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Exploring Mathematics Methods Courses and Impacts for Prospective Teachers

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This working group continues to develop a research program and scholarly inquiry focused on the study of mathematics teacher educators' (MTEs') practices and their impacts on preservice teachers (PSTs). The research agenda contains two strands of inquiry exploring (1) empirical links between PSTs' development and MTEs' practices and (2) variation in MTEs' practices and the evolution of methods course activities over time. Participants will discuss and dissect (a) existing literature illuminating the impact of methods activities on PSTs' development, (b) methods of documenting and exploring MTEs' practices and (c) the next steps to be taken in the development of the research agenda and the design of scholarly inquiry. Dialogues and collaboration among working group members will be encouraged. We will provide opportunities for individuals or teams to engage in the development of facets of the emerging research agenda.

Keywords: Teacher Education-Preservice, Instructional activities and practices

Background: Exploring the Content of Methods

The 2012 "*Content of Methods"* working group was established and began exploring one central question: "What does the research literature reveal about mathematics methods courses in terms of frameworks, activities, and residues?" (Kastberg, Sanchez, Edenfield, Tyminski, & Stump, 2012) . Central to our working group was a commitment to answering repeated calls to the field (Arbaugh & Taylor, 2008; Cooney, 1994; Lee & Mewborn, 2009; Mewborn, 2005) for research studies and a research agenda focused on informing and supporting the work of mathematics teacher educators (MTEs). In 2013, the working group will continue its explorations of methods courses framed by a research agenda developed through studies of existing activities conducted in 2012 and 2013 as well as reviews of scholarship investigating methods courses. Such work is focused on the empirical investigation of MTEs' practices and goals as they relate to preservice teachers' (PSTs') learning to teach mathematics and is grounded in the "psychological aspects of teaching and learning mathematics and the implications thereof" (www.pmena.org).

In the remainder of this proposal we identify how the working group has contributed and will continue to develop a research agenda for the content of methods. We first outline the history of the group including a summary of contributions to date. Second, we articulate a research agenda for the group, which draws from our group's prior work. Finally, we outline the working sessions and discuss the goals of methods courses as well as the potential impact of selected methods course activity-types on PSTs' learning and practice.

History of the Working Group

Prior empirical explorations of the content of methods (Harder & Talbot, 1997; Taylor & Ronau, 2006; Watanabe & Yarnevich, 1999) have uncovered some commonalities in activities used in mathematics methods courses, but have done little to move the field forward. Our research group was formed with the intent of moving toward a research agenda for studies of methods. Informed by the studies above, the working group leaders collected data from a voluntary survey of 79 MTEs, in which we asked respondents to identify 2-3 "important" activities from their methods courses. This survey differed from previous studies in that respondents identified important activities, rather than researchers inferring the importance of activities from course syllabi or providing respondents with *a priori* categories of important activities which they rated with respect to importance. Consistent with earlier findings, planning was identified as the most used activity in methods; 32 percent of the 205 "important" activities identified by MTEs were focused on planning. The survey results also suggested there is substantial variation across and within the activities MTEs use in methods courses. This result was consistent with earlier studies. However, the effect and meaning of this variation identified in all studies of methods is not clear. Taylor and Ronau (2006) suggested that further study of such variation is needed as MTEs do not understand the benefits of including or not including various activities within a methods course. The survey also identified activities used in methods not included in prior studies. One such activity focused on providing PSTs with opportunities to explore students' mathematical thinking through the exploration of student work or by interacting with students. Such opportunities made up 10% of the activities MTEs reported in the survey. The identification of activities in the survey data not included in prior studies suggests that methods course activities may have changed as MTEs' understandings of the complexity of learning to teach have evolved. Yet scholarship in mathematics education has not tracked or explored such changes. These investigations suggest that further investigation into MTEs' practices and the effect of such practices on PSTs' development is needed to inform and support MTEs as they design, enact and investigate practices for a methods course, as well as to document the variation in and evolution of practices used by MTEs.

Our initial discussions of existing literature and the examination of the survey findings resulted in a presentation at the Association of Mathematics Teacher Educators (AMTE) (Kastberg, Edenfield, Sanchez, & Tyminski, 2012). Participants engaged in active discussions of the frameworks and activities they used in methods courses and encouraged our development of a working group. Thus, session presenters organized a PME-NA 2012 working group to develop a research agenda for the exploration of mathematics methods courses.

Watson and Mason (2007) suggest a difference between tasks as conceived by teachers and the experiences of the students, as the intended purpose may be enriched or diminished in student experience. We differentiate between activities as they are experienced by PSTs during a course and more long-term effects we call *residue*. In a mathematics course, residue refers to the mathematics retained by students as a result of solving problems (Davis, 1992). In methods courses we define residue as evidence of the impact of an experience beyond methods courses. Experience and residue form the overall *impact* of an activity on PSTs. With impact on PSTs' practice as our ultimate goal, the working group sessions were organized around the following "two threads of inquiry" (Kastberg, Sanchez, Edenfield, Tyminski, & Stump, 2012, p. 1264) for the exploration of methods courses: "Framework-Activity-Residue" and "Activity-Framework-Residue." We suggested MTEs could take one of two approaches in their design of a methods course. One approach is to begin with an overall theoretical framework, select and enact

activities that support the development of that framework, and examine the impact of these enactments on PSTs. The second approach is to select and enact an activity, employ a particular framework as a lens for the activity, and examine the impact on PSTs. Each approach could be an avenue for empirical investigation. The exploration of the Framework-Activity-Residue strand was motivated by Stump's (2012) presentation of her study of the frameworks MTEs use in developing and teaching methods courses. The exploration of the Activity-Framework-Residue strand was motivated by Tyminski's (2012) presentation of his study of one activity used in his methods course and the impact of this activity on PSTs. Discussion unearthed additional foci for future work including identifying learning goals, exploring how MTEs build instructional activities to achieve goals, and the possibility of building a repository including thick descriptions of activities MTEs use. At the conclusion of the final session, a Dropbox, including resources generated during the conference, and a contact list were created and attendees were invited to join.

A Research Program

MTEs have developed practices by drawing on their own experiences teaching teacher learners, through practical knowledge (Arbaugh & Taylor, 2008), and scholarly practices (Lee & Mewborn, 2009) adapted from literature on mathematics learning and teaching. Building from this research base, our 2012 discussions and work completed to explore current literature on the impact of MTEs' activities, Kastberg, Tymiski, and Sanchez (2013) have proposed two strands of a research program intended to further the knowledge base of mathematics teacher education. The first strand focuses on building the empirical basis for what Lee and Mewborn (2009) referred to as scholarly inquiry: explorations of "issues and practices through systematic data collection and analysis that yields theoretically- grounded and empirically-based findings" (p. 3). In this way, scholarly inquiry would support the creation of scholarly practices. MTEs' development, selection and enactment of activities should be informed by research that reveals links between MTEs' instructional practices and PSTs' development. We identify reports of scholarly inquiry exploring such links as contributing to the *learning strand* of the proposed research program. Inquiry focused on the development of PSTs' pedagogical concepts (Simon, 2008) or on PSTs' development of ambitious practices (Kazemi, Franke, & Lampert, 2009) are examples of research that would contribute to the learning goal.

The second strand involves inquiry into the variation in MTEs' practices. Reports describing methods activities must be created and disseminated in significant detail in order to allow for replication by other MTEs wishing to foster similar outcomes, and more importantly, enabling researchers to look across reports and gain insights about the evolution of MTEs' practices and to explore the variation in activities used in methods. The purpose and limitations of current research venues prohibit this level of detail. We identify this as the *landscape strand* of the research program. Reports of the development and descriptions of MTEs' activities would involve theoretical frameworks and perspectives held by the instructor, discussions of iterations of the activity enacted, and decision points in the construction of the activity. Enabling access to this information is paramount to the development of scholarly practice in mathematics education.

Progress Since 2012 Working Group

Sanchez, on behalf of the working group, presented a session at the 2013 annual AMTE conference "*Building a Theoretically-Grounded Practice of Methods Instruction.*" All active members of the 2012 PME-NA working group were invited to attend. Attendees discussed outcomes of the PME-NA working group and findings from work completed by the working group leaders. This work included the identification of common activities used by MTEs and

findings from a review of empirical studies focused on those activities and published in the *Journal for Mathematics Teacher Education* (JMTE). To continue to build understandings of the empirical support for existing MTEs' practices, we completed a systematic review of select journals (*Journal for Research in Mathematics Education, Cognition and Instruction,* and *Educational Studies in Mathematics*) for articles focused on methods activities after the AMTE session. This effort was extended to the development of papers summarizing existing research focused on three activities used by MTEs: dynamic interactions, video cases, and task analyses. Findings were presented and discussed at the 2013 National Council of Teachers of Mathematics' Research Presession during a symposium titled "*Building Scholarly Inquiry and Practices for Mathematics Methods Courses."* Dr. Denise Spangler served as the session's discussant, providing critical feedback on the ideas from the papers and the significance of the work. The research summaries, revised based on discussant feedback, will be used during the 2013 working group to stimulate questions and discussion about the learning strand of the research agenda. In addition these summaries will serve as a springboard for discussions of further studies that are needed. Brief overviews of the three summaries are provided below as context for the description of the proposed 2013 working group sessions.

Dynamic Interactions with Students

The reports exploring experiences of PSTs resulting from dynamic interactions with K-12 students and the mathematical thinking they generate were varied in their approach and illustrate that PSTs' development is progressive (Crespo, 2000) and linked to existing mental structures such as beliefs (Ambrose, 2004). These interactions may be synchronous, as in student interviews, or asynchronous, as in letter writing. Student interviews often employ various forms and structure and have been shown to impact PSTs' beliefs (e.g., Ambrose, 2004), interpretive listening skills (e.g., Jenkins, 2010) and questioning ability (e.g., Moyer & Milewicz, 2002). Letter writing, as a form of interactions with student thinking, provides PSTs with more time to examine student work and decide how to respond. Crespo's (2000) use of letter writing between PSTs and fourth grade students also addressed PSTs' developing interpretive listening skills as well as PSTs' emerging abilities to pose problems. Studies of letter writing at the secondary level include how such interactions support PSTs' abilities to develop cognitively demanding tasks (Kastberg, Tyminski, & Sanchez, 2013). Questions raised include: How should MTEs design and sequence interactions with students' mathematical thinking to impact pedagogical concepts? How might experiences for elementary PSTs be different from those designed for secondary PSTs?

Task Analysis

Although frameworks have been developed for tasks designed to be used with PSTs (Baturo, Cooper, Doyle, & Grant, 2007), there are no clear guidelines for MTEs regarding how to design activities that support PSTs' development and analysis of tasks. Teachers' use of tasks and the evolution of task demand during classroom discussions were initially highlighted by Silver and Stein (1996) as a result of findings from the Quasar project. As a result, attention to the cognitive demand of tasks has resulted in a focus on analysis of different dimensions of tasks in mathematics methods courses. PSTs' analyses and design of tasks have been linked to their content knowledge (Osana, Lacroix, Tucker, & Desrosiers, 2006) and mathematical play and exploration (Crespo & Sinclair, 2008) respectively. What is less clear is how analyzing and developing tasks might be framed to impact PSTs' future practice. In particular, how might MTEs support PSTs in ways that produce experiences with task design and analysis that encourage PSTs to attend to issues such as cognitive demand?

Video Case Analysis

Video case analysis as an activity in methods courses took many forms. Evidence from reports suggested that video cases can be used by MTEs to impact many dimensions of PSTs' development including their beliefs and views of teaching (Friel & Carboni, 2000), attention to student thinking (Masingila & Doerr, 2002), focus on links between teacher actions and student learning (Santagata, Zannoni, & Stigler, 2007), reflective stance (Stockero, 2008), and professional and mathematical norms (Van Zoest, Stockero, & Taylor, 2012). The use of video cases provides opportunities for PSTs to revisit teacher actions and student utterances and to build meanings for what they see in interactions with colleagues. The impact of this activity depends largely on the goals of the MTE in selecting and structuring the activity as well as how the activity is implemented. Two explorations of the impact of video case analysis identified residue from early use of the activity in methods courses (Stockero, 2008; Van Zoest, et al., 2012). These reports are of significant importance to MTEs planning methods instruction with the intent to impact PSTs' future practice.

Plan for PME 2013 Sessions

Although the review of existing literature provided insights that can be used by MTEs in selecting and implementing activities in methods, there is a need for more inquiry in this area. For example, MTEs' use of planning activities suggests that scholarly inquiry exploring these activities and their impacts (experience and residue) is needed. Questions about how best to structure lesson plans have emerged from existing literature (Zazkis, Liljedahl, & Sinclair, 2009). Further exploration of variations within activities used by MTEs is needed. To continue the effort begun in 2012, the 2013 working group sessions will introduce new attendees to the essential question of the group: "What is the content of methods?" and will provide a brief history of the progress of the group (Figure 1). In addition, members of the group will present findings from summaries of research reports contributing to the learning strand and will share draft versions of reports MTEs could potentially create to contribute to the landscape strand. These presentations will be used to introduce the strands of the research program and to motivate attendee discussion.

The 2013 working group will focus on two guiding questions:

1. How do we envision and implement scholarly inquiry designed to explore the nature of the residue for a particular framework and/or activity?

This question focuses on understanding the experiences PSTs bring to and develop in methods and how they interact with experiences in other facets of teacher education programs and teaching experience. MTEs' roles in teacher education programs uniquely position them to ask questions about the influence of empirical research in programs of study and to motivate the use of empirical study in program design.

2. How can we encourage MTEs to leverage their current practice in order to contribute to the development of scholarly inquiry for methods?

This question focuses on the exploration and consideration of MTEs' existing practices developed through experiences in local contexts, "practical knowledge" (Arbaugh & Taylor, 2008), or designed by drawing on research findings. MTEs should share, structure, and review reports of these practices. Developing a repository of MTEs' practices can facilitate a systematic exploration of the evolution and variation in such practices.

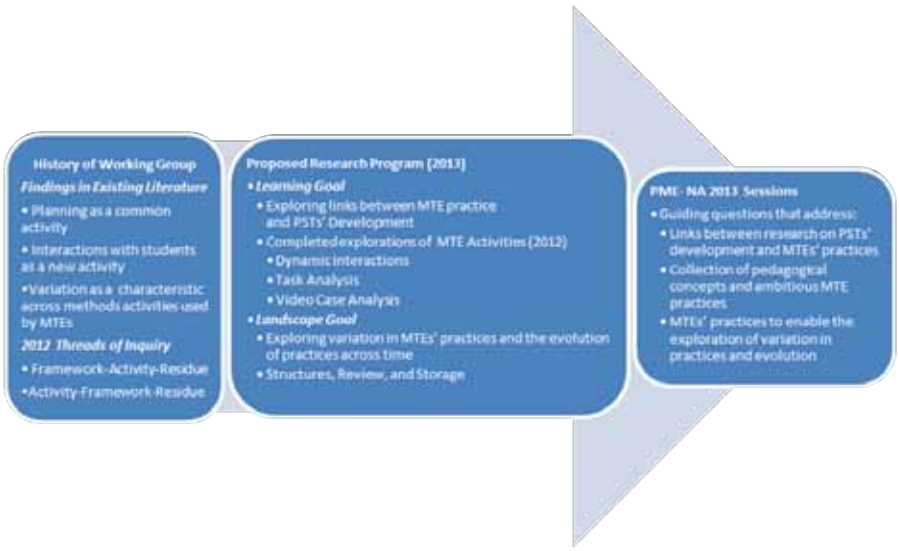

Figure 1: Evolution of Working Group Themes and Aims

Outlines of Working Group Sessions

Day 1. Our first session will include an introduction and overview of the working group (Figure 1). We will begin with a presentation describing the background and goals of the group. We plan to present the disparate knowledge base about methods courses and prior efforts to explore the content of methods courses. To orient the attendees to the discussion of the strands for the research program, we will share examples of reports that could contribute to the landscape strand and to the learning strand of the research program.

We address the landscape goal by presenting a report of one MTE's implementation of letter writing derived from scholarly inquiry (Crespo, 2003) describing the context and impacts of this interaction on PSTs. This report will be offered as an example of MTEs' reports of their scholarly practices. The characteristics of such reports and criteria for their review will be discussed (referred to as structures and review in Figure 1). In addition, plans for dissemination of such reports will be explored (referred to as storage in Figure 1). Attendees will then move to the learning strand. Pedagogical concepts (Simon, 2008) and processes such as routines to support ambitious practices (Kazemi, Franke, & Lampert, 2009) will be introduced to frame the discussion. The three research summaries described above of reports addressing the learning strand will be shared. Attendees will use these reports as a springboard to suggest additional lines of inquiry focused on linking MTEs' practices and PSTs' development. Attendees will be invited to contribute short presentations of their research or instructional activities on Day 3.

Day 2. The goal of the second session is to explore a conceptual plan for moving forward in addressing the learning and landscape strands. The session will begin with two presenters describing studies conducted with PSTs. The first study explored an assignment in which PSTs analyzed a video of their own teaching as reflection on the type of discourse the PST generated with students. The second study examined PSTs' capacity for lesson planning. In the study, PSTs wrote lesson plans using three different modes of production, namely synthesizing, creating, and modifying, and the study compared the quality of the lessons PSTs delivered. Noticing curriculum design as a primary topic in mathematics methods courses, the study questions whether or not curriculum design needs to be an essential part of the methods course. These two studies will serve as seeds for the ensuing discussion about the learning and landscape strands for the proposed research program. Discussion of the learning strand will be focused

with questions such as: What pedagogical concepts or ambitious practices are these studies exploring and are those pedagogical concepts or practices central to a methods course aligned with reform-oriented teaching? What pedagogical concepts or ambitious practices should be included in a methods course aligned with reform-oriented teaching? How do we prioritize the pedagogical concepts or ambitious practices to address the needs of beginning teachers? Discussion of the landscape strand will be focused on the question: What information do MTEs need from these studies in order to make use of these results in their own practice?

Day 3. Time will be allotted in our third session for working group participants to share their own methods activities and discuss scholarly inquiry related to these activities. In addition, the group will discuss what information would need to be provided about presented activities and their enactment for MTEs to make decisions about implementing the activity in their own methods practice.

The working group leaders intend to seek funding to underwrite a conference aimed synthesizing, supporting the development of, and disseminating scholarly inquiry focused on MTEs' practices in methods. On Day 3, participants will discuss the conference aims and make suggestions regarding participants and structures.

We will close out the working group sessions by discussing the development of appropriate venues, such as a repository, for MTEs' descriptions or reports of activities they use and their evolution. This topic was of primary interest to attendees in 2012. Time will be devoted to the development of a subgroup interested in pursuing the creation of a repository. The subgroup will be provided with sample reports drawn from research literature (e.g., Duffie, Akerson, & Morrison, 2003). In addition, we will discuss the logistics of follow up activities for the working group. The group will decide the best way to communicate and share files over the upcoming year (e.g., Google Group, Dropbox, etc.).

Anticipated Follow-up Activities

As we move forward in explorations of MTEs' practices our goal remains that of encouraging the development and dissemination of scholarly inquiry and practice within mathematics methods activities. Although there have been discussions about standardizing the preparation of teachers (for one discussion see, Richardson & Roosevelt, 2004) we view such movements associated with mathematics methods practices as premature. Instead, the working group seeks to understand MTEs' practices, impacts of practices, variations in practices, and evolution of practices. We claim that scholarly inquiry focused on experiences of PSTs in methods and the evolution of PSTs' understandings of those experiences across their careers has the potential to inform MTEs' practice. We further anticipate that the creation of publication venues that encourage MTEs to share the development and enactments of activities, with attention to frameworks, contexts (such as program size, student population, characteristics of space), critical decision points, as well as impacts, will support MTEs' development of scholarly practices and research explorations of variation within and between MTEs' practices.

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