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Table of Contents

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In 1989, the National Council of Teachers of Mathematics (NCTM) released a document of major importance for improving the quality of mathematics education in grades K-12. This document, "Curriculum and Evaluation Standards for School Mathematics," contains a set of standards for judging mathematics curricula and for evaluating the quality of the curriculum and student achievement. It represents the consensus of NCTM's members about the fundamental content that should be included in the school mathematics curriculum, establishing a framework to guide reform in school mathematics. Inherent in the STANDARDS is the belief that all students need to learn more, and often different, mathematics.

WHAT IS THE RATIONALE FOR THE STANDARDS?

Technology is changing the workplace, the home, and daily life. Moreover, the mathematics a person needs to know has shifted, and new mathematics is being created as technological applications emerge. Yet the teaching of mathematics has remained relatively unchanged. As it has for centuries, mathematics often relies on rote memorization.

The objectives of mathematics education must be transformed to meet the critical needs of our society: an informed electorate, mathematically literate workers, opportunity for all students, and problem-solving skills that serve lifelong learning. Both the content that is being taught and the way it is taught need to be reconsidered and, in many cases, transformed. To ensure quality, to indicate goals, and to promote change are the three reasons why NCTM issued the STANDARDS.

WHAT ARE THE UNDERLYING ASSUMPTIONS OF THE STANDARDS?

Several assumptions shape the vision of mathematics set forth in the STANDARDS: (1) Mathematical power can and must be at the command of all students in a technological society. (2) Mathematics is something one DOES--solve problems, communicate, reason; it is not a spectator sport. (3) The learning of mathematics is an active process, with students constructing knowledge derived from meaningful experiences and real problems. (4) A curriculum for all includes a broad range of content, a variety of contexts, and deliberate connections. (5) Evaluation is a means of improving instruction and the whole mathematics program.

WHAT GOALS ARE ESTABLISHED FOR STUDENTS?

All students should have opportunities to learn a broad spectrum of mathematics. Toward that end, the STANDARDS state five goals for students: to learn to value mathematics, to learn to reason mathematically, to learn to communicate mathematically, to become confident of their mathematical abilities, and to become mathematical problem solvers.

WHAT IS THE FRAMEWORK FOR SCHOOL MATHEMATICS?

The STANDARDS offer a framework for curriculum development--a logical network of relationships among identified topics of study. Although they specify the key elements of a high-quality school mathematics program, they neither list topics for particular grades nor show a "scope and sequence" chart. Instead, the 40 curriculum standards discuss the content at three grade-level groups: K-4, 5-8, and 9-12. The 14 evaluation standards provide strategies to assess the curriculum, instruction, and program.
The first three curriculum standards for each grade level and three of the evaluation standards deal with problem solving, communication, and reasoning. A fourth curriculum standard, Mathematical Connections, is predicated on the belief that mathematics must be approached as a unified whole. Consequently, curricula should deliberately include instructional activities to reveal the connections among ideas and procedures in mathematics and applications in other subject matter areas.

For each grade-level group, nine or ten content standards supplement the first four curriculum standards. While the titles are sometimes similar, the concepts and processes vary by level. In a lengthy presentation for each standard, the mathematical outcomes for students, the focus of the standard, discussion of what the standard means, and examples of how the content might be taught are provided.

WHAT STANDARDS ARE INCLUDED FOR EACH GRADE CLUSTER?

The 13 standards for K-4 are: Mathematics as Problem Solving, as Communication, and as Reasoning, and Mathematical Connections; Estimation; Number Sense and Numeration; Concepts of Whole Number Operations; Whole Number Computation; Geometry and Spatial Sense; Measurement; Statistics and Probability; Fractions and Decimals; and Patterns and Relationships.
There are 13 standards for grades 5-8: Mathematics as Problem Solving, as Communication, and as Reasoning, and Mathematical Connections; Number and Number Relationships; Number Systems and Number Theory; Computation and Estimation; Patterns and Functions; Algebra; Statistics; Probability; Geometry; and Measurement.

Fourteen standards pertain to grades 9-12: Mathematics as Problem Solving, as Communication, and as Reasoning, and Mathematical Connections; Algebra; Functions; Geometry from a Synthetic Perspective; Geometry from an Algebraic Perspective; Trigonometry; Statistics; Probability; Discrete Mathematics; Conceptual Underpinnings of Calculus; and Mathematical Structure.

WHAT STANDARDS ARE INCLUDED FOR EVALUATION?

Three standards pertain to general assessment: Alignment, Multiple Sources of Information, and Appropriate Assessment Methods and Uses. Seven standards concern student assessment: Mathematical Power, Problem Solving, Communication, Reasoning, Mathematical Concepts, Mathematical Procedures, and Mathematical Disposition. Finally, four standards are on program evaluation; Indicators for Program Evaluation, Curriculum and Instructional Resources, Instruction, and Evaluation Team.

WHAT ARE SOME SUGGESTED CHANGES THAT SHOULD BE INCLUDED IN

MATHEMATICS INSTRUCTION?Some aspects of doing mathematics have changed in the last decade, in large part because of technology. Changes in technology and the broadening of the areas in which mathematics is applied have resulted in growth and changes in mathematics itself. Technology makes it imperative that: (1) appropriate calculators should be available to all students at all times; (2) a computer should be available in every classroom for demonstration purposes; (3) every student should have access to a computer for individual and group work; and (4) all students should learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems.

The availability of calculators does not eliminate the need for students to learn algorithms; some proficiency with paper-and-pencil computational algorithms is important. Contrary to the fears of many, there is no evidence to suggest that the

availability of calculators makes students dependent on them for simple calculations. Students should be able to decide when they need to calculate and whether they require an exact or approximate answer. They should be able to select and use the most appropriate tool.

A constructive, active view of the learning process must be reflected in the way much of mathematics is taught. Thus, instruction should vary and include opportunities for: appropriate project work; both group and individual assignments; discussion between teacher and students and among students; practice on mathematical methods; and exposition by the teacher.

The STANDARDS were developed with consideration to the content appropriate for all students. This does not suggest that all students are alike; it does suggest that all students should have an opportunity to learn the important ideas of mathematics.

WHAT ARE SOME NEXT STEPS FOR TEACHERS AND ADMINISTRATORS?

The NCTM challenges all to work toward the goal of improving the school mathematics program as identified by the STANDARDS.
Teachers and administrators should obtain the materials listed in the reference section to learn more about the STANDARDS. The school staff should review the current program and instruction to identify changes that are desirable and begin to modify the experiences provided for pupils.

Several states and many school districts have started to modify programs. Materials describing these activities will be published in journals of the NCTM (The Arithmetic Teacher and The Mathematics Teacher) on a regular basis. Schools desiring more information or assistance should contact their state department of education mathematics education coordinator/ specialist, and periodically check Resources in Education and the Current Index to Journals in Education for information and materials.

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