working while in the program and teaching after completing the program. Secondly, participants completed a survey regarding their experiences with and perceptions of mathematical manipulative before, during, and after completing the elementary mathematics course. LastIn addition,ly, students completed the Mathematics Anxiety Rating Scale–Shortened Version (MARS-SV), developed and validated by Suinn and Winston (2003) as a shortened version of the original and widely used MARS survey instrument (F. C. Richardson & Suinn, 1972).

The MARS-SV contains 30 brief descriptions of behavioural situations. For each item (e.g., “thinking about a mathematics exam - five minutes before”), participants are rated their anxiety level on a Likert scale from 1 (not at all anxious) to 5 (very much anxious). Mean responses for the 15 items in each of the two subscales in the MARS-SV, namely test math anxiety and numerical math anxiety, can be interpreted on the same 5-point anxiety scale. Normative data has not been published for the MARS-SV instrument that might allow for diagnostic assessments of the levels of mathematics anxiety experienced by our study participants (Plaisance, 2007; Suinn & Winston, 2003). We used participants' scores on the test math anxiety and numerical math anxiety subscales – each ranging from 1 (low anxiety) to 5 (high anxiety), in combination with interview responses to develop holistic descriptions of participants' levels of math anxiety. Collectively, the interview participants reported moderate-to-high test math anxiety ($M = 3.4$, $SD = 0.6$, range = 2.2 to 4.1) and low numerical math anxiety ($M = 1.8$, $SD = 0.5$, range = 1.1 to 2.6). At the two ends of the test math anxiety spectrum, Aidan and Mika reported low levels of test math anxiety (scoring 1.6 and 2.2, respectively), while Olivia and Bailey described the highest levels (each scoring 4.1).

We open-coded (Patton, 2002) the interview transcripts with descriptive phrases based on our review of literature and research questions, then inductively synthesized the codes into categories and themes among responses. Throughout our analysis, we placed special emphasis on the variety of participants' experience and confirming and disconfirming evidence regarding

emergent themes. To add credibility to findings, we triangulated themes (Creswell, 2007) with the quantitative and qualitative data collected through the three survey instruments and member-checked (Merriam, 1998) our results with one of the study participants.

Description of Study Participants

Study participants were recruited from various sections of the mathematics for elementary teachers course offered at the research site during the fall semester of 2009. Seven of the ten interview participants completed the course together in one section taught by the primary author. A single participant came from a second section, taught by a fellow mathematics education professor; the remaining two participants took the course from an adjunct instructor. All were graduate students in the second semester of their first year of a non-traditional elementary teacher preparation program. Each student had earned a passing grade in the course during the previous semester. Since this course was not only the sole required, but also the sole offered, mathematics course in the program, the students had finished their mathematics coursework in the program.

Most of the study participants (8 of 10) were female and all but one described themselves as White (the remaining participant was Asian-American). Study participants ranged in age from 23 to 41 ($M = 27.7$, $SD = 6.1$), with five participants over the age of 24. The participants had each completed a U.S. bachelor's degree program up to 13 years prior ($M = 4.0$, $SD = 4.9$) to enrolling in the elementary certification program, and had professional work experience prior to joining the graduate program. The wide variety of reported occupations included flight attendant, publicist, assistant to an attorney, coordinator of an English language development program, substitute elementary school teacher, data analyst, teaching assistant at an elementary school, and activities coordinator at a small museum.

Five participants continued to work while they completed the graduate program, retaining jobs such as nanny, server at a restaurant, and data analyst, and reported working a mean of 31.5 hours per week ($SD = 11.4$) while completing their teacher preparation coursework. Though most of the prospective teachers (8 of 10) planned to teach in the New York City area after obtaining certification, they had substantial commutes to the central urban campus location ($M = 48.5$ minutes each way, $SD = 12.3$, Range = 23 to 68). All of the ten participants' undergraduate majors were in non-teaching fields and had no specific mathematics requirements (e.g., Urban Studies, Spanish, Art History, Communication Studies). Consequently, the participants reported limited college mathematics experience (just two participants completed a college calculus course), and three of the participants were required to complete an additional college-level mathematics course as a condition of admission into the teacher preparation program.

Results

Themes from our analysis suggest study participants desired additional coursework in mathematics content and methods, improved support and guidance for field experiences, and more opportunities to overcome mathematics anxiety stemming from their prior experiences as learners.

Theme #1 – Prior Experiences and Mathematics Anxiety: “You just get through it until you don't have to do it anymore.”

Our inquiry revealed five primary sources of math anxiety among graduate preservice elementary teachers relating to the participants' primary and secondary school experiences.

These included (1) experiences of ability-level tracking in elementary and middle school, (2) comments from previous mathematics teachers, (3) high expectations for performance in advanced coursework, (4) poor performance in previous mathematics classes, and (5) struggles during the transition to formal mathematics in middle and high school. In the following narrative, we provide specific examples of participants' accounts of these perceived sources of mathematics anxiety with the aims of highlighting the variety of the participants' experiences and stressing the profound ways in which the participants appeared to have internalized their early mathematical experiences.

Several participants traced experiences of mathematics anxiety to being tracked by ability into separate mathematics courses from their peers during early adolescence. When asked to describe the roots of her math anxiety, Cassidy pointed first to tracking: "I think it was when everything started to split up into the smart class, the middle-ground class, and the slow class. That was a huge factor." Scarlett's experience with tracking was also personally meaningful. She recalled doing well in mathematics in elementary school, even volunteering to attend extra mathematics sessions during recess in the fourth grade. In seventh grade, however, she recalled being transferred to a lower-level mathematics class halfway into the year: "I remember it being, to me, a huge deal, and since then I always felt really timid about math because of that one experience of being bumped down as a kid." Even though she was later tracked into advanced secondary classes, Scarlett reported avoiding higher-level mathematics coursework in high school and college, saying, "Anything to not touch a number."

In addition to describing social messages associated with tracking in mathematics courses, some participants' described perceptions of inadequate or hurtful teachers as affecting their mathematics anxiety. Logan recalled a teacher that put a refrigerator box around his desk because he was often distracted during class. Natasha recalled a teacher who taught exclusively from her chair, asking students to write main points on the board for her during her lectures. Olivia, described a particularly difficult year in her first secondary mathematics class:

In ninth grade, I didn't do well at all. I had a horrible teacher and I cried after every class, she was really unsupportive and I didn't really get what was going on... There was a lot of shame involved, and with something like math... So many people experience this... you know, to have someone tell you you're an idiot, you're so stupid for not getting it...I don't even remember specific comments. I just remember the feeling like, whatever it was she said, it made me feel like I was just, that I'm just not a math person, that math is just not for me.

At 41 years of age, Natasha was the oldest participant in the study. She described being "full of math anxiety," but also recalled being an average mathematics student until a very difficult freshman mathematics class in high school:

I hit high school and I had this horrendous algebra teacher freshman year - Mrs. Johnson... She made you feel very stupid if you didn't get it. I remember she was discussing I think it was distributive property and I remember her going like this [makes a forceful grabbing and dropping gesture with her hand]. Really angrily, "It's distributive, what don't you understand? Why don't you get it?!" Going just really angry, showing that she was distributing something. I'm like, "I have no idea what you're doing with this, what does this mean?" And I failed. I had to take it again in my next year.

Mika, Logan, Belle, Scarlett, and Olivia each described experiencing pressures to perform well in advanced mathematics coursework during secondary school. The internal and external pressures to meet the high expectations for success in mathematics led to experiences of math anxiety among Scarlett, Belle, and Olivia in particular. Belle, who struggled in mathematics during high school, summarized the strain associated with a culture of success among her schoolmates:

I went to a preparatory school that was competitive and really hard, and I remember just feeling terrible about not being as smart as my friends and not doing as well in math. There was shame and embarrassment. And I think part of it is not wanting to admit that you don't get something and so my strategy was to put it off.

Belle's experience of wanting to avoid mathematics as a result of episodes of poor performance was a consistent theme across nearly all study participants. Scarlett deliberately avoided an advanced placement course as a senior in high school and took a philosophy logic class in college to satisfy her general mathematics requirement. Aidan, who reported low mathematics anxiety and a strong affinity toward mathematics, said he still felt shame years later because of dropping out of an engineering program due to failing a college calculus class. Cassidy described taking a view of mathematics as a kind of academic waiting game, "You just get through it until you don't have to do it anymore. I think since I was probably in seventh grade... I've been mentally counting down until the day that I don't have to do math anymore." Natasha, who believed her dyslexia may have interfered with her ability to learn secondary mathematics, put it most clearly: "If I can avoid [mathematics], I will."

A final source of mathematics anxiety reported by participants regarded academic and cognitive struggles with learning mathematics during the transition to secondary mathematics, especially while studying formal algebra. Bailey, for example, remembered doing well in mathematics until high school, when she felt a shift in her perceptions of whether she was able to do mathematics:

As soon as I got to high school, it was like, you can't really coast by... I had some really good teachers, but it was weird that not until you're a teenager do you realize that there's something I'm really, really bad at. I'm good in school all around, so that was kind of a shock. And it's continued to this day.

Natasha likened the introduction of algebraic notation to doing mathematics in an unfamiliar language, saying, "It's like here, do this math in Spanish." Aidan described the sudden need for algebraic competency in high school as "a shock to the system" that required a shift in thinking for students as they made the transition to formal mathematics.

Theme #2 – Quantity of Mathematics Instruction: "It's a good stepping stone, but it's just one."

In order to address the second research question, we asked the interview participants about their perceptions of the single required mathematics course in the program. The participants responded by talking about their initial reactions to taking mathematics courses as part of their elementary teacher preparation program, their experiences in the course they completed, and whether they would benefit from additional mathematics coursework.

Several participants described efforts to avoid taking multiple mathematics courses in their teacher education programs. Scarlett, for example, said she did not know what to expect in mathematics courses, feared not being able to succeed in them, and even avoided other teacher education programs because they required multiple mathematics courses. After taking the course, however she expressed a consensus among participants that more mathematics courses are needed in the teacher preparation program:

Coming into the program, I thought one semester...a refresher would be fine. I really had this thought that you could look at the textbook also and if you didn't get something, you'll have the textbook to help teach you. And now it's so clear how important it is for you to have a full understanding in order to impart it to kids with different ways of teaching math. I would feel way more prepared to have at least another semester of delving into [math] more.

Natasha, Olivia, and Cassidy also noted a shift in their thinking about elementary mathematics after beginning the mathematics for elementary teachers course. They described feeling overwhelmed by the breadth of elementary mathematics content and agreed that a one-semester course is not enough to properly prepare them to effectively teach all levels of elementary mathematics. Natasha described a strong feeling of nervousness surrounding having to teach mathematics, and Cassidy said the instructor “did a really fantastic job giving us a good primer for teaching math...It's a good stepping stone, but it's just one. I definitely don't feel ready to go into a classroom.”

Although some participants said they initially wanted as little mathematics coursework as possible in their elementary teacher preparation programs, after completing the one required course of their program, several students echoed Scarlett's desire for additional mathematics instruction. As future teachers, they perceived they may need to teach mathematics differently from the ways in which they were taught mathematics as children. Sasha compared the teachings of the class to her elementary learning experiences saying, “Yeah, we never learned with manipulatives, we didn't have problem-based lessons so it's a totally new thing.” Natasha and Olivia's comments exemplify the apparent consensus during the two group interviews:

I think another class would absolutely do it. Because the foundation I was getting in the class was great and I know those things backwards and forwards and I feel confident about them. But we only got through a certain amount of [content] so there's a lot more out there that I'm just not comfortable with yet. –Natasha

I think a full year with one teacher, one course, designed...doing exactly what we did in the beginning but then continuing on to the higher level stuff. A lot of people in the class aim to teach fourth through sixth grade...I think it would make sense to focus there...I have a goal to teach the upper levels, fourth or fifth grade, and I'm feeling anxiety about that content. –Olivia

Participants described wanting at least one additional course to continue exploration of ideas beyond where their course had ended. They suggested a sequence of two consecutive courses taught by the same instructor that could be comprehensively designed to continue the current class onto topics relevant to upper elementary and middle grades, such as fractions, decimals,

and algebra. There was much agreement in the focus group interview after Natasha confessed, “I’m really not comfortable with fractions at all. Fractions are frightening, and I feel like I need an algebra class.”

Unfortunately, there are currently no other graduate mathematics courses offered at the research site that would be appropriate for preservice elementary teachers, even if they elected to take one in addition to their required coursework. In lieu of additional courses being offered, the participants suggested rearranging the program’s pre-planned sequence of courses so that full-time graduate students are not enrolled in their only mathematics course during the first semester of their program. Natasha proposed:

If they can't add another course, if they could at least put the course we did have later on in the program. Because first semester we hadn't had any real field experience, we didn't even know what questions to ask. And I'm just starting to formulate them now. But I didn't even know what I didn't know...it was just a little too soon to have it first semester. Ideally, I would like to have this first semester and then another one later on. If that's not going to happen, then at least move it on a little bit. Because I was unprepared for what math looked like.

Theme #3 – Quality of Mathematics Content and Instruction: “It’s how in touch you are with what it’s actually like to be an elementary school teacher, teaching math.”

We asked the interview participants about their perceptions of the curriculum and instruction they received during their mathematics for elementary teachers course. The participants, who had each taken the course from one of three different instructors, specified various elements of their course that were beneficial to their learning and offered critiques of, and suggestions for improving, course content and instruction.

The participants agreed on a need for instructors with specialized experience in the field of elementary education. Comparing her experience with other students in the program, Scarlett noted:

I remember talking to other people in other classes...they said that they had experiences where it was just someone who was a mathematics professor...just teaching math and not focusing on how are you going to teach this to kids and how does this fit in to education at large.

She also commented that institutions of higher education need to, “ensur[e] that instructors for these courses are people that are directly involved in education and mathematics education... it’s how in touch you are with what it’s actually like to be an elementary school teacher, teaching math.” Moreover, Aidan believed the ever-changing set of adjunct professors who teach the mathematics course at the research site could also negatively affect the quality of instruction.

Besides variations in the quality of instructors across sections of the course, participants made several comments about the mathematics content that had been covered in their courses. Bailey, who took the course from a mathematics education professor not involved with the research, described a perception that the content covered in her class was not relevant to elementary mathematics.

[The professor] would pick a topic and then go really into detail about it. And we would just kind of be like, okay, I don't really know what that has to do with elementary math...“what you [professor] are talking about, I have no idea what that is.” And the things that I've actually seen used in the classroom in elementary school, we did not even talk about it. We didn't even talk about ways to teach math to children. We did some math that was maybe for high school and college kids, just actually did the math...so I really didn't learn anything.

Bailey elaborated on her perceived disconnect between course content and elementary teaching when discussing manipulatives:

We had one day when we talked about [base ten blocks]...He just sort of gave them out for us to play with them, and he was like, "Do this problem," but then we went onto something else. And it was like, okay, but how does that relate to elementary students? How would we use this in a lesson? I would have appreciated more discussion about how this is going to help [children] continue their learning and build on their prior knowledge of math.

Bailey thought the course did not address the mathematics currently taught in the elementary school curriculum, especially the many different representations and procedures she perceived as being commonplace in local curricula. When Olivia mentioned that other preservice teachers in the program hadn't even see the lattice method for multiplication, Bailey interjected, "I've never seen that before." Aidan identified this variation in content as forming a "huge disconnect" in the course curriculum. In addition, some participants voiced concerns and fears about integrating the teaching strategies modelled in the mathematics for elementary teacher course with school and state-mandated mathematics curricula:

I'm kind of nervous about reconciling the curriculum with what we've been learning about...spending a lot of time working with manipulatives and allowing that time for students to discover connections and understand...and from what I understand, that's not necessarily aligned with the curriculum used in New York City. I'm just nervous about adapting the curriculum to fit my beliefs about education, and how math should be taught. And I don't know what kind of support I'm going to have in modifying the curriculum if I'd like to. –Olivia

In contrast to the dissatisfaction expressed by participants regarding the quality of course content, Riley described finding value in an activity in which the students in her class analyzed procedural errors made by children:

One particular thing that was helpful that I've never actually done in a math class before is looking at student errors and figuring out what went wrong, how they were thinking about the problems, how they got that wrong answer, and then talking about the different ways that we came up with, like, what they could have done... I never considered doing that...I thought about what questions the students might ask me and how I would respond.

In addition to the course content, participants described pedagogical elements of their

mathematics for elementary teacher courses that they found beneficial. Olivia said she learned from watching her instructor model effective teaching methods, and Cassidy said she found it “refreshing” that her instructor focused on conceptual understanding throughout the course:

I would say it kind of blew my mind just to think about math from a completely different perspective...[The instructor] focused so much on really understanding what was going on, and not necessarily getting the right answer. [The instructor] just reinforced that throughout the entire semester, you know, "why did you get what you did,"...the process and the whole thing. That was refreshing because that was the first time that I think I had really ever thought about math like that.

Moreover, several participants said they enjoyed working together in small groups during class time. These participants were all members of the same class, where the students worked in consistent, self-selected groups throughout the semester. Scarlett described feeling a sense of community and positive interdependence during group work:

You feel like you're entering into a community more. I think most people in the program really feel dedicated to education on the whole and so you are invested in helping your peers do well because it's only benefiting kids and the education community at large. I felt a sense of that.

Belle said that working in groups helped her to better understand how others learn, and Olivia added that she enjoyed the spirit of collaboration established in the class:

It wasn't competitive. I think we were all really collaborating. For a teacher preparation program, I think if you have that dynamic, the learning environment is really effective. I liked it a lot more than other classes, which were just round tables. Pretty much in every class, the best experience is doing group work. At this level.

Finally, Cassidy identified the pace of the class as being an important element in her learning:

I felt so comfortable with the pace that we were moving. It was like we were making progress and chopping away at things, but if we also were allowed time to really let things sink in...I felt like it gave us an opportunity to really feel comfortable with the material and not just in taking it in, but in spitting it back out.

Discussion

Summary of Findings

The majority of our participants described experiencing mathematics anxiety and identified an array of experiences they believed led to feelings of inadequacy and fear surrounding mathematics. The participants seemed to have internalized their early mathematical experiences from primary and secondary school, allowing prior events in their education to have remarkably direct influences on their learning of mathematics as adults. Their stories provided insight into the variety of elements of mathematics education at all levels, both content and pedagogical, that can stimulate and perpetuate mathematics anxiety.

In addition, participants described taking a negative view toward mathematics prerequisites when they were selecting a teacher preparation program. Some had purposely avoided programs that would have required them to take higher-level mathematics courses to make up for missing prerequisites, mentioning fears of not being able to succeed and feelings that such courses would not be relevant to their futures as elementary teachers. However, after completing the one required course of their current program, many students described wanting additional mathematics instruction. The results support the claim that effective elementary mathematics teacher preparation courses can change the way preservice teachers think about mathematics, and they highlight needs for (1) qualified instructors who can make content relevant to teachers, (2) additional opportunities for preservice teachers to continue developing their mathematics skills, and (3) program structures that support the pedagogical development of preservice teachers.

Connections to Mathematics Anxiety Literature

As mentioned in the review of literature, our study contributes to the large body of research on mathematics anxiety among preservice elementary teachers by focusing on the important subpopulation of adult career-switchers enrolled in non-traditional teacher preparation programs. Our results suggest that participants' perceived five primary sources of mathematics anxiety; we will now discuss how our findings compare to the related literature on origins of mathematics anxiety among preservice elementary teachers.

First, our work supports several studies that have indicated mathematics anxiety experienced by preservice teachers in collegiate content courses is largely rooted in the teachers' early experiences as mathematics learners (Brady & Bowd, 2005; Gresham, 2007; Uusimaki & Nason, 2004). As Philippou and Natashatou (1998) suggested, "teachers' formative experiences in mathematics emerge as key players in the process of teaching since what they do in the classroom reflects their own thoughts and beliefs" (p. 191). Second, our finding that participants traced anxiety to negative experiences with mathematics teachers and coursework during their transition to high school supports Brady and Bowd's (2005) conclusion that preservice elementary teachers' mathematics anxiety often stems from negative experiences in secondary school. The nature of the negative experiences described by our participants was consistent with the those reported by Brady and Bowd, whose participants encountered (1) fast-paced instruction, (2) comments from teachers that made them feel inadequate because of difficulty in understanding content, and (3) in one instance, being given a passing grade under the condition that the student take no further mathematics courses. In addition, we found that several participants avoided mathematics as a way of coping with feelings of mathematics anxiety and poor performance in school mathematics, and this underscores the importance of what Brady and Bowd (2005) term a "cyclical phenomenon" in mathematics education:

Negative experiences with formal mathematics instruction led many participants to discontinue their study of the subject, or discouraged them from pursuing formal mathematics instruction beyond that which was necessary to fulfil high school graduation or university admission requirements. This led to the perception on the part of many respondents that their mathematics education had not prepared them to teach the subject confidently, a condition that has the potential to be replicated in their students. (Brady & Bowd, (2005, p. 45)

Our results regarding mathematics anxiety do, however, contrast with some findings in the mathematics anxiety literature. For instance, Uusimaki and Nason (2004) found that

Australian preservice elementary teachers with high mathematics anxiety mostly attributed it to negative experiences with primary school teachers rather than to specific content or social factors, such as messages received from family or peers. However, with our participants, we heard more references to secondary school as a source of mathematics anxiety than elementary school; furthermore, our participants identified several social factors as primary sources of their anxiety, including messages associated with tracking and high expectations established by family members and peers. Our findings did align with Uusimaki and Nason's indications that specific mathematical content and social factors contributed to some participants' math anxiety, including (1) being asked to communicate their mathematics knowledge, (2) efforts to learn algebra, and (3) experiences with space and number sense content.

Another contrast we identified was between our participant's views of manipulatives and some reports indicating that the introduction of manipulatives in collegiate mathematics courses can be a source of mathematics anxiety for preservice elementary teachers (Gresham, 2007, 2008; Vinson, 2001). Vinson (2001) found that during their engagement with mathematics materials during methods courses, some study participants found that their math anxiety increased, largely due to a lack of prior experience using manipulatives; these students "were struggling with relearning mathematics at the same time that they were learning to use the manipulatives" (p. 93). In addition, one of the participants in Gresham's (2008) study described the apprehension felt by many preservice elementary teachers who encounter manipulatives for the first time:

I don't ever remember using manipulatives when I was in school. I remember my teacher giving us lots of worksheets or problems from our math book and that's how we learned. Either you got it or you didn't. It was horrible. During the math methods class, the instructor brought in all sorts of manipulatives. I freaked out and was so terrified at first, but after using them in class and learning how to use them to help us teach, I actually started enjoying the math I was learning. (Gresham, 2008, p. 179)

In comparison, all of the participants in our study described their interaction with manipulatives positively. Given the different study populations and sample sizes, our results do not necessarily contradict Gresham or Vinson's findings, but the contrasting accounts from our participants do suggest a potential need for future research in this area.

Implications

For mathematicians and mathematics educators involved in the preparation of elementary teachers, non-traditional aged students and career-switchers present a unique set of challenges. Our study, in combination with existing literature, suggests that many of these prospective teachers have a history of negative experiences as learners of mathematics, feel moderate-to-high levels of mathematics anxiety (especially in regards to tests), and can view mathematics as a threat to their ability to be a successful teacher. However, we also found our study participants to be remarkably self-aware of their mathematics anxiety and to hold well-reasoned views on what they need from their mathematics preparation to overcome these feelings. Collectively, our results suggest graduate preservice elementary teachers may particularly benefit from well-articulated, reform-oriented mathematics instruction (i.e., in the spirit of recent recommendations by the National Council of Teachers of Mathematics) and supplemental opportunities to apply and extend their emerging understanding of mathematics.

One of the most interesting outcomes of our study was that many of our participants

described a history of difficulties achieving in and anxiety pertaining to mathematics, yet many specifically requested more mathematics coursework as part of their teacher preparation program. We found this result extremely encouraging and reflecting indications that our participants had positive experiences in their single required mathematics courses. If practical, it might well be beneficial to graduate preservice elementary teachers if there were an additional mathematics course with emphasis on, as suggested by the participants, upper-elementary topics such as fractions and algebra. Such a course might also be bolstered by concurrent field experiences for preservice teachers to engage with elementary students, especially early in a teacher education program when classroom experiences are particularly valued by prospective teachers. In cases where additional mathematics requirements are impractical, our participants suggested optional mathematics courses, professional development opportunities, and local conferences for teachers as welcome supplements. The integration of voluntary mathematics opportunities could be particularly attractive to non-traditional students who might be put-off from enrolling in a teacher preparation program with heavy mathematics requirements.

The primary method for coping with mathematics anxiety among our study participants appears to have been simply avoiding mathematics whenever possible. However, preservice teachers need to engage in accessible, yet challenging mathematics in order to be prepared to teach elementary mathematics effectively. Our interviews suggested several avenues for accomplishing this goal, including (1) communicating clear expectations for assignments and assessments, (2) modelling effective strategies for teaching mathematics, (3) explicitly connecting course content and local mathematics curricula, and (4) offering repeated opportunities for preservice teachers to demonstrate mastery of conceptual understanding. Logan (self-described as highly math anxious) reported a major reduction in his level of anxiety after realizing he could succeed in the elementary mathematics course. He stressed that this success led to new-found confidence: “I think the ability to do the math gave me a confidence to teach it as well.”

Our data suggested that participants perceived the use of manipulatives. Our data suggested using manipulatives to represent elementary mathematics content was perceived by our participants to be pedagogically relevant, accessible, and cognitively helpful. Consequently, our study supports the common practice among mathematics educators to model mathematical content with physical manipulatives to emphasize a conceptual understanding of foundational mathematics (Vinson, 2001). As Levine (1996) found, “using manipulative materials to teach concepts underlying mathematical operations was different from the procedural focus of learning mathematics during [the preservice teachers'] elementary school experience and facilitated their conceptual understanding” (p. 7). Vinson’s (2001) study of 87 preservice elementary teachers enrolled in manipulative-rich mathematics courses reported that participants experienced better understanding of mathematics concepts and procedures when they were presented in pictorial or concrete forms rather than formal symbolic form alone. Our study supports Vinson’s findings in suggesting that elementary educators may benefit from teacher education programs that model effective manipulatives-based mathematics instruction.

Finally, our study identified several characteristics of a graduate elementary teacher preparation program that could potentially support the preparation of effective teachers of mathematics. Our participants stressed the importance of intra- and inter- disciplinary coordination across their coursework, especially consistency across sections of mathematics classes and communication between instructors delivering courses during a given semester. This would serve to allay some participants’ concerns that they received instruction that may have been disconnected from local mathematics curricula. Program coordination could also include

improved integration between preservice teachers' field experiences in local schools and their content coursework. As Bailey put it, much of the content learning for a teacher can be motivated by the demands arising from authentic teaching experiences: "I've learned more [math] in two days of being in a third grade classroom than I did all last semester."

Directions for Future Research

Since our study was primarily exploratory in nature, one strength of our findings is that they suggest several potentially fruitful avenues for future research. Some important questions flowing from our work include:

- How can teacher preparation courses/programs mitigate potentially negative effects of preservice elementary teachers' mathematics anxiety on their future teaching?
- How have adult preservice elementary teachers' life experiences afforded them with support networks and coping strategies for overcoming mathematics anxiety?
- What effect does manipulative-based instruction have on preservice elementary teachers' levels of mathematics anxiety?
- Do preservice elementary teacher preparation programs with varying mathematics requirements recruit, retain, and/or produce teachers with differing levels of mathematics mastery or anxiety?
- What impact could applying the recommendations of this article have on graduate elementary teacher preparation programs, in terms of student enrollment and demographic composition of students?

Summary

The primary reason for conducting the current study was to better understand graduate preservice elementary teachers as adult learners of mathematics. We found our participants to be attentive, reflective, and highly-motivated career-switchers who viewed mathematics as a necessary and important component of their preparation to effectively teach in elementary schools. The participants often recalled substantial mathematics anxiety and a history of avoiding mathematics whenever possible as adolescents, a pattern they attributed to experiences in formal school mathematics, including tracking, negative experiences with secondary mathematics teachers, and poor performance in one or more mathematics classes. Along the way, our participants provided meaningful insights into potential ways to effectively prepare non-traditional preservice elementary teachers to understand and teach mathematics in a reform-based, conceptual manner. As mathematics educators, this work has provided us a better understanding of adult career-switchers enrolled in elementary teacher preparation programs and will influence our teaching and advising of these students. We hope our readers have also been inspired to further consider ways in which we can effectively serve this population of preservice elementary teachers.

Acknowledgements

We would like to acknowledge the efforts of our graduate research assistant, Ms. Polina Novozhenets.

References

- Adler, J., Ball, D., Krainer, K., Lin, F.-L., & Novotna, J. (2005). Reflections on an emerging field: Researching mathematics teacher education. *Educational Studies in Mathematics*, 60(3), 359-381.
- Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, 130(2), 224-237.
- Ashun, M. A., & Reinink, J. (2009). Trickle down mathematics: Adult pre-service elementary teachers gain confidence in mathematics - enough to pass it along? *ALM International Journal*, 4(1), 32-40.
- Ball, D. L. (2003). *What mathematical knowledge is needed for teaching mathematics*. Paper presented at the Secretary's Summit on Mathematics.
- 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*, Fall, 14-46.
- Ball, D. L., Thames, M. H., & Phelps, G. C. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.
- Bean, J. P., & Metzner, B. S. (1985). A conceptual model of nontraditional undergraduate student attrition. *Review of Educational Research*, 55(4), 485-540.
- Beilock, S. L. (2008). Math performance in stressful situations. [Article]. *Current Directions in Psychological Science (Wiley-Blackwell)*, 17(5), 339-343.
- Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). *Female teachers' math anxiety affects girls' math achievement*. Paper presented at the Proceedings of the National Academy of Sciences.
- Blair, A., McPake, J., & Munn, P. (1995). A new conceptualisation of adult participation in education. *British Educational Research Journal*, 21(5), 629-644.
- Boyd, D., Grossman, P. L., Hammerness, K., Lankford, R. H., Loeb, S., McDonald, M., et al. (2008). Surveying the landscape of teacher education in new york city: Constrained variation and the challenge of innovation. *Educational Evaluation and Policy Analysis*, 30(4), 319-343.
- 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.
- Bundy, A. P., & Smith, T. B. (2004). Introduction to the special section - breaking with tradition: Effective counseling services for nontraditional students. *Journal of College Counseling*, 7(1), 3-49.
- Burton, L. (1987). From failure to success: Changing the experience of adult learners of mathematics. *Educational Studies in Mathematics*, 18(3), 305-316.
- Champion, J. K. (2010). The mathematics self-efficacy and calibration of students in a secondary mathematics teacher preparation program. *Dissertation Abstracts International*, 71(06).
- Chao, R., & Good, G. E. (2004). Nontraditional students' perspectives on college education: A qualitative study. *Journal of College Counseling*, 7(1), 5-12.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (Third ed.). Thousand Oaks: SAGE Publications, Inc.
- Elliott, J. C. (1990). Affect and mathematics achievement of nontraditional college students. *Journal for Research in Mathematics Education*, 21(2), 160-165.
- Fang, Z. (1996). A review of research on teacher beliefs and practices. *Educational Research*, 38(1), 47-65.
- Gleason, J. (2008). Relationships between pre-service elementary teachers' mathematics anxiety and content knowledge for teaching. *Journal of Mathematical Sciences & Mathematics Education*, 3(1), 39-47.
- Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. *Early Childhood Education*

- Journal*, 35(2), 181-188.
- Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers. *Teaching Education*, 19(3), 171-184.
- Harding-DeKam, J. L. (2005). Construction and validation of an instrument for assessing prospective elementary teachers' attitudes and beliefs in mathematics. *Dissertation Abstracts International*, 66(1293A).
- Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, 21(1), 33-46.
- Humphrey, D. C., Wechsler, M. E., & Hough, H. J. (2005). Characteristics of effective alternative teacher certification programs. *Teachers College Record*, 110(4). Teachers College, Columbia University. SRI International. Retrieved March 19, 2008, from http://policyweb.sri.com/cep/publications/AltCert_finalTCversion.pdf
- Lee, J., Meadows, M., & Lee, J. O. (2003). *What causes teachers to implement high-quality mathematics education more frequently: Focusing on teachers' pedagogical content knowledge*. Paper presented at the Association for Childhood Education International (ACEI) International Annual Conference, Phoenix, AZ.
- Levine, G. (1996). *Variability in anxiety for teaching mathematics among pre-service elementary school teachers enrolled in a mathematics course*. Paper presented at the Annual Meeting of the American Educational Research Association, April 12, 1996, New York, NY (ERIC Document Reproduction Service No. ED 398067).
- Ma, L. (1999). *Knowing and teaching elementary mathematics: Teacher's understanding of fundamental mathematics in china and the united states*. Mahwah, NJ. Lawrence Erlbaum Associates.
- Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco: Jossey-Bass.
- Patton, M. Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks, CA: SAGE Publications, Inc.
- Philippou, G. N., & Christou, C. (1998). The effects of a preparatory mathematics program in changing prospective teachers' attitudes towards mathematics. *Educational Studies in Mathematics*, 35(2), 189-206.
- Plaisance, D. V. (2007). *Identification of factors that reduce mathematics anxiety of preservice elementary teachers in mathematics content courses*.
- Rech, J., Hartzell, J., & Stephens, L. (1993). Comparisons of mathematical competencies and attitudes of elementary education majors with established norms of a general college population. *School Science and Mathematics*, 93(3), 141-144.
- Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology*, 19(6), 551-554.
- Richardson, J. T. E. (1994). Mature students in higher education: Academic performance and intellectual ability. *Higher Education*, 28(3), 373-386.
- Schloglmann, W. (2006). Lifelong mathematics learning - a threat or an opportunity? Some remarks on affective conditions in mathematics courses. *Adults Learning Mathematics*, 2(1), 6-17.
- Schuetze, H. G., & Slowey, M. (2002). Participation and exclusion: A comparative analysis of non-traditional students and lifelong learners in higher education. *Higher Education*, 44(3/4), 309-327.
- Suinn, R. M., & Winston, E. H. (2003). The mathematics anxiety rating scale, a brief version: Psychometric data. *Psychological Reports*, 92(1), 167-173.
- Taniguchi, H., & Kaufman, G. (2005). Degree completion among nontraditional college students. *Social Science Quarterly*, 86(4), 912.
- Thompson, A. G. (1984). The relationship of teachers' conceptions of mathematics and mathematics

- teaching to instructional practice. In T. Carpenter, J. Dossey & J. Koehler (Eds.), *Classics in mathematics education research* (pp. 173-184). Reston, VA: National Council of Teachers of Mathematics.
- United States Department of Education Office of Postsecondary Education (2009). The secretary's sixth annual report on teacher quality: A highly qualified teacher in every classroom. Retrieved June 18, 2009, from <http://www2.ed.gov/about/reports/annual/teachprep/t2r6.pdf>
- Uusimäki, L., & Nason, R. (2004). *Causes underlying pre-service teachers' negative beliefs and anxieties about mathematics*.
- Vinson, B. M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal*, 29(2), 89-94.
- Wedge, T. (1999). To know or not to know -- mathematics, that is the question of context. *Educational Studies in Mathematics*, 39, 205-227.
- Welder, R. M. (2007). Preservice elementary teachers' mathematical content knowledge of prerequisite algebra concepts. *Dissertation Abstracts International*, 68(02A), 504.
- Wheeler, A. M. (2009). Traditional and nontraditional preservice elementary teachers' perceptions about mathematics and mathematics teaching. *Dissertation Abstracts International*, 70(09A), 339.