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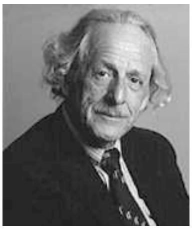

Let's Revitalize Math Education

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Last spring I pointed to student participation in research as a way to improve undergraduate science education and promised to focus subsequently on precollege science education (*The Scientist*, March 23, 1987, p. 9.) One key strategy for improving science education is the revitalization of elementary and secondary school math instruction.

Mathematics is said to be the "queen of the sciences." Indeed, it is basic to achievement in almost every field of science. But in the court of U.S. elementary and secondary education, mathematics holds a pitiful rank. Frankly, math instruction in U.S. schools is in a terrible state. In a recent Face-to Face interview, physicist Marvin Goldberger, the new director of the Institute for Advanced Study in Princeton, New Jersey, went so far as to call elementary math education "a catastrophe." (*The Scientist*, October 5, 1987, p. 20.)

Lynn Arthur Steen, math professor at St. Olaf College in Northfield, Minnesota, recently observed: "the mathematics yield of U.S. schools—the sum total of mathematics learned by all students—is substantially less than that of other industrial nations. Current levels of achievement in the United States are unacceptably low. Our mathematics curriculum is not what it ought to be, nor is it even close to what it could be. By looking downward through the grades, we can foresee the poor quality of mathematical understanding of future generations of scientists. ("Mathematics Education: A Predictor of Scientific Competitiveness," *Science* vol. 237, July 17, 1987, p. 251.)

With respect to math education, the United States is an undeveloped nation and its students are impoverished.

Steen marshaled a shocking list, culled from a number of reports issued this year and last, that outlines the extent of the problem. To mention only a few items: the average 12th grade student in Japan performs better on standardized tests than 95 percent of comparable U.S. students; even the top 5 percent of U.S. 12th-graders performs under the level of their peers in other industrialized countries; for fifth-graders, even the lowest average score of students in Beijing surpasses the highest score for students in Chicago and Minneapolis.

Other nations, such as Great Britain, have their problems, too. A 1986 study by the National Institute of Economic and Social Research, London, found that Japanese pupils take only seven years to learn as much mathematics as British pupils learn in eleven. (*New Scientist*, vol. 112, no. 1536, November 27, 1986, p. 12.)

To these quantitative data I would add a personal observation, admittedly subjective: young people I encounter seem, in general, to have very little feeling—or none at all—for numerical problem-solving. Fewer and fewer seem able to think mathematically or in concrete terms about number problems.

Even those few who excel in math are often advised to pursue another career. I recently heard of one high school counselor encouraging a brilliant math student to study law because "the money's better." Such misguided advice reveals an abysmal ignorance of the rewards, both intellectual and financial of a career in mathematics.

We are already seeing the results of U.S. underachievement in mathematics in the sharply declining number of Americans electing to pursue math degrees in the nation's graduate institutions. According to the National Science Foundation (NSF), 6,710 Americans were enrolled in graduate mathematics programs in 1984—down markedly from 7,910 in 1977. Simultaneously the number of foreign students enrolled in U.S. programs increased from one in three in 1980 to one in two now. Since only half of those foreign graduates remain to work or teach in the United States, the net effect is a smaller supply of mathematicians upon which the nation can call.

If the need for mathematicians in industry and academia is great, the need for math teachers at the precollege level is acute. One of Georgia's public school systems, for example, recently resorted to importing math teachers from Europe.

Looking to demographic data, Steen noted: "The number of 22-year-olds in the United States will decline by nearly 30 percent between now and the end of this century, just as retirements of post-World War II teachers peak and the second baby boom population wave that is working its way through our schools will produce a 30 percent increase in the school age population" (p. 251). Moreover, this cohort of turn-of-the-century school students will be increasingly black and Hispanic. But the number of minority teachers will, if present figures hold, likely be small, resulting in a "serious lack of black and Hispanic role models for those students who most desperately need not only quality but also motivation and incentive in the mathematics classroom" (p. 252).

In the past few years, and as part of the broader school reform movement, elementary and secondary math education has been receiving more attention. After getting out of the education business in the early 1980s, the NSF has returned and is committing increased funds to improving curricula and teacher skills in both precollege science and math education. It is also funding the research of the newly formed Mathematical Sciences Education Board of the National Research Council, which is defining the problem precisely and studying successful models for teaching mathematics. The dominant place of computers in our society, for one, requires new kinds of curricula that emphasize problem-solving rather than rote calculations. In Steen's words: "computers now compute, so students should learn to think" (p. 302).

And more attention must be given to improving both the training and the status of elementary and secondary math teachers. Salaries are too low to attract good mathematical minds or enough of them. Math graduates have many other options in our society, so teaching should compare more favorably in financial terms. Also, math teachers need more opportunities for continuing education and for closer integration with other professional mathematicians in industry and academia. That integration cannot start soon enough. ISI's neighbor, Drexel University, requires that undergraduates intending to teach math take the same math courses as engineering and science majors. Drexel's teacher-scholar program is one that deserves imitation.

Finally, professional mathematicians, scientists and engineers and others in technical vocations that require competence in math should consider a second career in teaching. Many have already done so. (See Alan Chapple, "Career shifts, retirement put engineers into nation's math, science classrooms," *Engineering News*, vol. 9, no. 7, July 1987, p. 1, and Wil Lepkowski, "Precollege science, math education enhanced by volunteers," *Chemical & Engineering News*, vol. 65, no. 38, September 21, 1987, pp. 42-43.) In our last issue the Employment section featured the results of a survey conducted by the National Executive Service Corps (NESC). That survey revealed a great interest in the possibility of a post-retirement second career in teaching by technically trained people in industry and the military. The survey also showed receptivity by school administrators to second-career teachers. The NESC report is aptly titled *Education's Greatest Untapped Resource: Second Career Scientists and Engineers*.

Knowledge of mathematics, from simple arithmetic to more sophisticated quantitative problem-solving, is essential to the well-being of our society. We must ensure that the future generations can claim minimal competence and that those individuals who elect to pursue technical careers, such as science, can obtain the mathematics education they will need to succeed. The problem is plain. We must commit ourselves, and the necessary resources, to its solution. ■