

ARTICLES

THE TROUBLED STATE OF U.S. SCIENCE EDUCATION: PROBLEMS AND POSSIBLE SOLUTIONS

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How is it that the United States is considered to be the world's leader in technological innovation including science research and development; yet in terms of science and mathematics testing, our 12th grade students scored near the bottom compared with students from other countries.¹

According to the Third International Mathematics and Science Study (TIMSS), U.S. 12th grade students not only scored near the bottom on recent tests, but specifically scored behind every other nation, except Cyprus and South Africa.²

Furthermore, in physics, the United States scored at the very bottom as well.

On December 2001, during a House Floor discussion on funding for science education in the FY 2002 budget, Representative Vernon Ehlers (R-MI) acknowledged that the United States is indeed “dead last among those nations in high school physics.” Interestingly enough, Representative Ehlers is one of only two physicists serving in Congress since 1996. He further went on to refer to the 2000 NAEP (National Assessment of Education Progress) results which found no improvement in science literacy in the 4th and 8th grades, and a decline in science performance in science performance in grade 12 since 1996.

Yet conferees on the FY2002 Labor-HHS-Education appropriations bill (H.F. 3061) provided substantially less targeted funding than in 2001 for improving science and math education. In the resulting conference report, however, states were encouraged to continue their current level of effort to improve science and math instruction by making use of funds available for improving overall teacher quality.

Is simply improving overall teacher quality the answer to the continuing troubled state of U.S. science education – or, are there and should there be other methods in addition?

On January 15, 2001, a study by Professor J. Hubisz, President of the American Association of Physics Teachers, published by the Associated Press, showed 85% of middle school students are using science textbooks so full of errors and inaccuracies as to make them unacceptable. These books have been called “terrible”³ from a science standpoint, and it has been stated that many science teachers have little science training.

According to a recent Bayer survey, ‘The Bayer Facts of Science Education VI: Americans’ Views on Science, Technology, Education and the Future’, 93% of respondents said students in their state need a stronger education in science to be prepared for the new inventions, discoveries and technologies that increased investment will likely bring. They also stated a belief that the way to strengthen science education is for their state and governor to support pre-college science education reforms that emphasize inquiry-based, hands-on learning over traditional textbook and rote memorization.⁴

I believe strongly that hands-on learning is the best, most practical way of learning in science education; when you consider the high school requirements of 3 years of science and math, the importance of truly immersing students in these subjects comes to the fold. A critical step in achieving strong, positive results, is to expose students to the hands-on approach.

Nobel Laureate in Physics, Leon Lederman, has stated that “Science works in a hierarchy. It’s a pyramid with mathematics at the base. Physics requires mathematics and is second.” So in a sense, the two go hand and hand and should be considered critical in learning.

In his paper, “Scientists and Science Education Reform: Myths, Methods, and Madness,” James Bower, Associate Professor of Biology at California Institute of Technology, states his own findings from studies of California schools. He theorizes that “attempts to transfer the excitement of science through lectures never gives teachers the opportunity to experience the thrill of doing science themselves.” He sites that in most cases, “the ‘hands-on’ activities are do-it-yourself ‘cookbook’ demonstrations of the sort professors design for their own undergraduates.”

Having taken more than a science course or two, particularly physics, in my lifetime, I have seen this in practice. Even in high school, the teacher would perform the experiment in lecture to ensure the same outcome each and every time. Often student reaction would flicker from slight interest into complete boredom in watching the teacher demonstrations. Although I do remember once, my biology teacher elicited quite a “shock-jock” response when he one day produced a fetus-in-a-bottle from a pocket in his lab coat merely for the “fun” of it.

My question is: Why should science experiments solely be performed by teachers in lectures? Why can’t time be specifically allotted for students to participate in science activities and experiments themselves in addition to being introduced to the subject at hand by their teachers?

And what of the claim that science teachers are inadequately prepared to teach science?

In his report on science education, Bower states his finding that “the more college science courses a teacher has taken, the more likely they are to model their teaching on the lecture-based approach of most university science professors.” He also states a finding that “teachers with fewer college lecture-based science courses are often more amenable to fundamental change to inquiry teaching methods than are those whose examples for science teaching come from college and university professors”, and “as these teachers become involved in real science experiments in their classrooms, they inevitably seek additional science content knowledge.⁵ This would seem to strongly sell the argument that teachers with fewer lecture-based science courses are more open and willing to use hands-on teaching methods in their courses. With this in mind, it is important to continue to establish the importance of having real experimental science and inquiry-based learning in our schools.

Science involves inquiry and exploration. Its teaching should allow opportunities for real open-ended scientific discovery. I believe that splitting lecture time into in-class hands-on lab time in pre-college education courses is the best way. Another key is in relating the teaching of scientific principles to what’s going on in the real world.

Students can be encouraged to read the newspaper on a regular basis, specifically looking for science articles discussing what’s happening around them. These articles can be brought into

class and shared with fellow students in discussions lead by teachers, further supporting the inquiry-based learning process.

Sooner or later, the deficiencies in U.S. science education will catch up with our advances in scientific and technological development. A new philosophy of true hands-on learning on the part of students in cooperation with their teachers seems the most practical solution.

Notes

1. IEEE*USA/Bayer, July 2000
2. Grandfather Education Report, February 2002
3. Grandfather Education Report, February 2002.
Bayer Corporation, July 2002.
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