Session Title:
Eliciting and supporting teachers' openness to discussing deep mathematical issues.

MSP Project Name:
NJ Partnership for Excellence in Middle School Mathematics

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Project Session

Strand 2

Summary:
The New Jersey Partnership for Excellence in Middle School Mathematics (NJ PEMSM) is an NSF-MSP project to help mid-career middle school mathematics teachers deepen their content understanding. Outside observers have noted that participants seem remarkably willing to reconsider the mathematics they teach and to discuss openly their questions and confusions. Authors present several conjectures about how NJ PEMSM achieves this level of engagement and trust and offer evidence collected from multiple sources to support these conjectures.

Section 1: Questions framing the session:
What programmatic structures, activities, and behaviors have supported teacher participants’ willingness to think about and discuss deep mathematical issues underlying middle school mathematics?
What programmatic structures, activities, and behaviors have enabled teachers to share their confusions and uncertainties openly in discussions of the mathematics they teach?
What evidence is available to NJ PEMSM to analyze conjectures in answer to the questions above? What conclusions can be drawn from the evidence in hand?

Section 2: Conceptual framework:
The New Jersey Partnership for Excellence in Middle School Mathematics (NJ PEMSM) is designed to help mid-career middle school math teachers deepen their mathematics content understanding. Outsiders have reported that teacher-participants seem unusually open to reconsidering the mathematics they teach and to discussing openly their questions and confusions. Accepting these reports, this presentation, will (1) present conjectures about how NJ PEMSM achieves this level of engagement and trust and (2) analyze supporting research evidence. The evidence is taken from video-recordings of classes, systematic observation of classes in the NJ PEMSM Institute, surveys and focus group interviews conducted by the project’s external evaluator, and surveys constructed and
analyzed by NJ PEMSM staff. Thus the presentation addresses the path from vision through implementation to impact and provides evidence of outcomes from the perspectives of mathematicians, mathematics educators, teachers, and researchers.

In designing the Partnership Institute, the leadership team took very seriously the districts’ expressed needs and desires, which focused on improving teachers’ mathematical understanding and confidence. Districts identified a need (in anticipation of the Common Core Standards) for professional development that increased flexibility when discussing mathematics in order to enhance student engagement and progress in the work of learning mathematics. Districts also requested the inclusion of special education teachers who supported mathematics teachers as one way to improve collaboration and to better support student learning. Another desire was that teacher participants develop capacity to facilitate informal peer-to-peer professional development activities to compensate (in part at least) for the loss of paid math coaches.

Another crucial input to planning was research evidence about the importance of affect in efforts to enhance engagement in mathematical learning – regardless of age or experience of the learners. This input came from the graduate students, faculty, and research associates of the NSF-funded MetroMath Center at Rutgers University. This strengthened our commitment to developing cohort cohesion and using small-group work with “guides on the side.”

Teachers moved through the Institute in cohorts of approximately 25 individuals. We tried to admit several teachers from each district to each cohort so that no teacher would feel isolated. The introductory course, Seminar in Mathematical Ideas, provided time for discussions of ideas from middle school mathematics that have been problematic throughout the history of mathematics – for example, the question “How can zero be a number? It doesn’t count anything.” This historical approach showed that these ideas are not “trivial” or “obvious” and that it makes sense for students to wrestle with them.

In the mathematics content course, we structured the classes to minimize “direct instruction” and to maximize small-group work on mathematically rich problems that would evoke multiple representations and multiple approaches to solution and explanation. Each morning two groups would report on assigned problems from the previous day – again providing a variety of methods and reasoning. Thus teachers could become more comfortable with explicit reasoning and would see how different points of view could arise naturally and usefully. The institute included two courses on aspects of mathematics pedagogy – a modified lesson study course on mathematical reasoning in middle school and a course on motivation and affect. These courses also reinforced explicitly the implicit messages we were sending about effective teaching styles. Finally we were careful to form instructional teams that included mathematics faculty, teacher peer mentors, and instructional assistants who were sympathetic to these design principles and were willing to invest time in developing workshop problems (and later revising them) to incorporate the experience and knowledge of our research associates.

**Section 3: Explanatory framework:**
The conjectures we have formulated for our apparent success in evoking open discussion amongst our teacher-participants can be organized into four groups.
1. The cohort structure provides a sense of safety and collegiality. Explicit emphasis by university personnel on their expectation of learning from teachers (e.g., about courses for prospective teachers) builds mutual respect. Good humor and good food also help; as does acting promptly on the results of “daily feedback forms.”

2. Focus on the math of the middle grades and explicit intent to build on prior understanding meets teachers’ interests and respects their professional status. Avoiding reliance on “trickle down” effects from advanced topics and/or esoteric topics keeps the emphasis on teachers’ interests as opposed to university interests. Daily sessions on “classroom connections,” with some presentations and activities led by our teacher peer mentors and teacher participants, also build mutual respect.

3. Avoiding direct instruction as much as possible and relying in large part on struggle with workshop problems generates engagement with the mathematics. The instructional teams’ focus on helping teachers articulate and clarify their ideas. It is valuable to point out that everyone makes mistakes (even professors!) and that errors are an opportunity to learn.

4. Even before the publication of the CCSS-M “core mathematical practices,” our emphasis on understanding, explaining, and employing a variety of mathematical approaches built confidence and flexibility while honoring teachers’ own ideas and concerns.

Examination of video-clips of classes and our evaluator’s data yields evidence in support of these conjectures. We mention teachers’ favorable reactions to the program because their satisfaction contributed to their own openness to learning and encouraged future cohorts to feel safe in participating. Space allows only a sample of findings here. Evaluators’ analyses of focus groups and test scores give strong evidence that teachers’ understanding of mathematics content deepened as a result of NJ PEMSM participation. Teachers described how their efforts to achieve better understanding helped them build empathy for their students who struggled with content. Teachers with weaker mathematics backgrounds cited epiphanies that they carried to their classrooms, and the revelations led them to see students’ errors no longer as “mistakes,” but instead as learning opportunities for all students. Although it is challenging to provide professional development for teachers with different levels of knowledge and skill, most teachers most teachers reported feeling challenged, engaged, and deeply satisfied with the learning opportunities provided to them. Even teachers with strong mathematics backgrounds reported learning content more deeply because they were encouraged to experiment and wrestle with concepts. Teachers with stronger mathematics backgrounds often reported learning how to make the more difficult or advanced content easier for students to understand. Teachers reported seeing results in their students’ participation in the classroom and observed improvements in students’ learning regardless of whether state test scores rose.

Video-clips show that the body language and spoken language of faculty was very friendly and inclusive. Teachers became more willing to ask questions and hazard conjectures. Many yelped happily when they found a sense of understanding; their colleagues often applauded. Everyone became comfortable joking while working and during breaks. Teachers gasped with incredulity, and later relaxed, when they saw faculty make mistakes, recognize them (often at a teacher’s prompting), and correct calmly. Subsequently, we saw teachers mention their own missteps during their
workshop reports. We saw the value of the “think-share-report” mode of evoking discussion. We learned and/or re-learned how difficult it is to break off enthusiastic small-group work to move on to full-class discussion formulating “take home” messages. Regular education teachers enjoyed seeing methods used by special education teachers to differentiate instruction and to provide concrete foundations for more “abstract,” or conceptual, learning.

We were surprised that teachers were often unaware of their implicit use of basic properties of number systems in their own computations and problem solutions. Making these properties explicit helped some teachers become more fluent in their mathematical work. They reported that asking their students, even special needs students, to articulate their use of such properties seemed to enhance learning and lengthen retention times. They also reported bringing parts of Institute material into their own classroom and finding that students looked forward to those bits of “Rutgers math.” This student reinforcement strengthened PEMSM’s credibility.

Section 4: Discussion:
We will increase the involvement of Institute graduates as teacher peer mentors and ask them to lead more of the “classroom connection sessions.” Inspired by the joy each cohort shows in reuniting at its graduation, we will invite graduates and participants to campus for an annual reunion with a speaker. Graduates reported that they intended to continue connecting with NJ PEMSM colleagues via social media, e-mail, and in person, if possible. We will maintain the partnership as a mutual support entity even after current funding ends. Partner districts will be actively involved in planning future grant proposals. Dissemination opportunities such as LNC will allow colleagues to adapt our methods and findings to their needs.

Section 5: How will you structure this session? What is your plan for participant interaction?
Following a brief introduction about the structure of NJ PEMSM we will list our conjectures about what generated openness to teacher engagement with the mathematics. The mathematician speaker and the evaluator/researcher speaker will alternately provide evidence in various forms – transcripts of teacher contributions to discussions and of instructors’ interventions, summaries of focus group discussions with the evaluator, and short video-clips if time permits. After evidence about each conjecture is presented, we will ask participants to talk briefly with their neighbors about their reactions and critiques – and then invite people to report on the ensuing conversations. We will incorporate participant insights into our summary remarks.