MATHEMATICAL SCIENCES EDUCATION BOARD

NATIONAL RESEARCH COUNCIL

Effective programs teach students, not just mathematics.

CHALLENGES FOR COLLEGE MATHEMATICS, MAA, 1990

All students should have an opportunity to learn important ideas of mathematics.

CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS, NCTM, 1989

Expectations for Mathematics Education

from High School through Career

Mathematics has long been thought of as a subject only for those with special talents. But across the nation, this attitude is changing. It is not hard to find mathematics classrooms—at all levels—that will surprise anyone who remembers their own mathematical experiences in school. Mathematics is no longer for the few, but for all.

In these classrooms, students do not just passively listen to a teacher present procedures, then examples. They are, instead, actively engaged in learning, often about topics that their parents never studied. They are using technology extensively, not only for calculation and visualization, but also as a tool for exploration and problem solving. The environment for learning mathematics is inviting and inclusive for all students regardless of gender, ethnicity, age, physical challenges, or cultural background. Many mathematics classrooms provide practical experience in ways of thinking that join the world of school to the world of careers and adult responsibilities.

These changes are the result of actions taken by individual mathematics faculty, guided by a consistent vision of mathematics education developed by their professional societies: the American Mathematical Association of Two-Year Colleges (AMATYC), the Mathematical Association of America (MAA), and the National Council of Teachers of Mathematics (NCTM).

The standards and guidelines prepared by these associations represent a consensus of the professional organizations most closely associated with mathematics education at the school and postsecondary levels. They establish common expectations for all students, even as they acknowledge differences in students' goals and aspirations. They enable smooth transitions from school to work and work to school; from school to postsecondary education and then to work; and from postsecondary education to further study at the graduate level. Through these guidelines the mathematics community speaks with one voice in addressing both the content and context of mathematics education at all levels.

The mathematics that students study should be meaningful, . . . understandable, relevant, and useful.

CROSSROADS IN MATHEMATICS, AMATYC, 1995

"Knowing" mathematics is "doing" mathematics.

CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS, NCTM, 1989

The associations' standards and guidelines, summarized below, address key issues concerning the nature of students, of mathematics, of instruction, and of assessment, and set important challenges for the mathematics community to address in the future:

NATURE OF MATHEMATICS STUDENTS

- Today's students represent the many ethnic, racial, and cultural backgrounds of our nation's increasingly diverse society.
- All students bring to the study of mathematics a variety of experiences, career goals, and personal aspirations.
- Students possess quite dissimilar degrees of interest in mathematics.
- Different students learn mathematics in different ways.
- Many students lack confidence in their own abilities to do mathematics.
- Returning students who did not have an opportunity for a standards-inspired education may have a difficult transition from work to school.
- Undergraduate students generally tailor the mathematics they study to their career path—teaching, other work settings, or graduate school.

NATURE OF MATHEMATICS STUDIED

- Mathematics is about ideas, not just about procedures.
- Realistic problems that are relevant to the students' world will be o greater interest to them.
- Mathematics uses multiple representations of concepts—numerical algebraic, graphical, and verbal.
- The practice of mathematics requires facility in recognizing patterns and relationships.
- Solving today's mathematical problems often calls for tools from discrete mathematics, geometry, probability, and data analysis.
- Contemporary mathematics depends on modeling, computer graphics, recursive procedures, randomness, and chaos theory.
- In this computer era, mathematics in practice requires the use of technology.

Teaching mathematics is a complex endeavor . . . [that]requires an understanding of the impact that socioeconomic background, cultural heritage, . . . and beliefs have on the learning environment.

PROFESSIONAL STANDARDS FOR TEACHING MATHEMATICS, NCTM, 1991

The manner in which students learn is inseparable from the content.

CROSSROADS IN MATHEMATICS, AMATYC, 1995

NATURE OF MATHEMATICAL INSTRUCTION

- Students should experience mathematics as active, engaging, and dynamic.
- Students should learn to view mathematics as a human discipline to which people of many backgrounds have contributed.
- Classroom practice should build on students' previous experiences.
- Mathematics instruction should at all times make appropriate use of technology, especially graphing calculators and computers.
- Applications that motivate theory enable students to recognize that theory contributes to their understanding of mathematics.
- Mathematics courses should make extensive use of writing assignments, open-ended projects, and cooperative learning groups.
- Mathematics instruction should acquaint students with the history of mathematics and its numerous connections to other disciplines.
- Faculty should use a variety of teaching strategies and should employ a broad range of examples.
- Students should be given the opportunity to participate in mathematical discourse to build their confidence about knowing and using mathematics.
- Students should be encouraged to pursue independent explorations in mathematics.

NATURE OF ASSESSMENT IN MATHEMATICS

- Assessment should enhance mathematics learning and support good instructional practice.
- Tests and other assessment instruments should reflect broad curricular goals including the full range of the mathematics that students need to know.
- Assessment should support every student's opportunity to learn important mathematics.
- Systematic assessments should reflect broad expectations of student learning, including the ability to solve problems, to communicate ideas, to use technology appropriately, to work in teams, and to read technical material.
- Students should be offered varied opportunities to demonstrate their mathematical knowledge.
- Instruments used for assessment should be consistent with the opportunities that students have had to learn mathematics.

Equitable assessment practices raise expectations, clarify what mathematics is, . . . [and] honor each student's unique qualities and experiences.

ASSESSMENT STANDARDS FOR SCHOOL MATHEMATICS, NCTM, 1995

Open-ended goals require open-ended assessment mechanisms; although difficult to use and interpret, such devices yield valuable insight into how students think.

HEEDING THE CALL FOR CHANGE, MAA, 1992

Extensive efforts to interpret this vision of mathematics in school and postsecondary institutions demonstrate that it will never again be "business as usual" in mathematics classrooms. Nevertheless, many important challenges remain:

CHALLENGES

- The full impact of technology on the teaching and learning of mathematics—and on issues of equity—is only beginning to be explored.
- Thoroughly incorporating new developments in mathematics into classroom instruction will require serious re-examination of the entire mathematics curriculum.
- The pace of change in mathematics education makes it critically important to accelerate programs for the continued professional development of faculty.
- As calls for accountability of educational institutions echo in society, mathematicians need to find new assessment instruments that reflect the new expectations of mathematics education.
- To prepare teachers to implement the new vision of mathematics education, colleges and universities will need to reflect the same principles in their programs for the preparation of teachers.
- For good reason, schools and postsecondary institutions are repeatedly asked to increase diversity in mathematics classrooms and to promote access to high quality mathematics education.

These challenges call for multiple yet consistent responses from faculty, administrators, parents, business leaders, and government policy makers. The vision provided by the mathematics community's standards and guidelines provides a coherent platform on which to build an effective plan of action.

Societal goals for education include mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate.

CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS, NCTM, 1989

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Full copies of the standards and guidelines are available from the sponsoring societies:

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The Mathematical Sciences Education Board was established in 1985 by the National Research Council, which is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The mission of the MSEB is to provide a continuing national capability to assess the status and quality of education in the mathematical sciences.