Big Changes Urged for Precollege Math

New standards would expand content and emphasize concepts and applications over rote learning. Down with true-false tests

A NEW SET of standards formulated by the National Council of Teachers of Mathematics calls for unprecedented changes in the content and teaching of precollege mathematics. Written by a panel headed by Thomas J. Romberg of the University of Wisconsin, the report outlines 54 curriculum standards covering kindergarten through 12th grade. The standards cover not only content, such as "algebra," and "measurement," but processes and relationships among disciplines, as in "reasoning" and "geometry from an algebraic perspective."

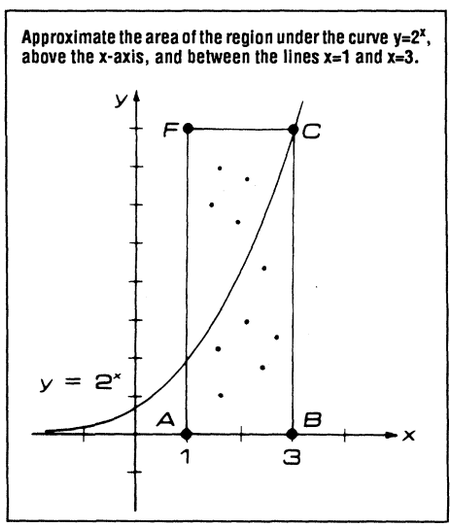
Math is usually treated in elementary and high schools as an unchanging body of knowledge. Yet, the report notes, "more than half of all mathematics [have] been invented since World War II."

The model standards promise to make math more interesting and more challenging for both students and teachers. They mark a major shift in emphasis away from rote learning and teacher lecturing toward active problem-solving by students, the understanding of underlying concepts, the use of tools such as calculators and computers, and the application of mathematical disciplines to real-life situations. Achievement tests would be downplayed in favor of multiple assessment techniques.

Classroom activities would be much more varied, encouraging more student initiative and questioning, and employing a variety of formats such as small group learning, peer instruction, individual and group projects, and class discussions. Deemphasized would be long periods of "seatwork," heavy reliance on texts and teacher lecturing, and routine paper-and-pencil work. Much more use of calculators and computers is urged. "Contrary to the fears of many," says the report, they have expanded student capabilities; "there is no evidence" that the availability of these technologies "makes students dependent on them for simple calculations."

The guidelines call for a considerable broadening of the content covered. For example, in kindergarten through the 4th grade, probability and statistics and "patterns and relationships" are included along with simple arithmetic, geometry, and measurement. In higher grades, a variety of sophisticated concepts are introduced, such as "reasoning inductively and deductively" in grades 5 to 8, and "real-world applications and modeling" in high school geometry. These would replace much of the traditional preoccupation with memorizing formulas and procedures, and drills on isolated functions (such as rounding numbers or translating fractions). For example, in high school, decreased attention would be given to "paper-and-pencil graphing of equations by point plotting" in favor of "computer-based methods such as successive approximations and graphing utilities for solving equations and inequalities."

At all levels, the emphasis is on combining knowledge of basics with an understanding of underlying concepts. For example, a traditional elementary geometry question might display a six-sided figure in which all the dimensions are specified, with the direction "find the perimeter." A student can answer this without understanding the concept of perimeter. A substitute item recommended by the report would be: "draw a six-sided polygon with a perimeter of 23 units. Show all dimensions." Another approach would be to ask a student how to arrange a 23-foot length of fencing to enclose a six-sided field. This question not only adds a tangible element to the problem but poses one for which there is more than one correct answer.



"Mathematical connections." *This is a calculus problem, but students unfamiliar with calculus can use probabilistic techniques to estimate the answer.*

"The most fundamental change" proposed for grades 9 through 12, according to the report, is a core curriculum involving the requirement for 3 years of math. The authors emphasize that this is not a call for a standardized curriculum. Rather, it is a proposal that "all students be guaranteed equal access to the same curricular topics."

The report has been endorsed by the National Research Council's Mathematical Sciences Education Board as well as a slew of educational and scientific organizations, including the American Federation of Teachers (AFT) and the National Education Association. However, resistance may be expected from teachers who believe there is no substitute for drillwork and rote memorization to pound facts into young minds. At a press conference announcing the changes, John A. Dossey of Illinois State University noted that the recommendations bear little resemblance to the much criticized "new math" initiative launched in the post-Sputnik years. New math, he said, was a "top down" initiative created by mathematicians for educating the elite. The new guidelines, in contrast, have broad support and emphasize principles designed to make mathematics relevant for all students.

Nonetheless, "It will be very difficult to make the changes in schools as they are now," says Ruth Whitman of the AFT. Considerable progress will have to be made in teacher preparation as well as the much vaunted "restructuring" of precollege education now going on at the state level. For example, the teacher-as-drill-sergeant model must be replaced by a variety of models including cooperative learning, team teaching, and peer tutoring as well as increased involvement of parents.

Education researcher Lauren B. Resnick of the University of Pittsburgh highlights the radical nature of the changes in a 1987 report for the National Research Council called "Education and Learning to Think." The emphasis on "higher order thinking" of the kind outlined in the proposals marks a major departure from historical tradition, in which separate goals have been espoused for mass education versus education for the elite. The revival of interest in "high literacy goals," she writes, "dictates an extension [of these goals] to a much broader segment of the population than has ever before been considered capable of such learning. . . . It is a new challenge to develop educational programs that assume that all individuals, not just an elite, can become competent thinkers." ■ CONSTANCE HOLDEN