Science and math education: No easy answer

In the last decade, parents and teachers, eager to raise U.S. children's test scores, have sent kids back to the books. Now, a recent study shows, U.S. students do more homework than their counterparts in many other countries yet score the same or worse in science and mathematics.

"U.S. performance is not due to how much time we spend, but rather to how we spend it," says Pascal D. Forgione Jr. of the U.S. Department of Education, a sponsor of the report, called "Pursuing Excellence."

Released on Nov. 20, the report focused on randomly selected eighth-grade classes in 41 countries (SN: 10/19/96, p. 244). East Asian nations led the ratings, with U.S. students turning in an average performance in math and slightly better than average in science.

In a bid to avoid criticisms of earlier international comparisons, the researchers not only tested the students but questioned them and their teachers about how they spent their time. Surprisingly, the study found that students from better-scoring nations spent as much time as U.S. students watching television and less time in school. Some Japanese students attend classes after school, but experts disagree on whether this extra training bestows any advantage.

The difference in learning came from the quality of teaching that students received in each nation, says William H. Schmidt of Michigan State University in East Lansing, who led the analysis. "Better schooling is the answer."

U.S. math and science teachers tackled many more topics than other educators. Students had scant time to assimilate new information before moving on to another area. U.S. teachers, compared to those in better-scoring nations like Japan, Singapore, and Hungary, also received less on-the-job training and mentoring by more experienced teachers.

Defying stereotypes, Japanese math classes spent only 40 percent of their time practicing routine problems. U.S. classes spent 96 percent of their time on such problems. "The Japanese goal is guiding students to a deeper understanding of math," says Jim Stigler of the University of California, Los Angeles. Stigler analyzed hundreds of classes in the United States, Japan, and Germany. "The U.S. teacher simply explains how to solve problems."

At a video demonstration in Washington, D.C., Stigler showed a typical Japanese math teacher first challenging students with a problem, then asking them to solve it with knowledge from previous lessons. With guidance from the instructor, students gradually derived the correct method.

In contrast, a video of a U.S. teacher showed him demanding vocabulary words from a chorus of students, rapidly solving a problem, and then assigning many more. Teaching styles differed little in public and private schools across the United States. "We were surprised at the lack of variation," says Stigler.

Furthermore, a group of mathematicians evaluated the organization of ideas in classes. Without knowing which countries they were examining, they awarded low ratings to 87 percent of the U.S. lessons. Forced to touch on many more topics, U.S. instructors invariably taught their students recipes for solving problems and then hurried on.

"This is as good a study as it gets," says Senta A. Raizen of the National Center for Improving Science Education, in Washington, D.C. One bit of good news, she adds, is that the study, unlike earlier ones, finds no significant differences in scores between girls and boys in U.S. math and science classes. "When we try, we can accomplish reform."

"American parents expect and want something better than average for their kids," says Gerald Wheeler of the National Science Teachers Association in Arlington, Va. "This study shows we need fewer topics and more depth."

— D. Vergano

Low-dose X rays can sharpen fine details

Inspecting a fuzzy X-ray picture for signs of a lung or breast tumor can challenge even the most skilled physician. Now, a high-resolution X-ray technology previously used only in special settings could make diagnosis easier, a new study shows.

The technique, called phase-contrast X-ray imaging, reveals details that get lost in conventional X rays, especially subtle distinctions between tissues that absorb radiation weakly. Scientists at CSIRO's Division of Materials Science and Technology in Victoria, Australia, describe the method in the Nov. 28 NATURE.

In addition to discerning finer details than current methods, this technique could require a lower overall X-ray dose to produce an image. "We have done some simple model calculations and simulations which indicate that the reduction could be quite significant," says study coauthor Stephen W. Wilkins. "Reduction in absorbed dose by 50 percent or more in mammography seems plausible."

A conventional X ray relies on differences in the amount of radiation that various tissues absorb. Dense tissues, such as bones, absorb more radiation and cast sharp shadows that show up on a piece of film, while soft tissues block the beam less effectively.

A phase-contrast X ray, on the other hand, records information from the beams themselves after they have passed through different tissues. All tissues cause the X rays to slow down, resulting in what's known as a phase shift. The size of the shift depends on the type of tissue.

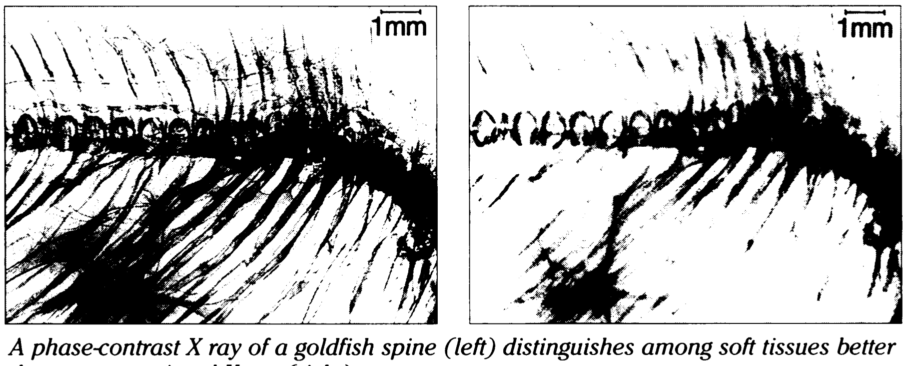
For conventional X rays, "when you detect the intensity, the phase information is gone," says Werner Meyer-Ilse of the Lawrence Berkeley (Calif.) Laboratory, "unless you have an experimental setup which converts the phase shift into intensity shift so that it can be recorded."

In the experimental setup that Wilkins' group used, the X-ray beam had a spot size of 20 micrometers or less, which makes the wave crests well matched, although not as completely correlated as in a laser. Also, the distances between object and image are larger than those used in X-ray imaging, Wilkins says.

Scientists currently use phase-contrast X rays to examine industrial materials and biological samples, says Meyer-Ilse, whose own work includes X-ray microscopy of cells. Those experiments typically require X rays of a single wavelength, so samples must be taken to the nearest high-energy synchrotron. For medical diagnosis, "that's not practical."

The CSIRO group's technique, on the other hand, makes use of typical clinical X-ray sources, which emit a range of wavelengths. A commercial phase-contrast system, Wilkins says, "may even be cheaper than existing systems, since it involves a lower-power—but more focused—X-ray source."

— C. Wu



Wilkins *et al.*/NATURE

A phase-contrast X ray of a goldfish spine (left) distinguishes among soft tissues better than a conventional X ray (right).