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AMTE Monograph 3
The Work of Mathematics Teacher Educators

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Continuing the Conversation on Mathematics Teacher Education

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A major focus of teacher education is the development of preservice teachers. However, it should not be the only focus of those who work in teacher education. Educating inservice teachers is equally important and the conversation among those involved in mathematics teacher education needs to include discussion of this group as well. This conversation also highlights a need for professional development for teacher educators and research on the development of teacher educators. This paper discusses issues in educating all of these groups of individuals in an effort to continue the conversation among those involved in mathematics teacher education.

Professional development is an important aspect of the work in which mathematics educators engage. In this monograph, we broadly define professional development so that it captures the teaching and learning of preservice and inservice teachers and teacher educators. During the initial conception of this monograph, we thought it would provide an opportunity to renew the conversation about professional development between mathematics teacher educators that began in volume one of the AMTE monograph series (Watanabe & Thompson, 2004). After reviewing and selecting manuscripts, three subcategories of research emerged: teaching preservice teachers; teaching inservice teachers; and teaching teacher educators. These three areas, although having the common goal of creating good mathematics teachers, are significantly different to warrant individual treatment as separate research foci. This collection of articles is not meant to be exhaustive but a sharing of the work in which our colleagues are engaging.

Teaching Preservice Teachers

The four articles in this monograph that have implications for teaching preservice teachers address three concerns: increasing the

mathematical content knowledge of preservice elementary teachers; gender equity; and capstone courses for preservice secondary teachers.

Lloyd (Chapter 2) and Flowers and Rubenstein (Chapter 3) outline ways to use mathematically rich problems from *Standards*-based K-12 curricula to enhance the content knowledge of preservice elementary teachers. The use of such problems helps preservice teachers examine curricula from the perspective of a student and also as a teacher and grounds preservice teachers in the mathematics they will teach while challenging their beliefs about traditional K-12 curriculum. Furthermore, the use of these curriculum materials has the potential to increase teachers' mathematical content knowledge consistent with the guidelines outlined in the *Principles and Standards for School Mathematics* (PSSM) (National Council of Teachers of Mathematics (NCTM), 2000) which states that "teachers must understand deeply the mathematics they are teaching." The Conference Board of the Mathematical Sciences (CBMS) (2000) has also recommended that mathematics content courses should be taught so they make connections with the school mathematics which teachers are expected to teach.

There are many inside and outside of education who subscribe to conventional wisdom that the majority of learning HOW to teach occurs when one actually starts teaching, and thus, teacher education programs are of little value. However, one overlooked fact is that all teachers have 16+ years of observations of teaching which shape their beliefs about teaching practices (Kennedy, 1999). These experiences impact preservice teachers' beliefs about mathematics and the way mathematics is taught effectively, perhaps explaining why the majority of teachers teach in the traditional manner in which they were taught. Currently, the usual course of study for educating preservice teachers is a series of college mathematics courses and then several mathematics education courses in which they learn how to apply that mathematics to what they are expected to teach in K-12 education. It is possible, in fact probable, that there is little or no connection between the mathematics courses or the mathematics education classes that typical preservice teachers take. Thus at the end of their college experience, mathematics may still appear to be a disconnected collection of topics which, in their view, has little or no connection to the school mathematics about which they are now expected to teach.

According to the Connections Standard in the PSSM, mathematics teachers should provide an instructional program which fosters understanding of the "interrelatedness of mathematical ideas" so that students learn the efficacy of mathematics as well as the mathematics itself. If teachers are taught in a disconnected fashion, it is

unreasonable to assume that they will necessarily make those connections when they start teaching. Thus, the need for communication between mathematicians and mathematics educators is critical in the education of preservice teachers to foster ideas such as using rich content problems and non-traditional teaching practices.

Many preservice teachers operate under the belief that the way they learned mathematics is an effective way to teach mathematics to their students, that is, it worked for them so it should work for everyone. This belief needs to be challenged in preservice teacher education courses. In both K-12 and college classes, the majority of teachers were taught in traditional mathematics courses, with few connections between different mathematics strands or to other subject areas. There are also few teachers who were taught with reform teaching methodologies or from *Standards*-based practices. Teacher educators and policy makers cannot expect preservice teachers to implement *Standards*-based curricula when they have never been exposed to them or to use pedagogical strategies that would enhance mathematical understanding for all students when they have limited experience with successful mathematics teaching practices. Hence, it is critical for mathematics teacher educators to converse about strategies for teaching preservice teachers pedagogy which fosters mathematical understanding for all students.

Pedagogical content knowledge (PCK) for mathematics education consists of knowing what mathematics to teach, how to teach it, and why it should be taught. The CBMS recommends a capstone course to enhance preservice teachers' PCK. In the early years of teaching, new teachers rarely consider what mathematics is important to teach, but let it be determined for them by outside sources, such as a prescribed textbook, pacing guide, or state mandated course of study. Education programs need to help preservice teachers consider what mathematics is important to teach, why it is important, and how it connects to mandated curricula.

Instituting a capstone course in teacher preparation programs is one strategy to provide preservice teachers with an opportunity to examine connections between mathematical ideas in the K-12 curriculum that they will teach. Developing a capstone course is not an easy task however. Decisions, such as what content to include in such a course, how to structure the course, and how the course will enhance PCK and preservice teachers' views of mathematics as a connected whole, are critical discussion topics among those involved in mathematics teacher education. Teacher educators who have developed or are revising such a course are an invaluable asset in leading or facilitating such discussion. Loe and Rezac (Chapter 4)

provide a glimpse of a capstone course for secondary teachers that hopes to bridge this divide.

Mathematics education professionals also must attend to preservice teachers' ability to teach the mathematics that they know equitably to all students. Even with previous strides to resolve issues of racial and gender equity in K-12 education, those issues still exist, as evidenced by the achievement gap on mandated tests by underserved populations. Thus, the conversation about racial and gender equity, as addressed by Breyfogle and Kress (Chapter 5), needs to be revisited by mathematics teacher educators.

There are many issues which shape preservice teacher education beyond what is possible to present in any one volume. The intent here is to reenergize the conversation among those involved in the education of future K-12 mathematics teachers. This sharing of ideas and best practices can enhance the mathematical and pedagogical education of mathematics teachers and ultimately the education of K-12 mathematics students.

Teaching Inservice Teachers

The three articles in the monograph that address teaching inservice teachers center around creating communities that provide high quality professional development for both novice and experienced mathematics teachers. Creating such communities is often a difficult process given the increasing demands on K-12 teachers.

The transition from preservice teacher to inservice teacher is often a challenge, even for well-prepared novice teachers. This is evidenced by attrition rates, especially in the areas of mathematics and science, which are highest for teachers leaving the profession in the first five years of teaching (Ingersoll, 2001). When preservice teachers enter their first classrooms, they are frequently overwhelmed by a myriad of daily details dealing with classroom organization and management and administrative responsibilities. As these fledgling teachers struggle for survival in the classroom, the textbook becomes their lifeline and pedagogy is reduced to lecture, drill and practice. To expect inexperienced teachers to break from a traditional emphasis and to institute reform methods is an idealistic notion when viewed from the perspective of the day-to-day realities of their classrooms. Once these teachers have gained experience, they are entrenched in this traditional teaching mode and rely heavily on the adopted text as their source of determining the mathematics they will teach. Mathematics educators need to continue the conversation regarding the implementation of *Standards*-based curricula and reform methodologies in both new and experienced teachers' classrooms.

One possible way to smooth the transition to teaching, retain quality teachers in the classroom, and encourage new teachers to institute reform methods is by providing mentoring for new teachers. Although mentoring might be easy in large schools with an abundance of qualified mathematics teachers, it is more challenging in rural areas where a new teacher might be the only mathematics teacher for a grade band, as evidenced by the research presented by Luebeck (Chapter 6). Finding an available qualified mentor who can answer a new teacher's questions regarding content and pedagogical aspects of their specific teaching assignment can be a problem in rural areas. Although a mentor may give novice teachers classroom management advice, the mentor may not be able to offer guidance about mathematics because the mentor teaches a different subject area. Often in rural settings, teachers feel isolated and disconnected from their subject area peers (Storer & Crosswait, 1995). Technology, as described by Luebeck (Chapter 6), may provide a solution to this mentoring problem through the use of internet media which provides two-way communication between rural teachers and mentors in other schools, districts, or even universities.

Given the availability of web based media, such as email, instant messaging, weblogs, and high-end video conferencing technologies, teachers and teacher educators have more ways to stay connected than ever before. The question remains of how to utilize these technologies to connect practicing teachers and teacher educators in appropriate ways to enhance professional development of all involved. Although there has been some research on best practices in distance education and distance professional development (Rider & Manning, 2005), there is a lack of understanding of how these media could assist the mentoring process of new teachers.

Establishing communities of practice (Wenger, 1998) among teachers, teacher educators, and other education professionals to look at standards, curriculum, classroom practice, student understanding, and rich problems in mathematics has been shown to be an effective professional development activity for both new and experienced teachers. Crespo and Featherstone (Chapter 7) address ways that they have created teacher groups and used rich mathematical problems to provide professional development, thus developing a community of practice. These communities of practice give teachers support from their peers as they grapple with issues of mathematical content, strategies that promote conceptual understanding for their students, diagnosing problems in students' work, connecting research to practice, and pedagogical aspects of teaching. All are issues when implementing reform curricula. Silver, Mills, Castro, and Ghousseini (Chapter 8)

address similar issues using a modified Japanese lesson study model with case analysis and discussion.

Teachers in small schools and rural communities do not have as many opportunities for professional development as do teachers in larger areas. Although it is possible to form communities of educators within a single school (Crespo & Featherstone, 2003, 2002, 2001), distance learning technology has been used to maintain communities of practice that are formed during teacher professional development activities with teachers from different schools and even different areas of the country (Rider & Manning, 2005). For many teachers, especially those in rural areas, technology becomes a key factor in making it possible for them to engage in these professional development activities, allowing them to explore problems in mathematics, observe and share classroom experiences, and examine student understanding (Rider & Hunting, 2006). The use of technology opens up a wealth of opportunities for teachers and a range of instructional design issues for teacher educators. Teacher educators need to consider and discuss how to utilize technological tools in ways that foster the same learning as face-to-face meetings.

The three papers by Luebeck, Crespo and Featherstone, and Silver et al. begin to touch on issues of creating community in professional development. Hence, they are first steps in meeting a critical need for conversation among teacher educators on how to create these communities and foster growth for participating teachers as they implement *Standards*-based curricula.

Teaching Teacher Educators

The final two papers in the monograph represent a growing concern and research area often overlooked in teacher education, namely the education and professional development of the teacher educator. Teacher educators come from diverse educational backgrounds and they may or may not have had any instruction in preservice or inservice teacher education. As evidenced by Van Zoest, Moore, and Stockero (Chapter 9) and Sztajn, Ball, and McMahon (Chapter 10), even experienced teachers may have difficulty transitioning from being a mathematics teacher to a mathematics teacher educator. It is imperative that the profession start and continue a conversation on how to educate this group of individuals.

Preparing teacher educators to provide professional development and meaningful learning opportunities to both preservice and inservice mathematics teachers is vital to the creation of better mathematics teachers. The recognition that there is a specialized body of knowledge and experiences that help the mathematics educator prepare preservice

and inservice teachers is of great importance. Often a mathematics education Ph.D. or mathematics Ph.D. has experiences and coursework on preservice teacher education throughout the program but there has never been explicit attention on how to transition from a Ph.D. student into a teacher educator. To some, this might seem to be an obvious transition; similar to preservice teachers transitioning into a classroom teaching experience, the transition can be challenging for new teacher educators. The two articles featured in this monograph may help the mathematics education community think about experiences which may be beneficial in the development of teacher educators.

Conclusion

In order to strengthen the field of mathematics education, the conversation among mathematicians, mathematics teacher educators, and other professionals involved in the education of mathematics teachers needs to continue and increase. In too many cases, there is little connection between departments of mathematics, mathematics education, and outside professional developers. Collectively, these individuals need to work together to produce not only more mathematics teachers but better prepared and trained teachers. The critical shortage of qualified mathematics teachers in K-12 (Sterling, 2004) and in tertiary (Reys, 2006) mathematics education positions makes the need for this conversation and collaboration more important than ever.

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