

**The Mathematical Sciences Curriculum K-12:
What Is Still Fundamental and What Is Not**
Conference Board of the Mathematical Sciences
1983

Why?

In response to a request made by the Educators Panel of the National Science Board (NSB) Commission on Precollege Education in Mathematics, Science, and Technology during a July 1982 meeting, a special session was called to address the topic “The Mathematical Sciences Curriculum K-12: What Is Still Fundamental and What Is Not.” On the heels of the *Agenda for Action* and *PRISM* reports, the NSB was looking for guidance from the larger mathematical sciences community as to what mathematics should be considered essential for primary and secondary school. In particular, the existing and anticipated advancements in technology provided impetus for curricular reform.

What?

The session was held in September 1982 at the Mathematical Association of America headquarters in Washington, D.C. (CBMS, 1983). It was designed for leaders from the mathematical sciences community to provide advice to the NSB and the greater mathematical sciences community regarding needed changes in the K-12 curriculum that would be in step with the emerging technology. Recognizing that the work during the two days of meetings could not possibly complete the task at hand, the recommendation to the participants was to formulate questions in need of further investigations and to suggest ways in which those investigations might proceed. At the end of the session, recommendations regarding proposed changes to the elementary and middle school mathematics curricula and general concerns and suggestions for the secondary school mathematics curriculum were made.

As catalysts for the work of the conference, six position papers on the fundamentals in the mathematics curriculum were commissioned prior to the meeting. The papers and other background readings were distributed to conference participants in advance of the session and helped to focus the conversations of the working groups during the conference. The papers and respective authors were:

Participant papers:

Richard D. Anderson, *An Analysis of Science and Engineering Education: Data and Information*

Richard D. Anderson, *Precollege Teacher Training and Retraining in Light of Expected Changes in School Mathematics*

Richard D. Anderson, *Arithmetic in the Computer/Calculator Age*

James Baldwin, Position Paper

James M. Landwehr, *Memo on Activities of American Statistical Association*

Stephen Willoughby, Position Paper

Non-participant papers:

Henry Alder, *List of Temptations to Resist*

Peter Hilton, *The Role and Nature of Mathematics: Implications for the Teaching of Mathematics Today*

Stephen White, *Notes on K-8 Math*

Who?

Henry Pollak of Bell Labs was the chairman of the conference. Many national organizations were represented at the session. Presidents of the following organizations participated in the conference:

- American Mathematical Society—Andrew Gleason
- National Council of Teachers of Mathematics—Stephen Willoughby
- Mathematical Association of America—Richard Anderson
- American Mathematical Association of Two-Year Colleges—James Baldwin
- Society for Industrial and Applied Mathematics—Seymour Parter

NSB Commission members and staff participants included Frederick Mosteller, Katherine Layton, Ray Hannapel, and Mary Kohlerman.

All total, 30 participants and 2 observers represented the mathematical sciences community.

What was produced?

The Commission produced a set of recommendations for needed additions, deletions, and changes in emphases of the elementary and secondary mathematics curricula and noted general concerns regarding the secondary curriculum. The written report was 15 pages with 32 pages of appendices. Sections of the report and brief summaries of selected sections follow.

Executive Summary

I. The NSF/CBMS Meeting

II. Recommendations to the Commission

Introduction

The limited time available for the meeting to establish consensus on all matters was recognized and a brief justification of the need to incorporate the use of calculators and computers, more data analysis, and adjust the topics and modes of thought in K-12 mathematics was provided. This section was a brief synopsis of the Working Group Reports below. Recommendations were made for detailed examination of model curricula along with consideration of the competing demands for time in the overall school curriculum. Real problems facing this needed reform were identified as well as

the necessity to improve the total school environment in order for these recommendations to be successful.

Some Additional Recommendations

The group recognized the importance of textbooks, testing, articulation, equal access, and the role of women and minorities when considering implementation of curricular change.

The Working Group Reports

- *Elementary and Middle School Mathematics*
“A principal theme of K-8 mathematics should be the development of number sense, including the effective use and understanding of numbers in applications as well as in other mathematical contexts” (CBMS, p. 2). Modest changes were recommended for grades K-3 with more significant changes for grades 4-6 and 7-8. These included:
 - 1) facility with one digit number facts is still expected;
 - 2) calculator use is encouraged;
 - 3) informal arithmetic strategies to calculate and approximate is expected;
 - 4) estimation should be emphasized;
 - 5) problem solving in appropriate contexts is emphasized;
 - 6) data analysis, statistics, and probability should be strengthened;
 - 7) decimal, percents, place value, and scientific notation are vital;
 - 8) integration of number and geometry is suggested;
 - 9) understanding of fraction concepts is more important than computation of fractions;
 - 10) three-digit number drill should be de-emphasized;
 - 11) conceptual development of geometric formulas should be emphasized;
 - 12) inclusion of dynamic function concept is suggested;
 - 13) set theory should be de-emphasized;
 - 14) algebraic symbolism is encouraged in grades 7 and 8;
 - 15) the use of mathematics in social science and science courses is encouraged.

Implementation concerns associated with these recommendations included the need for:

- 1) widespread dissemination and discussion relative to the changing roles of arithmetic in society;
 - 2) textbooks and teacher training materials;
 - 3) standardized tests to measure problem solving and number sense;
 - 4) highly qualified teachers assigned to teach mathematics classes;
 - 5) improved status of teachers;
 - 6) understanding the diminished role of paper and pencil computation.
- *Traditional Secondary School Mathematics*
The group recommended that the traditional mathematics component be streamlined in order for emergent topics related to technological advancements to

be added. The skills and procedures associated with the study of algebra should be de-emphasized and the power of technology should be seized to aid understanding of both form and function. Formal proofs were to be de-emphasized in geometry and more emphasis placed on integration between algebra and geometry through the study of transformations. Work in three dimensions was recommended, as was use of computers to support visual sense-making, mathematical argumentation, and algorithmic thinking. Precalculus may be relegated to history, provided appropriate reforms encourage earlier clear development of concepts. Computer programming may be used to reinforce algorithmic thinking. Use of computers may open opportunity for average students to succeed in mathematics. Calculus as the goal for able college-bound students was called into question.

Cautions associated with these recommendations included:

- 1) uncertainty regarding how much technology might replace traditional goals;
 - 2) little, if any, research existed to support these recommendations;
 - 3) articulation between schools, colleges, and employers is necessary;
 - 4) standardized testing must change to encourage these reforms.
- *Non-traditional Secondary School Mathematics*
This working group agreed that substantial change in both subject matter and pedagogy was needed at the secondary level. Additionally, they recognized the need to move slowly and to bring along the secondary school mathematics community. Regarding the subject matter, the group suggested the inclusion of discrete mathematics, elementary statistics, and computer science at the expense of traditional trigonometry beyond the study of trigonometric functions. Teaching should emphasize algorithmic thinking, in support of the computer age, and capitalize on the promise of discovery learning through data gathering and mathematical investigation. Because computers would potentially allow the study of previously inaccessible content, as well as make some content obsolete, content should be adapted. To accommodate new technology, care should be taken to “allow creative experimentation and discovery by students as well as to reduce the need for tedious computation and manipulation” (p. 5). In order to succeed with this mission, the working group recognized the need for training for existing teachers in the field as well as new teachers. The committee recommended for prospective secondary mathematics teachers a year of discrete mathematics in addition to traditional calculus, one semester or one year of statistics focused on statistical methods, and one year of computer science. The group was aware of the need to bring secondary teachers, college curriculum people, and state and local education organizations into the fold and recommended a conference to bring these people together.
 - *The Role of Technology*
This working group recognized the potential as well as possible pitfalls associated with rapid technological advances. They suggested that computers and calculators should enhance mathematics instruction and that access is an

important equity issue. Curricular issues relating to technology warranted study at the national level and would likely result in problem-solving experiences available for students far beyond the work at the time. Well trained, highly qualified teachers would be needed and inservice training required to meet the needs in a technological society.

- *Relations to Other Disciplines*

This group was optimistic about the promise for connections between mathematics, science, and social science due to the lack of limitations imposed computationally. Real problems would be able to be tackled without fear of unruly numbers. Also, the increase in statistical understanding would help to produce a more literate citizenry. They recommended discussion with college personnel and business leaders to ascertain the requirements desired of high school graduates.

- *Teacher Supply, Education, and Re-education*

Due to the serious and well-documented shortage of qualified mathematics teachers and the projected shortage, recommendations were made to make the problem a national priority and communicate the message to the public. They recommended incentives to attract and retain qualified mathematics teachers and several possible incentive scenarios were provided. The group recommended that elementary teachers teaching mathematics should specialize in mathematics. The suggestion was made that new elementary teachers pass at least three years of college preparatory mathematics in high school and secondary mathematics teachers take the equivalent of a major in mathematics in college.

Significance of the Report

The early 1980s was a period of great unrest with respect to mathematics education. Technology was rapidly advancing, student achievement was unsatisfactory, a new millennium was approaching, the world was becoming smaller, and economic competition was growing. Interestingly, during the Reagan Administration, the NSF Directorate of Education was abolished (1982) and it looked like funding would be significantly reduced for education (NSB, 2000). At the same time, the U.S. was seeing dismal results on international assessments. “What Is Still Fundamental and What Is Not” was one in a long list of reports with recommendations for mathematics reform written to respond to these concerns.

“. . . the Conference Board of the Mathematical Sciences (CBMS) recommended that the secondary school curriculum be streamlined to make room for new topics and techniques from discrete mathematics, statistics, and probability, and that the content, emphases, and approaches in algebra, geometry, and precalculus be reexamined in the light of emerging computing technologies (Schoen & Hirsch, 2003). With little research to substantiate the recommendations and almost no prototype school curricula for consumption, the case was made for strong support from the federal level, specifically NSF, to bring these recommendations to fruition.

When one looks to tangible products as results of these conference proceedings, it is difficult to attribute direct cause and effect. Nonetheless, *Everyday Mathematics* materials, under the leadership of Max Bell, can be seen to embrace many of the recommendations of this report. Various algebra reform projects began during this time period as well (UCSMP—Zal Usiskin, the Computer-Intensive Algebra Project—Jim Fey and Cathy Heid, the HIMAP Project—Sol Garfunkel), in the spirit of the technology explosion (Kaput, 1995). Looking at the NCTM Yearbooks of 1983, 1984, and 1985, with titles of *The Agenda in Action*, *Computers in Mathematics Education*, and *The Secondary Mathematics Curriculum*, respectively, it is clear that the “What Is Still Fundamental and What Is Not” report had a remarkably immediate impact (NCTM, 1983, 1984, 1985).

As sparked by *An Agenda for Action* and followed by *Educating Americans for the 21st Century* and *A Nation at Risk*, this report was significant in the role it would play in changing the face of mathematics education and for its strong influence on the evolution of national standards. (NCTM, 1989; NSB, 2000; Schoen & Hirsch, 2003). Renewed interest in mathematics and science, as evidenced by the multitude of national reports in the early 1980s, would eventually lead to increased federal funding for mathematics and science research and curriculum development. Conferences and reports like this one did little to answer questions; however, collectively, they were responsible for helping to set an extremely influential agenda for the remainder of the decade and beyond.

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