

**Overview and Analysis of School Mathematics**  
**Grades K –12**  
**Report of the Conference Board of the Mathematical Sciences**  
**National Advisory Committee on Mathematical Education**  
**1975**

### **Why?**

The Conference Board of the Mathematical Sciences (CBMS) was concerned regarding the controversy over conflicting reports of student success in the “new math” programs, as well as the confusion and disagreement over the goals of mathematics in the schools. In addition, the impact of the growing accessibility of computers and calculators in the schools needed to be addressed.

As the result of continuing debate about the influences of program priorities and the necessary resource, which referenced “national trends” in mathematics teaching, the National Advisory Committee on Mathematical Education (NACOME) was established by the CBMS. The National Science Foundation (NSF) provided funds for a comprehensive overview and analysis of the current status of mathematics education for K-12 and supported the work of the committee.

### **What?**

NACOME prepared a 150-page document examining and dissecting various aspects of mathematics education, as well as providing recommendations and perspectives from the Committee. NACOME gathered evidence and support from:

- National Council of Teachers of Mathematics
- Association of State Supervisors of Mathematics
- National Science Foundation
- National Assessment of Educational Progress
- National Center for Educational Statistics—*Course Offerings and Enrollments in Public Secondary Schools*
- American Institutes for Research—*Computing Activities in Secondary Education*

NACOME prepared a summary of its findings on the national trends of mathematics education, specifically the impact of “new math” goals and dispelled the claims that mathematics education was failing.

The Committee examined the objectives of U.S. school mathematics education, its practices, and achievements, and offered recommendations deemed appropriate.

## Who?

The Committee brought together a wide range of experience and expertise. It solicited information from professional organizations and published reports, including the survey of *Course Offerings and Enrollments in Public Secondary Schools* of the National Center for Educational Statistics, a survey of *Computing Activities in Secondary Education* by the American Institute for Research, and the 1972-1973 National Assessment of Educational Progress (NAEP) in mathematics.

The NACOME members included:

Shirley Hill, Chairperson	University of Missouri – Kansas City
James T. Fey, Executive Secretary	University of Maryland
Truman Botts, Project Director	Conference Board of the Mathematical Sciences, Washington, DC
Robert P. Dilworth	California Institute of Technology
James F. Gray	St. Mary’s University, San Antonio, Texas
John L. Kelley	University of California - Berkeley
Peggy Neal	Hilsman Middle School, Athens, Georgia
Jack Price	San Diego City Schools, San Diego, California
Rheta Rubenstein	Murray-Wright High School, Detroit, Michigan

“We are particularly indebted to Professor James Wilson of the of the University of Georgia for his continual input of information and insight throughout the study—initially as a member of NACOME and then as NSF liaison for the project during 1974-1975 when he was on leave at the Foundation.”

Shirley Hill, Chairperson (p. v)

## What was produced?

The 157-page final report was divided into 6 chapters:

1. Mathematics Curriculum Reform 1955-1975
2. Current Programs and Issues
3. Patterns of Instruction
4. Teacher Education
5. Evaluation
6. Recommendations and Perspectives

Each chapter provided a context for subsequent recommendations. The challenges associated with a report of this nature are illustrated by the following statement that prefaced their recommendations:

“. . . this survey covers a vast and jumbled mathematical landscape. It is more than the proverbial jungle; there are obvious mountain peaks and gaping chasms. As a survey it

came in a period of confused and changing boundaries amidst the particularly receding waters of the “new math” deluge. It attempts to chart what is because it is important to do so now, knowing full well that outcome may resemble those amusing early maps of the New World. It would be presumptuous for this small group, awed by the survey task itself, to formulate a comprehensive set of recommendations on the future course of mathematics in the schools. Nevertheless, having charted the waters, however roughly, we have come face to face with some unmistakable topographical features and feel that it is valid to call these to the attention of the mathematical community.”

Shirley Hill, Chairperson (p. 136)

Two kinds of recommendations were proposed to the mathematical community: (a) policy recommendations; and (b) recommendations for research and development.

### **Policy Recommendations**

#### **1. Anti-Dichotomy:**

Everyone (teachers, administrators, parents, general public) who is involved in the process of mathematical learning (creation, introduction, and support) should not be drawn into a false perception about the following: “the old and new mathematics, skills and concepts, the concrete and the abstract, intuition and formalism, structure and problem solving, induction and deduction” (p. 136). Furthermore, the Committee recommended that the term “new math” be limited in its use to describe the multitude of mathematics education concerns and developments of the period 1955-1975. Current school mathematics problems and trends should be referred to as “current school mathematics,” or “present mathematics program,” or “contemporary mathematics teaching.”

#### **2. Quality Education:**

Mathematics Education should be a full commitment to comprehensive mathematics for *all* “youngsters regardless of race, national origin, or sex” (p. 137) and should encourage every participant to learn mathematics. This commitment included the following recommendations:

*In particular:*

- a) Every child has a right to be competent in mathematics to use it for his/her daily activities, but the concept of “basic skills” should not only include computational skills, but the abilities to critically and logically analyze the given information or statistical data;
- b) Minimum skills should not draw a limit line for learner’s abilities to explore mathematics further;
- c) Provision for and support of qualified teachers is necessary to achievement of these goals;
- d) Teachers, despite their qualifications or physical locations, must choose the curriculum with respect to students’ abilities and needs, and create lesson plans in accordance with such standards;

- e) The school systems should be supportive of teachers and assist their input into the mathematical community;

### **3. Curriculum Content**

Curriculum content, subject to adaptability in all areas of our society; flexible, changing, receptive to human and technological lessons at all times. NACOME reviewed and analyzed the new curricular emphases and disputed the case for a return to the traditional skill and drill curriculum, as any drop in mathematics achievement was not attributable to the “new math” programs. NACOME offered the following essential elements for a contemporary mathematics curriculum:

- a) Logic must serve as a framework for the study of mathematics.
- b) Concrete experiences must be present to gain abstract conceptions.
- c) Students must have opportunities to apply mathematics into social and natural sciences and real life experiences.
- d) Symbolic representations and their properties must be introduced appropriately and proportionally.
- e) At the beginning of the eighth grade the calculator should be available for the student to explore mathematical concepts and use it for tests.
- f) Apply the recommendation of the Conference Board of Mathematical Sciences 1972 regarding computers in secondary curricula.
- g) All schools should pay special attention to teaching of the metric system and re-examine current instruction in fraction and decimals to fit the new priorities.
- h) Statistical concepts should be incorporated throughout the elementary and secondary curriculum.

*With regard to technology use in mathematics classrooms NACOME recommended:*

- 1) All students must have the opportunity to participate in computer science courses;
- 2) Schools must use computers beyond the computer instruction or management system requirements;
- 3) “Computer literacy” courses must provide an opportunity for students to be involved in “hands-on” experiences using computers;

### **4. Teacher Education**

This section of the NACOME report explored pre-service education, certification and accreditation, in-service education, general trends in teacher education and teacher effectiveness. One of the obstacles NACOME encountered while exploring the area of teacher education was, “the absence of hard data concerning programs and practices, requirements, and characteristics of the products” (p. 81). Despite limited access to data, NACOME offered these recommendations for pre-service and in-service preparation of mathematics teachers:

- a) Both NCTM and MAA need to present a unified position on the educational requirements of pre-college mathematics teachers.

- b) Professional organizations must recognize and assure mathematics educators' participation in important decisions related to the issues in the field (special education, early childhood education, bilingual education, career education, etc.).
- c) Mathematicians and mathematics educators must continue to contribute to the mathematical competencies of teachers (program designs, teacher certification, teacher education, etc.).
- d) Empirical rationale must serve as a critical constituent in teacher education and certification, along with competency and performance.
- e) The instruction and the background of the instructor of pre/in-service courses for teachers must consist of mathematical competence, efficient experience, and the interest in the curriculum especially for the grades/levels the instructor is teaching.
- f) Nationally accepted in-service workshops must identify the following factors:
  - 1) Teachers' conditions for attending the institute;
  - 2) Teachers' opportunity to contribute to the program;
  - 3) Teachers' opportunity to espouse the program's material into the classroom;
  - 4) Teachers' opportunity to address, analyze, and resolve potential difficulties of implementation.
- g) Teacher organizations and educational programs (school districts, sponsoring agencies, etc.) must encourage teacher involvement in in-service programs through incentives (e.g., leave time, academic credit, stipends, benefits, etc.).
- h) Important areas to improve in teacher education:
  - 1) Increase competence of teachers and the teachers' ability to foster in children (logic, problem solving, etc.);
  - 2) Advancement of teacher ability to make intelligent decisions about curriculum development and implementation, respond effectively to external pressures and address policy issues);
  - 3) Acknowledgment of the importance of the statistical analysis and data collection as an educational processes and every day activities;
  - 4) Recognize the importance of "real world" problems in mathematics instruction;
  - 5) Develop computational skills through the effective use of technology;
  - 6) Develop computer literacy and problem solving through computer programming, especially for secondary teachers;
  - 7) Prepare teachers to be professionally ready to teach and participate effectively in emerging developments of mathematics education.

## **5. Affective Domain:**

Mathematics remains a rapidly growing discipline for personal, industrial, and scientific society. NACOME recognized the importance of developing positive attitudes toward mathematics with these suggestions:

- a) Affective and cognitive domains must get special attention when learning or teaching mathematics;
- b) Basic research in mathematical affective domains must be done;
- c) The construction of more successful and susceptible mediums for assessing the affective domains must be accomplished;

- d) All of the evaluation programs (national, regional) must contain the items referred to in (c);
- e) The objectives of affective domains must be integrated into the pre/in-service programs;
- f) Gender issues in mathematics must be addressed and the notion of mathematics being a male dominated discipline rejected.

## **6. Evaluation:**

Evaluation plays an important role in today's education; therefore, there is a need to specifically address these recommendations.

- a) Evaluation instruments must be aligned with program goals;
- b) Standardized tests of student performance by grade levels should be discontinued;
- c) Standardized ("norm-referenced") tests should be replaced by more effective "objective-directed" tests (p. 142);
- d) Program evaluations should contain an appropriate amount of sampling techniques, to avoid over-testing problems;
- e) Evaluation forms and results must be "multi-componential" to match the "multiplicity" of the educational programs and their goals;
- f) The tests' structure and administration must avoid cultural biases;
- g) Evaluators must consider the factors that might affect the performance: time constraints, over-testing, motivation, physical conditions, etc.

## **Recommendations for Research and Development**

### **1. Needed Research**

Research is an important part of empirical mathematics education. The focus should be on areas of "overriding importance" for which "the evidential base is so weak" (p. 143). The Committee felt the most important areas that needed to be addressed were:

- a) Establishing effective teaching models, and this cannot be satisfactorily resolved without "sound research relating teacher characteristics and behaviors to successful educational outcomes and accomplishment of goals" (p. 143).
- b) Continuing research on instructional and curricular organizations (pattern, methods, materials, etc.). Alternative studies needed to be evaluated and compared.
- c) Examining relationships between teaching and learning styles.
- d) Establishing goals and conducting research to identify the techniques and practice to meet those goals.
- e) Researching relationships between attitudes and achievement outcomes.
- f) Examining informal and rigorous modes of optimal and effective balance in learning mathematics and its relationship to mathematics content, student ability, and experience.
- g) Computing and calculating instruments used in curriculum need to be researched at all levels of instructional objectives.
- h) Evaluating applied mathematical programs in relation to other fields.

## 2) Needed Information

The Committee identified a number of issues for which insufficient information exists. In such cases these issues were not address due to such informational deficiency. For example:

- a) Extensive information about the mathematics classrooms is needed.
- b) Surveys are needed to identify common practices, program requirements for teacher education and preparation. Educational institutions need to share such information on a broader scale.
- c) Creation of assessment tools to identify the needs of in-service teachers and build a database that does not rely on teacher' opinions are needed.

## 3) Needed Curriculum Development

Several curricular organizations, instructional materials, and courses are of urgent concern:

- a) Develop “instructional material such as calculators, applications, modeling, statistics” (p. 145) that utilize and reflect their significance.
- b) Revise the curricular program to increase the use of the metric system in measurement.
- c) Revise the curricular programs to increase the use of computers and calculators.
- d) Integrate statistical analysis into curricula at all levels.
  - 1) Use statistics to illustrate and motivate mathematics.
  - 2) Emphasize the connection of statistics with other disciplines.
  - 3) Develop additional courses to provide an outlook of the variations of statistical applications:
    - i. 9<sup>th</sup>-grade statistics course (no algebra prerequisite), where students (who are not intending to continue in college level mathematics) will learn statistical use for their life span;
    - ii. Senior year course with a prerequisite course in probability;
    - iii. Interdisciplinary course that ties statistics with computers, social, natural and physical sciences.
- e) Support recommendations of the CBMS 1972 Committee on Computers in the Secondary School:
  - 1) To understand the capabilities and limitations of the technology, there needs to be created a junior-high level “computer literacy” course;
  - 2) Printed (textbooks) materials need to be available to follow-up the “computer course” that would lead the students into high school;
  - 3) High school students need to be exposed to the unusual aptitude and promise in computer science through perhaps a special program;
  - 4) Computer science programs need to be broadly available, yet carry-out the quality of the instruction.
- f) Use materials that will effectively develop abilities in problem solving, through logical and critical thinking.
- g) Revise geometry courses in junior high and high school and provide imaginative approaches.

- h) Incorporate remedial instruction needs more effectively within materials.
- i) Revise teacher education programs to better prepare teachers to provide more effective remedial instruction.
- j) Broaden the use of short tests directed at specific objectives instead of standardized tests.
- k) Develop measures of the affective domain of mathematics education.

## Significance of the Report

NACOME offered a valuable and timely synthesis of the “current practices, proposals, and evidence of achievement” (p. 125). It provided valuable suggestions/recommendations to improve the overall quality of school mathematics, curricular content, and pedagogy.

The report affirmed “new math” was not a failure. The Commission summarized that “new math” was fundamentally sound and had lasting positive effects.

It made a strong case for the accessibility of mathematics for all “youngsters” regardless of gender or race.

It offered specific and practical suggestions to guide future curricular development, including the need to consider the impact of technology on what mathematics is important and how mathematics is learned.

It highlighted a number of specific areas in mathematics education where research was needed, and thereby served to stimulate much relevant research.

The NACOME report resulted in significant discussions and stimulated action by professional groups and organizations. For example, the *Agenda for Action* produced by the NCTM reflected a number of the recommendations contained in the NACOME Report. It also influenced some of the federal agencies as priorities for funding were identified.

## Suggested Reading

Conference Board of the Mathematical Sciences National Advisory Committee on Mathematical Education. (1975). *Overview and analysis of school mathematics grades K-12*. Copyright by the Conference Board of the Mathematical Sciences.

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