Obstacles to Teacher Education for Future Teachers of Post-Secondary Mathematics

Contributed Research Report

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The purpose of this study was to uncover issues and difficulties that come into play as mathematics graduate students develop their views of their roles as university teachers of mathematics. Over a six-month period conversations were held with mathematics graduate students exploring their experiences and perspectives of mathematics teaching. Using hermeneutic inquiry and thematic analysis, the conversations were analyzed and interpreted with attention to themes and experiences that had the potential to influence the graduate students' ideas about and approaches to teaching. Using Lave and Wenger's notion of legitimate peripheral participation, themes that are explored in this paper are the replication of mathematics teaching practice and identity, and resulting feelings of resignation. It is hoped that this research will contribute to the understanding of teaching and learning in post-secondary mathematics as well as provide guidance in structuring post-secondary teacher education in mathematics.

Keywords: post-secondary, mathematics graduate students, community of practice, teacher identity

Introduction and Purpose

Mathematics departments are often one of the largest departments within institutions of higher education, providing prerequisite courses for students in diverse disciplines such as engineering, psychology, chemistry, business, medicine, and education. Almost seventy-five percent of mathematics PhDs will become professors at post-secondary institutions dedicated to undergraduate education rather than research (Kirkman et al., 2006). Consequently, the teaching of mathematics at the university level is quite important in undergraduate education, and professors, instructors, and graduate teaching assistants in mathematics have a wide-reaching influence on the education of future researchers, teachers, and mathematicians (Golde & Walker, 2006). However, the format of post-secondary mathematics teaching has remained problematic for undergraduate success in mathematics and the sciences (Alsina, 2005; Kyle, 1997; NSF, 1996).

The preparation of the future mathematics professoriate has recently become a subject of investigation. In particular, the development of mathematics graduate students' teaching practices has become a focus for mathematicians and mathematics educators. Recent research into mathematics graduate students' teaching has examined their classroom practices and possible connections between their practices and beliefs about teaching and learning. Researchers concluded that newly acquired positive attitudes and beliefs about teaching mathematics did not bring about hoped for changes to graduate students' teaching practices (Belnap, 2005; Speer, 2001). Although the mathematics graduate students in at least one study developed a new vocabulary for discussing teaching, these students also reported that they maintained a lecture-style form of instruction (Belnap, 2005). Other research has shown that enrollment in a course

in pedagogy also did not produce expected changes to mathematics graduate students' teaching practices (DeFranco and McGivney-Burelle, 2001).

In light of these conclusions, the purpose of this research study was to learn about the obstacles and issues that might exist for mathematics graduate students that could prevent teacher preparation programs from taking root and being successful. To uncover these potential barriers, this study was undertaken with the following questions in mind: How do graduate students come to understand their roles as mathematics teaching assistants and possible future professors of mathematics? How might experiences and interpretations of experience serve as obstacles to teacher education programs for these future teachers of post-secondary mathematics?

Theoretical Framework

Lave and Wenger (1991) have offered the term *legitimate peripheral participation* in relation to a community of practice to name one central process by which novices gain knowledge and understanding about the practices of a community. Lave and Wenger claimed "even in cases where a fixed doctrine is transmitted, the ability of the community of practice to reproduce itself through the training process derives not from the doctrine, but from the maintenance of certain modes of coparticipation in which it is embedded" (p. 16). Moreover, within the framework of legitimate peripheral participation exist issues of identity where Lave and Wenger describe how "the development of identity is central to the careers of newcomers in communities of practice" where "learning and a sense of identity are inseparable" (p. 115). As such, the concept of legitimate peripheral participation offers an interesting perspective for understanding what might be happening for the mathematics graduate students as they progress through their programs. Legitimate peripheral participation prompts an interesting question for this study: How might the attention to legitimate peripheral participation in a mathematics department prevent graduate students from adopting alternate modes of teaching?

Mode of Inquiry

As hermeneutics "holds out the promise of providing a deeper understanding of the educational process" (Gallagher, 1992, p. 24), hermeneutic inquiry was chosen as the mode for exploring the experiences that mathematics graduate students face in their programs. Hermeneutics helps to understand how we create and find meaning through experience and social engagement (Brown, 2001). Davis (2004) offered a description of hermeneutics as a mode of inquiry that asks "What is it that we believe? How did we come to think that way?" (p. 206). Hermeneutic inquiry into mathematics graduate students' understanding of their possible future roles as professors compelled a look at what is present in departments of mathematics that might cause them to adopt the teaching methods that persist as part of their role in maintaining "certain modes of coparticipation."

Carson (1986) and van Manen (1997) propose conversation as a mode of doing research within hermeneutic inquiry to uncover interpretations and understanding of experience. For this study, a series of five audio-recorded semi-structured, recursive conversations were conducted with the research participants, all of whom were mathematics graduate students in a doctorate granting university. Each conversation was analyzed by the researcher, who listened for the topics of conversation attended to by the research participants. The participants had the opportunity to review the analyses in a

collaborative effort to refine the reporting of their experiences. Because of its recognition of the interpretive work of data analysis, Braun and Clark's (2006) six-stage process for thematic analysis was coupled with hermeneutic inquiry. The stages of thematic analysis are in accord with Laverty's (2003) description of a hermeneutic project where "the multiple stages of interpretation allow patterns to emerge" (p. 23). Combining these two notions, the themes and the participants' comments within each theme were analyzed using a hermeneutic, interpretive lens.

Results

The participants in this study lacked a forum to discuss their views, explore different ideas for teaching, and were not provided mentorship for their teaching duties. They were left to creating meaning amongst themselves, relying solely on the reproduction of the teaching and a unitary identity they observed. They resigned themselves to a notion that there was only one way to teach mathematics and one way to be as a professor of mathematics. These conclusions are explored in the themes below.

Replication of identity and practice

The replication of mathematics professors' identity and teaching practices resonated in the conversations with the research participants. Similar to Lave and Wenger's (1991) idea that communities "reproduce themselves" (p. 121), the post-secondary teaching of mathematics, as viewed by the participants, appeared to be a practice of replication, a reproduction of others' teaching. Specifically, one participant spoke of the structure of all mathematics courses as "definition, theory, example," while another participant described teaching as "You just do examples," pointing to a replication of the fixed structures of mathematics texts and courses as the legitimate form of teaching practice. Other participants acknowledged the replication of legitimate practice seen in calculus courses, with one stating "It's easy to keep teaching calculus like this. We've been doing it forever" and another asking "How many ways can you skin a calculus class?" Beyond replication of teaching practice, though, was also a notion of replication of identity. Jardine (2006) has written that in mathematics there exists a "mood of detached inevitability: anyone could be here in my place and things would proceed identically" (p. 187), signaling the replication of identity amongst mathematics teachers. This view echoed in the language of professor A and professor B used by one of the participants: "You could teach a little bit better, but I don't know how much variety you can actually put in. How much different is professor A from professor B?" which spoke to an interchangeability between professors, as though their identities might be so alike or the differences so insignificant that it would not matter who was in the classroom.

Resignation

The act of replication of mathematics teaching and the thought of taking on a particular identity in mathematics evolved into feelings of resignation among the participants. With regard to his current role as a graduate student, one participant said, "You can't have an opinion; you can't have anything except the fact that 'yeah, this is true.'" Here it seemed that this participant was resigned to a passive position within his role as mathematics graduate student, and that he must accept the ways he could participate in the department. Further, when speaking about the possibilities for his future teaching practice and, in particular, about the use of discussion in a mathematics classroom, he said, "that's never going to happen in math," a statement that expressed a

resigned view that there are no alternative possibilities for what can occur in mathematics classrooms. Concerning his own observations of the ways in which the undergraduates were being taught by professors in the department, another participant remarked "I might have the same complaints, but there's nothing I can do about it," signaling a resignation to being unable to change the way mathematics courses are taught or structured. With regard to his own teaching, another participant spoke of how he could not work "outside of a certain box" in the department. As a result, he no longer appeared to have a concern for his teaching, saying, "I would not be able to change things even if I wanted to." When this participant spoke of his hopes for his future career as an academic, teaching was no longer of consequence to his success as a mathematician and future professor. In the final year of his doctoral program, this participant was an illustration of what Lave and Wenger (1991) refer to as the "transformation of newcomers into old-timers" (p. 121) and how "an extended period of legitimate peripherality provides learners with opportunities to make the culture of practice theirs" (p. 95).

Implications of the study

The goal of this project was to understand what the obstacles might be for post-secondary mathematics teacher education. The participants in this study did not report a public statement or acknowledgement that they had to abandon other ideas about teaching and that they should no longer consider teaching important, but they interpreted their lives in mathematics to be restricted to a particular way of being and of teaching mathematics. Thus if the current structures and suggestions of what is important to graduate study in mathematics remain in place, it is unlikely that new teacher education programs that are established for mathematics graduate students will produce hoped for changes to teaching in post-secondary mathematics.

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