Smokestack Classrooms

by Lynn Arthur Steen

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 our smokestack industries, can no longer compete with our international rivals.

The subject of these recent studies is 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—the sum total of mathematics learned by all students—is substantially less than that of other industrialized nations. By looking downward through the grades, we can foresee the future of American mathematical prowess. The indicators provide unremitting bad news:

- The mathematics achievement of the top 5% of 12th grade students—almost all of whom are enrolled in similar college-bound curricula in all countries—is lower in the U.S. than in other industrialized nations. The *average* 12th grade mathematics student in Japan outperforms 95% of comparable U.S. 12th graders.
- U.S. 8th graders are at about the international average in rote computation, but are well below international norms in solving problems that require higher order thinking skills. Indeed, as the "back-to-basics" movement has flourished in the last 15 years, U.S. students' ability to think (rather than just to memorize) has declined accordingly.
- In 5th grade, the *highest* average mathematics achievement in typical U.S. schools (in Chicago and Minneapolis) is below the *lowest* average scores from similar schools in China (Beijing) and Japan (Sendai). Only 1 of the top 100 fifth grade students in these studies was an American.
- Even in kindergarten and first grade, differences emerge. Due to different home environments, Japanese children enter school already ahead of U.S. children in mathematical skills. Only 15 of the top 100 first graders in a U.S.-China-Japan study were American.

The unanimity of these studies, from different countries and different investigators, underscores their significance. Their results are about as secure as anything ever is in educational research. Although experts differ on possible remedies, all agree that there is no single cause and no simple solution to the poor U.S. performance.

Because so often in the past we have responded with simplistic remedies to complex problems, 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 politically attractive explanations are totally deceptive—no more reliable than last century's medicinal potions or this century's economic theories.

There is no correlation internationally between student achievement and time spent in mathematics instruction. Most countries devote *less* classroom time to mathematics than we do, but they use it more efficiently. Japanese students, for example, average 100 hours per year of school mathematics instruction, U.S. students 144. 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 are in school in all industrialized countries. At the 12th grade level, most countries (including the United States) enroll about 12-15% of the age group in college preparatory mathematics courses, although in Hungary it is as high as 50%. So 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 homogeneous 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 an inner city school with over 90% minority population.

So what's left, after simplistic explanations are eliminated? The major difference seems to be one of attitude and resolve. Despite our Horatio Alger legends and a 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, mathematics can be learned by Americans as well as by others, but it does take hard work. Except in the United States, students, parents, and teachers the world over believe this, and structure their schools on this belief.

America must come to understand that achievement in mathematics *is* possible for all students—not only for the rich or talented. But equality of opportunity will not be possible unless we make a national commitment to dramatic improvement in the respect, expectations, and standards of school mathematics. It won't be easy, and it won't be cheap. But it is the only viable strategy for insuring long-term leadership in an increasingly competitive international arena.

This is not to say that we should simply imitate present leaders, be they Japan or West Germany. Mathematics is changing, and so must mathematics education. The pervasive nature of computing is changing significantly the role of mathematics, requiring corresponding changes in school curricula and expectations. Computers now compute, so students must learn to think. Solving complex problems rather than regurgitating rote learning is becoming the new international standard of success in school mathematics. This must be our national goal for school mathematics in the year 2000.

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