IMPROVING PRESERVICE ELEMENTARY TEACHER EDUCATION THROUGH THE PREPARATION AND SUPPORT OF ELEMENTARY MATHEMATICS TEACHER EDUCATORS

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This working group will bring together researchers and practitioners to work collaboratively towards unifying goals centered around the work of elementary mathematics teacher educators (eMTEs, including mathematicians and graduate students) who teach elementary mathematics content courses. The working group will aim to conceptualize the work of eMTEs as a unique population of practitioners, their development, and the ways in which they may be supported in this work. Areas of focus will include, but are not limited to: (a) the development of prospective elementary teachers’ learning in content courses; (b) the content and pedagogy enacted in elementary content courses; (c) the mathematical knowledge needed for teaching teachers; (d) the educational backgrounds and teaching experiences of eMTEs; (e) the preparation of eMTEs at the doctoral level; and (f) the institutional guidance and support from the greater community that eMTEs are currently being offered. Our vision is to create research-based practitioner resources for eMTEs, including: writing and publishing a handbook, based on research and policy recommendations, to serve as a practitioner guide for teaching elementary content courses; and building and maintaining an online repository of instructional resources that eMTEs may utilize in their work with prospective elementary teachers.

Keywords: Teacher Education-Preservice, Elementary School Education, Teacher Knowledge, Instructional Activities and Practices

Motivations for a New Working Group

History
This is a new working group that arose from interactions between the leaders of a PME-38 discussion group on the opportunities and challenges surrounding the preparation and support of mathematics teacher educators who work with elementary teachers (Welder, Jansen, & McCloskey, 2014), the presenters of a PME-39 research report on the purposes of mathematics teacher educators in their teaching of elementary content courses (Taylor & Appova, 2015), and the presenters of the Association of Mathematics Teacher Educators (AMTE) symposium on supporting mathematics teacher educators’ work with elementary teachers through multiple perspectives (Taylor, Appova, Welder, & Feldman, 2016). Collective feedback received from participants (which included novice mathematics teacher educators and graduate students) highlighted a strong need for research and resources to support the development of elementary mathematics teacher educators (eMTEs), specifically in their teaching of mathematics content courses for prospective elementary teachers (ePTs).

Problem
Recent research and political initiatives have suggested that, while in teacher education programs, many ePTs receive inadequate preparation to become effective teachers of mathematics.

and do not develop the deep, conceptual knowledge of the mathematics they will teach (e.g., Conference Board of the Mathematical Sciences (CBMS), 2012; Greenberg & Walsh, 2008). These issues stem from, among other things, a lack of clarity and consensus within the field about what ePTs should learn and experience while in mathematics content courses (e.g., Ball, Sleep, Boerst, & Bass, 2009; Zaslavsky, 2007) and a lack of preparation and support for the eMTEs who teach mathematics content courses for ePTs (e.g., Bergsten & Grevholm, 2008).

There has been a recent increase in the efforts of mathematics teacher educators to study and share the work they are doing with ePTs, primarily regarding the content (e.g., Ball, et al., 2009) and pedagogy (e.g., Lampert et al., 2013) enacted in mathematics methods courses; however, little of this work has specifically focused on elementary content courses (e.g., Bergsten & Grevholm, 2008). Research has indicated that these content courses are often taught by eMTEs, in mathematics departments, who have little to no experience working with elementary content or children and do not receive the training or support necessary to effectively address the needs of the ePTs with whom they work (Masingila, Olanoff, & Kwaka, 2012).

Goals

In response, the leaders have developed this working group to bring together researchers, mentors of mathematics teacher educators, and experts from the larger community to work collaboratively towards unifying goals regarding the teaching of elementary mathematics content courses and the preparation and support of those who teach these courses. More specifically, the aim of this new working group is to generate an understanding of how eMTEs develop as practitioners, particularly in light of recent recommendations, including the Mathematics Education of Teachers I and II (CBMS, 2001; 2012), the National Council of Teachers of Mathematics for the Council of the Accreditation of Educator Preparation Standards (NCTM CAEP, 2003; 2012), and the forthcoming Standards for Mathematics Teacher Preparation (AMTE, 2016).

Specifically, we aim to better understand, document, and address eMTEs’ needs by: (a) providing opportunities for eMTEs to make sense of the content and pedagogical recommendations provided in the aforementioned documents; (b) inviting eMTEs to reflect on their current practices in light of these recommendations; (c) understanding the challenges eMTEs face in addressing these recommendations in their teacher preparation courses/programs; (d) providing a platform for eMTEs to develop a shared vision for mathematics teaching and learning in elementary content courses; and (e) constructing resources, including research-based strategies and recommendations, for strengthening the preparation and support of eMTEs. From these discussions, we aim to open new scholarly and practitioner-based avenues for research and collaborations in the field of eMTE development.

Focal Issues

Jaworski (2008) defines mathematics teacher educators as “professionals who work with practicing teachers and/or prospective teachers to develop and improve the teaching of mathematics” (p. 1). Studying the work and practices of teacher educators is a fairly new area of research in the field of mathematics education. In the past two decades, the related research has mostly fallen into six overall categories: (1) knowledge needed by teacher educators to teach prospective teachers (e.g., Chick & Beswick, 2013; Rowland, Turner, & Thwaites, 2014; Superfine & Li, 2014); (2) general pedagogical practices of mathematics teacher educators (e.g., Dixon, Andreassen, & Stephan, 2009; Steele, 2008); (3) efforts of mathematics teacher educators to improve their own practices (e.g., Berk & Hiebert, 2009; Cad, Hopkins, & Hodges, 2008; Hiebert et al., 2003; 2007; Marin, 2014; Monroe, 2013; Nolan, 2015; Tzur, 2001); (4) actions, goals, purposes, and intentions enacted by experienced mathematics teacher educators in their content/methods courses (e.g., Appova & Taylor, 2014; Taylor, 2013; Taylor & Appova, 2015); (5) effects of particular activities, or series of activities, on

prospective teachers’ learning (e.g., Castro 2006; Goodell, 2006); and (6) the design of tasks specifically for use in mathematics content courses for ePTs (e.g., Chval, Lannin, & Bowzer, 2008; Liljedahl, Chernoff, & Zazkis, 2007; Thanheiser, et al., 2016; Van Zoest & Stockero, 2008).

The working group leaders have been directly and indirectly involved in this research community, collecting, analyzing, and reporting data related to various aspects of the work of eMTEs. A major impetus for our work is our overlapping interests in strengthening the development of ePTs’ mathematical knowledge for teaching (Ball, Thames, & Phelps, 2008) through the preparation and support of the eMTEs who work with them. The leaders of the working group have critically considered several factors influencing the work and development of eMTEs, including: (a) educational backgrounds, research, and teaching experiences of eMTEs (especially those related to elementary mathematics); (b) specialized knowledge needed by eMTEs for teaching mathematics content to ePTs; (c) actions taken by eMTEs in elementary mathematics content courses and the purposes/intentions behind those actions; and (d) preparation and support of eMTEs for their work with ePTs. Below, we summarize the current research foci of the working group leaders and how we envision our work connecting to the larger goals of the working group, both during and after the conference. For the purpose of the working group, we will use the term “elementary” to broadly encompass PreK-8 grade-levels to be inclusive of varying state-certification requirements and institutional course offerings.

Educational Backgrounds and Teaching Experiences of eMTEs

Many, if not most, instructors of elementary mathematics content courses have not worked as elementary teachers themselves (Masingila, Olanoff, & Kwaka, 2012). Welder and McCloskey (under review) have been working to investigate this phenomenon through three lenses: (a) analyzing job opportunities for mathematics teacher educators, (b) surveying early-career mathematics teacher educators, and (c) conducting focus group interviews with educators who lack elementary experience yet work primarily with elementary teachers. Preliminary findings suggest that most mathematics teacher educators will work with elementary teachers in some capacity at some point in their careers and highlight that most will do this work without being able to claim the title or draw upon the expertise that only comes with having worked as a practicing elementary teacher (Welder, McCloskey, & Searle, 2013). By better understanding the nature of the challenges faced by eMTEs, especially those without elementary-specific educational backgrounds or teaching experience, the goal of this research is to find ways in which eMTEs may be better supported for their work with elementary teachers.

Connection to working group. In addition to better understanding the multitude of factors that may affect the quality of eMTEs’ interactions with teachers, there is much work to be done to identify where and how eMTEs develop (or could or should develop) such knowledge, experience, and dispositions toward elementary mathematics teaching. Reys and Reys (2012) note, “[P]rofessionals continue to grow and adapt throughout their careers. It is unreasonable to expect that a Ph.D. program will adequately prepare mathematics educators for the wide range of challenges and expectations they will confront” (p. 290). How might responsibility for eMTE development be shared among doctoral programs, hiring institutions, and individual eMTEs themselves? The field of mathematics education could benefit from collectively identifying learning goals for the preparation of eMTEs and developing practices to support eMTEs in reaching these goals.

Specialized Knowledge of eMTEs Needed for Teaching Mathematics to ePTs

Much research has been done on the nature of mathematical knowledge for teaching (MKT) children (e.g., Ball, et al., 2008). However, much less research has looked at the knowledge required by mathematics teacher educators to facilitate the development of ePTs’ MKT. It is generally assumed that teachers need to know more than their students, but in looking at the mathematical

knowledge for teaching teachers (MKTT), researchers are still investigating what this “more” entails. Deborah Zopf (2010) identifies three areas where the work of teaching mathematics to teachers differs from teaching the subject to students. First, the content is different; students are learning mathematics, whereas ePTs are learning MKT. Second, the audience is different; eMTEs are teaching adults who are already somewhat familiar with the mathematics content that they are learning, though mostly in procedural ways (Thanheiser et al., 2014). Third, the goals for instruction are different; students generally learn mathematics for academic purposes, whereas ePTs learn mathematics for the purpose of teaching it to children.

**Connection to working group.** Research is needed to look more deeply at how the differences between teaching students and ePTs influence the knowledge required by eMTEs. What challenges are involved in teaching mathematics to ePTs who already have some (albeit mostly procedural) knowledge of the content, but lack the deep, conceptual understandings needed to teach the subject to children? How should eMTEs determine the scope and sequence of mathematics content courses? Is less content, studied at a deeper level, more effective than covering more topics in less depth? How can eMTEs design formative and summative course assessments to capture the development of ePTs’ conceptual understandings (Hill, Schilling, & Ball, 2004)? These are merely a few of the field’s unanswered questions regarding MKTT.

**Classroom Actions and Purposes of eMTEs in Mathematics Content Courses**

Taylor and Appova (in preparation) closely examined the classroom actions, and purposes and intentions behind those actions, of experienced eMTEs. The authors define classroom actions as teaching practices eMTE employ during instruction (i.e., what eMTEs say and do while instructing ePTs, including the content that is visually presented) and purposes/intentions as what eMTEs want ePTs to learn from content and methods courses, which may or may not be listed in the course syllabi and/or curriculum. Preliminary results from this study indicate that experienced eMTEs situate their actions and purposes around specific learning opportunities that provide ePTs with essential foundations for developing two specific domains of MKT: specialized content knowledge (SCK), mathematical knowledge separate from pedagogy and knowledge of students, that is not needed in other professional settings (Ball et al., 2008), and pedagogical content knowledge (PCK), a special type of knowledge that blends “content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interest and abilities of learners” (Shulman, 1987, p. 8).

More specifically, in their content courses, experienced MTEs provided opportunities for ePTs to re-learn elementary mathematics in a way that helped them to make pedagogical connections to children’s learning, teaching, and curriculum. They also focused on providing ePTs with opportunities to experience mathematics beyond the surface-level procedural learning, developing a deeper conceptual knowledge and problem-solving nature of mathematics through connections, representations, and modeling (echoed in the Standards-based documents, put forth by NCTM, 2000). These visions are described by Magnusson, Krajcik, and Borko (1999) as orientations towards teaching, encompassing “teachers’ knowledge and beliefs about the purposes and goals for teaching [mathematics] at a particular grade level” (p. 97).

**Connection to working group.** The authors hope to open a window of collaborative research opportunities to extend their current work and provide the mathematics education research community with additional and new insights into the knowledge, practices, and purposes that eMTEs draw upon in their content and methods courses. Without a shared knowledge base, eMTEs will continue to teach and design courses with limited resources and support, contributing to even greater variability across teacher preparation programs (Floden & Philipp, 2003). Specifically, the authors are interested in exploring ways in which university faculty (especially non-mathematics educators, such as, graduate students, adjuncts, and mathematics faculty) can be supported in
developing ePTs’ PCK and SCK through content and methods courses. Such work will help the mathematics education community develop a shared vision, curriculum, and knowledge base for the work of eMTEs, specifically in regards to their classroom actions, practices, and intentions/purposes when teaching courses for ePTs.

**The Preparation and Support of eMTEs**

With the recent policy documents and recommendations regarding elementary teacher preparation, there comes a greater need to prepare and support eMTEs in their work with ePTs. However, Masingila, Olanoff, and Kwaka (2012) found that, in their survey about who teaches mathematics content courses for ePTs, over half of the respondents indicated that there is no training or support for the eMTEs who teach content courses at their institutions. Of those who indicated that there is support, most described it as informal and infrequent (only occurring once or twice a year). Furthermore, findings from a study of novice mathematics teacher educators highlighted their collective need for gaining additional teaching experience during doctoral preparation programs and receiving mentorship during their initial years as university faculty (Yow, Eli, Beisiegel, McCloskey, & Welder, 2016). Kimani, Olanoff, and Masingila (2012) were able to successfully support the development of novice eMTEs by creating mentoring programs and relationships between novice and experienced eMTEs. In their research, the authors formed a community of practice to reflect on the processes of learning to teach mathematics content courses for ePTs. Through this community of practice, novice and experienced eMTEs were able to work together to establish learning goals for their ePTs and reflect on their abilities to help ePTs achieve these goals.

**Connection to working group.** This avenue of research is strongly aligned with all of the aforementioned areas of our working group; yet, little research has been conducted in this area suggesting that the field of mathematics education needs to identify best practices in preparing and supporting eMTEs and implement these practices throughout various stages of eMTEs’ development. The leaders of this working group believe that this work is particularly important for novice mathematics teacher educators who are often assigned to teach content and/or methods courses for ePTs, within their first few years as faculty, regardless of their backgrounds or experiences (Welder & McCloskey, under review). Forming communities of practice to address the mathematical preparation of elementary teachers and conduct action research around the teaching of mathematics content courses for ePTs will help the field better recognize, understand, and address the needs of eMTEs. By helping the field better define the goals, purposes, and classroom practices that may best support the development of ePTs’ learning, eMTEs will be able to confront their own knowledge, backgrounds, and experiences that may aid (or impede) their ability to facilitate ePTs’ development. This knowledge may help us begin to develop a shared vision for effective mentorship practices and professional development structures specific to the needs of eMTEs (including mathematicians and graduate students).

**Projected Working Group Outcome**

Our primary goal is publishing a handbook containing research-based practitioner resources, based on theories of eMTE development, that will guide eMTEs (including mathematicians, graduate students, and those who prepare and mentor eMTEs), in their work with elementary teachers. Although the focus of our materials will be specifically on the teaching of content courses for ePTs, they will also be relevant to eMTEs who provide inservice teacher professional development. Our plan is to contact several publishers to find an appropriate outlet for our work, mainly focusing on opportunities for publishing research-based recommendations and guidelines (rather than individual research reports) such as those provided by special issues of Theory into Practice (published by Taylor & Francis).

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We foresee the printed handbook being comprised of several interrelated chapters for eMTEs to draw upon when teaching elementary content courses. Potential chapters and/or topics may include, but are not limited to:

- An overview of elementary mathematics curriculum development in the United States (e.g., state-level standards and assessments; commonly used elementary curricula, state-specific teacher certification requirements);
- The mathematical content and practices recommended for supporting the development of ePTs’ MKT through content coursework, as explicated in local and U.S. national standards and policies related to elementary teacher preparation (e.g., CBMS, NCTM CAEP, AMTE);
- Unique aspects of the ePT population (including an overview of the research on ePTs’ knowledge, misconceptions, attitudes, beliefs, dispositions, etc.);
- The ways in which teaching mathematics content courses for ePTs differs from the teaching of other mathematics courses, including discussions of unique challenges faced by eMTEs when teaching teachers mathematical content they will eventually teach and asking ePTs to develop conceptual knowledge of content for which they are most likely procedurally fluent;
- Task design for content courses for ePTs (including samples of problem-based exploratory tasks, research-based recommendations for engaging teachers in cognitively challenging tasks [Stein, Grover, & Henningsen, 1996; Stein, & Smith, 1998], and resources for finding research-based tasks designed for elementary content courses);
- Benefits of having ePTs work directly with elementary children (through lab schools or fieldwork experiences) and/or exposing them to the mathematical thinking of children during content courses (e.g., children’s math ingenuities, problem-solving strategies, and misconceptions, Cognitively Guided Instruction [CGI; Carpenter, Fennema, Franke, Levi, & Empson, 2015], van Hiele levels of thinking [Fuys, Geddes, & Tischler, 1988]);
- Sample course syllabi and suggestions for the scope and sequencing of content based on various university course offerings (e.g., how content goals and pacing may differ at institutions offering one, two, or three semester- or quarter-long courses);
- Valid and reliable assessments that eMTEs can use to measure various aspects of ePT development throughout content courses and teacher preparation programs, including MKT (e.g., Hill, Schilling, & Ball, 2004; Welder & Simonsen, 2011), attitudes, beliefs, and dispositions towards the teaching and learning of mathematics (e.g. Jong, Hodges, Royal, & Welder, 2015), self-efficacy (e.g., Bandura, 2006; Tschanen-Moran, Hoy, & Hoy, 1998), and math anxiety (e.g., Bursal & Paznokas, 2006; Vinson, 2001);
- A printed collection of resources relevant to the development of ePTs, including books, activity guides, articles, student artifacts, information regarding projects, conferences, and professional development opportunities for eMTEs, and online resources for tasks, lessons, and video collections (e.g., the IMAP Integrating Mathematics and Pedagogy: Searchable Collection of Children’s-Mathematical-Thinking Video Clips, [Philipp, Cabral, & Schappelle, 2012]; Videos of How Children Learn [Children’s Mathematical Learning, Feikes, 2016]; GDK Math Lessons [GDKMath, 2016]; CGI Online Video Clips [Carpenter, Fennema, Franke, Levi, & Empson, 2015]).

**Plan for Working Group Sessions**

The first session will begin with an overview of the literature on mathematics teacher educators to build rationale and purpose for this working group. The working group leaders will highlight gaps
in the extant literature surrounding eMTE development and use these as starting points for guiding the direction of the group’s work. Key activities will include:

- Providing a platform for eMTEs to begin developing a shared vision for elementary content courses and the learning of ePTs;
- Identifying challenges faced by eMTEs and how they may differ from those of classroom mathematics teachers and other teacher educators;
- Sharing the leaders’ goals for developing research-based resources for eMTEs teaching content courses;
- Providing the opportunity for participants to articulate their specific interests regarding the development of eMTEs and how they might fit into the overall goals of the working group.

The second session will provide opportunities for participants to break into smaller subgroups based on their areas of interest. Each subgroup will discuss the current research related to their area with the goal of making research-based recommendations and suggestions related to their topic. This may include identifying possible avenues for future research and resource development. Each group will have an opportunity to brainstorm and develop an outline for how their topic may contribute to the development of a practitioner handbook for eMTEs.

During the third session, each group will finalize their discussions, prepare a report to present to the larger group, and map-out a plan for “next steps” in moving forward with the work, goals, and outcomes of the working group. In particular, participants will identify specific opportunities for organizing future work and collaborations, including co-authoring the chapters of the upcoming publication and contributing to anticipated follow-up activities.

**Anticipated Follow-up Activities**

In addition to writing and publishing the practitioner handbook described above, the leaders of the working group intend to build, develop, and maintain an online repository of resources and instructional materials specifically designed for eMTEs. The goal of providing the repository is to support eMTEs in providing effective learning opportunities for ePTs and align their instruction with national standards and recommendations for mathematics teacher preparation (AMTE, 2016; CBMS, 2001; 2012). The online repository will offer explicit and concrete information about the instructional resources provided, such as mathematical tasks and activities, sample lesson plans, ideas for course scope and sequencing, videos of children’s mathematical thinking and experienced eMTEs leading ePT instruction, and links to relevant online resources, such as virtual classrooms and manipulatives. The leaders plan on pursuing grant opportunities to secure funding sources to support the continued development and maintenance of this online repository. Together, the handbook and repository will provide an effective platform for building a community of practice of eMTEs and supporting the development of their work with ePTs.

**References**


Welder, R. M., & McCloskey, A. (under review). "I don't want to lack credibility:" Preparing and supporting elementary teachers of mathematics without having been one.


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