Editorial & Letters

EDITORIAL

The Wake-Up Call We Dare Not Ignore

The science and mathematics education community is still recoiling from the latest results on student performance in the Third International Mathematics and Science Study (TIMSS). Although scores were not expected to be high, the fact that the nation's 12th graders were among the lowest performers was disheartening. TIMSS, the most comprehensive and well-designed international study to date, paints a fair and accurate picture.

U.S. 12th graders performed below the international average and among the lowest of the 21 TIMSS countries that participated in the general science knowledge assessment. And in the advanced physics assessment, U.S. 12th graders performed among the lowest of students from the 16 countries participating.

Earlier TIMSS results showed that American students did well in science at the fourth-grade level, although even then it was not clear that American students had a firm foundation in some basic math and physical science concepts. By eighth grade, our students were losing ground. Although they were above the international average in earth science, life science, and environmental issues, they were about average in chemistry and physics. These earlier TIMSS results foretold a downward trend in performance as students enter the higher grades, but the education community never expected that our best students, those more likely to pursue careers in science, would not measure up to students from most other nations.

The science teacher is the single most valuable resource in the science education equation. There are many dedicated teachers in classrooms across the nation. But they cannot do the job alone. Our greatest challenge is for all of us—teachers, parents, scientists, administrators, business leaders, and policy-makers—to work together to change the system in which they work.

Earlier TIMSS data indicate that when compared to other countries, U.S. teachers lack support throughout their teaching career and feel isolated from their teaching colleagues. They teach more classes per week than their Japanese counterparts, and there is no time set aside in the U.S. school day for teachers to learn from one another and share strategies about teaching. Science teachers also face the challenge of having to teach subjects outside their field of expertise. U.S. Secretary of Education Richard Riley notes that, in the physical sciences, "almost half of American students are taught by teachers without a major or minor in that field."

Soon after the National Science Education Standards were released in late 1995 (after the TIMSS data had been gathered), the National Science Teachers Association surveyed 5000 randomly selected members on their reactions to standards they had yet to see. When asked if they thought standards would improve the way science is taught in their classrooms, 80 percent of those who answered said yes. But the teachers said they expected to run into barriers when they tried to put standards into practice. The three top barriers cited were the need for adequate time for planning and working with other teachers, financial support for professional development, and adequate science materials, resources, and facilities.

There is a disconnect in the system. Students from around the world come to the United States to receive what is considered the best education in the world. We produce world-class scientists who continue to win Nobel prizes and make extraordinary contributions to many fields of science and technology. Yet at the same time, our universities and colleges fail to effectively train the teachers of our future scientists. We must overhaul the education of science teachers so they enter the classroom with both a strong knowledge of science and effective teaching skills. Schools of education and science departments must work together to provide that training. We must require teachers to take many more courses in science and show them how to direct student learning through inquiry and investigation.

We can certainly point out many shortcomings in the education system that may or may not contribute to the most recent TIMSS results, including the lack of a requirement that students take math and science throughout their K through 12 years and the fact that national and international standards and tests are tougher than those used by many states. However, we are optimistic that finally we are going in the right direction. Science teachers nationwide are working to implement the goals of the National Science Education Standards that provide a clear and concise path for improved science teaching and learning: more emphasis on inquiry science, teaching fewer topics in greater depth, long-term meaningful professional development for veteran teachers, and the involvement of everyone in the process.

Gerald Wheeler

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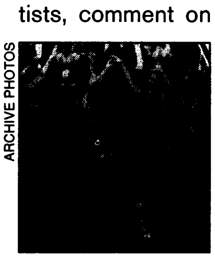
LETTERS

"Duck soup"?



ARCHIVE PHOTOS

Readers, both scientists and nonscientists, comment on a rich mélange of topics, including Marx Brothers movies (left, Groucho in *Duck Soup*), genome databases, NMR history, release of crystal structure coordinates, agriculture in resource-poor countries, fractal structures in nature, *Science*'s Compass, the pros and cons of public funding of the arts and of science, catching frogs, and education of the deaf.

Unexpected Opportunity?

James Glanz's excellent News article about the possible antigravity force found by astronomers (27 Feb., p. 1298) typifies what I have admired and benefited from in *Science* over the years. It was clear and provided far more enlightening detail than did other news accounts. But I appreciated it all the more when I saw, near the end, that it contained an unexpected opportunity—the chance for me, a lay person, to write in to correct a troublesome error and to do so in the magisterial tone that the letters you publish routinely, and doubtlessly justifiably, adopt. The Marx Brothers movie in which a large number of people show up in Groucho's stateroom ("Do you want your nails long or short?" Groucho is asked by a manicurist who has wandered in. He replies, "Better make them short. It's getting crowded in here.") is *A Night at the Opera*, not *Monkey Business*, as reported.

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After the Genome Database

An item in ScienceScope of 30 January (p. 645) reports on the imminent closure (on 31 July) of the Genome Database (GDB) project housed at Johns Hopkins University. The database itself, however, will not disappear, but will be publicly available at the same Web address (www.gdb.org), with dedicated servers maintained by the Oak Ridge National Laboratory. Thus, with high-resolution genetic maps in place and the well-advanced state of large-clone and radiation-hybrid–based physical maps, important quantities of mapping information will be preserved and available. What is not clear is the fate of acquisition, interpretation, and annotation of new mapping data. At the moment, there are no plans to continue these activities.

There are quite a few genome databases publicly available on the World Wide Web (1). Also, the Human Genome Organization Nomenclature Committee will continue to provide approved symbols for human genes in accordance with its Guidelines for Human Gene Nomenclature and will maintain the Human Gene Nomenclature Database. Thus, new mapping data, often generated in laboratories of institutions hosting databases, will be available on the Internet. In the post-GDB–project world, the user may have to click more often to find mapping information and perform interpretation and editing personally. Problems that might be expected in the absence of GDB coordination include recognizing duplicates of new markers and conflicting map locations from different resources.

Perhaps the community will get by with the available final copy of the GDB and with database "shopping" on the Internet. If not, the international community may have to pull together to arrive at a solution. For instance, database host institutions could form a consortium for the purpose of reviewing new data and maps in a coordinated fashion before release to the public. External expert reviewers might volunteer efforts (similar to those of the "editor" group of scientists that now review and edit GDB data) within the framework of such a consortium, injecting further assurances of quality and coordination. This type of program or something with similar intent could be provided at a minimal cost increase and would continue to support the efforts of many scientists involved in mapping and eventually identifying genes underlying complex disorders.

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Notes

1. These include databases from the National Center for Biotechnology Information (UniGene and Online Mendelian Inheritance in Man, for example), various genome sequencing centers, the Whitehead Institute for Biomedical Research/MIT Center for Genome Research, the European Bioinformatics Institute, the Stanford Human Genome Center, Los Alamos National Laboratory, Centre d"Etude du Polymorphisme Humain, Lawrence Livermore National Laboratory, the Cooperative Human Linkage Center, Généthon, the University of Southampton (the Génétic Location Database), and INFOBIOGEN (GENATLAS).

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NMR Availability

Robert Service, in his News & Comment article "NMR researchers look to the next generation of machines" (20 Feb., p. 1127), states, "For the past 50 years, NMR [nuclear magnetic resonance] machines have been cheap and small enough to allow hundreds of individual investigators to buy and house their own." To be sure, the earlier spectrometers were much cheaper than the new 800- and 900-megahertz (MHz) variety, but they were priced in different dollars and were generally considered too expensive for the funding agencies. When I set up a biological NMR laboratory at Harvard Medical School in 1959, I was first warned by the dean that such an outrageously expensive ($600,000) item would never be funded, and then advised by the National Science Foundation (NSF) that it must be shared, which it was. When Harden McConnell, John Baideschwieler, and I set up the 360-MHz spectrometer at Stanford in 1972 ($360,000), it was set up as a Shared Instrumentation Resource under a joint grant from NSF and the National Institutes of Health. It was a prime example of interagency cooperation and remained the only resource of its kind and the highest field spectrometer in the world for some time—accommodating more than 200 scientists from 24 countries in the first 10 years. Axel Bothner-By's Resource at Pittsburgh, which developed the first 600-MHz spectrometer in 1979, played a similar role. The same principle of sharing applies today to 750- to 800-MHz resources at Oxford, Cambridge, the University of Wisconsin, Harvard, and Stanford. It was not until the late 1980s that 500- and 600-MHz spectrometers were more generously dispensed by the funding agencies and industries alike, lured by the prospects of quick structure determination and rational drug design.

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Eating Cake?

I want to add my support for removing the absurd procedure of withholding coordinates from crystal structures after "publica-