1. Questions(s) or issue(s) for dialogue at Learning Network Conference session:

How are the projects using their own research and evaluation to inform implementation and sustainability? What types of sustainability are valuable and achievable: sustaining the ideas learned by partnerships through scholarship that embeds research into practice?

2. Context of the work within the STEM education literature and within your MSP project:

Hill et al. (2008) posited that mathematical knowledge for teaching is not limited to the common mathematical knowledge used across diverse professions and extended their definition to include subject matter knowledge that supports teaching. This subject matter depends upon a deeper understanding of mathematical concepts to allow explanations of why specific mathematical procedures work, descriptions of mathematical terms in language understood across the developmental levels of students, and explanations of student errors. In response to concern that middle school teachers “are not familiar with the content except at a rather superficial, disconnected, and symbolic level” (p. 31), Sowder, Philipp, Armstrong, & Schappelle (1998) developed teachers’ knowledge of rational numbers through a two-year professional development program. Participating teachers implemented their new knowledge in their classrooms through greater coverage of content, a focus on conceptual understanding in their instructional goals, and emphasis on student understanding. Although Hill, Rowan, and Ball (2005) found a link between mathematical knowledge for teaching and student achievement gains, Hill et al. (2008) cautioned that little is understood about how mathematical knowledge for teaching influences the quality of teacher instruction or the planning and behaviors through which knowledge is put into practice.

One goal of the WTMSMP is to develop middle-level mathematics teachers’ knowledge for teaching. In the first year, middle school mathematics teachers enrolled in a graduate level summer mathematics course with emphasis on deep conceptual understanding of the algebraic structure of the rational number field. The course was developed by a senior level mathematician and taught by a team of mathematicians across four university sites in West Texas. Also a segment of the course was devoted to the introduction of the importance of mathematics self-efficacy, or the beliefs one possesses in his or her knowledge and skills to successfully complete mathematical problems, in both teachers and students. Mathematics self-efficacy is associated with increased mathematics achievement in public school students (Stevens, Olivarez, Lan, & Tallent-Runnels, 2004; Stevens, Olivarez, & Hamman, 2006) and teachers’ self-efficacy has been linked to students’ self-efficacy, motivation, and achievement (Anderson, Greene,
Loewen, 1988; Ashton & Webb, 1986; Midgley, Feldlaufer, & Eccles, 1989; Ross, 1992). This additional focus allowed the WTMSMP to provide teachers with not only deep mathematical knowledge but with the belief, grounded in their actual class performance, that they could effectively use it.

Although few would argue the importance of mathematical knowledge for teaching and self-efficacy in this specific domain, teacher development opportunities do not always emphasize this type of content knowledge and instead focus on classroom strategies and programmed interventions. This is consistent with states’ and school administrators’ decisions to invest in curricula and programs that only require clearly prescribed delivery, which are decisions fueled by standardized testing (Bromley & Apple, 1992). Thus, teachers are dependent upon the mathematical knowledge of curriculum developers when they should be learning more about the subjects they teach. Because many teachers were trained with an emphasis on memorizing facts rather than the importance of deep conceptual understanding of content knowledge (Darling-Hammond & McLaughlin, 1995; Porter & Brophy, 1988), they require experiences that promote a deepening of their knowledge and skills (Garet, Porter, Desimone, Birman, & Yoon, 2001).

The WTMSMP goal of developing teachers’ mathematics knowledge for teaching appears consistent with expert recommendations and without controversy, especially in the context of the research literature that makes salient the importance of teachers’ deep conceptual understanding of the content they teach. However, when considering the high-stakes testing and standardized curriculum context of the State of Texas in addition to the resulting tendency for professional development to promote standardized curriculum, challenges to the implementation and sustainability of the WTMSMP become evident.

3. Claim(s) or hypothesis(es) examined in the work (anticipating that veteran projects will have claims, newer projects will have hypotheses):

1. The WTMSMP activities will significantly increase teachers’ deep conceptual knowledge of elementary mathematics. (This hypothesis was partially supported by initial findings)
2. The WTMSMP activities will significantly increase teachers’ mathematics and teaching self-efficacy. (This hypothesis was supported by initial findings)

4. Evaluation and/or research design, data collection and analysis:

The WTMSMP evaluation and research design is quasi-experimental and includes both within-subjects and between-subjects analyses. Additionally, a qualitative component was developed to support the quantitative results through description and explanation. The first year of data collection included a Q-sort of pilot of project teaching strategies (see Stevens, Harris, Aguirre-Munoz, & Cobbs, 2009); selected classroom observations; participant pre- and post-testing on measures of mathematics knowledge for teaching, teachers' self-efficacy, self-efficacy for cultural sensitivity, and teachers’ WTMSMP content self-efficacy; and a participant Q-sort of project activities. Finally, participants have been engaged in an online learning community since the completion of their first course where they participate in blogging, discussing, and sharing implementation experiences. The resulting online text and documents have been an additional source of qualitative information. Data were collected from 65 participants who attended a three-week course at one of four university course sites. Data collection of the comparison group
measures as well as continued observations of participating and comparison group teachers is in progress to address additional hypotheses investigating positive changes in student outcomes.

Initial analyses of within-subject differences revealed the following:

1. Overall, participants performed slightly better on the number concepts and algebra MKT tests, although these improvements were not statistically significant to suggest the change was beyond what would be expected by chance. Because participants received WTMSMP at four different locations and times through the summer of 2009, paired-sample *t*-tests were also conducted for each participant group. That is, pre- and post-test comparisons were separately calculated for participants attending the Texas Tech (TTU), Angelo State (ASU), Sul Ross (SRS), and University of Texas at the Permian Basin (UTPB) locations. Evidence was present for the significant growth in only the SRS participants on one measure, the MKT Algebra test (*t*(6) = -2.54, *p* = .04). Two groups, those attending the SRS and UTPB, locations, showed growth, although not significant, across all MKT measures. Participants attending the ASU location also showed growth on the Number Concepts and Algebra measures. TTU participants, however, scored lower, although not significantly lower, on all MKT measures at the posttest in comparison to their pretest scores.

2. Overall, pre- and post-test comparisons on self-efficacy measures indicated statistically significant growth in all areas with the exception of self-efficacy for classroom management. Statistically significant growth in areas of self-efficacy was not consistent across the four groups. Although the same pattern of growth (i.e., statistically significant posttest scores for all self-efficacy domains with the exception of classroom management) was observed for both TTU and ASU participants, SRS participants did not report statistically significant increases in their overall sense of teaching self-efficacy. In sharp contrast to these three groups, the UTPB group reported significant increases in only their instructional self-efficacy. Posttest scores for overall teaching efficacy, efficacy for engaging students and managing classrooms, efficacy for culturally responsive teaching, and efficacy for WTMSMP content knowledge did not significantly differ from those assessed at the pretest, although differences did exist to indicate the presence of higher scores at the posttest.

3. Results from qualitative analyses are discussed in Section 5 as they provide insight into the aforementioned quantitative results.

5. Key insights (retrospective for veteran projects, prospective for newer projects) that have value for the Learning Network:

Through the first year of WTMSMP implementation, several interesting challenges emerged that indicated teachers’ investment in the development of deep conceptual mathematics knowledge is not readily made. Pre-test information analyzed from open-ended questioning and initial interviews revealed that participants did not know what to expect from the WTMSMP course and related activities. For example, when initially asked “What knowledge and skills should highly qualified middle school math teachers possess,” teachers cited more pedagogical skills than content. After the intensive course, the majority (70%) shifted priorities to content based responses. Although this was the goal, the short nature of the WTMSMP course (i.e., three weeks) suggests that participants did not have much time to experiment with and elaborate upon this new perspective. Although this provides some explanation for the lack of statistically significant increases in participant mathematics knowledge for teaching scores, other issues that
relate to the amount and depth of content covered and measurement have also been suspected and due to the greater speculation and description involved are left to the presentation discussion. Furthermore, these issues may account for the differences across the growth of the groups by location and will also be a topic of discussion. For example, the number of participants attending the course at the Sul Ross State University location was considerably smaller \((n = 8)\) than the number at the other locations, which averaged about 19 participants. Observation suggested that the smaller group was able to move through the content more quickly, which allowed greater time for analysis and in depth discussion that could have resulted in the identification of implementation challenges and, thus, the limitation of increases in teaching self-efficacy. Additionally, participants’ initial reports of self-efficacy were high when addressing the open-ended questions, “Suppose your school adopted a new math program and it required that you begin to teach some topics you have never taught before. What initial action would you take? Would this affect your beliefs about your ability to teach effectively?” However, about 30% indicated they felt less confident after taking the course because they realized they needed to know more about the mathematics content they teach. Although all participants reported gaining knowledge from the WTMSMP course and quantitative results indicated an overall increase in self-efficacy, about half the respondents still had fears about future intensive math courses. Of these, 68% provided content-based fears.

Providing participants with clear expectations about the content they will learn in the WTMSMP as well as the purpose for a strong emphasis on deep conceptual understanding may not only help to allay content-based fears but promote participant investment. This approach would also assist participants who are moving forward in incorporating WTMSMP content into their practice and experiencing challenges from administrators and parents to provide a rationale to support their changes in curriculum and teaching. For example, a participating teacher blogged about the receipt of complaints from parents in response to the teacher’s change in order of the presentation of certain mathematical concepts (i.e., the teacher chose to not present topics in order of the textbook) based on knowledge developed from WTMSMP content. The parents complained to the school administrator who cited problems with standardized testing and demanded the teacher return to the prescribed curriculum. Thus, in addition to participants’ ability to demonstrate their new understanding of mathematics content and how to use it in the classroom they must be able to explain why they should be using it. These insights garnered from the research and evaluation of the first year if WTMSMP implementation have yielded the following recommendations to ensure that participants will sustain project ideas by putting their new knowledge into practice.

1. Openly address participants’ concerns that the WTMSMP content is focusing on their understanding rather than solely on the understanding of students.
2. Provide ongoing support for participants who are incorporating their knowledge into practice.
3. Provide opportunities to inform school administrators and policy makers of the role of mathematics knowledge for teaching in student achievement and to encourage their support of WTMSMP participants.