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WHAT IS THE CONTENT OF METHODS? BUILDING AN UNDERSTANDING OF FRAMEWORKS FOR MATHEMATICS METHODS COURSES

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This discussion group will focus on exploring the use of conceptual frameworks in building mathematics methods courses for prospective mathematics teachers. Participants will consider (a) frameworks, (b) activities, (c) relationships between frameworks and activities, (d) the residue of activities and how they contribute to learning to teach, (e) research literature and attempts to explore these questions, and (e) development of a research agenda. Dialogues and collaboration among working group members will be encouraged by the development of teams to address facets of the emerging research agenda.

Keywords: Teacher Education–Preservice; Instructional Activities and Practices

Focuses and Aims for the Working Group

In light of the improved ability to track and compare student performance, mathematics teachers' impact on that performance has drawn increased scrutiny. Additionally, national accountability movements have begun to turn a lens toward mathematics teacher preparation in order to identify why some teachers are able to impact student performance, while others struggle. Although mathematics teacher educators (MTEs) have always examined and sought to justify their practices, studies have identified broad differences in emphases and instructional approaches (Harder & Talbot, 1997; Taylor & Ronau, 2006; Watanabe & Yarnevich, 1999) employed in teaching preservice teachers (PSTs). To begin to build descriptions, understanding, and theory about the work of MTEs in methods courses, we posed the question "What is the content of mathematics methods courses?" This question includes the idea of curriculum in a broad sense. We view learning opportunities and MTE's enactment of them with PSTs as content, but also realize that discussions during the working group will help us explore notions of content. The central question that emerged through our discussions was whether and how MTEs use research-based frameworks to build and explore their work and the impact of that work on our PSTs' learning and teaching. The exploration and development of frameworks used by MTEs will enable the field to build "a deeper and better understanding of the psychological aspects of teaching and learning mathematics and the implications thereof," one of the three main goals of PME-NA.

In the remainder of this proposal we interweave the focus of the working group with what we hope to accomplish during our working group sessions and beyond. First, we position ourselves as MTEs in the role as researchers who, collectively, must begin developing records of our practice in methods courses. Next, we summarize studies conducted on the content of methods courses. This prior research is then linked to a survey administered by our research team that asked MTEs to consider how they frame their methods courses. Finally, before outlining the working sessions, we discuss the goals of methods courses and the potential impact of selected methods course activity-types on PSTs' learning and practice. In each section we pose a few questions that may be of interest to working group participants.

Scholarly Inquiry in Teaching Methods Courses

In 2005, Mewborn identified confusions regarding frameworks and perspectives, or worldviews, in the reporting of research. In this work she called for the development of frameworks for individual researchers and at the level of the field of mathematics teacher education. In 2010, Arbaugh and Taylor (2008), drawing from Hiebert, Gallimore, and Stigler (2002), called for the development of "professional knowledge" they described as "knowledge that the research community establishes" or knowledge developed from empirical studies (p. 2). This knowledge was contrasted with "practical knowledge" that is built up by MTEs as they do the work of teaching and reflect on that work. Building from this view, in 2009, Lee and Mewborn, citing Richlin (2001), emphasized the significance of the development of scholarly inquiry and scholarly practices. Scholarly inquiry was described as explorations of "issues and practices through systematic data collection and analysis that yields theoretically grounded and empirically-based findings" (p. 3). This work could in turn be used to develop scholarly practices, "practices adapted from empirical studies of the teaching and learning of mathematics and the preparation of mathematics teachers" (p. 3). Within the tangle of terminology lies the idea that MTEs build practices for and through their interactions with PSTs and engage in the work of teacher as researcher by reflecting on and modifying the practices they enact. Such practical knowledge contains facets of scholarly inquiry, but is not often recognized as research. Yet MTEs know that they are doing what researchers might call a personally powerful form of action research. These pieces of work are powerful to individual MTEs and close colleagues, who are collaborators or confidants, but are often not shared more widely in the form of peer-reviewed articles in mathematics teacher education literature. In this working group we hope to build a collaboration that develops methods for communicating and synthesizing these personally powerful practices and comparing these practices to what we can find in the research literature.

Practices may be shaped by worldviews or frameworks as defined by Mewborn (2005). One example of this direction is provided by Kazemi, Franke, and Lampert (2009), who describe their work to develop "pedagogies of practice" and generate activities for prospective mathematics teachers using a view of practice from social practice theory. They assert,

> The future viability of professional teacher preparation requires that we systematically pursue appropriate ways to develop, fine tune, and coach novice teachers' performance across settings. These activities must find their way into university coursework rather than be relegated solely to field placements (Lampert & Graziani, 2009). Our hypothesis is that organizing professional education in mathematics education around core instructional activities and building links from the activities to student outcomes will enable us to support ambitious teaching. (p. 12)

Efforts such as this begin to build a perspective for the work of MTEs in which frameworks and goals for teacher practice are used to build instructional activities. As Kazemi et al. point out, we have empirical evidence of teacher practices that impact students in various ways; what is less clear is how MTEs' practices builds the sorts of teacher practices that can be sustained in the varied contexts of schools. Identifying and hypothesizing about pedagogical practices and their links to frameworks (not just worldviews) that enable the subtle modification of activity and analysis of associated evidence is critical for our field.

Studies of Methods Courses

Members of the mathematics education field have recognized both the lack of communication and the lack of consistency across methods instructors and courses in the United States, and studies have been conducted documenting these inconsistencies. For example, Harder and Talbot (1997) collected methods course syllabi from members of the Association of Mathematics Teacher Educators (AMTE), and examined the instructional approaches and assignments in the syllabi. The most commonly reported instructional approaches were whole class and group discussions, lab experiences (software, manipulatives, graphing calculators), student presentations, micro-teaching or peer-teaching, field-experience, lecture or direct instruction, and cooperative learning. The five categories of assignments reported were writing assignments, planning, presentations, participation, and resource files.

Watanabe and Yarnevich (1999) gathered survey data from elementary mathematics methods instructors, mathematics supervisors, inservice elementary school teachers, and preservice teachers. It is noteworthy that the survey used for this study asked respondents to rate pre-determined topics on a Likert Scale (1—topic should not be included, up to 4—topic must be included). This context is important when interpreting the findings of the study, given that participants were not able to say what was important to them in methods courses from their own perspective—they were limited by the choices on the survey, and they were also limited by their understanding of the meaning of the topics on the survey. The authors found substantial agreement between methods instructors, mathematics supervisors, and inservice teachers that mathematics methods courses should include current trends, doing mathematics, teaching a lesson, curriculum resources, manipulatives, problem-centered teaching, and questioning techniques. The inservice teachers and supervisors felt that demonstration lessons, lesson plan analysis/critique, writing in mathematics, lesson plans, authentic assessment, and performance assessment were important topics for elementary mathematics methods courses.

Taylor and Ronau (2006) approached this line of inquiry differently, examining methods course syllabi and identified seven common categories of goals and objectives: pedagogical skill, knowledge of content, dispositions, professionalism/leadership, pedagogical content knowledge, human development, and pedagogical knowledge. The authors noted,

> the most remarkable result is the surprising level of variability between mathematics methods courses … Syllabi that are clearly different from the de-facto consensus with respect to what they chose to include, or perhaps more strikingly, what they do not include, may offer quite different experiences for their students. We do not know if their students benefit from these differences or if they miss something crucial. (pp. 14–15)

These studies illustrate that there is substantial variation between mathematics methods courses in general. What is less understood is the source of such variation. Do MTEs draw from different frameworks as they develop activities? If different frameworks are drawn upon and a common activity is used, what are the impacts on PSTs?

Working Toward Frameworks

To explore the notion of framing in methods courses, we solicited MTEs on two listserves to respond to the following questions. Seventy-nine MTEs responded.

1. If you already have a frame for your mathematics methods course briefly describe how you organize/frame it.
2. If you do not have an existing framework, look through your syllabus and posit a framework to describe it.
3. Briefly describe the most impactful activities you engage in with your methods students.

We intentionally did not describe what we meant by "frame" to see how members of the field would interpret the term. In our conversations, we had come to view frames as more a way of *orienting* students to our course than of *organizing* our course. What we found in our categories, however, was more of an organizing structure. The categories ended up sounding more like the *topics* of the course more than the *framework* for the course. Responses of MTEs who named a framework and activities they shared are summarized in Table 1.

Table 1: Frameworks and Activities from Survey

Frameworks	Activities
1. Importance of knowing the learner 2. NCTM Process Standards and CCSS Standards for Mathematical Practice 3. Addressing the needs of all learners 4. Task selection and analysis 5. Understanding how students learn mathematics 6. Emphasis on students' mathematics 7. Manipulatives and concrete models 8. Cognitive or developmental stages and learning trajectories 9. Motivation and engagement 10. Curriculum 11. Modeling best practices for teaching 12. Reflection on mathematics teaching and learning practice 13. Integration of content and pedagogy/mathematical knowledge for teaching	1. General lesson planning 2. Manipulatives and technology 3. Making sense of PST's own mathematics 4. Microteaching 5. Interviews and interventions with K–12 students about their mathematical thinking 6. Assessment 7. Discourse-focused activities 8. State and national standards 9. Problem solving 10. Reading reflections 11. Facilitating lessons or tasks with undetermined audiences 12. Analyzing student work and error analysis 13. Unit planning

We hope to encourage participants to move beyond thinking about organizational structures and to think about frameworks as structures for orienting methods courses. We also hope to consider frameworks as something more specific than worldviews. How are framework(s) used in planning and exploring impacts of mathematics methods course? How do the results of activities help inform frameworks? To answer these questions, we need to consider goals for methods courses and the impact on our PSTs' learning and eventual teaching practice.

Goals for Methods Courses

NCTM (2007) outlines standards for the education and professional growth of mathematics teachers, focused around five issues: (a) teachers' mathematical learning experiences, (b) knowledge of mathematical content, (c) knowledge of students as learners, (d) knowledge of mathematical pedagogy, and (e) participation in career-long professional growth (p. 109). Although these standards do not constitute a framework as described by Mewborn (2005), they do provide a structure around which to identify specific goals that inform the development of frameworks for methods courses.

Despite the recommendations and vision statements from NCTM over the last few decades, much of the teaching in the United States focuses on helping students get through courses and pass standardized tests. If our PSTs experienced this type of mathematics, expecting them to teach in other ways can lead to cognitive dissonance for the PSTs and frustration for the MTE. However, this does not mean that MTEs should abandon expectations that new teachers teach in ways outlined by NCTM's vision documents. Instead, developing PSTs' proficiency "in designing and implementing mathematical experiences that stimulate students' interests and intellect" (NCTM, 2007, p. 5) might be addressed by many activities in methods courses, including task/lesson/unit planning and equity/diversity activities. Teachers must also be able to "orchestrate classroom discourse in ways that promote the exploration and growth of mathematical ideas" (p. 5) and "assessing students' existing mathematical knowledge and challenging students to extend that knowledge" (p. 6). To work toward becoming proficient in these areas, PSTs need to be provided opportunities to analyze student work—both written and verbal, to formatively and summatively assess student reasoning and understanding, and to interact with students in an effort to understand their thinking and learn to ask good questions.

Although methods courses might implicitly, or even explicitly, address the teachers' mathematical learning experiences and content knowledge, one might argue that these courses should launch PSTs into their careers with some knowledge of learners' mathematics, knowledge of pedagogical strategies, and a disposition toward continual growth and collaboration. We hope to generate discussion of these, and other, goals for the education of mathematics teachers, particularly at the preservice level. What additional goals might help us build frameworks for our methods courses? How can we design activities that support our goals?

Residue of Activities

In the process of envisioning and designing effective methods courses, MTEs must consider their goals and outcomes for PSTs and the activities or experiences they believe will be useful in helping PSTs reach these goals. One facet that is often neglected or unknown, however, is the ultimate impact methods courses experiences have on PSTs once they leave campus and enter their own classrooms. In a mathematics course, the term *residue* refers to the mathematics retained by students as a result of solving problems or completing a specific task (Davis, 1992). In considering an approach to the framing, content, and design of methods course activities, we posit it is crucial to consider, understand, and empirically examine the residue the methods course activities have on PSTs. A search of the *Journal of Mathematics Teacher Education* revealed approximately 70 articles about activities in methods courses; however, those articles do not paint a coherent picture of what is valued in methods courses or of the long-term residue of such activities on the PSTs' eventual teaching practice. Similarly, in examining our survey results, we realized that although some of the activities most commonly used in methods courses are supported by empirical evidence, we would do well as a field to engage in further study of the implementation and outcomes of specific activities and to findings about residue to systemically inform the design of methods courses.

Lesson planning activities. A few empirical studies of commonly used methods course activities have documented the residual effects, albeit short-term, of those activities. For example, in recent years, MTEs have used lesson study or modified versions of lesson study in their methods courses and have reported that the experiences help PSTs learn to become collaborative, reflective practitioners (Matthews, Hlas, & Finken, 2009; McMahon & Hines, 2008; Suh & Parker, 2010). McMahon and Hines also noted that the PST's post-lesson reflections were focused on student learning rather than on the role of the teacher. However, the PSTs indicated reluctance to instigate lesson study cycles with their collaborative teachers, citing concerns about inconveniencing the teachers. If the PSTs are not likely to engage in lesson study in the future, we might question the lasting residue from such activities. Matthews et al. found that PSTs benefitted from the ideas developed during lesson study in the short-term. They discussed the value in the 4-column lesson plan common in lesson study to focus PSTs' attention on how to build and support student understanding rather than to focus merely on what the teacher does during the class. Finally, Suh and Parker found that engaging PSTs with inservice teachers in the lesson study process helped develop the PSTs' mathematical knowledge for teaching, revealed gaps in the PSTs' mathematical knowledge, and increased the PSTs' awareness of the complexity of teaching and the importance of reflective practice. For each of the last two studies, because no post-methods course data were reported, MTEs are left wondering about the residue of using this 4-column lesson plan format, or lesson study in general, in methods courses.

Discourse activities. A synthesis of the types of discourse and associated research demonstrates the powerful impact of mathematical discourse on student learning (Franke et al., 2007). This impact was also reflected in the beliefs of our survey respondents; a number of MTEs reported inclusion of activities focusing around helping PSTs learn strategies and approaches to facilitate mathematical discourse. Specific examples reported in the survey include use of the texts, *Classroom discussions: Using math talk to help students learn* (Chapin, O'Connor, & Anderson, 2003) and *5 practices for orchestrating productive mathematics discussions* (Smith & Stein, 2011). These specific frameworks for discourse are readily used in professional development. Of interest would be activities used to support understandings of discourse and the impact of these activities on PSTs facilitations of mathematics discourse.

Understanding and extending students' current mathematical thinking. According to our survey results, another outcome valued by MTEs is the development of PSTs interpretations of and utilization of students' current ways of thinking. Research in this area has demonstrated the power of teachers' use of children's thinking as a basis for mathematics instruction (Franke et al., 2007; Koehler & Grouws, 1992). Recently, Jacobs, Lamb, and Philipp (2010) have introduced the *professional noticing of children's mathematical thinking* construct as a means to make sense of teacher actions in the classroom. Their study involved a group of PSTs as well as three other groups of increasingly more experienced teachers. The authors concluded that the constructs of noticing were much less developed in PSTs than would be expected. For MTEs the question might be how to provoke noticing that leaves residue useful in interactions with children. More importantly, the authors posit these skills are not a part of the typical knowledge of adult learners and presented evidence that with experience and training, teachers can become much more effective at attending, interpreting and responding to student thinking.

Equity and social justice activities. The Equity Principle of the NCTM (2000) calls for high expectations and support for all students to learn challenging mathematics. This call "challenges a pervasive societal belief in North America that only some students are capable of learning mathematics" (p. 12). NCTM also states that accomplishing equity, including providing the kind of accommodations, resources, and differentiation needed for all students to be successful requires teachers "to understand and confront their own beliefs and biases" (p. 14). Researchers have highlighted the difficulties of preparing PSTs to teach in ways that support a vision of equity described by Gutiérrez (2002) and NCTM (Garii & Rule, 2009). Yet work has begun to identify instructional activities (de Freitas & Zolkower, 2009; Rodriguez & Kitchen, 2005) and learning trajectories (Turner et al., 2012) that help MTEs understand learning to teach "effectively in diverse classrooms" (p. 67). Such work builds from existing research on noticing (Jacobs et al., 2010) and transformation. But will any of the short-term residue of these activities remain with the PSTs as they meet the daily challenges of their teaching contexts? How do differences in field experiences impact residue of such activities?

With the notion of residue in mind, it is crucial that we tie our activities closely to our goals and frameworks. Is residue the reflection of goals? Which activities are most likely to result in residue? Are there clusters of activities that might lead to residue? We also may need to consider how our goals and activities are supported or challenged by the teacher education programs in which our methods courses exist. How can we promote residue within the existing culture? Which activities have the most potential for residue within the existing culture?

Exploration of the content of methods, to build understanding of MTEs' use of frameworks to inform activities and activities to inform or develop frameworks, supports the PME-NA conference theme of navigating transitions in professional learning. While learners in this context are both MTEs and PSTs, they work together to navigate career transitions and understandings of the academic and school settings in which they work. Explorations of frameworks and activities will further allow MTEs to leverage their considerable practical knowledge to build lines of scholarly inquiry supportive of the development of scholarly practices.

Outline of Working Group Sessions

Our first session will include an introduction and overview of the working group. 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 participants to the discussion of frameworks and activities, we will present one activity used by authors of the proposal and explore how it links to the framework for the course. In addition, participants will discuss how the framework can be used to gather evidence of residue that engagement in an activity might precipitate. Next, we will introduce two threads of inquiry with respect to frameworks, activities, and residue for the working group. The first thread is Framework-Activities-Residue and the second thread is Activity-Frameworks-Residue. Pictorial representations are provided in Figures 1 and 2, respectively.

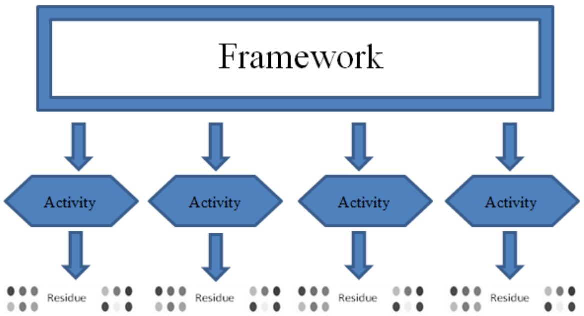

Figure 1: Framework-Activity-Residue

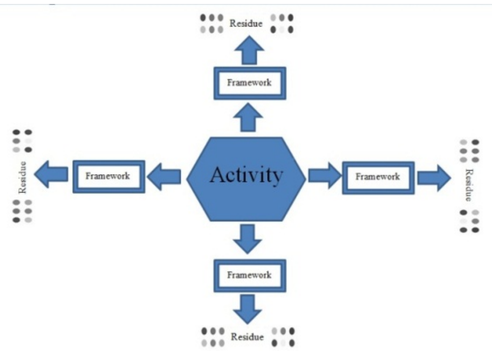

Figure 2: Activity-Framework-Residue

In the first thread, a particular framework is selected as a starting point. For example, consider the Task Analysis Framework (Stein, Smith, Henningsen, & Silver, 2009) for the cognitive demand of mathematical tasks. Authors have used the Task Analysis Framework to build activities for methods courses (e.g. Rutledge & Norton, 2008; Norton & Kastberg, 2012). We are interested in the residues of the activities. The question for the first thread of inquiry is:

> For a particular framework, what are the activities for which we have empirical evidence of residue, and what is the nature of that residue?

The second thread of inquiry takes as its starting point an activity. Here, let us take as an example video case analysis. Alsawaie and Alghazo (2010) used van Es and Sherin's (2002) Learning to Notice Framework. Stockero (2008) adapted van Es and Sherin's (2008) attributes of reflection by replacing their levels of reflection with those from Manouchehri (2002). The question for the second thread of inquiry is:

> For commonly used activities in methods courses (or novel ones that have been reported), what frameworks are supported, what empirical evidence of residue is available, and what is the nature of that residue?

Looking across both threads of inquiry, we seek to identify and describe existing findings. This inquiry will also reveal gaps in the literature, for which scholarly inquiry can be designed. In general we seek to describe gaps in the literature and answer the broader question:

> What does the research literature reveal about mathematics methods courses in terms of frameworks, activities, and residues with respect to mathematics methods courses?

The answer to this question sets a research agenda for scholarly inquiry into the practice of methods instruction.

In our second session, participants will start by unpacking frames and activities from courses. Participants will focus on looking at potential residue and relationship to frameworks. A series of presentations will serve to launch our conversations. One presenter will share activities and findings illustrating residue from the activities. Another presenter will share her study of MTEs frameworks, goals, and activities. Participant discussions of the work of the presenters will focus on connections between frameworks, activities, and residue and relationships to the two threads. Following the presentations, participants will break into smaller groups to work on the two threads of inquiry to propose syntheses of existing literature and research questions to be explored by the group as part of a developing research agenda. A database of articles, compiled by the authors of the proposal, exploring facets of MTEs' work with PSTs in mathematics methods will be used as a resource.

In our third session we will focus on building a plan for follow up activities.

1. Small groups will present a summary of discussions and plans for scholarly inquiry. This work will likely not be completed during the conference, but will be continued throughout the year electronically.

2. We will develop potential collaborations and plans to move forward on proposals for scholarly inquiry and opportunities to present at national conferences such as the national meetings of NCTM and AMTE.
3. We will discuss the use of Skype and Google Group for working as a group throughout the year.

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