



Conference Board of the Mathematical Sciences

Common Standards and New Assessments for K–12:
Recommendations from the National Forum 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 2009, CBMS convened its second National Forum on School Mathematics. The Forum focused on three main areas:

- Content of School Mathematics
- Assessment of School Mathematics
- Teacher Education

In September, prior to the Forum, a draft of the College and Career Readiness Standards for Mathematics was released. These standards are part of the Common Core Standards Initiative, an effort coordinated by the National Governors Association and the Council of Chief State School Officers committed to developing a common core of state standards in English-language arts and mathematics for grades K–12.¹ A major goal of the Forum was to provide policy makers and the broad mathematics education community an opportunity to listen and share concerns about the standards and their implications for assessment and teacher education.

The Forum participants represented a wide spectrum of people who are involved with and knowledgeable about K–12 mathematics education in the United States. They included mathematical scientists from academe and industry, representatives from the CBMS member societies, mathematics education researchers, teachers, curriculum developers, test developers, textbook publishers, and representatives from state and county departments of education.²

At the Forum, participants had the opportunity for small-group discussions of the draft standards. Separate sessions focused on different aspects of the draft standards, assessment, and teacher education. Each session produced a short report outlining key concerns and recommendations in those areas.

This white paper is a synthesis of those reports, thus is informed by a wide range of expertise and many years of experience in K–12 mathematics education. It represents key concerns and recommendations from the mathematical sciences community that should be addressed in order to build support for the Common Core Standards Initiative.

¹ <http://www.corestandards.org>.

² For further details about the Forum and Forum participants, see <http://www.cbmsweb.org/Forum2/index.htm>.

Introduction

The Significance of This Report

Together with teachers and others whose daily work involves precollege education, mathematical scientists—mathematicians and statisticians—are deeply concerned about K–12 mathematics education. Their concern has been expressed in many different ways, from long-term projects and programs with students³ and teachers⁴ to the “Math Wars”—heated debates that have surfaced in the news media.⁵

Their concern is not surprising. Mathematical scientists teach college students, including prospective teachers, and quickly gain a sense of what their students have learned—or not learned—about mathematics and statistics before college. However, for a mathematical scientist to act on concern about precollege education often requires extraordinary commitment, collaboration, and effort. Those who do are able to develop a rare kind of expertise grounded in experience and knowledge of research mathematics, together with experience in teaching undergraduates or working with K–12 teachers, students, and schools.

Together with the Common Core Standards Initiative, current legislation offers an opportunity to make good use of this expertise and to address some of the mathematics community’s longstanding concerns about mathematics education in the United States. The Race to the Top Fund (RTT), authorized under the American Recovery and Reinvestment Act of 2009, provides approximately \$4.3 billion for competitive grants to states for educational innovation and reform, \$350 million of which has been set aside for development of new assessments.⁶ Many of the recommendations of the CBMS Forum fall within the four main reform areas of the Race to the Top Fund: standards and assessment, data systems, teachers and principals, and schools.

However, the Forum participants also made recommendations that crosscut and extended beyond the Race to the Top categories—sustained commitment, long-time plans, and communication with all stakeholders. These stakeholders include *all* concerned with mathematics education: Students, teachers, parents, principals, school boards, superintendents, textbook publishers, test developers, and teacher educators as well as mathematical scientists. Many will need to gain a better understanding of the abilities described by the standards. Many will need to be convinced of their importance. And,

³ One example is an annual award from the American Mathematical Society in recognition of outstanding programs that successfully address the issue of underrepresented groups in mathematics, <http://www.ams.org/ams/press/CoProf-Programs-2009.html>.

⁴ See, e.g., the collaborations and coalitions described in *Teaching Teachers Mathematics: Research, Ideas, Projects, Evaluation*, Mathematical Sciences Research Institute, www.msri.org/calendar/attachments/workshops/430/TTM_EdSeries3MSRI.pdf.

⁵ See, e.g., Schoenfeld, “The Math Wars,” *Educational Policy*, 18(1), 253–286, 2001, http://gse.berkeley.edu/Faculty/AHSchoenfeld/Schoenfeld_MathWars.pdf.

⁶ See www.ed.gov/programs/racetothetop/index.html; www.ed.gov/programs/racetothetop-assessment/index.html.

many will need to learn about the excitement, creativity, and beauty of the mathematical sciences as well as their necessity and usefulness in science and everyday life.⁷

Moreover, many stakeholders, especially teachers, will need to be convinced that this reform is different—not just another swing of the pendulum, but an initiative that will be sustained by continued commitment and support at all levels. Otherwise, the Common Core Standards Initiative is likely to become yet another short chapter in the history of education reform in the United States.

The Organization of this Report

In this report, recommendations are organized according to the Race to the Top education reform categories, followed by a section with recommendations that fall outside those categories.

- Section 1: Standards
- Section 2: Assessment and Data Systems
- Section 3: Teachers, Teacher Education, and Teacher Support
- Section 4: Supporting the Race to the Top: Changing the Culture

The mathematical sciences community is already engaged in efforts consistent with the Race to the Top priorities and President Obama’s Educate to Innovate campaign—intended to improve the participation and performance of U.S. students in science, technology, engineering, and mathematics.⁸ These efforts include projects and programs that support teachers, connect teachers and mathematicians,⁹ encourage students to consider STEM careers by providing career advice, and engage students in doing mathematics in “math circles,” math camps, and mathematics competitions. The expertise and experience generated by these efforts was represented at the Forum and is reflected in this report.

How the Race to the Top and Forum Categories Overlap

The five priorities of the Race to the Top (RTT) Fund are described briefly here.¹⁰ Priority 1 comprises reforms in four areas:

Reform Area 1. Adopting standards and assessments that prepare students to

⁷ Many of the CBMS societies are engaged in this effort, see their web sites for information. For other examples, see Mathematical Imagery: www.ams.org/mathimagery; What’s Happening in the Mathematical Sciences: www.ams.org/ams/happening-series/index.html; *High School Mathematics at Work*: http://books.nap.edu/catalog.php?record_id=5777.

⁸ www.whitehouse.gov/issues/education/educate-innovate.

⁹ An important example is the Mathematics and Science Partnerships (MSPs). Teachers’ participation in MSPs is significantly correlated with their students’ achievement (see *K-12 District and Partnership Projects Surveys, MSP-MIS (Wave 3)*, September–November, 2007).

¹⁰ See information at <http://www.ed.gov/programs/racetothetop/index.html> for the full statement and updates.

succeed in college and the workplace and to compete in the global economy;

Reform Area 2. Building data systems that measure student growth and success, and inform teachers and principals about how they can improve instruction;

Reform Area 3. Recruiting, developing, rewarding, and retaining effective teachers and principals, especially where they are needed most; and

Reform Area 4. Turning around our lowest-achieving schools.¹¹

The remaining RTT priorities are:

Priority 2 (Competitive Preference Priority). Emphasis on Science, Technology, Engineering, and Mathematics (STEM).

Priority 3 (Competitive Preference Priority). Innovations for Improving Early Learning Outcomes.

Priority 4 (Invitational Priority). Expansion and Adaptation of Statewide Longitudinal Data Systems.

Priority 5 (Invitational Priority). P–20 Coordination and Vertical Alignment.

Priority 6 (Invitational Priority). School-Level Conditions for Reform and Innovation.

The majority of the recommendations generated by Forum participants concerned the four educational reform areas of Priority 1, particularly area 1 (standards and assessment) and 3 (teachers). Reflecting this distribution, standards and assessment, both in Reform Area 1, are each allocated a separate section. Recommendations that involve RTT Priorities 2–6 are mentioned within these sections. Because of the nature of the Forum, there was little discussion of data systems and no discussion of school-level strategies. Thus, this report has a very short section on data systems and no section on underperforming schools. However, school-level strategies that concern teacher support are discussed in Section 3 of this report.

¹¹ *Race to the Top Executive Summary*, p. 2, www.ed.gov/programs/racetothetop/index.html.

Section 1

Standards

At the CBMS Forum, a widespread reaction to the draft standards was that the standard for mathematical practice is extremely ambitious, but the content described by the ten content standards would be insufficient for a student entering college with the intent to major in STEM.

Another widespread reaction was that the Common Core Standards would require major effort in teacher education, in both preparation and professional development. Related recommendations are:

- Guidelines for professional development *must* be incorporated into the Common Core Standards.¹²
- National organizations should release standards for professional development within a year of the Common Core Standards.

These and further recommendations regarding teachers are discussed in Section 3.

The remaining recommendations for the standards had four main themes:

- *Content*: Be explicit that students intending to major in STEM will need mathematical content beyond that described in the standards. Include more statistics and emphasis on quantitative literacy.
- *Connections*: Many kinds of connections—between the mathematical sciences and other disciplines, within the mathematical sciences, and among topics, between concepts and skills—must receive attention.
- *Organization*: In the K–12 standards, benchmarks, learning trajectories, and longitudinal development should be carefully considered and clearly communicated.
- *Research*: Make use of available research in creating the standards.

These recommendations have implications for the way in which the K–12 and College and Career Readiness standards are written. Also, these have direct implications for the design of instruction, assessment, textbooks, and teacher preparation and professional development.

¹² Note that the final RTT priorities, which were published after the Forum, include professional development for teachers as a criterion for funding. See (D)(5) Effective Support for Teachers and Principals.

Note that these recommendations are *not* meant to imply that the standards determine a single curriculum, allowing only one organization of topics. Nor do they imply that every standard should receive equal emphasis in each grade.

Section 2

Assessment and Data Systems

At the CBMS Forum, discussion groups focused on different aspects of assessment—large-scale assessment, classroom-based formative assessment, assessment of K–12 mathematics programs, placement testing, equity and assessment, and assessing mathematics teacher education programs. Data systems were discussed as part of assessment and its uses.

Concerns about assessment also surfaced in discussions of the draft standards. Different groups noted the need for benchmarks in the K–12 standards that would give a blueprint for grade-level assessments. A related concern was the difficulty of creating assessments to measure students’ achievement of each standard, particularly the mathematical practice standard.

The assessments envisioned by the Forum participants were quite different from current state tests. Not only are the draft Common Core Standards different from standards in many states, but the available evidence suggests that current state tests contain few if any complex problems and that reports have inflated students’ performance on state tests.¹³ These are but two ways in which the implementation of the proposed standards would differ greatly from much current practice. Recommendations regarding this change with respect to teacher education are discussed further in Section 3. In particular, “assessment literacy” and experience with formative assessment are recommended as part of teacher education. Recommendations regarding cultural change in general are given in Section 4.

Major recommendations for the creation of a large-scale assessment system are:

- *Long-term Transition:* The transition effort should be long term and systemic.
- *Planned Implementation:* A national assessment should be well-conceived, supported and implemented. A time line should indicate how the assessment program will be phased in over time.
- *Aligned Policies:* Policies regarding assessment at the national, state, and local levels must be aligned.
- *Involved Teachers:* Teachers should be involved in the development at every stage.
- *Specific Purpose:* The purpose of the assessment must be specified up front. Results should be used to develop and improve classroom instruction.

¹³ For discussion of test items, see Hyde et al., “Gender Similarities Characterize Math Performance,” *Science*, July 25, 2008; for discussion of state reporting strategies, see Carey, *Hot Air: How States Inflate their Educational Progress Under NCLB*, Education Sector, May 2006, www.educationsector.org/research/research_show.htm?doc_id=373044.

- *Department of Education Initiative:* Formative assessment should be explicitly called for, and supported, as part of the Department of Education’s national assessment initiative.
- *State Collaboration:* States should be encouraged to collaborate on test development—and not to continually reinvent the wheel.
- *Guidelines for Use:* An independent body should be identified to establish guidelines for state administration, scoring, and reporting information.
- *Quality Control:* Test items and construction, including content and technical aspects, should be reviewed by an independent entity. Quality control should be of critical importance.
- *International Benchmarks:* A large-scale assessment system should be internationally benchmarked.
- *Research Support:* Research funding should support development of assessments and an assessment system, drawing on the expertise of cognitive scientists, psychometricians, policy experts, mathematicians, statisticians, mathematics education researchers, teachers, and others knowledgeable about different student groups.
- *Considerations for Design and Use:* Assessment design, administration, and interpretation should address the following issues:
 - Assessment items that use only multiple-choice format will not suffice to measure all of the knowledge described by the draft Common Standards.
 - Assessment items must address the mathematical practice standard as well as the content standards. Items should address concepts and skills.
 - Consider using technology. However, issues of access as well as familiarity with technology may be barriers.
 - Assessments must be fair, that is, they allow *all* students to show what they know—regardless of race, gender, social class, disability, and other factors irrelevant to abilities being assessed.¹⁴ And, assessments must be perceived to be fair.

¹⁴ For further discussion of fairness, see American Psychological Association’s Code of Fair Testing Practices in Education: <http://www.apa.org/science/fairtestcode.html>.

Section 3

Teachers, Teacher Education, and Teacher Support Policies

Most students are unlikely to achieve the Common Core Standards for College and Career Readiness unless serious attention and sustained commitment is given to teacher education and support. At the Forum, several discussion groups stated that teachers will need to be convinced that the Common Core Standards Initiative cannot be dismissed as yet another reform that will pass without lasting impact. Teachers' involvement in the Initiative is crucial.

Overview of Major Recommendations

To support the implementation of the Standards, 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.
- Include guidelines for professional development in the Standards.¹⁵

State departments of education should:

- Establish policies for initial certification that clearly expect new teachers to have a good understanding of the mathematics that enables them to teach mathematics to high standards across the full range of grades for which they become certified.
- Include opportunities to be credentialed as an elementary mathematics specialist. Encourage colleges and universities to establish programs leading to such credentials.¹⁶

National organizations should:

- Involve more teachers in the Common Core Standards Initiative. Teachers and the National Council of Teachers of Mathematics (NCTM) should be more visibly involved in this effort. Connections with work that NCTM has already done (e.g., *Focus in High School Mathematics*) should be visible.
- Release standards for professional development within a year of the Common Core Standards.

¹⁵ The final RTT priorities, which were published after the Forum, include professional development for teachers as a criterion for funding. See (D)(5) Effective Support for Teachers and Principals.

¹⁶ The Association of Mathematics Teacher Educators notes in its draft Standards for Elementary Mathematics Specialists: "Only 9 states (Arizona, California, Georgia, Michigan, Ohio, South Dakota, Texas, Utah and Virginia) currently offer professional designations for elementary mathematics specialists and these programs differ in substantive ways" (see www.amte.net).

- Provide stronger national leadership with regard to preparation programs for teachers of mathematics. The CBMS *Mathematical Education of Teachers Report (MET Report*¹⁷) has been a good start. The emergence of the Common Core State Standards motivates building from that beginning (possibly via a thorough revision of the *MET Report*) and creating a context in which an accredited program of mathematical preparation for teachers is uniformly recognized among the states.

¹⁷ The *MET Report* can be downloaded at www.cbmsweb.org/MET_Document/index.htm.

Section 4

Supporting the Race to the Top: Changing the Culture

In summary, the major recommendations of this report that fall into the Race to the Top areas are:

- The expertise of mathematicians and statisticians needs to be represented in discussions, design, and decisions about standards, assessment, and teacher education.
- Teachers should be involved at every stage of the process.
- Teachers and mathematical scientists need to be among those who construct a roadmap to full implementation of the standards.

However, some recommendations crosscut and extend beyond the Race to the Top categories.

Forum participants recommended that a process for revising the standards be established as part of a long-term strategic commitment to improve mathematics education. Within states, this long-term commitment might build on current efforts such as the Mathematics and Science Partnerships.¹⁸

Communication about the standards should occur to all concerned in mathematics education—teachers and students, but also school administrators, school board members, parents, guardians, and the general public as well as textbook publishers, test developers, teacher educators, and mathematical scientists. Many of these stakeholders will need to gain an understanding of the standards, particularly the mathematical practice standard. They may need to reconsider their ideas about learning, in particular, that covering material faster is not necessarily better. The mathematical abilities described by the standards may not conform to their beliefs about the nature of mathematical expertise, and they may need to reconsider the belief that mathematics is mainly computation. Many will need a sense of what different assessments can and cannot measure, and help in interpreting the results of large-scale assessments.

Strategies for accomplishing these goals might include establishment of a web site associated with the standards and overseen by experts—including mathematicians, statisticians, and teachers. Such a web site might include annotated video examples of mathematical practices and other aspects of the standards. In addition to a web site, grassroots efforts should involve students' parents and guardians, and the general public. Existing grassroots outreach efforts might be expanded and amplified to include information about the standards and assessment for teachers, parents, and guardians.

¹⁸ More information is available at <http://hub.mspnet.org>.

Inside and outside of school, there should be endeavors to communicate the excitement of mathematics and statistics to students, and to expand their ideas about these subjects. Teachers should be sure that students see mathematics and statistics being used in a variety of ways. Students should be encouraged to engage in supplemental activities such as online activities, math circles, math clubs and contests. Students and teachers should be aware that information about STEM careers is available from CBMS societies and other scientific societies.

Many involved with mathematics education have already devoted much effort and many years to the goals described in this report. Now is an opportune time to build on their efforts and expertise. These, in conjunction with the Common Core Standards Initiative, the Race to the Top, and the Educate to Innovate campaign provide an exceptional opportunity to improve mathematics education—allowing many more students to experience the beauty, utility, and cultural significance of the mathematical sciences.