A Mixed Methods Study of Teach for America Teachers' Mathematical Beliefs, Knowledge, and Classroom Teaching Practices during a Reform-based University Mathematics Methods Course

Susan Lee Swars: Georgia State University

This mixed methods study examined the mathematical preparation of elementary teachers in a Teach for America (TFA) program, focal participants for whom there is scant extant research. Data collection occurred before and after a university mathematics methods course, with a particular focus on the participants' (n=22) mathematical beliefs, specialized content knowledge, and classroom teaching practices. Data were collected via two beliefs surveys, a content knowledge instrument, and interviews. The results show the added value of the course and offer considerations for learning experiences during mathematics teacher preparation, some of which are specific to alternative teacher preparation programs such as TFA.

Background

Across the U.S. numerous and varied alternative teacher preparation programs (ATPP) exist that place individuals with little formal educator preparation in teaching positions, often in the lowest performing PreK-12 schools (Glazerman, Mayer, & Decker, 2006). ATPP offer pathways to teacher certification for students who typically have undergraduate degrees in areas other than education. Proponents of ATPP argue that such pathways provide the teaching workforce with a diverse and "bright" pool of teachers (Dobbie, 2011). Of the ATPP that exist, Teach for America (TFA) stands out as one that has gained marked notoriety. TFA is designed to recruit graduates from top universities, particularly those who have superb academic records and leadership capabilities, who are willing to commit to teach for two years in under-resourced PreK-12 schools (TFA, 2014). The placement of TFA teachers, often in high needs rural and urban PreK-12 schools with teacher shortages, is intended to off-set existing challenges of teacher turnover and instability at the school sites (Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005).

The initial training that TFA teachers receive is comparable across the U.S., but differences in preparation experiences occur after placement in PreK-12 classrooms. All TFA teachers are provided an intense 5-week introductory summer training experience implemented by the TFA organization that includes a small amount of coursework and instructional experiences with PreK-12 students in summer school (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006a). After successful completion of the summer training, TFA teachers assume teaching positions in PreK-12 schools and are required to continue their education in order to acquire teacher licensure. According to the TFA website, "corps members must receive a state-issued teaching credential, certificate, license, or permit before they're hired by a school as a highly-qualified teacher," and to do so, "corps members can complete coursework through a local college or university, another certification provider such as a school district, or a nonprofit such as Teach for America" (TFA, 2014). Additionally, in some programs, TFA teachers have the option of completing a master's degree. For all TFA teachers, during the initial 2-year teaching commitment, the TFA organization continues to provide support via a manager of teacher leadership and development (MTLD), who provides feedback on classroom teaching.

Since TFA teachers' continued education leading to teacher certification provides differing experiences (e.g., course content and sequencing, duration of program, classroom support via coaching or supervision, etc.), the type and rigor of education that TFA teachers receive varies from location to location. Given these distinctions, as well as the established links between teacher preparation experiences, teacher effectiveness, and student achievement, studying the embedded learning experiences of TFA programs is paramount in determining which components are making a meaningful difference.

This mixed methods study focused on the elementary mathematics teacher preparation of TFA teachers, focal participants for whom there is scant extant research. The purpose of this study was to examine the impact of a reform-based university mathematics methods course on TFA teachers' mathematical beliefs, knowledge, and classroom teaching practices.

Related Research

Research relevant to this study focuses on TFA teachers and elementary mathematics education and also factors related to teacher effectiveness in mathematics, specifically teacher beliefs, knowledge, and classroom teaching practices.

TFA Teachers and Elementary Mathematics Education

There is scant research on the mathematics teacher preparation of elementary TFA teachers; the researchers found none in their search of the literature that focuses on changes in elementary TFA teachers during a reform-based university mathematics methods course. Of the studies linked to elementary mathematics education, almost all focus on the impact of TFA-prepared teachers on student achievement, with findings revealing mixed effects. For example, a study of 1,800 elementary students revealed positive effects in mathematics as measured by the Iowa Test of Basic Skills for those who had TFA-prepared teachers compared to those who did not (Glazerman et al., 2006). However, another study indicated mixed effects on student achievement (n=212,724) (Darling-Hammond et al., 2005). For some measures of mathematics, elementary students with TFA-prepared teachers performed better than those who had traditionally-prepared teachers, but on other measures of mathematics the opposite proved true.

In another study linking TFA-prepared teachers with student outcomes in mathematics, Boyd, Grossman, and Lankford (2006b) examined different pathways to teacher licensure and associated effects on student achievement. Students' test scores (n= 1,035,949) in mathematics in grades three through eight were compared with teachers' chosen pathways to teaching certification. The results indicated that students with TFA-prepared teachers performed better in mathematics compared to those with teachers who completed other pathways to teaching, but only if the TFA-prepared teachers had at least three years of teaching experience. This was not the case with less than three years of teaching experience, suggesting length of time in the teaching profession as a mediating factor.

However, Boyd et al. (2006b) pointed out the limitations of a sole focus on student achievement data:

> Achievement tests measure only a small part of students' learning. By focusing on these measures, we are missing many important aspects of learning, as well as other valued outcomes of schooling; this is an inherent limitation to these kinds of data. (p. 163)

A similar constraint is pointed out by Henry et al. (2010) based on a large-scale study (e.g., 1,556,982 test scores, 939,016 students, and 19,940 teachers with less than five years of experience) of pathways to teaching in North Carolina, including TFA as one route. While they found no differences in elementary student mathematics achievement when comparing TFA teachers and teachers who had graduated from the traditional education program at the University of North Carolina, they advocated for additional ways of studying teacher performance beyond student achievement. Specifically, they asserted a need for examining other teacher attributes (e.g., soft skills, teacher perseverance and leadership) that should be developed in teacher preparation programs to determine success.

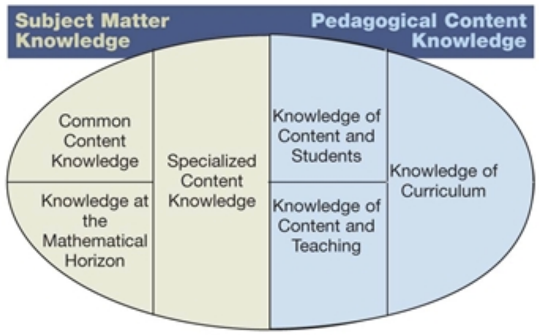
Factors Associated with Teacher Effectiveness in Mathematics

Beliefs. A salient factor influencing teacher effectiveness is teacher beliefs. Over time, research has established a robust relationship between teachers' beliefs and teaching by showing that beliefs influence teacher thinking and behaviors, including instructional decision-making and use of curriculum materials (Buehl & Fives, 2009; Clark & Peterson, 1986; Philipp, 2007; Romberg & Carpenter, 1986; Thompson, 1992; Wilson & Cooney, 2002). Beliefs are considered to be the cognitive set of psychological understandings, premises, or propositions through which interpretations are made of the surrounding world (Philipp, 2007). Teachers have deep-rooted mathematical beliefs formed during their seminal years as students in K-12 classrooms (Lortie, 1975), and they tend to resist changing these beliefs (Bird, Anderson, Sullivan, & Swidler, 1993; Handal & Herrington, 2003; Philipp, 2007). Philipp (2007) underscores the importance of beliefs in mathematics when he asserts, "For many students studying mathematics, the feelings and beliefs that they carry away about the subject are at least as important as the knowledge they learn of the subject" (p. 257). As such, teachers' beliefs are influential in how and what they learn and should be targets for change during teacher preparation (Feiman-Nemser, 2001; Philipp, 2007; Richardson, 1996). Two belief constructs relevant to this study included pedagogical beliefs (i.e., beliefs about teaching and learning) and teaching efficacy beliefs (i.e., beliefs about capabilities to teach effectively and influence student learning).

Knowledge. Teachers require deep and broad knowledge of mathematics to be effective in their teaching (Hill, 2010), especially to create standards-based learning environments that promote classroom discourse and foster conceptual understandings of mathematics. Multiple efforts have attempted to define the exact mathematical knowledge needed for teaching (Ball & Forzani, 2010; Ball, Thames, & Phelps, 2008; Hill 2010), and researchers have recently proposed a specialized content knowledge (SCK) characterized as "mathematical knowledge needed to perform the recurrent tasks of teaching mathematics to students" (Ball et al., 2008, p. 399).

This characterization builds upon Shulman's (1986) conceptualizations of subject matter knowledge (SMK), presented on the left side of Figure 1, and pedagogical content knowledge (PCK), presented on the right side of Figure 1. Specifically, the SCK for teaching mathematics includes teachers' abilities to (a) analyze and interpret students' mathematical thinking and ideas, (b) use multiple representations of mathematical concepts, and (c) define terms in mathematically correct and accessible ways (Hill, 2010; Thames & Ball, 2010).

Figure 1. Mathematical Knowledge



The complexity of the mathematical knowledge for teaching is conceptualized by Hill and Ball (2009)

Classroom teaching practices. The Principles and Standards for School Mathematics (National Council of Teachers of Mathematics [NCTM], 2000) and the Common Core State Standards for Mathematics (CCSS for Mathematics) (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010) recommend the amalgamation of mathematical content and process standards requiring a pedagogical approach different from the traditional instruction found in many U.S. classrooms. Many of the NCTM suggestions are grounded in a constructivist compatible method of teaching, in which teachers present learning tasks intended to develop students' understandings of concepts and procedures in ways that foster students' abilities to solve problems and to reason and communicate mathematically. There has been recent emphasis in the field of teacher education, including mathematics teacher education, on the development of a "common core for teaching practice" (Ball & Forzani, 2011, p. 19), including a set of high leverage practices that underlie effective teaching. Two examples of high leverage practices include the ability to recognize key patterns of thinking, ideas, and misconceptions of students when encountering a given idea and using relevant culture and social knowledge (Ball & Forzani, 2009; Ball & Forzani, 2011; Ball, Sleep, Boerst, & Bass, 2009).

Research Questions

The scant research on TFA teachers and elementary mathematics education, which primarily focuses on links to student achievement, provides a narrow understanding of this focal population of teachers. It does not account for the complexity of teaching or the other research-based factors associated with teacher effectiveness, including teacher preparation experiences, as well as teacher knowledge, beliefs, and classroom teaching practices (Dobbie, 2011). In addition, the mixed results on TFA teacher effectiveness as related to student achievement in mathematics, the wide range and variance of preparation of TFA teachers, and the influence of teacher beliefs, knowledge, and classroom teaching practices on teacher effectiveness, provide warrants that studying specific TFA teacher preparation programs is of critical import. Impactful teacher preparation programs need to be identified and replicated. Accordingly, the following research questions were explored:

1. Do TFA teachers' mathematical beliefs and knowledge change during a reform-based university elementary mathematics methods course?
2. How do TFA teachers who have completed a reform-based university elementary mathematics methods course describe their beliefs and knowledge?
3. How do TFA teachers who have completed a reform-based university elementary mathematics methods course describe their classroom teaching practices?
4. What are the tensions associated with the classroom teaching practices of TFA teachers who have completed a reform-based university elementary mathematics methods course?

Method

This study used a mixed methods research design with data collection occurring via belief surveys, a knowledge assessment, and individual interviews. Specifically, a "sequential explanatory" (Creswell, Clark, Gutmann, & Hanson, 2003, p. 223) approach to mixed methods was used, which for this study implies (a) quantitative data collection was followed by qualitative data collection, (b) quantitative and qualitative data were given equal priority, and (c) integration occurred in the interpretation phase. The qualitative data were intended to illuminate the findings of the domains of the quantitative data, specifically related to mathematical beliefs and knowledge, and also provide insights into classroom teaching practices in mathematics.

Participants and Context

The participants consisted of 22 novice elementary TFA teachers enrolled in an elementary education (grades PreK-5) teacher certification and master's degree program at a large, urban university in the southeastern U.S. Almost all held undergraduate degrees in non-education fields. The 2-year, 5-semester, cohort-based program focuses on authentic collaboration around learning, teaching, and advocacy and is designed to seamlessly link theory, content, and practice across all courses. Successful completion of the program and passage of the state-required teacher certification test lead to teacher certification and a master of art in teaching degree. At the time of data collection, the TFA teachers were in the second semester of the program and completing a mathematics methods course. All of the teachers were teaching in urban elementary schools with some of the distinctive characteristics identified in the literature—prevalence of minority student populations, high numbers of students eligible for the federally funded free and reduced lunch program, high numbers of immigrant students with English as a second language, and teacher shortages (Jacob, 2007).

The mathematics methods course was taught by a mathematics educator in the elementary education department. Its overall purpose was the development of effective instructional methods grounded in constructivist compatible instruction across the major strands of the elementary mathematics curriculum as proposed by the NCTM and CCSS for Mathematics. Specifically, the course focused on high leverage teaching capabilities in the elementary classroom including: (a) selection and implementation of mathematical tasks with high levels of cognitive demand, (b) use of multiple mathematical representations, (c) use of mathematical tools, (d) promotion of mathematical discourse, explanation and justification, problem solving, and connections and applications typical of a standards-based learning environment (NCTM, 2000), and (e) use of children's thinking and understanding to guide instruction. Learning in the courses occurred via (a) active inquiry and analysis of the mathematics in the elementary curriculum, (b) study of children's thinking and learning via video clips and teaching cases, (c) examination and analysis of classroom practice via video clips and teaching cases, and (d) opportunities to relate coursework to elementary classrooms.

Data Collection

Quantitative data were collected via two belief surveys and one knowledge assessment, and qualitative data were collected via interviews. Participants completed the two belief surveys and the knowledge assessment two times: at the beginning and end of the mathematics methods course. All interviews were conducted immediately upon completion of the mathematics methods course.

All TFA teachers completed two belief surveys: the Mathematics Beliefs Instrument

(MBI) and the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). The MBI is a 48-item Likert scale instrument designed to assess teachers' beliefs about the teaching and learning of mathematics and the degree to which these beliefs are cognitively aligned (Peterson, Fennema, Carpenter, & Loef, 1989, as modified by the Cognitively Guided Instruction Project). The three subscales include: (b) role of the learner (Learner), (b) relationship between skills and understanding (Curriculum), and (c) role of the teacher (Teacher). The Learner subscale contains 15 items that assess the degree to which teachers believe that children can construct their own mathematical knowledge. The 16-item Curriculum subscale examines the degree to which teachers believe that mathematics skills should be taught in relation to understanding and problem solving. The 17 items on the Teacher subscale address the extent to which teachers believe that mathematics instruction should be organized to facilitate children's construction of knowledge. The instrument uses a Likert-type scale with five response categories (strongly agree, agree, uncertain, disagree, and strongly disagree), with higher scores indicating beliefs that are more cognitively aligned. The ranges of possible scores on the subscales include: 15 to 75 for Learner, 16 to 80 for Curriculum, and 17 to 85 for Teacher. These subscales have high reliability (Cronbach's alpha =.89 for Learner, .80 for Curriculum, and .90 for Teacher) and represent independent constructs based on confirmatory factor analysis.

The MTEBI consists of 21 items, 13 on the Personal Mathematics Teaching Efficacy (PMTE) subscale and 8 on the Mathematics Teaching Outcome Expectancy (MTOE) subscale (Enochs, Smith, & Huinker, 2000). The two subscales are consistent with the two-dimensional aspect of teacher efficacy. The PMTE subscale addresses teachers' beliefs in their individual capabilities to be effective mathematics teachers. The MTOE subscale addresses teachers' beliefs that effective teaching of mathematics can bring about student learning regardless of external factors. The instrument uses a Likert-type scale with five response categories (strongly agree, agree, uncertain, disagree, and strongly disagree), with higher scores indicating greater teaching efficacy. Possible scores on the PMTE subscale range from 13 to 65; MTOE subscale scores range from 8 to 40. These subscales have high reliability (Cronbach's alpha = .88 for PMTE and .81 for MTOE) and represent independent constructs based on confirmatory analysis.

All TFA teachers also completed the Learning Mathematics for Teaching (LMT) instrument, which examines teachers' SCK for teaching mathematics (Hill, Schilling, & Ball, 2004). The instrument assesses this knowledge by posing mathematical tasks that reflect what teachers encounter in the classroom, such as assessing students' work, representing mathematical ideas and operations, and explaining mathematical rules or procedures. Content knowledge subscales in this instrument include: (a) Number and Operations; (b) Patterns, Functions, and Algebra; and (c) Geometry (Hill, 2004). Content validity was established by mapping items for congruence with the NCTM Standards (Siedel & Hill, 2003; Dean, undated). Analysis of reliability indicated alpha coefficients of .79 for the Number and Operations subscale, .75 for the Patterns, Functions, and Algebra subscale, and .85 for the Geometry subscale (G. Phelps, personal communication, October 6, 2006).

Five randomly selected TFA teachers participated in individual, semi-structured interviews. This sample size is consistent with standards for a sequential explanatory mixed methods design (Creswell et al., 2003). The interview questions were developed to illuminate the same domains as the quantitative instruments, as well as provide insights into classroom teaching practices in mathematics. Questions related to teaching partially included connections between practices and their learning in the mathematics methods course. The interview protocol includes nine multi-part questions with examples including:

1. Do you believe you can teach math effectively? Why or why not?
2. What do you believe should be the teacher's role during math instruction? Are you able to fulfill that role? Why or why not?
3. Describe your teaching practices in math. What does a math lesson look like? What are you doing as a teacher? What are the students doing?
4. Do you find what you learned in the math methods course is useful in your current teaching situation? If so, how? If not, why? What do you apply that you learned in the course?
5. Do you believe your math teaching will impact your students' learning? If so, how? If not, why?

The interviews ranged from 30 to 45 minutes in duration.

Data Analysis

Analysis of the quantitative data included both inferential and descriptive statistics. Specifically, the data from the two beliefs surveys were considered by subscale and overall scale; the data from the content knowledge assessment focused on overall scale.

Audiotapes of the interviews were transcribed, and members of the research team individually analyzed the interview data via classical content analysis (Leech & Onwuegbuzie, 2011), as pre-determined categories were subjected to systematic identification. Using the individual as the unit of analysis, transcripts were examined for: (a) personal teaching efficacy beliefs; (b) teaching outcome expectancy beliefs; (c) beliefs about the teacher's role during mathematics instruction; (d) knowledge of elementary mathematics; and (e) classroom teaching practices, including tensions associated with what they were learning in the mathematics methods course. After this individual analysis was completed, the team engaged in recursive dialogue to verify their individual findings and reach agreement on descriptions that could be used to summarize the findings.

Trustworthiness

Trustworthiness of the study was established in several ways (Freeman, deMarrais, Preissle, Roulston, & St. Pierre, 2007; Lincoln & Guba, 1985). For example, the study involved: (a) multiple researchers with in-depth knowledge of the context; (b) multiple data sources both quantitative and qualitative in nature; (c) consensus-building procedures, such as multiple examinations and discussions of interview transcripts by the researchers; (d) and quantitative instruments with established reliability and validity.

Results

Research Question 1: Do TFA teachers' mathematical beliefs and knowledge change during a reform-based university elementary mathematics methods course?

The first research question was answered using data from the MBI, MTEBI, and LMT. Table 1 shows the mean scores, differences in mean scores, and standard deviations for the MBI and the MTEBI by overall scale and subscale. The mean scores on the MBI reveal changes in pedagogical beliefs during the mathematics methods course, with a difference in pretest and posttest mean scores of 35.18 on the overall scale. Using alpha level of .05, dependent samples t-tests were applied to evaluate change across the course, which are shown in Table 2. The t-test indicates a significant change (overall scale) in the pedagogical beliefs of the TFA teachers ($t=9.75$, $p=.000$). Across the course, the TFA teachers' beliefs about teaching and learning mathematics became significantly more cognitively aligned. All three of the subscales on the MBI had significant increases in mean scores (see Table 2), and the subscale related to the Teacher, which measures the extent to which teachers believe mathematics instruction should be organized to facilitate children's construction of knowledge, had the greatest change in mean scores (see Table 1).

The findings from the MTEBI also reveal increases in the TFA teachers' mathematics teaching efficacy beliefs (see Tables 1 and 2). A dependent samples t-test indicates the mean difference of 6.43 was significant at the alpha level of .05 (t=2.65, p=.015) on the overall MTEBI. While the overall change in mathematics teaching efficacy is significant, as measured by the MTEBI, individual subscales of the instrument did not have significant shifts. The MTOE had a nominal mean increase of .38, which the t-test indicates as not significant (t=.258, p=.799). Though the TFA teachers had significant increases in beliefs about their individual capabilities to teach mathematics effectively, they did not have significant increases in beliefs that their teaching would impact student learning in the classroom.

Table 1: **Means, Standard Deviations, and Mean Differences for MBI and MTEBI**

	Pretest		Posttest		
Instrument	**Means**	**Standard Deviations**	**Means**	**Standard Deviations**	**Mean Differences**
Overall MBI	151.05	17.19	186.23	23.73	35.18
Learner subscale	48.65	5.99	59.05	8.94	13.14
Curriculum subscale	49.5	6.00	56.18	7.53	6.68
Teacher subscale	55.68	7.8	71.00	9.35	15.32
Overall MTEBI	72.67	6.13	79.10	12.28	6.43
PMTE subscale	44.23	6.47	50.36	9.69	6.13
MTOE subscale	29.00	4.02	29.38	5.98	.38

Table 2. Dependent T-Test scores for MBI and MTEBI

	Dependent T-Test	
	Scores	**Significance α =.05**
Overall MBIz	-9.75	.000
Learner subscale	-8.63	.000
Curriculum subscale	-4.59	.000
Teacher subscale	-11.96	.000
Overall MTEBI	-2.65	.015
PMTE subscale	-3.0	.006
MTOE subscale	-.258	.799

A dependent samples t-test was also applied to the data from the LMT. Though there was an increase in IRT scores, the analysis does not indicate a significant change in these scores during the mathematics methods course (t=2.82, p=.055).

Research Question 2: How do TFA teachers who have completed a reform-based university elementary mathematics methods course describe their beliefs and knowledge?

Findings for the second research question were gleaned from the interview data and provide insights into mathematical pedagogical beliefs, personal teaching efficacy beliefs, teaching outcome expectancy beliefs, and knowledge; these interview data largely support the findings of the MBI, MTEBI, and LMT. When considering pedagogical beliefs, which were quantitatively measured by the MBI, the interview data revealed all of the TFA teachers believed the role of the teacher was to serve as a guide for student learning in mathematics. They spoke of their beliefs shifting from a "direction instruction" (Participant #1, interview, May 4, 2012) approach to a facilitator model, which they attributed to the mathematics methods course. They described their role as: "giving them [students] materials and letting them make discoveries" (Participant #5, interview, May 7, 2012), "listening and watching" (Participant #4, interview, May 7, 2012), "prompting thinking" (Participant #2, interview, May 4, 2012), "asking questions" (Participant #4, interview, May 7, 2012), "letting students explore" (Participant #2, May 4, 2012), and promoting students "making their own conclusions" (Participant #3, interview, May 4, 2012).

Similar to the findings of the PMTE subscale on the MTEBI, the interview data show that all of the TFA teachers generally believed they could teach mathematics effectively, with their personal teaching efficacy grounded in a variety of sources, including their learning in the mathematics methods course (e.g., "the [mathematics methods] class gave me a very different perspective, and it really helped me to gain confidence in teaching math" [Participant #3, interview, May 4, 2012]), strong mathematical background (e.g., "it [mathematics] was always one of my better subjects" [Participant #1, interview, May 4, 2012]), and how they viewed the teaching and learning of mathematics as being relevant, motivating, and engaging for students (e.g., "easy to make it [mathematics] fun and exciting and engaging for the students" [Participant #5, interview, May 7, 2012]). In addition, all of the TFA teachers believed their teaching of mathematics positively impacted student learning, though these beliefs as measured by the MTOE subscale on the MTEBI did not significantly change across the mathematics methods course. Their teaching outcome expectancy beliefs were attributed to their perceptions of providing effective teaching and learning experiences in mathematics for their students (e.g., "positive experiences will definitely affect these kids" [Participant #4, May 7, 2012]), as well as the observed learning, motivation, and engagement of their students during mathematics lessons (e.g., "they [students] want to go to math stations, they want to be mathematicians because they really like numbers" [Participant #2, May 4, 2012]).

All of the TFA teachers professed to have the mathematical knowledge needed for teaching elementary mathematics, which was quantitatively assessed via the LMT. They linked this knowledge largely to their learning in the mathematics methods course and also strong mathematical background. However, they professed more confidence with this knowledge as related to the lower elementary grades mathematics versus the upper elementary grades. Further, they expressed how their mathematical knowledge had been challenged by having to "unlearn" (Participant #2, interview, May 2, 2012) mathematics as simply procedures and memorized algorithms as a result of the mathematics methods course.

Research Question 3: How do TFA teachers who have completed a reform-based university elementary mathematics methods course describe their classroom teaching practices?

The interview data revealed the TFA teachers' descriptions of their classroom teaching practices generally aligned with their professed pedagogical beliefs related to the role of the teacher during mathematics instruction, as well as the findings of the MBI. They described the use of teacher "questions" (Participant #1, interview, May 4, 2012), "conversational-type lessons" (Participant #5, interview, May 7, 2012), "problem solving" (Participant # 3, interview, May 4, 2012), mathematical "tasks" and "activities" (Participant #5, interview, May 7, 2012), students "working together" in "small groups" (Participant #2, interview, May 4, 2012), students "discussing" and "sharing" their thinking (Participant #2, interview, May 4, 2012), student explanation of mathematical thinking and reasoning (e.g., "I would want her [a student] to be able to share that thinking and explain it further, even if she didn't necessary get the right answer" [Participant #4, interview, May 7, 2012]), representations such as "manipulatives" and "tools" (Participant #2, interview, May 4, 2012), "centers" (Participant #3, interview, May 4, 2012), and integration of mathematics with literacy and other content areas across the school day (e.g., "I always tied in some sort of literacy activity into my math lesson" [Participant #4, interview, May 7, 2012], and "so even though we're talking about words or what we're doing during the day, I try to sneak that [mathematics] in" [Participant #2, interview, May 4, 2012]) . They attributed their changes in instructional practices to their learning in the mathematics methods course.

Research Question 4: What are the tensions associated with classroom teaching practices of TFA teachers who have completed a reform-based university elementary mathematics methods course?

During the interviews, the TFA teachers described tensions, linked with a variety of sources, with implementing teaching practices learned in the mathematics methods course, which sometimes caused them to use instructional practices that did not align. Notable tensions were associated with past experiences with learning mathematics, the placement of the mathematics methods course in the second semester of the program, and the protracted emphasis on preparing students for standardized tests. For example, several of the TFA teachers described a tension associated with using teaching practices focused on cultivating mathematical understanding and their past learning of mathematics in a procedural way, which posed challenges for "breaking down" (Participant #3, interview, May 4, 2012) the mathematics and explaining it in an easily understood way (e.g., "I just know the trick to it [mathematics], but I can't explain why it works [Participant #2, interview, May 4, 2012]).

The TFA teachers also described the difficulty of shifting pedagogical practices in mathematics mid-way through the school year, as the mathematics methods course fell during the second semester of their teacher preparation program. A participant stated:

I had set up my centers at the beginning of the year in a way that it was hard for me to transition my kids to think about problem solving, and I think that if I had started earlier, that would have been nice. . . . My high kids were the most resistant. "This is too hard. Why are you giving me a problem to solve? I don't want to read it and draw a picture and answer all these questions." (Participant #3, interview, May 4, 20120)

They spoke of the need for the mathematics methods course to come earlier in their teacher preparation program, as a TFA teacher felt like she was "teaching blind, stabbing in the dark" (Participant #4, interview, May 7, 2012), and another expressed "My only criticism is that I wish that that class had been one of my first semester courses. . . . That class was really important." (Participant #1, interview, May 4, 2012).

The TFA teachers also spoke of challenges related to effort, persistence, and patience with trying out the new strategies learned in the course, as exemplified by these statements: "It was kind of challenging thinking about ways to have really meaningful lessons for every topic that we have" (Participant #5, interview, May 7, 2012), and "It requires a lot of reflection, practice, and figuring things out. I just have to have the patience to keep trying things out" (Participant #4, interview, May 7, 2012).

Another tension included the pressures associated with a protracted emphasis on student achievement measured via standardized tests in the elementary school. The TFA teachers described constraints associated with teaching mathematics for understanding and the: little amount of time allotted for mathematics instruction, along with a lengthy list of standards to be covered; the exclusive focus on student achievement on standardized testing (e.g., CRCT) and the pressure to only address standards on the CRCT; and the frequent presence of others in the classroom such as administrators and content specialists with varied suggestions about effective teaching:

> I actually have to start teaching you (a student) methods and steps, not trying to make you understand (the mathematics), because that would take a little bit of time and when you (a teacher) have this long list of standards, and you have people constantly in your classroom saying "that you have to do this, you have to do that". . . you're still kinda like hindered in what you can and can't do. . . people are in those grade levels (grades 3-5) even more, making sure you are doing what the standards say, what the CRCT is about. You're teaching directly to that. . . . You are really limited in what you can and can't do. And you have to go against your own methods at times. . . . So, you get cornered into where you are not able to do what you know to be right and true for the children. (Participant #1, interview, May 4, 2012)

Discussion and Conclusions

Though TFA is an increasingly popular alternative teacher preparation program, no research was located by the researchers with elementary TFA teachers as the focal participants in a university mathematics methods course, reform based or not. This study aimed to address this gap in the existing literature. Using a mixed methods design to explore TFA teachers' mathematical beliefs, knowledge, and classroom teaching practices during a reform-based university mathematics methods course, the findings affirm similar studies involving groups other than TFA teachers. The results suggest the added value of the mathematics methods course, as well as offer insights into ways of improving learning experiences during mathematics teacher preparation. Additionally, tensions associated with implementing the instructional methods learned in the course by the TFA teachers, who were teaching in urban school settings, were also illuminated.

The study revealed significant shifts in mathematical beliefs on the MBI during the mathematics methods course, and the interview data aligned with this finding. Across the course, the TFA teachers' pedagogical beliefs became significantly more cognitively aligned as they shifted their beliefs about the teaching and learning of mathematics from that of a direct instruction model toward reform-based, constructivist compatible instruction (Ravitz, Becker, & Wong, 2000; White-Clark, DiCarlo, & Gilchriest, 2008). They came to view the teacher as a "facilitator" of and "guide" for student learning with descriptions of teaching practices that generally aligned with such a viewpoint. They did, however, identify challenges for teaching this way.

In addition, the TFA teachers had significant increases in their personal mathematics teaching efficacy beliefs, or their beliefs in their capabilities to teach mathematics effectively, as measured by the PMTE subscale on the MTEBI. Bandura (1986; 1997) postulated that efficacy beliefs are formed during experiences with a task; successful performances strengthen these beliefs while failures lower them. The TFA teachers linked their personal mathematics teaching efficacy beliefs with three sources: their learning in the mathematics methods course, their strong mathematical background, and how effective student-centered mathematics pedagogy is in motivating and engaging students. Mathematics teacher efficacy is a two-dimensional construct and though personal teaching efficacy significantly changed, the TFA teachers' mathematics teaching outcome expectancy beliefs as measured by the MTOE subscale did not. There was not a significant shift in beliefs that their effective teaching of mathematics impacts student learning. Perhaps this finding can be explained by their status as neophyte teachers, struggling with the complexities and challenges of teaching for the first time, coupled with an uncertainty about the extent of their students' learning. Previous studies (Hoy & Spero, 2005; Hoy & Woolfolk, 1990) have shown that prospective teachers tend to have an unrealistic optimism about teachers' abilities to overcome negative influences, with a tempering of this expectation through actual teaching experiences in the classroom. The nature of the TFA program, with immersive teaching experiences and little initial educator preparation, may have contributed to a lack of shift in expectations for successful learning outcomes in mathematics given the many demands of teaching, variations across students, and other uncontrollable factors.

The findings also show the TFA teachers' SCK as measured by the LMT did not significantly change across the mathematics methods course. Though there was an increase in mean scores, the lack of significant increase may be attributed to the course focusing largely on effective instructional methods for the elementary classroom, rather than direct development of content knowledge. During the interviews, the TFA teachers professed to already having the knowledge they needed for teaching in the elementary classroom, with greater confidence in this knowledge for the lower elementary grades as compared to the upper. However, in responding to the interview question, it is unclear as to how the TFA teachers were defining "knowledge needed for teaching in the elementary classroom." That is, it is not clear if they were defining mathematical content knowledge as common content knowledge (CCK) rather than the SCK needed for teaching mathematics as described by Hill and Ball (2009). The TFA teachers did describe how the mathematics methods course challenged them to "unlearn" mathematics as simply procedures and memorized algorithms.

The TFA teachers professed enactment of teaching practices learned in the mathematics methods course congruent with constructivist compatible instruction, but they described several tensions associated with teaching in this way. Similar to constraints identified in the literature (Philipp, 2007) such as conflicting and competing values promoted by schools and school systems, the TFA teachers expressed concern over the excessive emphasis on student achievement via standardized test scores, which influenced their teaching practices. Another tension was the emphasis in the mathematics methods course on cultivating mathematical understanding in children, which posed challenges for the participants based on their past learning of mathematics and subsequent understandings largely grounded in procedural knowledge.

The TFA teachers also offered an emphatic call for the mathematics methods course to come earlier in their teacher preparation experiences, describing the difficulty associated with shifting pedagogical practices mid-way through the school year. The overall program as designed focused on child development, learning theory, and classroom community/management during the first semester, which may have been under-appreciated by the TFA teachers at this very early juncture in their career. Making explicit the relevance of the first semester coursework or a reconsideration of the course sequence in the program, with content-focused courses such as mathematics methods offered during the first semester, may be needed.

Implications

Previous studies of TFA teachers and elementary mathematics education have largely examined relationships between this specific population and student achievement in mathematics via standardized tests. This study extends the extant research with this group of focal participants by examining multiple factors shown to be important to effective teaching in mathematics and offering considerations for teacher preparation in mathematics. When considering potential implications, the sequencing of courses in ATPP such as TFA may be significant. The TFA teachers described a need for the mathematics methods course to come earlier in their program of study. Perhaps novice teachers almost immediately immersed in PreK-12 schools with almost no educator preparation would be better served with initial coursework that is more practical in nature and subject matter oriented. Courses that are directly related to the content they are teaching every day (e.g., mathematics, reading) could be offered initially, rather than more theoretical courses (e.g., child development, learning theory) that might be better appreciated later in their program after the teachers have more classroom experience.

Additional implications are evident. Given that TFA teachers are almost immediately immersed in PreK-12 schools, the lack of significant change in mathematics teaching outcome expectancy beliefs may reveal a need for intentional and purposeful interventions during teacher preparation experiences with the aim of increasing confidence about impacting student learning in mathematics, while emphasizing realistic expectations. Lastly, the findings of this study suggest that the tensions that appear to counter the reform-based beliefs and classroom teaching practices TFA teachers acquired and learned in the mathematics methods course could have serious implications for teacher effectiveness. The disconnect between teachers' experiences during teacher preparation programs and experiences in PreK-12 schools has been similarly illuminated in the literature (Philipp, 2007). Certainly, for these neophyte teachers fully immersed in schools with little educator training, the differences between learning in teacher preparation programs and experiences in PreK-12 school contexts is troubling. Perhaps such a disconcerting disconnect contributes to the teacher attrition in the TFA ranks. Further, perhaps there are ways instructors of mathematics methods courses can off-set the identified tensions between their learning in the course and enacted classroom teaching practices.

The "best and the brightest" TFA teacher population has much to offer. Studying the efficaciousness of their teacher preparation in order to create the most promising learning experiences is a worthy endeavor.

References

Ball, D. L., & Forzani, F. M. (2009). The work of teaching and the challenge for teacher education. Journal of Teacher Education, 60(5), 497-511.

Ball, D. L., & Forzani, F. M. (2010). What does it take to make a teacher? Phi Delta Kappan, 92, 8-12.

Ball, D. L., & Forzani, F. M. (2011, Summer). Building a common core for learning to teach, and connecting professional learning to practice. American Educator, 35(2), 17-21, 38-39.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? Journal of Teacher Education, 59, 389-407.

Ball, D. L., Sleep, L., Boerst, T., & Bass, H. (2009). Combining the development of practice and the practice of development in teacher education. Elementary School Journal, 109, 458- 476.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

Bird, T., Anderson, L., Sullivan, B., & Swidler, S. (1993). Pedagogical balancing acts: Problems in influencing prospective teachers' beliefs. Teaching and Teacher Education, 9, 253-268.

Boyd, D., Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J. (2006a). How changes in entry requirements alter the teacher workforce and affect student achievement. Education Finance and Policy, 1(2), 176-216.

Boyd, D. J., Grossman, P., & Lankford, H. (2006b). Complex by design: Investigating pathways into teaching in New York City Schools. Journal of Teacher Education,57(2), 155-166.

Buehl, M. M., & Fives, H. (2009). Exploring teachers' beliefs about teaching knowledge: Where does it come from? Does it change? Journal of Experimental Education, 77, 367-407.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.), Handbook of research on teaching (3rd ed., pp. 255–296). New York: Macmillan.

Creswell, J. W., Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), Handbook of mixed methods in social & behavioral research (pp. 209-240). Thousand Oaks, CA: Sage Publications.

Darling-Hammond, L., Holtzman, D. J., Gatlin, S. J., & Heilig, J. V. (2005). Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. Education Policy Analysis Archives, 13, 1-48.

Dean, C. (undated). Content validity: Mapping the items from the A04 and B04 forms to the NCTM standards. Unpublished manuscript, University of Michigan, Ann Arbor.

Dobbie, W. (July, 2011). Teacher Characteristics and Student Achievement: Evidence from Teach For America. Harvard University

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. Teachers College Record, 103,1013-1055.

Freeman, M., deMarrais, K., Preissle, J., Roulston, K., & St. Pierre, E. (2007). Standards of evidence in qualitative research: An incitement to discourse. Educational Researcher, 36, 25-32.

Glazerman, S., Mayer, D., & Decker, P. (2006). Alternative routes to teaching: The impacts of Teach for America on student achievement and other outcomes. Journal of Policy Analysis and Management, 25, 75-96.

Henry, G. T., Thompson, C. L., Bastian, K. C., Fortner, C. K., Kershaw, D. C., Purtell, K. M., & Zuli, R. A. (2010). Impacts of teacher preparation on student test scores in North Carolina: Teacher portals. Report of the Carolina Institute of Public Policy. Chapel Hill, NC: University of North Carolina.

Hill, H. C. (2010). The nature and predictors of elementary teachers' mathematical knowledge for teaching. Journal for Research in Mathematics Education, 41, 513-545.

Hill, H. C., & Ball, D. L. (2009). The curious-and crucial – case of mathematical knowledge for teaching. Phi Delta Kappan, 91(2), 68-71.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' content knowledge for teaching. Ann Arbor, MI: University of Michigan.

Hoy, A. W., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. Teaching and Teacher Education: An International Journal of Research and Studies, 21, 343-356.

Hoy, A. W., & Woolfolk, A. E. (1990). Socialization of student teachers. American Educational Research Journal, 27, 279–300.

Jacob, B. A. (2007). The challenges of staffing urban schools with effective teachers. The Future Children, 17, 129-153.

Leech, N. L., & Onwuegbuzie, A. J. (2011). Beyond constant comparison qualitative data analysis: Using NVivo. School Psychology Quarterly, 26, 70-84.

Lincoln, Y., & Guba, E. (1985). Naturalistic inquiry. New York: Sage.

Lortie, D. (1975). Schoolteacher: A sociological study. Chicago: University of Chicago Press.

National Council of Teachers of Mathematics (NCTM). (2000). Principles and standards for school mathematics. Reston, VA: Author.

National Governors Association Center for Best Practices and Council of Chief State School Officers. (2010). Common core state standards for mathematics. Washington, DC: Author. Retrieved from Common Core State Standards website: http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf.

Peterson, P. L., Fennema, E., Carpenter, T. P., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. Cognition and Instruction, 6, 1-40.

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In Lester, F. K. (Ed.), Second handbook on mathematics teaching and learning (pp. 1099-1109). Charlotte, NC: Information Age.

Ravitz, J. L., Becker, H. J., & Wong, Y. T. (2000). Constructivist-compatible beliefs and practices among U.S. teachers (Report no. 4). Irvine, CA: Teaching, Learning and Computing.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), Handbook of Research on Teacher Education (pp. 102-119). New York: Macmillan.

Romberg, T., & Carpenter, T. (1986). Research on teaching and learning mathematics: Two disciplines of scientific inquiry. In M. C. Wittrock (Ed.), Handbook of research on teaching (3rd ed., pp. 850-873). New York: Macmillan.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Siedel, H., & Hill, H. C. (2003). Content validity: Mapping SII/LMT mathematics items onto NCTM and California standards. Ann Arbor: University of Michigan, School of Education.

Teach for America. (2014). Retrieved February, 24, 2014, from http://www.teachforamerica.org/

Thames, M., & Ball, D. (2010). What math knowledge does teaching require? Teaching Children Mathematics, 17, 220-229.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 127-146). New York; London: Macmillan Library Reference USA; Simon & Schuster and Prentice Hall International.

White-Clark, R., DiCarlo, M., & Gilchriest, N. (2008). Guide on the side: An instructional approach to meet mathematics standards. High School Journal, 91, 40-44.

Wilson, M., & Cooney, T. (2002). Mathematics teacher change and development: The role of beliefs. In G. Leder, E. Pehkonen, & G. Toerner (Eds.), Beliefs: A hidden variable in mathematics education? (pp. 127-148). Dordrecht, Netherlands: Kluwer Academic Press.

Author's Note

Dr. Susan Lee Swars is an Associate Professor mathematics Education in the Department of Early Childhood Education at Georgia State University. Dr. Swars is also the STEM Coordinator for the College of Education.