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Redefining Science Education

THERE IS A MAJOR MISMATCH BETWEEN OPPORTUNITY AND ACTION IN MOST EDUCATION SYSTEMS today. It revolves around what is meant by "science education," a term that is incorrectly defined in current usage. Rather than learning how to think scientifically, students are generally being told about science and asked to remember facts. This disturbing situation must be corrected if science education is to have any hope of taking its proper place as an essential part of the education of students everywhere.

Scientists may tend to blame others for the problem, but—strange as it may seem—we have done more than anyone else to create it. Any objective analysis of a typical introductory science course taught today in colleges and universities around the world, whether it be biology, chemistry, physics, or earth sciences, would probably conclude that its purpose is to prepare students to "know, use, and interpret scientific explanations of the natural world" (strongly emphasizing the "know"). This is but one of four goals recommended for science education by the distinguished committee of scientists and science education experts convened by the U.S. National Academies that produced *Taking Science to School: Learning and Teaching Science in Grades K-8.* And yet college courses set the model for the teaching of science in earlier years.

The three other goals of equal merit and importance are to prepare students to generate and evaluate scientific evidence and explanations, to understand the nature and development of scientific knowledge, and to participate productively in scientific practices and discourse (summarized in the Academies' *Ready, Set, Science!*). Scientists would generally agree that all four types of science understanding are critical not only to a good science education but also to the basic education of everyone in the modern world. Why then do most science professors teach only the first one?

As the scientist and educator John A. Moore emphasized in his prolific writings, science provides a special way of knowing about the world.* The failure of most students and adults to understand this fact, despite having taken science courses, reveals a serious deficiency in our education systems. And the failure of students to acquire the logical problem-solving skills of scientists, with their emphasis on evidence, goes a long way to explain why business and industry are so distressed by the quality of our average high-school and college graduates, finding them unable to function effectively in the workforce.

Vast numbers of adults fail to take a scientific approach to solving problems or making judgments based on evidence. Instead, they readily accept simplistic answers to complicated problems that are confidently espoused by popular talk-show hosts or political leaders, counter to all evidence and logic. Most shocking to me is the finding that many college-educated adults in the United States see no difference between scientific and nonscientific explanations of natural phenomena such as evolution. Their science teachers failed to make it clear that science fundamentally depends on evidence that can be logically and independently verified; instead, they taught science as if it were a form of revealed truth from scientists.

Teaching the missing three strands requires that students at all levels engage in active inquiry and in-depth discussion in classrooms. What would it take to get scientists to teach their college courses this way? I suggest that we start with new assessments. It is much easier to test for the facts of science than it is to test for the other critical types of science understanding, such as whether students can participate productively in scientific discourse. For the United States, I therefore propose an intense, high-profile national project to develop quality assessments that explicitly measure all four strands of science learning that were defined by the National Academies.† Designing such assessments for students at all levels (from fourth grade through college), energetically advertising and explaining them to the public, and making them widely available at low cost to states and universities would greatly accelerate the redefinition of science education that the world so urgently needs. **– Bruce Alberts**

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*See *Science as a Way of Knowing* (Harvard Univ. Press, Cambridge, MA, 1999).

†E. S. Quellmalz, J. W. Pellegrino, *Science* **323**, 75 (2009).

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