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Teaching Mathematics for Social Justice: Examining Preservice Teachers' Conceptions

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ABSTRACT Teaching for social justice is a critical pedagogy used to empower students to be social agents in the world they live. This critical pedagogy has extended to mathematics education. Over the last decade, mathematics education researchers have conceptualized what it means to teach mathematics for social justice, but little is known about preservice teachers' perspectives on this topic. The purpose of this study was to examine elementary preservice teachers' conceptions of teaching mathematics for social justice at the beginning and end of a mathematics methods course. Preservice elementary teachers (n = 230) enrolled in mathematics methods coursework at three universities across the United States described what it meant to teach mathematics for social justice in response to an open-ended question on the Mathematics Experiences and Conceptions Surveys.

KEYWORDS *social justice, preservice elementary teachers, mathematics methods course*

Teaching for social justice is a critical pedagogy used to empower students to be social agents in the world they live. Several educators and researchers have advocated the importance of preparing teachers to teach for social justice and to challenge inequities so the learning of all students would be enriched (Cochran-Smith, 2004; 2010; Irvine, 2004; Kaur, 2012; Ritchie, 2012). We, as mathematics teacher educators, claim that teaching mathematics for social justice provides opportunities for all students "to learn rigorous mathematics in culturally specific, meaningful ways that seek to improve the economic and social conditions of marginalized individuals and groups, and that work toward[s] reduc[ing] deficit-oriented beliefs about who is or is not 'good' at mathematics" (Leonard & Evans, 2012, p. 100).

Although considerable efforts have been made to understand social justice within the contexts of mathematics teaching and learning (Wager & Stinson, 2012), limited research exists on preparing teachers to teach mathematics for social justice. Similarly, Koestler (2012) argues, "more work is needed in understanding how to best support preservice teachers and in-service teachers in the endeavor of learning and teaching mathematics for social justice" (p. 91). While there has been some effort to educate preservice teachers (PSTs) to teach mathematics for social justice (Boylan, 2009; de Freitas & Zolkower, 2009), most research has not examined preservice teachers' conceptions of what it means to teach mathematics for social justice. Garii and Appova (2013) found that most of the PSTs they studied had limited understandings of connections between social justice and the teaching of mathematics, and were unable to provide examples of contexts that applied to both areas. While this study shed light on PSTs' conceptions of teaching mathematics for social justice for a small group, we were interested in conceptions among a larger sample in an effort to diversify research methods in this area (Bullock, 2012). Thus, the purpose of this study was to examine elementary preservice teachers' conceptions of teaching mathematics for social justice at the beginning and end

of a mathematics methods course. The research questions underlying this study include:

1. What are elementary preservice teachers' conceptions about teaching mathematics for social justice?
2. To what extent do elementary preservice teachers' conceptions of teaching mathematics for social justice change after completing an elementary mathematics methods course?
3. To what extent do mathematics methods courses, which explicitly address issues related to social justice, influence elementary preservice teachers' conceptions?

Related Literature

Over the last decade, mathematics education researchers have conceptualized what it means to teach mathematics for social justice (Gutstein, 2006; Skovsomose & Velero, 2002). Gates and Jorgensen (2009) presented a framework with three levels of understanding social justice to include moderate, liberal, and radical forms beginning with fairness and equity, to recognizing structural inequalities, to taking an active approach to address and disrupt structural inequalities. To further conceptualize teaching mathematics for social justice, Bartell (2012) drew on Gutstein's (2006) work of developing students' sociopolitical consciousness, sense of agency, and positive social and cultural identities in mathematics. Foundational to Bartell's conceptualization of teaching mathematics for social justice is the relational aspect of caring between the teacher and student. For example, Bartell (2012) found that all of her preservice teachers (elementary education majors who were seeking middle level certification in mathematics) viewed caring as an essential component to establishing and having a mathematics classroom rooted in social justice.

Teaching mathematics is not a neutral activity (Gutstein & Peterson, 2005; Koestler, 2012). Teaching mathematics encompasses the students' culture, prior knowledge, and the structural inequities in our society. However, it can be challenging for teachers to make sense of social justice in the context of mathematics. Bartell (2011) conducted a study with eight in-service teachers who were enrolled in a graduate course that focused on teaching mathematics for social justice. She examined how the teachers negotiated the two goals of mathematics and social justice in their instructional practice, and found that the teachers experienced a tension in negotiating mathematics and social justice. Thus, work in this area needs to uncover the ideas (preservice) teachers have about mathematics for social justice to address anticipated challenges when adopting such a practice.

Teachers' conceptions are "a general notion or mental structure encompassing beliefs, meanings, concepts, propositions, rules mental images, and preferences" (Philipp, 2007, p. 259). Leonard and Evans (2012) argue that if social justice and what it encompasses in the mathematics classroom does not take into account teachers' beliefs and dispositions, then it is not sufficient. Typically, society has held deficit views related to students of color (i.e., African Americans, Latin@s, Native Americans), particularly about who can and cannot do mathematics (Martin, 2009a). As a result, only a select few (e.g., Asians and White males) were challenged in rigorous mathematics (Martin, 2009b). Therefore, if teachers are going to teach mathematics for social justice, it is imperative that they examine, acknowledge, and reflect on their conceptions on what it means to teach mathematics for social justice (Leonard & Evans, 2012). It is important to study these conceptions because it shapes and influences teachers' instructional practices (Horn, 2007).

Methods

To study PSTs' conceptions about teaching mathematics for social justice, we examined open-ended responses from the Mathematics Experiences and Conceptions Surveys ([MECS], Jong & Hodges, 2015). MECS are a set of instruments designed to examine teachers' conceptions about mathematics teaching and learning over time. The instruments consist primarily of Likert-scale items and four open-ended questions. For this study, we analyzed open-ended responses to the following question: "What does teaching mathematics for social justice mean to you?" MECS was administered at three universities in the eastern United States. The three teacher education programs in this study were all initial certification in elementary education. Data consisted of responses written by preservice teachers at the beginning and end of a mathematics methods course at the three participating universities (n=230).

To analyze the data, we used an inductive content analysis approach. "Content analysis is a systematic coding and categorizing approach…to explore large amounts of textual information in order to ascertain the trends and patterns of words used, their frequency, their relationships and the structures and discourses of communication" (Grbich, 2007, p. 112). We used open coding by taking an inductive approach to discover patterns and themes that directly emerged from the data (Strauss and Corbin, 1998). To do so, we organized the raw data into an Excel spreadsheet and read all of the responses. As we read through the raw data, we made notes of the

types of responses being made as potential preliminary codes. Then we created codes based on the raw data. We repeated this process and refined codes after reading the data. Then we coded the data in the Excel spreadsheet by including a "1" when a particular code was present within a response. This allowed us to compute frequencies. Finally, we categorized the codes into themes and created a clear description for each theme (Creswell, 2009).

To establish consistency between the raters, we computed a percentage agreement as a measure of interrater reliability (Huck, 2012). An agreement was recorded if both raters used identical codes for a set of responses. A disagreement was recorded if responses were not coded identically. Percent agreement for a set of 40 responses was calculated. We completed two rounds of coding until an interrater reliability of 90.5% was achieved. After each round of coding, we discussed our rationale for coding responses, clarified definition of codes, and revised existing codes. Then we divided the responses in half, individually coded, and calculated frequency counts for each code. In total, we coded the beginning and end of the semester responses for each of the 230 PSTs. After analyzing the overall responses, we examined aggregate frequency counts and disaggregate frequency counts to compare responses between our university and the two other participating universities. Our elementary mathematics methods courses had an explicit goal to connect mathematics with social justice; thus, we wanted to examine whether any difference existed among the universities. To examine whether differences were significant, we used z-scores to compare proportions. We realize that there are limitations to concise responses; thus, we made sure we had a relatively large sample size to be able to detect themes and patterns in the data.

Context

In the mathematics methods course at University 1, our PSTs reflected on what it meant for "all students to learn mathematics." More specifically, our PSTs had to (1) define what "all students" meant, (2) explain whether they agreed or disagreed with the statement and why, and (3) describe how this should or should not be addressed in the elementary mathematics classroom. This was the focus of one classroom discussion prior to having PSTs read articles on equity-based topics to build on the discussion. Our PSTs read articles related to English Language Learners (e.g., Bresser, 2003) and differentiating instruction for students with special needs (e.g., Lovin, Kyger, & Allsopp, 2004). In another class at the same university, the PSTs compared and contrasted instructional strategies that could be used with students with special needs as well as English Language Learners. They discussed any similarities and/or differences among the instructional strategies for special needs learners, English Language Learners, and "typically developing" students. The PSTs also read and reflected on a chapter on *Equity* by Secada and Berman (1999), and an article connecting mathematics and culture (McCulloch, Marshall, & DeCuir-Gunby, 2009). The PSTs discussed the potential benefits and challenges of incorporating students' culture and diverse backgrounds when teaching mathematics.

To our knowledge, the mathematics methods courses at Universities 2 and 3 did not explicitly integrate issues of equity and social justice into their assigned readings or course activities. However, their programs required PSTs to complete a foundational course on diversity, which was not a requirement at University 1. One common course goal across all three universities was an emphasis of teaching and learning mathematics with a conceptual understanding.

Results

To investigate our first research question about PSTs' conceptions, we created 36 codes based on the 460 responses and categorized the codes into 7 themes, as listed in Table 1. We realize that many of the ideas mentioned in the responses were not fully fleshed out due to brevity because most responses were 10 to 60 words in length. It is also possible that PSTs who wrote statements such as "empowering students through mathematics" or "closing the achievement gap" may not have fully understood what these ideas meant beyond the surface level. However, we thought it was valuable that PSTs appeared to have an awareness of a range of topics, prior to the mathematics methods course, that related to social justice that are often discussed within the mathematics education literature.

Two findings resulted from our analyses, indicating that 1) the range of themes present were consistent with various conceptualizations of teaching mathematics for social justice in the literature, and 2) preservice teachers enter into mathematics methods courses with promising ideas about teaching mathematics for social justice and are able to make important connections between teaching mathematics and social justice. We were cautiously optimistic about the themes that surfaced from the responses knowing that rationales were not provided. Underlying the notion of the *Access and Opportunity*

theme, for example, could be the idea that all students should have the same instruction rather than instruction that is equitable and connects to their lives. For example, one student stated, "Teaching so that all students understand everything equally as much as possible. Also, giving all students the same opportunities to learn math." It was still encouraging to see that several PSTs had positive associations with the concept, considering how difficult it can be to comprehend (Garii & Appova, 2013). While some of the themes, such as *Learning Environment* and *Instructional Strategies,* could possibly viewed as generic or "good teaching," scholars have made the case that teaching for social justice serves to advocate the learning of all students with efforts for broader structural changes (Cochran-Smith, 2010). As an example of the *Learning Environment* and *Demographics* themes, one student stated the following:

> Acknowledging students' diverse needs, backgrounds, language-needs, and teaching with this in mind. Knowing that not all children come from privileged backgrounds and do not have the access to math materials and exposure to math as others.

The *Demographics* theme consisted of any groups of people or topics in which people have different backgrounds or views mentioned in the responses to include classifications such as race, language, sex, socioeconomic status, and religion. While this category was more clear-cut, we were pleased to find a variety of ways in which participants viewed people as being diverse (see Table 1).

To address research question 2, which focused on the changes in PSTs' conceptions, we compared the percentages of responses by themes and used a two-proportion z-test to determine whether the proportions of the beginning and end of the course responses were statistically significantly different (see Table 2). Findings showed that the range of themes were present in both the beginning of the course responses and the responses at the end of the semester. We were not surprised to find that the overall percentages of the PSTs' responses from the beginning and end of the semester at the three universities were quite similar, considering that social justice was not the focus in mathematics methods courses for two of the participating universities. For example, 30% of the PSTs' beginning responses mentioned access and opportunity, which remained consistent at the end of the course. It was assuring to see that there was a statistically significant decrease from 36% to 19% in preservice teachers stating that they did not know what it meant to teach mathematics for social justice or did not see a connection between teaching mathematics and social justice. For example, a PST indicated, "I'm honestly not sure what that means or how the two relate but I am looking forward to learning about how teaching math for social justice works" on her survey at the beginning of the course. At the end of the course, the PST proclaimed,

> I want to teach mathematics to my students so that they all feel included and interested in my classroom instruction. I want for all students no matter what their class, race or learning level might be, to feel comfortable and secure in my teaching environment. I want for my room to be socially just for all children, and for all children to benefit from my teaching.

Other PSTs had a similar change in their conceptions of teaching mathematics for social justice from the beginning to the end of the semester.

The only other theme that was statistically significantly different in overall responses across all three universities from the beginning of the course to the end was *Instructional Strategies*. This was likely due to the fact that the nature of mathematics methods courses focus explicitly on this theme, and the PSTs were able to specify approaches they would use to teach mathematics effectively, which many of them connected as a way to teach mathematics for social justice.

To answer research question 3, we further examined the changes in PSTs' conceptions across universities. We compared our PSTs (University 1), who had been exposed to ideas of mathematics for social justice, to the PSTs at Universities 2 and 3. Table 3 displays the compared responses and z-score by themes according to universities. In our mathematics methods course, we explicitly discussed issues around social justice, assigned readings, and assigned a reflection on the topic. The explicit discussion of social justice was not done in the mathematics methods courses at Universities 2 and 3. However, it was the case that a foundational course on diversity was part of these two universities, which may have accounted for some of the entering conceptions.

There were some similarities in the data with the overall responses, such as the decrease in the *Unsure/Limited* theme and increase in the *Instructional Strategies,* which were both statistically significant at the three universities. The PSTs at University 1 had a higher percentage of responses that were *Unsure/Limited* initially, indicating that their entering conceptions may have been more limited than those of PSTs at other universities. Moreover, only the PSTs' responses at University 1 had a statistically significant difference on the *Learning Envi-*

Table 1

Themes, Codes, and Descriptions About Teaching Mathematics for Social Justice

Theme	Code	Description
Unsure/Limited	• Not sure • No connection • Teaching math the same way to all	Not knowing what it meant, not seeing a connection, or having a limited idea such as teaching all students the same way
Mathematics Content	• Math is neutral • Integrate subjects • Math for Understanding	Mentioning ideas about mathematics content ranging from mathematics as a universal or neutral subject to understanding mathematics including critical thinking
Access/Opportunity	• Opportunity to learn • Everyone can learn • Math is important/society • Achieving academic success • Achievement gap	Emphasizing the importance of mathematics, being able to access it, providing students with an opportunity to learn to achieve academic success, and addressing the achievement gap
Demographics	• Different backgrounds/awareness • Race, ethnicity, nationality • Gender, sex • Ability Levels (and Special Education) • English Language Learners • SES, class • Religion • Age	Having an awareness of students from different backgrounds, meeting the needs of students regardless of their race, age, gender, religion, language, or ability
Learning Environment	• Unbiased, No discrimination • Treating students fairly • Inclusive classroom environment • Respect • Adequate resources • Equal opportunity, quality teaching • Math attitude/interest • Accountability	Creating an inclusive learning environment where students are respected and treated fairly, providing adequate resources, and helping students develop an interest in and positive attitude toward mathematics
Instructional Strategies	• Differentiation • Embed cultures • Connect math to real world • Connect math to students' lives • High expectations • Help students overcome challenges	Differentiating instruction to meet the varied needs of students, making mathematics meaningful to students by connecting it to their lives, and having high expectations
Critical	• Empower • Learn about social issues with math	Empowering students through mathematics, and teaching students about social issues and the world through mathematics

Table 2

Overall Percentages of Responses by Themes

Theme	Beginning of Course	End of Course	*z*-Score
Unsure/Limited	36%	19%	3.9729*
Mathematics Content	13%	11%	0.4311
Access/Opportunity	30%	31%	– 0.2019
Demographics	17%	22%	– 1.5344
Learning Environment	27%	32%	– 1.2261
Instructional Strategies	17%	29%	– 2.9994*
Critical	17%	13%	1.1752

*p-value significant at the 0.05 level

Table 3

Percentages of Themes by Universities

	University 1 ($n = 54$)			Universities 2 & 3 ($n = 176$)		
Theme	Beginning of Course	End of Course	*z*-Score	Beginning of Course	End of Course	*z*-Score
Unsure/Limited	43%	19%	2.7156*	34%	19%	3.264*
Access/Opportunity	35%	46%	– 1.175	29%	28%	0.2364
Instructional Strategies	20%	41%	– 2.2978*	16%	25%	– 2.1142*
Learning Environment	22%	46%	– 2.6359*	28%	28%	0
Critical	15%	9%	0.8872	18%	16%	0.567
Math Content	9%	9%	0	14%	12%	0.6325
Demographics	19%	19%	0	16%	23%	– 1.6201

*p-value significant at the 0.05 level

ronment theme and an increase in *Access/Opportunity*, which was not the case for University 2 and 3. We did not expect to find a difference in the *Critical* theme because we did not spend a great deal of time discussing critical (or more radical) perspectives of teaching mathematics for social justice, but were somewhat puzzled to see the decrease. It may have been the case that some of the PSTs who started with more critical perspectives reflected on the realities of being able to make systematic changes based on mathematics methods coursework and field experiences, and thus, tempered their initial conceptions. While the instructional time we dedicated to discussing issues of social justice was limited, we found it promising to see positive differences in our preservice teachers' conceptions overall from the beginning to the end of the course.

In summary, we found that preservice teachers' conceptions about teaching mathematics for social justice could be categorized into seven distinct themes. The themes ranging from a limited understanding where preservice teachers did not see a connection between mathematics and social justice or were unsure of what it meant, to acknowledging a variety of ways in which learners of mathematics can be diverse (e.g. race, language, ability), to establishing an inviting classroom environment, to empowering students to use mathematics to gain social mobility. Further investigation of the aggregate responses indicated that there were positive changes in preservice teachers' conceptions from the beginning to end of the semester where there was a statistically significant decrease in the *Unsure/Limited* theme and a statistically significant increase in the *Instructional Strategies* theme. Lastly, a comparison of the change in responses between University 1 and Universities 2 and 3 resulted in similar positive changes as the aggregate data, but University 1 had an additional statistically significant increase in the *Learning Environment* theme.

Implications and Future Research

While there exists variation within the framework on the forms of social justice, it does not include a spectrum of understandings needed for preservice teachers in relation to teaching mathematics for social justice (Bartell, 2012; Gates & Jorgenson, 2009). We contend the themes that arose from this study are foundational in developing this needed continuum of conceptions about teaching mathematics for social justice. The themes can be categorized, to a certain extent, into the first two levels of understanding social justice that Gates and Jorgenson (2009) present, including mostly moderate and some liberal perspectives. These perspectives include fairness and equity by including various groups, but to a less extent are questions raised about classroom and school power structures. The majority of our themes fit into the moderate level that focuses on *fairness and equity* while a few mentioned the liberal level of *recognizing structural inequalities.* None of our themes, or individual responses, mentioned topics related to level three—*taking a radical approach to address structural inequalities.* However, the present conceptions could be foundational to build upon in coursework and co-requisite field experiences in teacher education programs. Mathematics teacher educators must be cognizant of preservice teachers' conceptions in mathematics content and methods courses. It is with this awareness that we can incorporate meaningful activities and assignments that will further develop and refine preservice teachers' conceptions about teaching mathematics for social justice.

The findings in this study of preservice teachers' conceptions of teaching mathematics for social justice are crucial for teacher education programs. While there is familiarity with teachers' general conceptions about teaching for social justice (Cochran-Smith et al., 2009), more work is needed in content-specific areas as they relate to social justice (Garii & Appova, 2013). Teacher educators need to report successful approaches that were used with PSTs and that could be potentially replicated across various teacher education programs. It is also important for researchers to examine contexts, such as field experiences, that are fruitful for developing more socially just pedagogy. Further research is also needed to examine changes in PSTs' conceptions over time and how such conceptions might influence teaching practices along with how the conceptions found in this study are similar to middle and secondary preservice mathematics teachers' conceptions of teaching mathematics for social justice.

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