Education: Math and aftermath

When asked, schoolchildren in the United States seem quite happy with how well they do in mathematics classes, according to a recent study. The majority say they find the subject easy. Moreover, U.S. parents are generally satisfied with their children's performance in mathematics, and mathematics teachers, at least at the eighth- and twelfth-grade levels, report finding their classes easy to teach and most students attentive.

But measurements of mathematical *achievement* among U.S. students reveal a much bleaker picture, especially when compared with that of students in other countries. A slew of studies now suggests that precollege mathematics students in the United States lag far behind their contemporaries in countries such as Japan, China and the Soviet Union.

Consequently, attention in the United States is starting to focus on why students attain such different levels of achievement and on what can be learned from the way mathematics is taught in other countries. As one step in this learning process, the Mathematical Sciences Education Board, a new branch of the National Academy of Sciences in Washington, D.C., earlier this month sponsored a symposium highlighting the policy implications of international comparisons of mathematics education.

To set the stage, Kenneth J. Travers of the University of Illinois at Urbana-Champaign described results from the Second International Mathematics Study. According to that study, U.S. students in eighth-grade mathematics classes, when compared with students in some 20 other countries, rank near or below average on a special international test covering arithmetic, algebra, geometry, statistics and measurement. On the same test, seventh-grade Japanese students score highest on all five topics. Moreover, U.S. scores have declined slightly since the first international study 20 years earlier. The picture is even more dismal for U.S. students in advanced mathematics classes at the twelfth-grade level.

These data and much more appear in "The Underachieving Curriculum," a newly released report summarizing the U.S. component of the international study. "In school mathematics," the report says, "the United States is an underachieving nation." The study's results affirm the concerns of many that "mathematics education in the United States is in need of renewal."

Harold W. Stevenson and Shin-ying Lee of the University of Michigan in Ann Arbor and James W. Stigler of the University of Chicago studied mathematics classrooms in Japan, Taiwan and Beijing to find out why first- and fifth-grade children in those classes do considerably better than U.S. schoolchildren. Because the differences appear as early as kindergarten, the researchers looked closely at cultural differences that may be related to academic achievement.

One key difference they found is the relative importance that both children and their mothers attribute to ability and effort in accounting for higher achievement. U.S. mothers and children place greater emphasis on ability, whereas Chinese and Japanese mothers and children place it on effort. "Motivation for academic achievement may . . . be enhanced to the degree that students, as well as their parents and teachers, believe that increased effort pays off in improved performance," the researchers suggest. "The willingness of Chinese and Japanese children, teachers and parents to spend so much time and effort on the children's academic work seems to be explained partly by this belief."

Furthermore, in the United States, people tend to believe that developing skill in mathematics is less important than learning to read. Hence, less time is spent on mathematics, and the mathematics curriculum is not difficult. In Japan and Taiwan, reading and mathematics take up an equal amount of time. "Without a stronger belief among American parents that mathematics is an important skill to be acquired," Stevenson and his group say, "it is unlikely that teachers will devote more time to mathematics, that the curriculum will become more demanding or that children will be motivated to spend the time necessary to master fundamental mathematical knowledge and skills."

Imitating Japan, however, is not the answer, says James T. Fey of the University of Maryland in College Park. "We don't need to follow the leader," he says. "We can find ways to help [students] work smarter." One such method involves encouraging the use of calculators and computers so that problem solving, rather than simple, repetitive mathematical manipulations, becomes the focus of mathematics classes. In Japan and most other countries, the classroom emphasis, even in the first grade, is on problem solving and understanding instead of on drill and memorization. By emphasizing drill, says Fey, "we are teaching students to behave like machines."

Travers and his group focus on ways in which the mathematics curriculum can be changed. They suggest that the "spiral" curriculum commonly used in the United States is more like a "circle." In theory, the idea is to visit a large number of topics briefly every year, going into somewhat greater depth each time. In practice, a lot of time is spent in review, and students often get bored. The educators recommend that the "excessive repetition" of topics from year to year be eliminated. "A more focused organization of the subject matter, with a more intense treatment of topics, should be considered," they argue.

Nevertheless, says John A. Dossey of Northern Illinois University in De Kalb, "no single factor begins to explain the lack of achievement." Quick fixes, he says, such as lengthening the school year or changing class size or calling for improved teacher qualifications, won't work.

The problems are complex, says Shirley A. Hill, Mathematical Sciences Education Board chairman. "They are, in my opinion, not intractable," she says, "but they are difficult." One hope is to develop a national consensus on what should be done and what kind of curriculum would be appropriate. The statement of such a consensus would serve as a guide for the 15,000 or so local school boards that make the decisions on what happens within schools. — *I. Peterson*

Bloom's enzyme identified

Two teams of scientists have independently found that an enzyme deficiency may be responsible for the rare human disease called Bloom's syndrome. The disease carries an increased risk of leukemia and lymphoma, and is one of a small group of inherited diseases in which an abnormal amount of unrepaired chromosomal breakage occurs.

A British group from the Clare Hall Laboratories in Hertfordshire and a U.S. group from the New York Blood Center in New York City and the M.D. Anderson Hospital and Tumor Institute in Houston report their respective research results in the Jan. 21 NATURE. Their discovery that cells from Bloom's patients are deficient in a DNA "ligase" enzyme involved in DNA replication could explain many of the abnormal findings in the disease.

Earlier studies had revealed that bacteria mutants with a defective DNA ligase also show characteristic chromosomal and DNA problems. The scientists searched for a similar enzyme in cells from Bloom's syndrome patients. Unlike bacteria, which have a single DNA ligase, mammalian cells contain two DNA ligases: DNA ligase I functions during DNA replication, DNA ligase II during DNA repair.

Results suggest it is the DNA ligase I that is defective. The researchers do not know whether the abnormal DNA ligase is the primary defect in the disease, or a secondary effect of some other cellular problem. The British group did not find defective DNA ligase I activity in cells from patients with other rare diseases associated with unrepaired chromosomal breakage. □