Mathematical Sciences Research Institute
Critical Issues in Mathematics Education series
The Mathematical Education of Teachers
Schedule, May 11 - 13, 2011

Wednesday, May 11

4:00 – 4:30 Introduction and overview

4:30 – 5:00 William McCallum, University of Arizona, *Common Core State Standards and Their Impact on the Education and Professional Development of Teachers.*

5:00 – 6:30 Reception and light buffet dinner

6:30 – 7:00 Denise Spangler, University of Georgia, *Why Content Knowledge Matters in Teaching and the Implications for Teacher Education.*
There is much discussion in mathematics education these days about "mathematical knowledge for teaching." We will look at some examples of student work to see why teachers' mathematical knowledge matters and to think about how using student work in teacher education can help develop mathematical knowledge for teaching.

7:00 – 7:30 Diane Briars, President of the National Council of Supervisors of Mathematics (NCSM)

7:30 – 7:45 short break

7:45 – 8:15 Deborah Ball, University of Michigan, *Learning to Teach Something in Particular: How the Common Core Can Leverage Radical Improvement in Teacher Training*.
David Cohen recently published an article in the American Educator entitled, "Learning to Teach Nothing in Particular," in which he argued that the lack of a common K-12 curriculum in this country has been a major impediment in teachers' training. In this talk, we show how we could use the CCSS together with a common core for teaching practice to build a reliable system for preparing teachers for responsible practice.

Thursday, May 12

8:00 – 8:30 coffee and tea

8:30 – 10:00 How can the community of all mathematics teachers work together and learn from each other to improve mathematics teaching?

8:30 – 8:50 Sybilla Beckmann, University of Georgia, *Could the mathematics teaching community become as successful as the mathematics research community?*

Conditions leading to the success of the mathematics research community are contrasted with the case of mathematics teaching at all levels.

8:50 – 10:00 Catherine Lewis, Mills College, *Lesson Study: A Promising Means to Support the Learning of Students, Teachers, and Mathematicians?*
This session will take up Sybilla Beckmann's call to create a community of all mathematics teachers, and will examine lesson study as one possible means to accomplish this. The session will present recent research on the impact of lesson study on both teachers' and students' mathematical knowledge, drawing on data from a recent randomized controlled trial. The session will explore the role of high-quality mathematical materials in lesson study, and will illuminate models of university-school collaborative lesson study from Japan as well as the United States. It will focus on the progress that has occurred in the US, and the challenges that remain, to create a community of all mathematics teachers.

10:00 – 10:30 Break

10:30 – 12:00 Panel on curriculum and teacher education in light of the Common Core – comments from curriculum developers.

Zalman Usiskin, University of Chicago
Paul Goldenberg, EDC
Andy Isaacs, University of Chicago

12:00 – 1:30 lunch

1:30 – 3:00 Susan Jo Russell, TERC and Deborah Schifter, EDC, *Early Algebra and the Common Core: What Do Teachers Need to Know?*
The phrase "properties of the operations" recurs throughout the elementary grades in the Common Core State Standards. How might elementary teachers introduce these properties to their students in ways that support students' work in computation and provide a link between arithmetic and algebra? What do teachers need to know in order to enact the standards in these ways? In this talk, we will consider a constellation of Common Core content and practice standards that relate to early algebra, offer classroom examples that illustrate how elementary students can engage with these standards, and engage with participants to consider what teachers need to know to enact such lessons.

3:00 – 4:00 coffee and tea

4:00 – 5:30 Research findings about teacher education

4:00 – 4:45 Raven McCrory, Michigan State University, *Achievement in Mathematics Classes for Future Elementary Teachers: What Matters?*
In this talk, I will address two aspects of undergraduate mathematics courses

for future elementary teachers.

1. What do these courses look like? That is, who teaches them, what is the content, how are courses organized, how do they differ across institutions, etc.

2. What systematic factors explain differences in *learning* across these courses, with different instructors and at different institutions?

Data come from a study of over 2000 undergraduate students at certifying institutions in four states, and include pre- and post-tests of students taking a mathematics course required for elementary certification; surveys of instructors of these courses; and interviews with mathematics department chairs.

Results suggest that, controlling for students' prior knowledge, two factors that matter are *use of a textbook* specifically written for a mathematics course for teachers; and teaching in a way that *engages students with doing mathematics*. These two factors have differential impact on students depending on students' prior knowledge. Models will be explained and implications of results for the design and implementation of mathematics classes for teachers will be discussed.

4:45 – 5:30 Sharon Senk and Maria Teresa Tatto, Michigan State University, *Mathematics Teacher Preparation: An International Perspective*.
The Teacher Education and Development Study in Mathematics collected data from approximately 24,000 future primary and secondary mathematics teachers in 17 countries. We will present findings and discuss implications for mathematics teacher preparation in the U.S.

Friday, May 13

8:00 – 8:30 coffee and tea

8:30 – 9:00 Joan Ferrini-Mundy, National Science Foundation, *Common Core Implementation and the Mathematical Education of Teachers: Policy Perspectives and Support*
The policy formulations that resulted in the establishment of the Common Core State Standards (CCSS) initiative by the National Governors Association and the Council of Chief State School Officers were rooted in the need to provide clear and consistent frameworks to prepare our children for college studies and, ultimately, successful working lives in science, technology, engineering, and mathematics (STEM) careers. Forty-one States, the District of Columbia and the U.S. Virgin Islands have formally adopted the common core standards in mathematics.

We are poised at the doorstep to implementation activities, state-by-state, as well as important policy research to brace the efforts. The new standards in mathematics elicit a well-known problem: If we expect children to demonstrate deeper mathematical understanding and be able to articulate their own reasoning, then we must strengthen programs for the education of both existing and future teachers of mathematics and align that preparation

with what is expected by the common core in mathematics.

Scholarly organizations across the country are already at work (the Conference Board of the Mathematical Sciences has issued recommendations on January 1, 2011) and this workshop is part of that national effort. In this talk, I will offer a NSF perspective about the challenges and opportunities in reaching tens of thousands of current mathematics teachers (as well as the undergraduate and graduate students in mathematics education programs that will soon join the workforce). What is NSF planning in terms of support for building the knowledge base to fortify these efforts? What are other federal and non-federal funders planning in terms of providing the resources for both professional development and teacher preparation?

9:00 – 10:00 Panel on curricula and teacher learning.

Aki Murata, Stanford University, *Navigating Standards: Teacher and Student Learning through Different Instructional Paths*
Standards and curricula present varied images of mathematics instruction that may at times seem conflicting and confusing to teachers. By contrasting how mathematics content is treated across grade levels in standards (e.g., Common Core Standards, California Content Standards) and curricula (e.g., Everyday Mathematics, Japanese mathematics textbooks), we will discuss how they can frame students' learning and experiences in different ways, and how these paths may also guide teachers' understanding of student learning of mathematics.

W. Stephen Wilson, Johns Hopkins University, *Textbooks: math as arbitrary rules.*
Some logic gaps in the development of mathematics in standard texts will be discussed. Examples will be given.

10:00 – 10:30 Break

10:30 – 12:00 Breakout sessions

Session A: *Lesson Study Models: What Models of Mathematics Lesson Study Have Emerged in the U.S. and What Can They Each Contribute?*

Catherine Lewis, Ruth Cossey & Elizabeth Baker, Mills College; Aki Murata and Bindu E. Pothen, Stanford University; Jackie Hurd, Palo Alto Unified School District; Ben Ford, Sonoma State University; Stan Pesick and Marlene Wilson, Oakland Unified School District; David Foster, Silicon Valley Mathematics Institute, and Tracy Sola, Belmont-Redwood Shores School District.

In this session, we will hear from experienced organizers and participants of four different lesson study models: preservice, school-wide, district-based,

and regional. Each model will be briefly described, with a focus on its particular niche within the improvement of mathematics instruction. Half the session will be devoted to Q & A with the audience, and suggestions will be provided for session participants who want to learn more about this model.

Several different lesson study models have emerged in the U.S. and have now been sustained, in some cases, for 5-10 years. Panelists will very briefly introduce examples of these different models of lesson study from the greater San Francisco Bay Area, focusing on the role each can play in building and spreading mathematical knowledge for teaching. Half of the session will be devoted to Q & A with session participants. Each presentation will (1) briefly describe the lesson study model; (2) illustrate what this model can accomplish (why it is important); and (3) provide references for session participants who want to learn more about this model.

Session B: Interactive session: Improving Teacher Education

Jim Lewis, University of Nebraska-Lincoln and Kristin Umland, University of New Mexico.
In this interactive session we will talk about efforts to improve teacher education. We will begin by discussing program development and partnership building efforts of the facilitators. Jim Lewis has many years of experience conceptualizing and implementing teacher education and professional development projects. Kristin Umland will share the struggles and triumphs of similar efforts at a less well-developed stage. The remainder of the time will allow for small and whole-group interaction between the participants and the facilitators.

Session C: Teacher education and professional development

Herbert Clemens, Ohio State University, *What does preservice math for middle school teachers look like? One perspective from a large state school.*
We will discuss how the preservice program for middle school math teacher needs to differentiate itself from that for elementary teachers and from that for high school math teachers. One underlying premise will be that the middle school experience of students is arguably the most critical period in their mathematical development. One has the sense that that is where, to quote Robert Frost, "two roads divide in a yellow wood..."

James Madden, Louisiana State University, *Geometry: Traditions and Standards.*
A "modern American pedagogical tradition" is apparent in the most commonly used high school geometry textbooks. They share terminology, selection and arrangement of topics, conceptual flow, kinds of exercises, etc. The presentation is conceptually shallow, procedure-oriented and lacking in coherent themes, except in a small number of exceptions. What professional

development do teachers need in order to acquire greater geometric understanding and proficiency and to be able to foster its development in young learners? How might the Common Core State Standards help?

Session D: Findings from mathematics education research

Anderson Norton, Virginia Tech, *Modeling Students' Mathematics*
Research on students' mathematical thinking can form the basis for educational decisions, including curricular design, professional development, and appropriate use of technology. We'll discuss examples stemming from teaching experiments on middle school students' reasoning with fractions. These teaching experiments reveal the roles of key mental operations (splitting and units coordinating) that are necessary for meaningful mathematical development.

Andrew Izsak, University of Georgia, *Teachers' Knowledge for Using Drawn Models of Fraction Arithmetic.*
The Common Core Standards emphasize the use of drawn models throughout the elementary and middle grades. Much more is known about how children reason with drawn models for fraction arithmetic than about how teachers reason with drawn models for fraction arithmetic. I will present research that uses results on children's reasoning to study teachers' reasoning about fraction multiplication and division and identify challenges for preparing teachers for the Common Core Standards.

12:00 – 1:30 lunch

1:30 – 3:00 Breakout sessions

Session A: *Lesson Study: Advice From K-12 and University-based Lesson Study Practitioners.*

Catherine Lewis, Elizabeth Baker and Ruth Cossey, Mills College; Brigitte Lahme, Sonoma State University; David Foster, Silicon Valley Mathematics Initiative; Jackie Hurd, Palo Alto Unified School District; Stan Pesick and Marlene Wilson, Oakland Unified School District; Tracy Sola, Belmont-Redwood Shores School District; Jane Decker, Petaluma High School; Erik Moll, Oakland Unified School District. Experienced lesson study participants, from departments of mathematics and mathematics education, and from elementary and secondary schools, will share thoughts about what is needed to build toward Sybilla Beckmann's vision of one community of mathematics teachers, and how lesson study can contribute.

During the first half of the session, panelists will discuss the following questions.

- How is lesson study similar to and different from other forms of professional learning you have experienced?

- What have you learned about mathematics and its teaching-learning through lesson study? How did your learning of mathematics occur–what were the supports and catalysts for it?
- What advice do you have for mathematicians and mathematics educators who may be interested in initiating or participating in lesson study work?
- What tools and resources are useful for mathematics lesson study–both generic tools for lesson study and specific types of mathematical resources. What kinds of mathematical resources tend *not* to be useful?
- How should teachers' mistakes be handled?

The second half of the session will be devoted to Q & A with the audience.

Session B: Randolph Philipp, San Diego State University, *How A Focus on Children's Mathematical Thinking Supports the Professional Development of Elementary School Teachers.*
Teachers in the United States do not have built-in means by which to continue to grow professionally. One promising means for supporting teacher professional development is for teachers to learn from their own practice in general, and from their students' mathematical thinking in particular. This presentation will share results of how focusing on children's mathematical thinking supported the professional development of elementary school teachers. In addition to considering mathematical content knowledge and beliefs, we will also look at what teachers notice from instructional settings. Video examples of students' mathematical thinking will be used to ground the conversation about mathematics, teaching, and learning.

Session C: Teacher education and professional development

Richard Bisk, Worcester State University, *New Requirements for the Mathematical Preparation of Elementary Teachers in Massachusetts.*
In 2007, the Massachusetts Board of Elementary and Secondary Education voted unanimously to upgrade the mathematical requirements for new elementary school teachers. Elementary teacher candidates now have to pass a separately scored mathematics test to earn certification. A detailed document (www.doemass.org/mtel/mathguidance.pdf) describes "the breadth and depth of mathematics that teachers at the elementary level must not only be able to do, but understand and explain in many ways to students." This talk will discuss the new requirements and the rationale behind them.

Katherine Socha, Math for America, *Is one of these things not like the others? Comparing Math for America with other national teacher preparation and professional development programs.*
Math for America is a 6-year old secondary school mathematics teacher

professional development program that started in New York City. Despite the similarity of names, MfA differs greatly from the Teach For America model. This session will explore similarities and differences between the MfA, TFA, Knowles Teaching Fellowships, NYC Math Immersion, and one or two more programs. The aim is to seek out a central collection of practices and set these practices in context of the experiences of practicing teachers.

Session D: Paul Goldenberg, EDC. Discussion session: *Interpreting the Mathematical Practices of the Common Core State Standards for the elementary and middle grades.*

Session E: Zalman Usiskin, University of Chicago. Discussion session: *Recruiting More Students into Mathematics Teaching.*

3:00 – 3:30 coffee and tea

3:30 – 4:15 Breakout sessions

Session A: Robert Farinelli, President of the American Mathematical Association of Two-Year Colleges (AMATYC), *The Role To Two-Year Colleges in Teacher Preparation*. Since many prospective teachers take some, if not all, of their mathematics requirements at a two-year college, the two-year college role has become very important in this process. However, the requirements vary greatly from state to state and department to department. This presentation will address some of the highlights and will look for participant input.

Session B: Henry Kepner, University of Wisconsin, Melissa Hedges, Mequon-Theinsville Schools, and Astrid G. Fossum, Milwaukee Public Schools. *Teachers reflect on the mathematics they need to teach their students.* An interactive report from teachers and teacher leaders on sense-making in mathematics instruction.

Session C: Marc Roth, Woodside Learning Center, San Francisco Unified School District, *A Teacher's Perspective: the help that I have received and not received from the mathematical community.*
As a math teacher in a Juvenile Justice Center, I write all of my curriculum. Which authors and speakers have helped me the most? How accessible are the texts to a secondary teacher who, like myself, managed to complete a major in mathematics without truly mastering the art of reading terse, symbolically dense text. And finally, I would like to explain the benefits of exploiting college level mathematics in the teaching of K-12 topics.

Session D: Patti Huberty, Comer Elementary School, *A teacher's perspective on Daily Professional Development: How do we utilize our classroom experiences to gain*

mathematical understanding and enhance future instruction? This session will focus on how teachers can use their daily mathematics teaching as a means for professional development. Successful questioning techniques, as well as what we can learn from (and how we react to) student responses, will be the main point of discussion. Specific examples of Kindergarten through College level classroom experiences and student work will be shared. The session will include time for question/answer with the facilitator.

Session E: Jerry Dwyer, Texas Tech University, *The Perspective of an Outreach Mathematician: Bridging the Gap*
A college outreach mathematician reflects on 15 years of teacher education and K-12 collaboration. The need to foster relationships and build respect across all boundaries is discussed. Examples of successful partnerships are described and the benefits to all parties are outlined.

Session F: Andrew Tyminski, Clemson University, *Developing pre-service elementary mathematics teachers' knowledge bases through Standards-based curriculum materials.*
Our research with pre-service elementary mathematics teachers (PSTs) focuses on what they learn as a result of interactions with *Standards*-based elementary mathematics curriculum materials. We examine PSTs' learning in the domains of curricular knowledge (Shulman, 1986) and mathematical knowledge for teaching (Ball, Thames, & Phelps, 2008). Example activities and results will be shared. The session will conclude with a discussion regarding the kinds of knowledge PSTs will need to be prepared to teach using the Common Core Standards.

Session G: David Foster, *Inside Mathematics Dot Com*
The Silicon Valley Mathematics Initiative is a comprehensive professional development initiative that integrates ongoing professional development, a summative and formative assessment system, lesson study, mathematics coaching and school leadership training. The initiative, initially funded by the Robert Noyce Foundation, was founded in 1996. Using products and lessons learned from SVMI, the Noyce Foundation created in a public access website to provide tools and resources to educators to enhance mathematics teaching and learning. The site offers curriculum, assessment instruments, professional development tools, leadership resoruces and classroom videos of effective practice. The session will highlight the work of SVMI and provide an overview of the tools and resources available.

4:15 – 4:30 Short break

4:30 – 5:15 **Follow-up efforts to the Common Core State Standards**

Jim Lewis, University of Nebraska-Lincoln, *The Mathematical Education of Teachers II*

William McCallum, University of Arizona, *Projects to support success of the Common Core State Standards for Mathematics*

5:15 – 5:45 **Closing comments** by Herbert Clemens, Ohio State University, *Common Core Mathematics Standards and Teacher Professional Development.* Acceptance by the States of the Common Core Mathematics Standards represents a once-in-a-lifetime opportunity for mathematics teachers to enhance their professional status much in the same way that university mathematicians did during the post-Second World War era. Mathematics teachers themselves will have to drive this process--numbers of teachers are too big, and the interests of other constituencies too compromised, for it to be otherwise. But the university community and government, among others, can help in essential ways. Those include programs for teacher-leaders and teacher professional developers, and the nurturing of 'laboratories of excellence.'

5:45 – 7:00 Reception