

Everybody Counts

A Report to the Nation on the Future of Mathematics Education 1989

Why?

The *A Nation at Risk* (NCEE) report, published in 1983, brought to America's attention the need for fundamental changes in mathematics education. In response to this national need to revitalize mathematics and science education, the National Research Council (NRC) undertook a study of U.S. mathematics education from kindergarten through graduate school. The Mathematical Sciences Education Board, the Board on Mathematical Sciences, and the Committee on the Mathematical Sciences in the Year 2000 each conducted studies for the NRC to identify both strengths and weaknesses in the present system. *Everybody Counts* is the joint work of these three groups.

What?

Published in 1989, *Everybody Counts* was a public call to revitalize mathematics education. It outlined the challenges facing mathematics educators in our country and emphasized how important it is that all students receive high-quality education in mathematics.

Everybody Counts was intended to begin a process through which a number of groups concerned with mathematics education could come together in a sustained revitalization effort. It treated all the major components of the system, including curriculum, teaching, assessment, human resources, and national needs. Rather than merely identify problems, it charted a general course for the future and outlined a national strategy for pursuing that course.

Who?

This report was synthesis of three years of work by the Mathematical Sciences Education Board (Shirley A. Hill, chair), two years of analysis by the Board on Mathematical Sciences (Phillip A. Griffiths, chair), and the first year of work of the Committee on the Mathematical Sciences in the Year 2000 (J. Fred Bucy, chair). It reflected the thinking of 70 leading Americans, among them classroom teachers; college and university faculty and administrators; research mathematicians and statisticians; scientists and engineers; mathematics supervisors; school principals; school superintendents; chief state school supervisors; school board members; members of state and local governments; and learners of parent groups, business, and industry. The report was authored by Lynn Arthur Steen, professor of mathematics at St. Olaf College.

What was produced?

Everybody Counts is a 114-page booklet, divided into seven sections and including 15 pages of references. The seven sections include the following:

- Opportunity ... tapping the power of mathematics
- Human Resources ... investing in intellectual capital
- Mathematics ... searching for patterns
- Curriculum ... developing mathematical power
- Teaching ... learning through involvement
- Change ... mobilizing for curricular reform
- Action ... moving into the 21st century

The report established a need for change in mathematics education in the U.S. and also provided a vision of what mathematics education in the U.S. could look like. It identifies who needs to be involved in the process of change, and what needs to be done. What follows are summaries of each of the above sections.

Opportunity ... tapping the power of mathematics

This section discusses the opportunities made available to those who are able to think mathematically and outlines the problems with the current school mathematics curriculum. It states that “We have inherited a mathematics curriculum conforming to the past, blind to the future, and bound by a tradition of minimum expectations” (NRC, 1989, p. 1). Historically, U.S. schools were designed to teach all students basic skills and to prepare a small number for college. A “structure designed for the industrial age [is being] misapplied to educate children for the information age” (NRC, 1989, p. 11). The level of education formerly required of the few who enrolled in college must now be a goal for all.

The report notes the following observations of past practices in American mathematics education:

- In 1983, *A Nation at Risk* made the nation aware of the problems in our educational system. Since then, a variety of reports have called for changes in all aspects of mathematics education, including the curriculum, the structure of schools, and teacher preparation. This report contends that any changes must be systematic, involving all aspects of these components.
- In the past 25 years, many factors, including the growth of technology, increased applications, impact of computers, and the expansion of mathematics itself, have combined to significantly change the scope and the application of mathematics.
- Mathematics filters students out of programs leading to professional careers. “The half-life of students in the mathematics pipeline is about one year” (NRC, 1989, p. 7).
- Most students cannot learn mathematics by only listening and imitating, yet this is how most teachers teach it. Mathematics becomes useful to a student only when it has been developed through a personal engagement that creates new understanding.
- Children can succeed in mathematics, as evidenced by the achievements of many students in other countries and some children in the U.S.

- The American public tends to assume that differences in mathematics achievement are due to differences in innate ability. Poor performance in mathematics has become socially acceptable.

Human Resources ... investing in intellectual capital

This section gives the demographics of those involved in mathematics education, painting a bleak picture of the future of mathematics education in the U.S. if significant changes are not made.

The following statistics related to past and future (ca. 1989) problematic trends in mathematics education in the U.S. are noted:

- During the next two decades, the number of 20-30 year olds in the U.S. will decline by 25%, while the number of school age children will increase by about the same amount. This will create a teacher shortage, unless more young people can be attracted to the mathematics education profession.
- More minorities must be attracted to the field of mathematics. In the 1990s, 30% of public school children will be minorities, but only 5% of mathematics teachers will be minorities, eliminating classroom role models and perpetuating a cycle of mathematical poverty among minority groups.
- The total number of American Blacks and Hispanics receiving a doctoral degree in the mathematics sciences has averaged less than 10 per year for the last 15 years. 95% of Americans who receive college degrees in the physical sciences are Whites and Asians.
- Teachers of mathematics must have appropriate mathematical and pedagogical training. Over half of nation's secondary school mathematics teachers do not meet current professional standards for teaching mathematics and it is estimated that no more than 10% of elementary teachers meet professional standards.
- More women must be encouraged to study advanced mathematics. There is no difference in performance between male and female students who have taken advantage of similar opportunities to study mathematics, yet only 35% of master's degrees and 17% of Ph.D. degrees in the mathematical sciences are earned by women.
- U.S. students must be encouraged to take advantage of the educational opportunities available to them. Fewer than half of the mathematics doctorates awarded by U.S. universities go to U.S. citizens. In the last 10 years, the number of U.S. doctorates in the mathematical sciences has dropped by nearly 50%.

This section also discusses problems associated with large numbers of international graduate students teaching American college freshmen. Even if universities had enough money to staff all courses with Ph.D.-level faculty, there are not enough Ph.D. mathematics faculty to fill all university teaching positions (estimated need is 10,000).

Mathematics ... searching for patterns

This section begins by defining mathematics as “a diverse discipline that deals with data, measurements, and observations from science; with inference, deduction, and proof; and with

mathematical models of natural phenomena, of human behavior, and of social sciences” and “a science of pattern and order” (NRC, 1989, p. 31).

This section argues that all students need mathematics and gives statistics related to the inadequate amount of mathematics instruction received by American students.

- Mathematics empowers us to better understand the information world in which we live.
- The ideas of mathematics infiltrate our lives in many ways, including in practical, civic, professional, leisure, and cultural activities.
- Computers afford new opportunities for mathematics learning and research.
- Only half of the nation’s students take more than two years of high school level mathematics; only one-quarter take more than three years. The remaining quarter enter college with four years of mathematics.
- 15,000 students graduate from college each year with degrees in mathematics. One-quarter of these students go on to earn a master’s degree, and only 3% complete a doctoral degree in mathematical sciences.
- Elementary teachers are most often in the three-quarters of students who took three or fewer years of high-school mathematics.
- Reform must begin at the university level, but promotion and tenure for university faculty are usually based on research, not teaching or work related to curricular reform. This makes it doubtful that time will be spent on these issues.

Curriculum...developing mathematical power

This section makes observations about the learning of mathematics, outlines the problems with the current school mathematics curriculum, and provides objectives for future mathematics curricula.

Observations about the learning of mathematics:

- Virtually all young children like mathematics and learn mathematics through natural curiosity.
- As children learn school mathematics, they begin to view mathematics as “a rigid system of rules governed by standards of accuracy, speed and memory” (NRC, 1989, p. 44).

Problems with U.S. mathematics education curriculum:

- Educational policy in the U.S. is set at the state and local level; there is no national curriculum as in other countries. Control often comes from textbooks and standardized tests.
- We have an “underachieving curriculum that follows a spiral of almost constant radius, reviewing each year so much of the past that little new learning takes place” (NRC, 1989, p. 45).

Objectives and recommendations for mathematics education:

- The major objective of elementary school mathematics should be to develop number sense; the objective of secondary school mathematics should be to develop symbol sense; the objective of undergraduate mathematics should be to develop function sense.
- Mathematics instruction must not reinforce the idea that all problems have one correct answer or leave the impression that mathematical ideas are the product of authority.
- All students should learn a core of mainstream mathematics. Different groups of students should not be distinguished by curricular goals, but only by speed, depth, and approach.

Teaching ... learning through involvement

This section provides observations about and guidelines for teaching mathematics that promote student understanding and addresses issues of student assessment.

- Many students master mathematics without any understanding; some achieve retroactive understanding after they have reached a more advanced vantage point, but many quit studying mathematics before they reach this point.
- No one can *teach* mathematics; effective teachers help students to *learn* mathematics through the construction of understanding. This happens when students work in groups, engage in discussion, make presentations, and take charge of their own learning.
- Teaching cannot be effective if it does not take into account students' prior ideas.
- "It is not the memorization of mathematical skills that is important ... but the confidence that one knows how to find and use mathematical tools when they become necessary" (NRC, 1989, p. 60). Students build this confidence through the process of creating, constructing, and discovering mathematics.
- The teacher should be a consultant and moderator, not just a presenter and authority.
- Less teacher-centered strategies require greater effort and students may not move through the curriculum at the expected rate, but less teaching will yield more learning.
- Calculators and computers require educators to rethink the priorities for mathematics education. With their use, school mathematics can become more like the mathematics people really use, mathematics learning can become more active and dynamic, students can explore mathematics on their own, and weakness in algebraic skills need not prevent students from understanding more advanced mathematical ideas.
- Preservice teachers need to learn grade-appropriate contemporary mathematics, in a way that consistent with how they will be expected to teach. "The U.S. is one of the few countries in the world that continue to pretend ... that elementary teachers are able to teach all subjects equally well" (NRC, 1989, p. 64).
- In no other subject is the text followed so closely. Text-based learning in mathematics needs to be reduced. Publishers and teachers need to explore new materials that will enable good innovative practices to be enacted in the classroom.
- In America, objective, multiple-choice tests are the norm. Tests must measure what is important, not just what is easy to test. Minimal competency tests stressing basic skills fail to encourage able students to progress as far as they can.

- Assessment should be an integral part of teaching, and must align with curricular objectives.

Change ... mobilizing for curricular reform

Since the publication of *A Nation at Risk* (NCEE, 1983), Americans have known that fundamental changes must occur if we want to raise performance levels, prepare young people for lifelong learning and educate *all* students well.

Challenges facing mathematics educators:

- Too many students, many minority, leave school before they acquire the mathematics necessary for productive lives.
- There is a shortage of qualified mathematics teachers and minority teachers.
- U.S. students, on the average, do not master mathematics sufficiently at a level to sustain the needs of a technological society, and lag behind students in other countries in terms of mathematical accomplishment.
- Calculators and computers have had virtually no impact on mathematics instruction, despite their great potential.
- Common methods of evaluation are obstacles to teaching higher-order thinking skills.
- Public attitudes encourage low expectations in mathematics, and the public is skeptical about change because of the failure of past reform efforts.
- The U.S. has neither a national curricula nor nationwide curricular guidelines; many schools simply adopt a series of textbooks as the curriculum.

Lessons from past reform efforts:

- Full-service curriculum development projects adopted intact by school districts do not work;
- A district-by-district approach to curriculum change will not work given the demands placed on educators;
- An extensive public information campaign will be necessary if any effort to change mathematics education is to be successful.

Transitions that mathematics educators will need to negotiate in the process of change:

- A shift in focus to a core of mathematics for all students;
- A shift from a teacher-centered instructional model to a student-centered model;
- A shift from teaching routine procedures to developing mathematical reasoning;
- A shift from an emphasis on paper-and-pencil calculations to use of calculators and computers;
- A shift to improved public recognition of the importance of mathematics in society.

Action ... moving into the 21st century

This section outlines what must happen if significant changes are to be made in mathematics education and also looks ahead to the publication of the NCTM's *Curriculum and Evaluations Standards for School Mathematics* (1989).

- “Our national goal must be to make U.S. mathematics education the best in the world” (NRC, 1989, p. 88).
- For change to occur, one must influence teachers, state and local agencies, administrators, local and state school boards, colleges and universities, textbook publishers, software developers, professional societies, test-makers, state legislators, employers, parents and the general public. The report outlines how each of these key players must be involved.
- The *Curriculum and Evaluations Standards for School Mathematics*, to be published in early 1989 by the National Council of Teachers of Mathematics (NCTM), represents the first effort ever to establish national expectations for school mathematics. It will provide parents and teachers with a vision what a school mathematics program might look like if it is to serve our national objectives.
- Our national strategy must be to make significant improvements in mathematics education on a national scale. The key to success will be national standards with local implementation. National support systems must be developed.

Significance of the Report

- This report clearly established a need for change and provided a vision of what mathematics education should look like in the U.S. in order for our students to reach the achievement level of students in other countries.
- It forecast the significance of the NCTM *Standards*, particularly because they would provide a national framework for mathematics education in the U.S.
- The publication of this report helped the NCTM plan for the dissemination of the *Standards*. MSEB and NCTM cooperated in the publication of this report, which gave NCTM a chance to plan how they would deal with the media upon the release of the *Standards* (McLeod, 2003).
- It is difficult to determine the specific curricular impact related to this report, as it was immediately followed by the publication of the *Standards*.

References

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