The Mathematical Education of Teachers II

Jim Lewis
University of Nebraska – Lincoln

CIME - 2011
The Mathematical Education of Teachers

- Sybilla Beckmann discussed the need for an active, vibrant, interdisciplinary community that will drive a cycle of improvement in both the teaching of mathematics at all levels (elementary school to collegiate education) and knowledge about mathematics teaching.
- Denise Spangler argued that knowing mathematics to pass a test ≠ knowing mathematics in the ways needed to teach it.

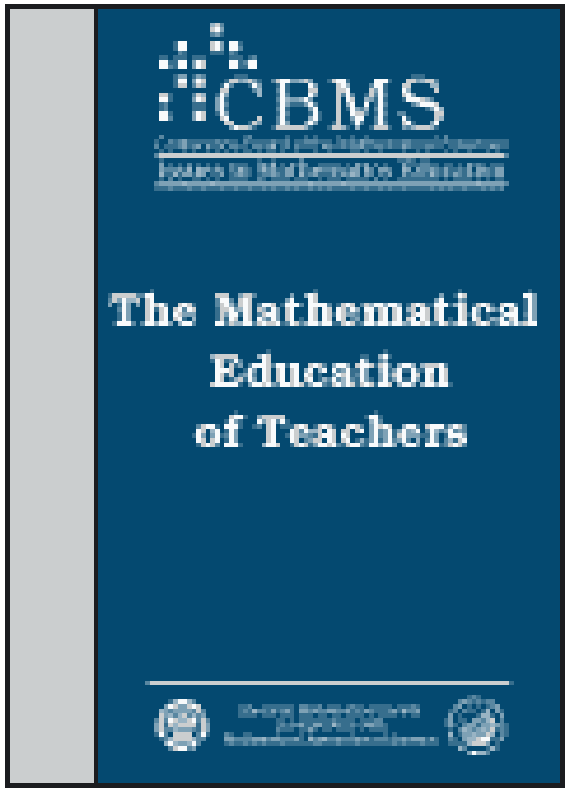
  (and) Teaching mathematics involves knowing, representations, analogies, illustrations, examples, explanations, demonstrations.

  (and) Focusing on preservice or inservice teachers' content knowledge is necessary but not sufficient.

CIME - 2011

- Deborah Ball discussed the need for teacher candidates to learn to teach *Something in Particular* and expressed the belief that the Common Core could leverage **radical improvement** in teacher training.
- Many speakers discussed the Common Core and related it to their views on teacher education.
- Raven McCrory discussed her study on elementary teacher education including two factors that matter
  - *use of a textbook specifically written for a mathematics course for teachers;*
  - *teaching in a way that engages students with doing mathematics.*

In 2001 CBMS produced The Mathematical Education of Teachers



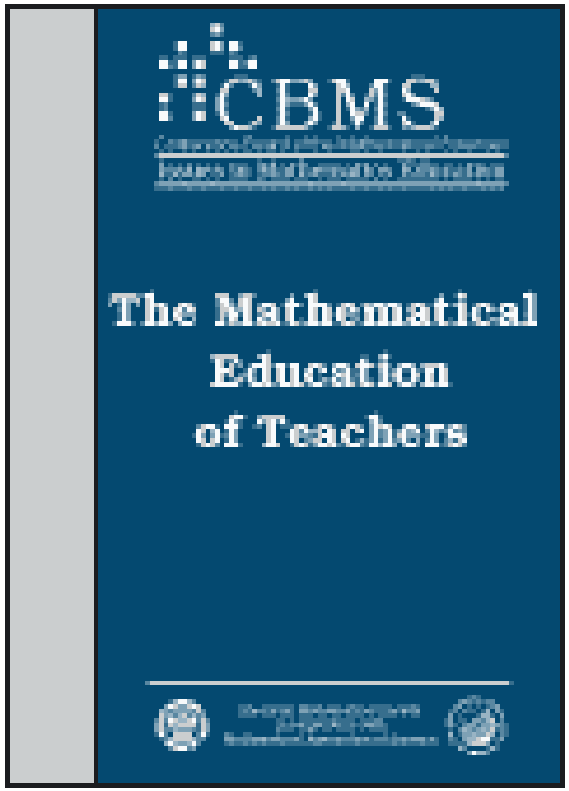
Themes

- the intellectual substance in school mathematics

and

- the special nature of the mathematical knowledge needed for teaching

The Mathematical Education of Teachers



Audience

- the primary audience were the faculty in mathematics departments
- we hoped the document would be useful to other audiences

MET recommendations

- Mathematics Curriculum and Instruction for Prospective Teachers
- Cooperation Among Parties Involved in Teacher Education
- Policies to support High Quality School Mathematics Teaching

Mathematics Curriculum and Instruction

1. Teachers need math courses that develop a deep understanding of the mathematics they will teach.
2. Quality is more important than the quantity, but …
   - Elementary – at least **9 hours** on fundamental ideas of elementary school mathematics.
   - Middle grades – at least 21 hours of mathematics, that includes at least 12 hours on fundamental ideas of school mathematics appropriate for middle grades teachers (i.e. **grades 5-8**).
   - High school – teaches should complete the equivalent of an undergraduate major in math, that includes a **6-hour capstone course connecting their college mathematics courses with high school mathematics**.

3. Courses on fundamental ideas of school mathematics should focus on a thorough development of basic mathematical ideas. All courses designed for prospective teachers should develop careful reasoning and mathematical 'common sense' in analyzing conceptual relationships and in solving problems.

4. Along with building mathematics knowledge, mathematics courses for prospective teachers should develop the habits of mind of a mathematical thinker and demonstrate flexible, interactive styles of teaching.

5. Teacher education must be recognized as an important part of mathematics departments' mission at institutions that educate teachers. More mathematics faculty should consider becoming deeply involved in K-12 mathematics education.

Cooperation

6. The mathematical education of teachers should be seen as a **partnership** between mathematics faculty and mathematics education faculty.
7. There needs to be greater **cooperation** between 2-year and 4-year colleges in the mathematical education of teachers.
8. There need to be more **collaboration** between mathematics faculty and school mathematics teachers.

Policies

9. Efforts to improve standards for school mathematics instruction, as well as for teacher preparation accreditation and teacher certification, will be strengthened by the full-fledged participation of the academic mathematics community.

10. Teachers need the opportunity to develop their understanding of mathematics and its teaching throughout their careers, through both self-directed and collegial study, and through formal coursework.

11. Mathematics in middle grades (grades 5-8) should be **taught by mathematics specialists**.

What has changed in 10 years?

- The 2005 CBMS Survey reported that there had been an increase in the number of mathematics courses required for elementary and middle level math teachers.
  - **Will the 2010 CBMS Survey report that this trend has continued?**
- There have been several textbooks for teaching elementary teachers written by mathematicians
- It is harder to document the degree to which:
  - Mathematicians are involved in teaching teachers
  - Mathematician-mathematics educator partnerships are developing
  - Coursework focuses on a deep understanding of school mathematics

NSF and DoEd have made a major investment in Math Science Partnerships

- The NSF web site lists 120 active Math Science Partnerships
  - For once, mathematics may be receiving its share (or even more than its share) of NSF dollars invested in MSPs.
  - Mathematicians are heavily involved in MSP work not just in offering advice or teaching mathematics courses but also in leading MSPs.

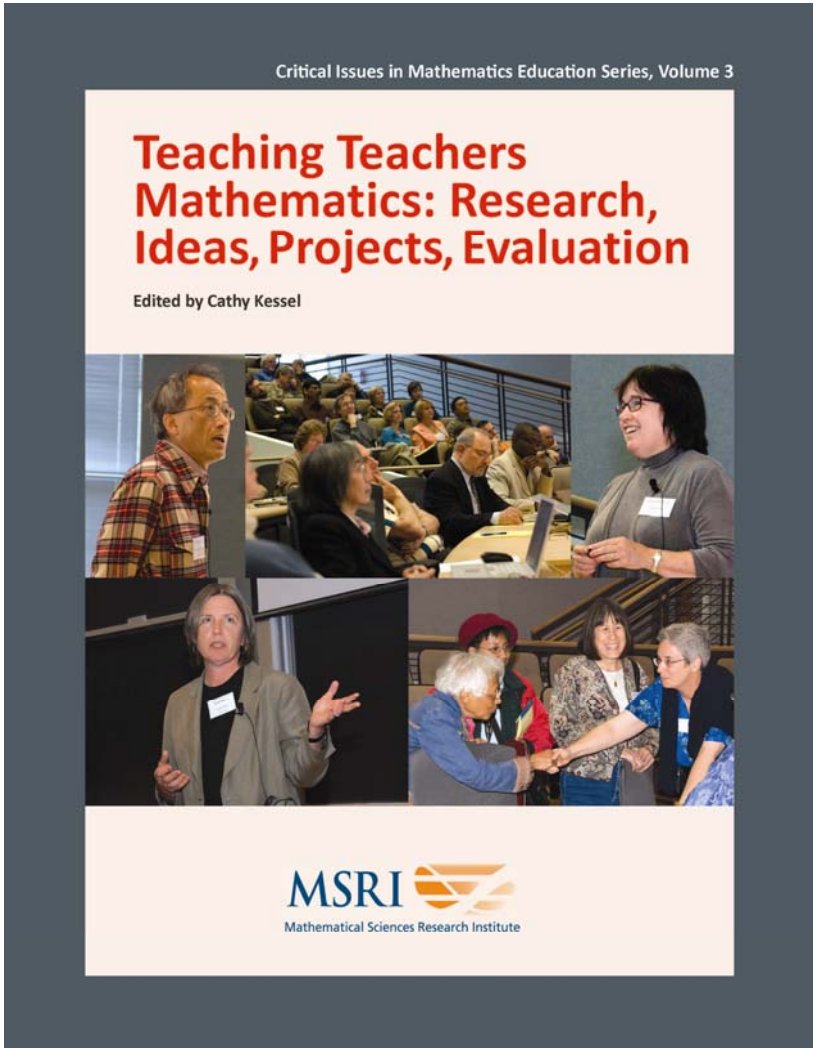
A sample of MSPs led by a mathematician

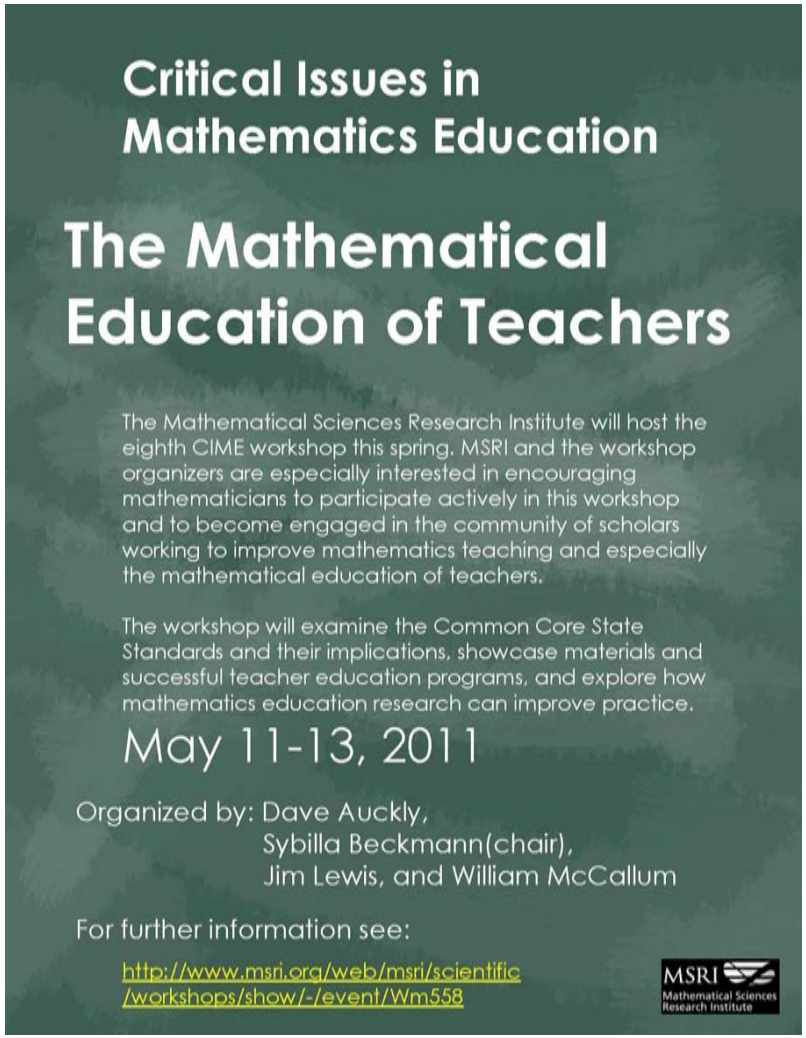
- Appalachian Mathematics and Science Partnerships
- Arizona Teacher Institute
- Greater Birmingham Partnership
- Louisiana Math and Science Teacher Institute
- NebraskaMATH
- New Jersey Partnership for Excellence in MS Math
- Oregon Mathematics Leadership Institute Partnership
- Preparing Virginia's Mathematics Specialists
- Rice University Mathematics Leadership Institute
- Standards Mapped Graduate Education and Mentoring
- System-Wide Change for All Learners and Educators
- Vermont Mathematics Partnerships

Four major national programs

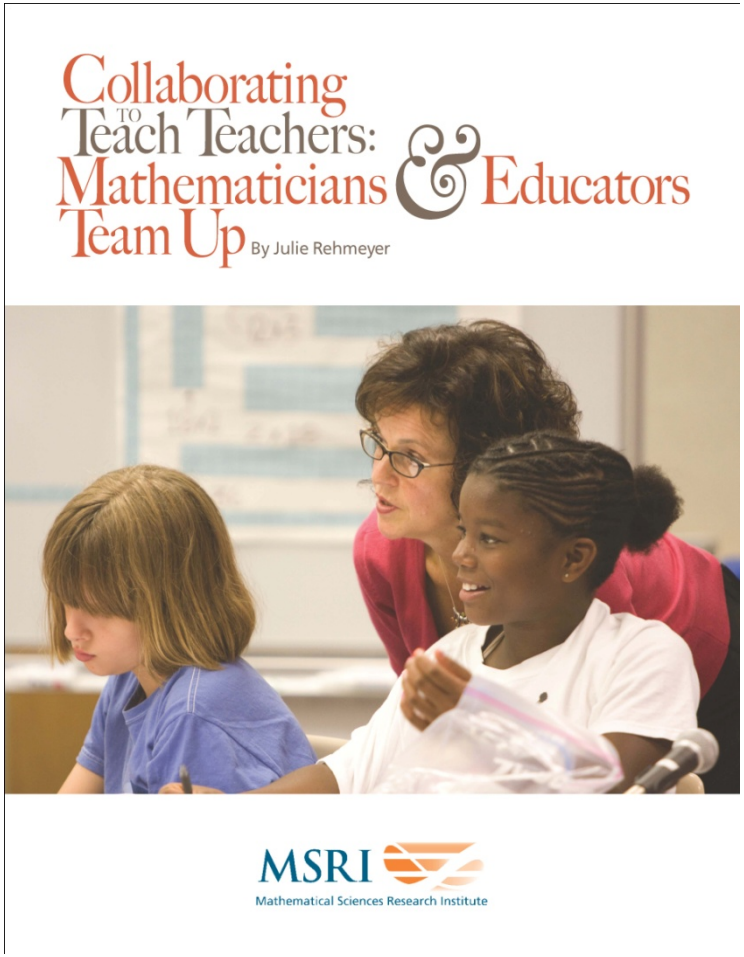
- IAS Park City Mathematics Institute
- IntelMath
- Math for America
- UTeach

MSRI's Critical Issues in Mathematics Education





MSRI hosted a workshop on mathematician-mathematics educator partnerships



Unfortunately, significant partnerships between mathematicians and mathematics educators (and partnerships that include classroom teachers) appear to be rare.

Now, more than ever there is a need to strengthen the mathematical education of teachers.

- NCTM's Curriculum Focal Points for Prekindergarten through K-8 Mathematics
- Foundations for Success – The Final Report of the National Mathematics Advisory Panel
- Common Core State Standards for Mathematics

MET II – Getting Started

- Funded by Math for America and CBMS
- Goal is to enhance and extend the MET
  - The MET contains information that is still quite useful
  - Recommendations are still relevant
- MET II should address professional development
- Environment is better
  - “Math Wars” replaced by Common Ground
- Public interest is greater than ever
  - Agreement on importance of the teacher

Who is involved in MET II?

- Deborah Ball
  - University of Michigan,
- Sybilla Beckmann
  - University of Georgia
- Al Cuoco
  - EDC
- Dan Chazen
  - University of Maryland
- Cathy Kessel
  - Education Consultant
- Karen King
  - NCTM
- Jim Lewis
  - University of Nebraska-Lincoln
- Bill McCallum
  - University of Arizona
- Ira Papick
  - University of Nebraska-Lincoln
- Barbara Reys
  - University of Missouri
- Ron Rosier
  - Georgetown and CBMS
- Katherine Socha
  - Math for America
- Denise Spangler
  - University of Georgia
- Alan Tucker
  - SUNY Stony Brook

And more to come …

Issues to address in MET II

- How should the Common Core State Standards influence what MET II says about the mathematical education of teachers?
- Who is the audience for MET II?
- What special challenges result from a decision to address professional development for current teachers?
  - There are many non-university based providers of PD. Are they part of our audience?
  - Can we make the case that learning mathematics should be a substantial part of professional development?

Elementary teacher education issues

- Should we object to K-8 certification of elementary teachers if the mathematical preparation is really to be a K-4 teacher?
- Should 5th grade and 6th grade teachers be educated as elementary teachers or middle level mathematics teachers?
- What is the appropriate mathematics education for early childhood educators?
- What is the appropriate education for math coaches or elementary math specialists?
- Are there ways to significantly improve the mathematical knowledge of large numbers of current elementary teachers? This is a daunting issue of scale.
- What approach, math coaches or math intensive instructors, is financially viable and results in the greatest improvement of math education for students?

Issues

- The space available in a teacher certification program is limited and is not likely to expand. What choices does this force with respect to both the opportunity to learn mathematics and what mathematics is taught?
- What knowledge and experiences are desirable for a high school mathematics teacher and can this be provided as part of an undergraduate major in mathematics?
  - Is the answer very different for different types of institutions?
- Must teacher preparation programs try to prepare high school teachers for their complete professional career, or might it be acceptable to certify teachers as well-started beginners who still need continuing education?
- Should passing some type of mathematics exam be a required part of certification to be a mathematics teacher?

The challenge of teaching math

a very old issue

One of the first questions which a student asks at, or near, the beginning of his study of any branch of mathematics is, “What is it good for?” In most cases he is not satisfied unless he can be shown some specific utilitarian use to which his new knowledge may be put.

…

It must be acknowledged, however, that a student of good mathematical ability, or one who has been well taught and has followed a well arranged program of mathematical study, oftentimes is apparently unable to apply his mathematics to the study of a new science --

In other words, he seems to lack that **mathematical habit of mind** at which we have aimed.

– F. H. Bailey
  Massachusetts Institute of Technology
  The American Mathematical Monthly
  May 1910

(thanks to Rich Millman for sharing this with me)

And some good news

2011 Best Jobs

1. Software engineer
2. Mathematician
3. Actuary
4. Statistician
5. Computer systems analyst

As ranked by CareerCast (job search site) which ranked 200 jobs from best to worst based on five broad metrics: Physical Demands, Work Environment, Income, Outlook (Job Growth), and Stress. And, on their list of the 10 least stressful professional jobs, the best paid is:

8. Mathematician ($94,178)

•