

Explanatory note. This is a draft of recommendations that update those in the *Mathematical Education of Teachers* report published in 2001, hereafter called MET I. That report may be downloaded at http://www.cbmsweb.org/MET_Document/index.htm.

This draft makes reference to examples posted on the CBMS web site. Such examples are not currently posted, but will be posted when MET II is published.

Draft MET II Recommendations

1. *Prospective teachers need mathematics courses that develop a good understanding of the mathematics they will teach.* To produce well-started beginning teachers, coursework should include the opportunity to study in depth and from a teacher's perspective most of the mathematics they will initially teach. The mathematical knowledge needed by teachers at all levels is substantial yet quite different from that required by students pursuing other mathematics-related professions. Prospective teachers need to understand the fundamental principles that underlie school mathematics, so that they can teach it to diverse groups of students as a coherent, reasoned activity and communicate an appreciation of the elegance and power of the subject.

2. *Coursework that allows time to engage in reasoning, explaining, and making sense of the mathematics that prospective teachers will initially teach is needed to produce well-started beginning teachers. Although the quality of mathematical preparation is more important than the quantity, we offer the following recommendations for the amount of mathematics coursework for prospective teachers.*

- (i) *Prospective elementary grade teachers should be required to take at least 9 semester-hours on fundamental ideas of elementary school mathematics.*
- (ii) *Prospective middle grades teachers of mathematics should be required to take at least 21 semester hours of mathematics that includes at least 12 semester-hours on fundamental ideas of school mathematics appropriate for middle grades teachers.*
- (iii) *Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes three courses with a primary focus on high school mathematics from an advanced viewpoint.*

3. *All courses designed for prospective teachers should develop the habits of mind of a mathematical thinker: reasoning and explaining; modeling and using tools; seeing structure and generalizing. Courses should also develop and demonstrate the flexible, interactive styles of teaching that will enable teachers to develop these habits of mind in their students.* A long-standing goal of mathematics education is to develop in students not only knowledge of content but the ability to work in ways characteristic of the discipline. Such ability has been described in various ways in the last 10 years: the National Council of Teachers of Mathematics process standards, the *Adding It Up* strands of mathematical proficiency, and the CCSS standards for mathematical practice. In order to develop these

abilities in their students, teachers must experience them in their own mathematical education, through, for example, immersion experiences, research projects, or seminars devoted to doing mathematics.

4. 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. Mathematics departments need to devote commensurate resources to designing and offering courses for teachers. At a minimum, these courses should be supervised by a faculty member (full-time or part-time) with expertise in teacher education.

5. Mathematics teaching, including the mathematical education of teachers, can be greatly strengthened by the growth of a professional community that includes mathematicians as one of many constituencies committed to working together to improve mathematics education.

This recommendation updates recommendations 6, 7 and 8 in MET I. It remains important to encourage partnerships between mathematics faculty and mathematics education faculty, between faculty in two-year and four-year institutions and between mathematics faculty and school mathematics teachers. But more is needed to sustain efforts to strengthen the mathematical education of teachers, both future teachers and those who currently teach in K–12 US schools and efforts to improve mathematics teaching at all levels, from early childhood learning to our colleges and universities. Certainly, we already have many initiatives, communities, and professional organizations focused on some aspect of this work. Needed are more intentional efforts to bridge current communities in ways that are built upon mutual respect and the recognition that there are opportunities for professional growth for university faculty in mathematics and mathematics education as well as the mathematics teachers and supervisors in the K–12 community. The CBMS web site includes examples of collaborative work that enhances the mathematical education of teachers include mathematicians and K–12 teachers who co-teach professional development courses for teachers, integrative approaches to teaching future teachers, and partnerships between universities and two-year colleges. Also needed are more opportunities to make public the work of teaching, including learning communities, math circles, conferences, and publications, from newsletters to scholarly articles. Because the potential for contributions are great and research mathematicians are underrepresented in the community described by Recommendation 5, it is especially important for research mathematicians to be members of this community.

6. 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. Mathematicians have recently become more involved in this arena as witnessed by their major role in writing the Common Core State Standards. One growing area of mutual interest is alternative routes for state licensing of mathematics teachers, where better standards for mathematical knowledge are needed.

7. Throughout their careers, teachers need opportunities for continued professional growth that include opportunities to learn mathematics on the job, through informal teacher-driven initiatives, and as part of graduate education.

The goal of initial certification should be to create well-started beginners. Initial certification programs do not, and probably cannot, allocate sufficient time to learning mathematics so as to ensure that even the best prepared future teachers have the knowledge of mathematics, of teaching, and of students that is possessed by outstanding master teachers. A well designed professional development program offers teachers opportunities for professional growth appropriate for their experience as they make the transition from new teacher to mid-career professional, to master teacher.

Reflective practitioners will, of course, learn from the work of teaching itself, but if their careers are to allow continued professional growth, they will need regular opportunities to learn and do mathematics and to increase their pedagogical content knowledge. This should include both school- and district-sponsored content-based professional development and university-based professional development offered either as “short courses” or graduate coursework. Highly motivated teachers will also seek out opportunities for teacher driven professional experiences such as teachers’ math circles.

Continued opportunities to learn mathematics are particularly important at the secondary level. A well prepared new teacher should be ready to teach the mathematics of grades 7 and 8, as well as algebra and geometry. But, continued graduate education in mathematics is needed before a high school teacher is ready to teach, and teach well, the subjects typically found in grades 11 and 12, including precalculus, calculus, discrete mathematics, matrix algebra, and statistics.

8. To ensure high quality mathematics teaching and learning in K–12 schools, collegiate mathematics faculty, in collaboration with mathematics education faculty, must become more involved in professional development programs in mathematics.

State departments of education and local school districts recognize the need for continuing education and implement policies requiring either inservice work or graduate education. Unfortunately, in far too many colleges and universities, mathematics departments have few, if any, graduate education opportunities designed to meet the professional needs of K–12 mathematics teachers. Instead, this important work is left to faculty in the College of Education. In the absence of opportunities to learn mathematics, teachers often take graduate work leading to administrative certification, or other graduate work that, while valuable, does little to strengthen their knowledge of mathematics.

There are notable exceptions that can serve as models for mathematics departments interested in supporting and serving this important part of the mathematics community. Several of the Math Science Partnerships sponsored by National Science Foundation (NSF) include significant professional development programs for K–12 mathematics teachers. The Master Teaching Fellows track of the Robert Noyce Teacher Scholarship Program is an example of how universities can support professional development for master teachers

who then work to benefit mathematics teaching in their district, often by providing professional development opportunities for fellow teachers. Math for America supports both early career teachers and master teachers through a program that centers on solid knowledge of mathematics to strengthen mathematics teaching in secondary mathematics classrooms. Both the American Institute of Mathematics and the Mathematical Sciences Research Institute have made a commitment to encourage mathematicians and mathematics teachers to participate together in teachers' math circles. Examples of these and other professional development programs for mathematics teachers can be found on the CBMS web site.

9. The mathematics community should support raising the standards of professionalism for teachers. Strategies for raising these standards include: (i) ensuring that teachers have adequate knowledge of mathematics at certification; (ii) developing a career ladder that keeps outstanding teachers in the profession; and (iii) providing professional development opportunities for teachers to grow from early career teachers to mid-career teachers to master teachers.

Society will be better served by focusing efforts to raise standards at the time of entry into the teaching profession rather than looking to weed out ineffective practicing teachers. Advancement in a career ladder provides another framework to establish high standards. In return, schools need to provide high-quality, content-based professional development to support teachers' efforts to deepen their mastery of mathematics and to apply this mastery to provide high-quality instruction. Models for creating high standards of professionalism in teaching can be found in other professions such as health care, law, and engineering.

Building a greater sense of community among all mathematics educators—school teachers and collegiate mathematics faculty members—(as discussed in Recommendation 5) will contribute to higher professional standards for teaching.

10. In grades 5–8, mathematics should be taught by teachers whose preparation and knowledge base meets the standards outlined in this document for middle grades teachers. The mathematical preparation of an elementary teacher is not sufficient.

This recommendation seeks to clarify Recommendation 11 in MET I. Historically, grades 5 and 6 teachers have been prepared as elementary teachers and certification requirements in many states permitted teachers with an elementary preparation to teach 7th and 8th grade mathematics. This is not adequate preparation to teach challenging mathematics in grades 5–8. The need for mathematics specialists starting in grade 5 is especially important for a challenging curriculum such as that consistent with the CCSS. As topics such as algebra and functions receive increased attention and work with fractions and decimals becomes more complex, teaching mathematics well requires subject matter expertise beyond that of even a well prepared elementary teacher. It is also important, especially in grades 7 and 8, for middle grades mathematics teachers to know the high school mathematics curriculum well and to understand how their instruction lays the foundation for high school mathematics.

Ideally, all states will acquire different certification requirements for elementary and middle grades, so that elementary certification ensures preparation for teaching grades K-4 and middle level certification programs are developed and required to teach grades 5-8 mathematics. In the interim, states without a stand-alone middle school teacher certification program can assist in educating future grades 5-6 teachers by requiring candidates to pursue a strong specialist program (focusing major attention on a key content area such as mathematics) as part of their current elementary education program. Grades 5-6 teachers with strong preparation to teach mathematics will prove an important resource for their elementary schools, both as classroom teachers and as mathematics specialists who can assist K-4 teachers in strengthening their mathematical knowledge and delivering a strong mathematics program to their students.