Conference Board of the Mathematical Sciences

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Common Standards and the Mathematical Education of Teachers

Recommendations from

the October 2010 Forum on Content-Based Professional Development

convened by

the Conference Board of the Mathematical Sciences

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About the Conference Board of the Mathematical Sciences

The Conference Board of the Mathematical Sciences (CBMS) is an umbrella organization consisting of seventeen professional societies all of which have as one of their primary objectives the increase or diffusion of knowledge in one or more of the mathematical sciences. Its purpose is to promote understanding and cooperation among these national organizations so that they work together and support each other in their efforts to promote research, improve education, and expand the uses of mathematics.

The CBMS member societies are:

American Mathematical Association of Two-Year Colleges

American Mathematical Society

Association of Mathematics Teacher Educators

American Statistical Association

Association for Symbolic Logic

Association for Women in Mathematics

Association of State Supervisors of Mathematics

Benjamin Banneker Association

Institute for Operations Research and the Management Sciences

Institute of Mathematical Statistics

Mathematical Association of America

National Association of Mathematicians

National Council of Supervisors of Mathematics

National Council of Teachers of Mathematics

Society for Industrial and Applied Mathematics

Society of Actuaries

TODOS: Mathematics for ALL

For more information about CBMS and its member societies, see www.cbmsweb.org.

Preface

In October of 2010, the Conference Board of the Mathematical Sciences convened its third national forum, Content-Based Professional Development for Teachers of Mathematics.

By the time of the Forum, 37 states had adopted the Common Core State Standards (CCSS), the creation of which was initiated by the National Governors Association and the Council of Chief State School Officers.[1] These standards had been released in early June, followed several weeks later by Appendix A, Model Course Pathways in Mathematics, produced under the leadership of Achieve and intended to illustrate possible approaches to organizing the content of the CCSS into courses that lead to college and career readiness.[2]

Individual states had applied for federal Race to the Top funding to support educational innovation and reform. Especially relevant to the Forum: the Race to the Top program includes funding for professional development of teachers and principals.[3] Phase 1 funding was awarded to Delaware and Tennessee in March. In August, Phase 2 funding was awarded to the District of Columbia, Florida, Georgia, Hawaii, Maryland, Massachusetts, New York, North Carolina, Ohio, and Rhode Island.

In September, the President's Council of Advisors on Science and Technology made recommendations supporting the movement toward shared standards in mathematics and science.[4] In the same month, a report appeared from a joint task force of the Association of Mathematics Teacher Educators, Association of State Supervisors of Mathematics, National Council of Supervisors of Mathematics, and National Council of Teachers of Mathematics. This report identifies recommendations for action and ways in which the four organizations can collaborate to support implementation of the CCSS. The organizations have begun to implement the recommended actions. The National Council of Supervisors of Mathematics has begun its outreach efforts with a webinar.[5] The National Council of Teachers of Mathematics has created an overview presentation and presentations by grade band intended to inform teachers about the CCSS.[6]

In the winter of 2009 and spring of 2010, the National Research Council conducted two workshops designed to explore some of the possibilities for state assessment systems. Their goal was to pull together data and perspectives on current assessment and accountability systems and on innovative assessment approaches in order to assist educators and policy makers.[7]

State consortia formed and applied for Race to the Top assessment funding in 2010. In September, funding was awarded to two consortia that will design assessment systems

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[1] For more information about the CCSS and an up-to-date listing of adopting states, see www.corestandards.org.
[2] www.achieve.org/files/CCSSI_Mathematics%20Appendix%20A_101110.pdf.
[3] See (D)(2)(iv)(a) and (D)(5)(i) of www2.ed.gov/programs/racetothetop/executive-summary.pdf.
[4] See K–12 education report at www.whitehouse.gov/administration/eop/ostp/pcast/docsreports.
[5] See http://ncsmonline.org.
[6] www.nctm.org/news/highlights.aspx?id=26084&blogid=6806.
[7] The report, "State Assessment Systems: Exploring Best Practices and Innovations: Summary of Two Workshops," is available from the National Academies Press web site.

intended for grade 3 through high school.[8] Background papers on long-term assessment questions commissioned by the Fordham Institute have been produced.[9] Guidance for assessment efforts will be provided by the Illustrative Mathematics Project at the Institute for Mathematics and Education, intended to illustrate the range and types of mathematical work that students will experience in a faithful implementation of the standards.[10] Guidance for teacher education and curriculum development will be provided by the *Progressions for the Common Core Mathematics Standards*.[11]

Although they began years ago, other projects within the mathematical sciences community are also relevant to the demands of the CCSS. These include UTeach, a secondary mathematics and science teacher preparation program, and Intel Math, a scaled-up adaptation of the Vermont Mathematics Initiative program for K–8 teachers, both of which are being replicated across the United States.[12] The Institute for Advanced Study Park City Mathematics Institute runs intensive summer institutes for secondary teachers that are designed to initiate year-round professional development.[13] Math for America, which recruits and trains outstanding secondary teachers, has expanded from New York City to Berkeley, Boston, Los Angeles, San Diego, Utah, and Washington, DC.[14]

In the mathematical sciences community, a common reaction to the Common Core State Standards has been a strong call for more systemic and more effective professional development for teachers. The CBMS Forum was convened as the beginning of a major effort to improve and increase content-based professional development for teachers of mathematics. This effort continues, building on the collective experience of the mathematical sciences community and the relationships that CBMS has developed with the National Governors Association, the Council of Chief State School Officers, the American Council on Education, Achieve, Math for America, and other organizations concerned with education in the United States.

CBMS, Math for America, and the Institute for Advanced Study through its Park City Mathematics Institute (IAS/PCMI) are organizing a leadership meeting for next summer to discuss and develop a professional development strategy to support mathematics teachers, especially secondary teachers, as they confront the challenges occasioned by the advent of the Common Core State Standards Initiative. Leaders of key mathematics and education organizations and representatives of relevant government agencies will be invited.

CBMS gratefully acknowledges support from the Brookhill Foundation and the National Science Foundation for the Forum on Content-Based Professional Development and this report.

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[8] www2.ed.gov/programs/racetothetop-assessment/index.html.
[9] www.edexcellence.net/publications-issues/publications/common-education-standards.html.
[10] http://illustrativemathematics.org.
[11] http://ime.math.arizona.edu/progressions/#about.
[12] www.changetheequation.org/featuredprograms/featured-programs. For further information about Intel Math, including instructor applications, see http://ime.math.arizona.edu/intelmath.
[13] http://pcmi.ias.edu/program-sstp.
[14] www.mathforamerica.org/home.

Introduction

This white paper presents key recommendations for the continuing mathematical education of teachers generated at the 2010 CBMS Forum.[15]

As noted at the previous forum, teachers will be essential in helping students to attain the Common Core State Standards.[16] Contributing effectively to the professional development of teachers is thus an important concern for the mathematical sciences community. The 2010 Forum overview states:

> [This is] an opportunity for the mathematics community to work toward a major scaling up of content-based professional development opportunities. Common standards should make scaling up easier in that there will be commonality across states in what teachers at a certain level need to know. Our goal is not only in scaling up professional development opportunities, but in getting these opportunities into our systems so they are a part of the on-going responsibilities of departments and other organizations and thus can be factored into the planning of school districts. This forum will be an important step in bringing the community together to begin work on this ambitious goal.

Scale. The following statistics suggest the magnitude of the necessary professional development effort. In 2007, there were approximately 3.7 million elementary and secondary teachers in the United States. Of these, approximately 82% teach full time. In public schools, approximately 53.1% of elementary teachers are generalists and approximately 1.1% have mathematics as their main assignment.

In 2007–08, about 102,000 bachelors degrees were granted in education. In 2005, approximately 3,000 bachelors degrees in mathematics education were granted, out of about 21,000 bachelors degrees granted by mathematics, statistics, and computer science departments. These figures suggest upper bounds on the numbers of new elementary and secondary teachers of mathematics entering the workforce each year.

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[15] For other information about the meeting including files from the presentations, see www.cbmsweb.org/Forum3/Panels.htm.

[16] Teacher education was one section of the report from the 2009 forum, see www.cbmsweb.org/Forum2/CBMS_Forum_White_Paper.pdf. For a summary of survey findings about prospective and practicing teachers' mathematical education, see pp. 8–22 of *Teaching Teachers Mathematics*, www.msri.org/calendar/attachments/workshops/430/TTM_EdSeries3MSRI.pdf.

Estimated Number of Full-time Teachers Teaching and Yearly Bachelors Degrees

	Total	Public	Private	Bachelors Degrees
Elementary	2,103,400	1,936,400	166,900	102,582 (education)
Main teaching assignment				
General	1,131,600	1,028,200	103,300	
Mathematics	25,000	21,300	3,800	
Secondary	1,093,400	1,032,800	60,600	3,369 (math education) 21,437 (math, stat, cs)
Main teaching assignment				
Mathematics	156,300	147,700	8,300	

Source: National Center for Education Statistics and *Fall 2005 CBMS Survey*, Table E.1.[17]

In contrast with the many elementary and secondary teachers who teach mathematics, there are fewer than 60,000 mathematics and statistics faculty members at two- and four-year institutions.

Full- and Part-Time Mathematics and Statistics Faculty Members in 2005

	Full-time	Part-time
Four-year college and university mathematics departments	21,885	6,536
Four-year college and university statistics departments*	946	112
Two-year college mathematics departments (public institutions)	9,403	18,227
Total	32,234	24,875

Data compiled by CBMS from several sources. See *Fall 2005 CBMS Survey*, Table S.14, p. 31.
*This count excludes departments that do not offer undergraduate courses or programs.

Forum recommendations. The statistics above describe one important aspect of the context for which the Forum recommendations were made.

The Forum participants reflected a wide spectrum of people involved with K–12 mathematics education in the United States. Among them were mathematicians, statisticians, K–12 teachers, mathematics education researchers, and publishers. They included representatives from the CBMS member societies, school systems, state departments of education, and other state and national organizations involved with education.[18]

The Forum participants were requested to keep in mind three overarching questions:

[17] Statistics about teachers: http://nces.ed.gov/programs/coe/2010/pdf/27_2010.pdf. This report did not distinguish between elementary and middle grades teachers. Statistics about education degrees: http://nces.ed.gov/programs/digest/d09/tables/dt09_271.asp.
[18] For further details about the Forum and Forum participants, see www.cbmsweb.org.

Continuing teacher education. As states adopt increasingly higher standards, what are the implications for the continuing education of teachers?

Collaboration. How can mathematics departments, colleges of education, school systems, and state departments of education best encourage, support, and collaborate with faculty members and teachers who want to offer content-based professional development?

Scaling up. How can we scale up opportunities for content-based professional development and make such opportunities systemic?

In this report, recommendations are organized in three sections that correspond to the questions addressed in the breakout sessions:

Mathematical practice standards. What are the implications for the mathematical content of professional development raised by the "Standards for Mathematical Practice" in the Common Core State Standards?

Regional concerns. What are the professional development challenges in our region and how can we work together and support each other in addressing them?

MET2. What are the three most important recommendations about the mathematical education of teachers that should be highlighted in *MET2*, the new edition of *The Mathematical Education of Teachers*[19]?

[19] The entire *MET1* report may be downloaded, free of charge, at at www.cbmsweb.org/MET_Document/index.htm.

Professional Development and the Standards for Mathematical Practice

The first group of parallel breakout sessions focused on the CCSS standards for mathematical practice.[20] As noted in the CCSS, these practices rest on important "processes and proficiencies" such as those described by the process standards of the 2000 National Council of Teachers of Mathematics *Principles and Standards* and proficiencies of the National Research Council's report *Adding It Up*. At the Forum, they were also discussed in terms of "habits of mind."[21]

Processes, proficiencies, and habits of mind all concern aspects of mathematics that have not traditionally been emphasized at the school level and are often invisible in curriculum reform. This invisibility problem was described by Al Cuoco, Paul Goldenberg, and June Mark in terms of habits of mind:

> For generations, high school students have studied something in school that has been *called* mathematics, but which has very little to do with the way mathematics is created or applied outside of school. One reason for this has been a view of curriculum in which mathematics courses are seen as mechanisms for communicating established results and methods—for preparing students for life after school by giving them a bag of facts. Students learn to solve equations, find areas, and calculate interest on a loan. Given this view of mathematics, curriculum reform simply means replacing one set of established results by another one. . . .
>
> There is another way to think about it, and it involves turning the priorities around. Much more important than specific mathematical results are the habits of mind used by the people who create those results.[22]

The Forum participants formed small groups focused on three aspects of the practice standards—problem solving and modeling, habits of mind, reasoning and precision—in elementary, middle, or high school. Each group discussed the following question with respect to its area of focus.

> What are the implications for the mathematical content of professional development raised by the "Standards for Mathematical Practice" in the Common Core State Standards?

As noted above, aspects of mathematics related to the standards for mathematical practices are often invisible in discussions of curriculum reform. Forum participants noted the implications of this situation for specific audiences.

Administrators. School principals and other administrators need to understand that the CCSS are not "business as usual"—"replacing one set of established results by another."

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[20] See CCSS, pp. 6–8, www.corestandards.org/the-standards/mathematics.
[21] A short description of mathematical habits of mind is "Mathematics as a Way of Thinking about Things" in the National Research Council's *High School Mathematics at Work*, www.nap.edu/catalog.php?record_id=5777.
[22] Cuoco, Goldenberg, & Mark, www2.edc.org/CME/showcase/HabitsOfMind.pdf.

Parents. Parents need to have an appreciation of the importance of the standards for practice. Thinking of how a parent might react, Forum participants said, "The issue here is along the lines of, 'I don't have a clue about what my child is being asked to do—I want to go back to the math I know and understand.'"

Teachers. Teachers need to acquire the practices described in the CCSS. For secondary teachers, this might occur in intensive experiences such as the summer programs for high school teachers at the Park City Mathematics Institutes[23] or PROMYS.[24] Forum participants said, "Immersion experiences in mathematical thinking are important for teachers." "Teachers need professional development that specifically gets at how to write and speak math coherently, clearly, comprehensively, logically, accurately, and precisely." Illustrations of the standards for practice should not be divorced from content.

A second type of professional development mentioned was learning communities. Teachers might create or examine tasks, or examine student work on tasks or classroom instruction. A group discussing problem solving in elementary grades said: Begin at K–2. This makes sense developmentally and also provides a no fault audience with respect to state assessments. Involve leader specialists and principals, and make sure the professional development is site based and not "drive by."

Relationship with school mathematics. Some Forum participants asked: How are the practices related to school mathematics? Are they the result of mathematical knowledge learned in school? Or do they emerge with examples which help them develop? The answer to this is "both." Students begin to use these practices in kindergarten. For example, they model with mathematics, representing quantities with numbers, use sets of objects to represent situations, and see equations such as $5 + 2 = 7$ and $7 – 2 = 5$ used to represent these situations (CCSS, p. 9). Students' use of the practices increases in sophistication as they progress through the grades. Examples will be elaborated in *Progressions for the Common Core Mathematics Standards*. Other Forum participants commented that children's cognitive development and learners' needs must interface with the Standards for Practice. The *Progressions* are intended to provide a link between standards and research that will allow for collaborative work on this issue.

Assessment. In this and other sessions, participants noted that assessment was an important constraint for teachers. Ideally, assessment can serve to indicate how students are doing with respect to the Standards for Practice. The Illustrative Mathematics Project at the Institute for Mathematics and Education is intended to delineate how this can be done.[25]

[23] http://pcmi.ias.edu/program-sstp.
[24] www.promys.org/pft.
[25] http://illustrativemathematics.org.

State, Regional, and National Recommendations

For the second breakout session, Forum participants were grouped by geographical region. Each group considered the following:

> What are the professional development challenges in our region and how can we work together and support each other in addressing them?

Their responses describe concerns and give recommendations at state, regional, and national levels.

Recommendations for states

Leadership within states, districts, and schools. Some states have no one with mathematics education expertise at the state level. In some states, the Common Core State Standards are interpreted as "business as usual." Building leaders, district curriculum coordinators need to understand that sustained professional development is important and to support its occurrence. They also need to understand that professional development will not show results immediately.

Some districts have disbanded central offices and thus have no central curriculum specialists.

Principals and math leaders need professional development.[26] Department chairs are sometimes very inexperienced teachers.

Coordinate professional development. Many groups offer professional development. Depending on the offerings, this may result in redundancy, inefficiency, conflict, or incoherence. In particular, state professional development offerings for special education teachers and other teachers may convey different messages. (A related difficulty is that teachers from these two groups do not always work together to coordinate their efforts for students.)

Moreover, guidance is needed about determining the quality of professional development opportunities.[27] (Some programs reflect what research tells us is good quality, others don't.) A clearinghouse of types of professional development that do and don't work would be helpful. Implicit in this is that more needs to be known and communicated about how quality is assessed.

Another Forum group suggested that the professional development opportunities offered needed to be fewer, better coordinated, and that the menu of offerings be better organized.

There is a need for vertical coordination from pre- to in-service to leadership positions. Implementation of professional development in a district needs to be part of a system, not

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[26] A step in this direction is the National Council of Supervisors of Mathematics webinar "Getting Started with the Common Core State Standards: First Steps for Mathematics Education Leaders," http://ncsmonline.org.

[27] Iris Weiss and Dan Heck's presentation at the Forum offers some general guidance and links to more information, www.cbmsweb.org/Forum3/Presentations/Weiss&Heck.pdf.

an external piece. The CCSS provide an opportunity for developing coherence in professional development as well as in curriculum.

Compare activities and initiatives. Forum participants noted the following in particular states:

> Math specialists in Virginia and math coaches in other states are making a difference.[28]
>
> In Kentucky, there is a state-wide initiative for CCSS. The Kentucky Department of Education has guidelines for highly effective teaching and learning.[29] Kentucky students will be tested on CCSS in 2011–2012.
>
> The annual meeting of the Ohio Council of Teachers of Mathematics focused on CCSS.

More generally, Forum participants recommended that states compare reports of CCSS-related activities.

Funding. State funding tends to foster competition rather than collaboration among groups. States need funds to pay for effective professional development, to provide teachers with resources that they need to implement what they learn in professional development sessions, and to serve as incentives for teachers.

Some states have small, rural districts that are very spread out and do not have many resources. Teachers may require a stipend to attend events that are not within the school day, but districts may not have that money, nor the money to provide substitutes for events during the school day. Several potential solutions are:

> Charge schools for PD, because they may have Title I and Title II (A and B) funding.
>
> Use distance technology to provide more cost-effective and convenient professional development.
>
> Build support at the state and district level for STEM education, so that it becomes a priority.

Concerns for states. Forum participants expressed concerns about teacher turnover, non-traditional routes to teaching, and alignment of tests and textbooks.

Teacher turnover. The rapid rate at which many teachers enter and leave teaching militates against their development of mathematical knowledge for teaching. In some states, full-time teachers are being replaced with adjuncts.

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[28] For descriptions of math specialists in Virginia and Vermont, Teaching Teachers Mathematics, www.msri.org/calendar/attachments/workshops/430/TTM_EdSeries3MSRI.pdf, pp. 36–41. The scaled-up version of the Vermont program is known as Intel Math. Other information about math specialists has been collected by the Elementary Mathematics Specialists and Teacher Leaders Project, www2.mcdaniel.edu/emstl.

[29] www.education.ky.gov/KDE/Instructional+Resources.

Licensure, certification, and teacher preparation. Some states are getting new teachers via non-traditional routes, e.g., Teach for America or other states or countries. Some of these teachers have weak mathematical backgrounds that are not addressed by their preparation or professional development. These teachers may need a different sort of professional development.

In some states, many teachers come through alternative routes and already have a masters degree.

State tests. In many districts of some states, state assessment is determining the curriculum. In some states, state tests are driving professional development.

Textbooks. Some textbooks in use are not aligned with the CCSS.

These concerns were not accompanied by recommendations at the 2010 Forum. However, several recommendations from the 2009 Forum are relevant:

- The transition from current standards to the CCSS should be long term and systemic, with a time line to indicate how the assessment program will be phased in.
- National organizations should provide stronger leadership with regard to preparation programs for teachers of mathematics.
- The Common Core Standards Initiative should address the roles that colleges and universities and state departments of education should play in ensuring that newly educated teachers are ready to teach in ways that lead to students meeting the standards.

Implementation of these recommendations is a task that remains to be accomplished.

Recommendations for regions

Create regional umbrella organizations. State and regional associations and regional representatives of national organizations (e.g., NCSM regional teams, NCTM state affiliates, and MAA regional sections) might create regional umbrella organizations to coordinate professional development efforts and foster collaboration among groups. Such organizations might run list serves for sharing ideas.

Build on existing state or regional networks and organizations. In addition to the organizations already mentioned, there are federal and state government organizations concerned with education and professional development. For example, Massachusetts has a Governor's STEM Council and there is a network of ten regional education labs—the Regional Educational Laboratory Program—funded by the U.S. Department of Education's Institute of Education Sciences.[32]

[32] http://ies.ed.gov/ncee/edlabs.

Recommendations for national organizations

Build social networks. How can web and communications technologies be harnessed to create community among teachers? Could CBMS create a social network with different rooms according to topic? One Forum group said: Where can I go as a regular teacher interested in education to see a page with the top five resources posted? Another group suggested "something like the Math Forum."

Communicate. The professional organizations need to communicate their plans and let members know what to expect so that they can plan accordingly.

Work with assessment consortia. Build in professional development to support implementation of the assessments (and implementation of the standards).

Recommendations for the *Mathematical Education of Teachers 2*

In 2001, CBMS published the first *Mathematical Education of Teachers* (*MET1*) report. This report was distributed widely and made available on the Web.[33] It gave recommendations for the involvement of mathematicians in the mathematical education of teachers from preparation to professional development; the main discussion in *MET1* concerned teacher preparation.

Almost a decade has passed, and with it, changes in teacher preparation practices[34] and increased involvement of mathematicians and statisticians in teacher education. It is time for an update of this report to incorporate the decade's experience and research, and to consider teacher education within the context of the Common Core State Standards (CCSS).

At the Forum, participants were asked:

> What are the three most important recommendations about the mathematical education of teachers that should be highlighted in *MET2*, the new edition of *The Mathematical Education of Teachers*?

Their responses were rich and detailed. These reports have been sent to the *MET2* writers. Here is a summary of the main themes.

The nature of the knowledge that teachers need. In addition to specific mathematical topics, *MET1* discussed teaching-related knowledge, and mathematical habits. The Forum participants called for even more emphasis on these two kinds of knowledge, and the inclusion of more recent developments, responding to research findings and to the context of the Common Core State Standards.

- *CCSS context*. This includes specific mathematical topics and progressions, also applications of mathematics, modeling, and connections with other disciplines such as engineering and computational biology.

- *teaching-related knowledge*. Recommendations included: mathematical knowledge for teaching, research-based pedagogical practice, learning progressions, and knowledge of assessment. Participants noted that, consistent with Recommendation 1 of *MET1*, teachers need deep understanding of the mathematics they teach and of the mathematics in previous and later grades. This recommendation can be expanded to include learning progressions.

- *mathematical dispositions, habits, and practices*. Recommendations included habits of mind (as in *MET1*), and mathematical practices as discussed in CCSS.

A related issue is how these various kinds of knowledge can be measured, and current licensure and accreditation requirements.

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[33] The entire report may be downloaded, free of charge, at at www.cbmsweb.org/MET_Document/index.htm.
[34] See McCrory & Cannata, 2010 for an account of current elementary teacher preparation, www.ams.org/notices/201101/rtx110100029p.pdf.

Opportunities to attain that knowledge. Opportunities for teachers to gain the mathematical knowledge described above include:

- *immersion experiences*. The primary objective of such experiences is a "deep dive" into mathematics for the purpose of gaining or deepening mathematical habits of mind, mathematical practices, and mathematical disposition. Such experiences may be summer institutes, year-long professional development, on-line mathematics experiences, or incorporated in undergraduate courses.

- *courses*. These may be part of carefully planned programs, for teacher preparation or for continuing education, e.g., part of a masters program.

- *field and clinical experiences*. Field and clinical experiences should be part of carefully planned programs for teacher preparation.

- *professional learning communities*. These include teachers at all levels, mathematicians (at two- and four-year institutions), and mathematics educators. Teachers should take responsibility for ongoing and continued professional growth. Teachers should be part of the planning and execution of professional development offered to teachers.

Policy. *MET1* focuses on teacher preparation and its primary audience was (and continues to be) the faculty of mathematical sciences departments. *MET2* will address both teacher preparation and professional development. Forum participants suggested that the audience for *MET2* include colleges of education, K–12 schools, and policy-makers as well as the faculty of mathematical sciences departments.

The following recommendations are also addressed to members of this audience.

- *policy-makers*. Policy-makers must be made aware of the importance of sustained high-quality professional development.

- *coherent professional development*. Change, moving from the current patchwork of mathematics and statistics professional development, toward a more coherent system, must be made a high priority.

- *math specialists, in particular elementary math specialists*. *MET1* recommends that mathematics in middle grades (5–8) be taught by mathematics specialists. Acknowledging the need for greater mathematical expertise in teaching mathematics in elementary grades also, the Forum participants recommended that all elementary schools should have access to elementary math specialists and that the roles of such specialists should be elaborated. This recommendation is consistent with a statement from four CBMS societies, the Association of Mathematics Teacher Educators, the Association of State Supervisors of Mathematics, the National Council of Supervisors of Mathematics, and the National Council of Teachers of Mathematics, in response to the release of

Elementary Mathematics Specialists: A Reference for Teacher Credentialing and Degree Programs.[35]

- *teacher preparation*. In academe, sustained collaboration between mathematics, statistics, and education is needed for teacher preparation.
- *academic reward structure*. Mathematicians and statisticians who are involved in mathematics education should be appropriately rewarded by their departments for these contributions.
- *life-long learning for all involved in mathematics education*. *MET2* should describe expectations for professional development for teachers at all levels, math specialists, math coaches, early childhood teachers—and others involved in mathematics education, curriculum specialists, administrators for district, county, and state—and mathematicians and statisticians. Teachers' career trajectories should include mentoring for novice teachers and on-going professional development built into the school day.

[35] http://ncsmonline.org/docs/resources/prime/JointStatementOnMathSpecialists.pdf.