



Smokestack Classrooms

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As Wall Street tracks the health of American business by monitoring indicators of economic productivity, so should parents and taxpayers heed indicators of educational productivity. A recent convocation sponsored by the National Research Council produced a cornucopia of evidence that our nation's classrooms, like many of our smokestack industries, can no longer compete with our international rivals.

The subject of these recent studies was mathematics, the central enabling discipline for science and technology. Because of its widespread utility in industrial, military, and scientific applications, mathematics is a crucial indicator of future economic competitiveness. The evidence is overwhelming, however, that the mathematics yield of U.S. schools is substantially less than that of other industrialized nations. For example:

- The mathematics achievement of the top five percent of 12th grade students—almost all of whom are enrolled in similar college-bound curricula in all countries—is lower in the United States than in other industrialized nations. The *average* 12th grade mathematics student in Japan outperforms 95 percent of comparable U.S. 12th graders.
- U.S. 8th graders are at about the international average in rote computation, but well below international norms in solving problems that require higher-order thinking skills.
- In fifth grade, the *highest* average mathematics achievement in U.S. schools (in Chicago and Minneapolis) is below the lowest average scores from similar schools in China (Beijing) and Japan (Sendai).
- Even Japanese children entering kindergarten are ahead of U.S. children in mathematical skills.

The unanimity of these studies, from different countries and different investigators, underscores their significance. Because we have responded so often in the past with simplistic remedies to complex problems, the investigators responsible for these recent studies made a special point of examining many of the factors that are commonly suggested to explain or excuse our relatively poor performance. They found that most of these attractive explanations are, in fact, deceptive.

For example, there is no consistent correlation internationally between student achievement and time spent in mathematics instruction. Many countries devote *less* classroom time to mathematics than we do, but they use it more efficiently. Class size, similarly, seems to be quite unrelated to achievement.

Contrary to popular myth, the United States is not among the world leaders in the percentage of its youth who receive advanced education in mathematics. At the 8th grade, virtually all students in industrialized countries take mathematics. At the 12th grade level, most countries (including the United States) enroll about 12 to 15 percent of the age group in college-preparatory mathematics courses. Thus, our lower scores are not due to averages taken over a higher percentage of our population.

Finally, there is the conjecture that the enormous cultural diversity of American society makes it more difficult to achieve uniform excellence in education. Yet even in culturally homogenous Minneapolis-area schools, average performance is way below comparable schools in China and Japan. And among Chicago schools, the one that came closest to matching the Asian performance was a school with a minority population of more than 90 percent.

So what's left after simplistic explanations are eliminated? The major difference seems to be one of attitude and resolve. Despite our ringing historical declaration that all men (and women) are created equal, Americans, more than any other people, attribute success in mathematics to innate ability rather than to hard work.

The fact is that mathematics *can* be learned by Americans as well as by others, but it takes hard work. Students, parents, and teachers in other countries accept this and structure their schools accordingly. Americans must come to understand that achievement in mathematics is possible for all students—not only for the rich or talented.

Equality of opportunity will not be possible until we make a national commitment to dramatic improvement in the respect, expectations, and standards of school mathematics. It won't be easy or cheap, but it is the only viable strategy for ensuring long-term leadership in an increasingly competitive international arena.

This is not to say that we should simply imitate present world leaders. Mathematics is changing, and so must mathematics education. The pervasive nature of computing is changing the role of mathematics, requiring corresponding changes in school curricula. Computers now compute, so students must learn to think.

Indeed, solving complex problems, rather than rote learning alone, is becoming the new international standard of success in school mathematics. It must become our own national goal for school mathematics in the year 2000.