



Reflections

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Thoughtful Curricula Developing Thinking Students

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Redefining Science Education

By Bruce Alberts★

A Note from the editors of *Reflections* (the authors of *IPS* and *FM&E*)—we are often asked to supply justification for teaching courses using our textbooks rather than the usual textbooks offered by other publishers. The following editorial from *Science*, the weekly journal of the American Association for the Advancement of Science (AAAS), the largest professional scientific society in the U.S., was published very recently. We are reprinting it here with permission.

We might be tempted to analyze the editorial line by line to justify our long-standing approach to teaching embodied in *Introductory Physical Science* and *Force, Motion, and Energy* but we believe it is important for you to do that on your own. It might be a profitable discussion topic at your next departmental meeting or could be used in preparation for an upcoming round of textbook selection. - *The Editors*

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

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An Important Message from SCI Concerning Future Newsletters...

As email and electronic media have become more widely used, it has become increasingly difficult for us to justify the environmental impact and cost of our paper newsletters. Consequently, **this issue of Reflections will be the last that we send by standard mail.**

We will continue to publish and distribute both *Reflections* and *eTips for Science Teachers* electronically. We will also continue to keep you updated about workshops and new products by email... if we have your email address.

If you already receive *Reflections* and *eTips* by email, no further action is needed. Your subscriptions will continue uninterrupted.

If you do not currently receive *Reflections* and *eTips* by email, we encourage you to visit

<http://www.sci-ips.com/newslettersignup.html>

to register your email address on our email distribution list. To prevent any interruption in your subscriptions, this must be done before March 31.

Soon after submitting your email address, you will receive an email message welcoming you to the SCI

Email Distribution List and asking you to confirm your registration by clicking "Reply" and "Send." **Your reply is necessary to complete the registration process.**

This process will ensure that you continue to receive our newsletters. When your email subscription begins, you will notice that there is an "unsubscribe" link at the bottom of each message. If ever you decide that our newsletters and messages are no longer of value to you, you can unsubscribe from the distribution list quickly and easily by clicking on that link.

Please know that we will never sell or distribute your email address. It will be used only to provide you with our newsletters and keep you informed concerning *IPS*- and *FM&E*-related items and events.

Thank you for your continued interest in Science Curriculum Inc. and our ***Introductory Physical Science (IPS)*** and ***Force, Motion, and Energy (FM&E)*** textbooks. We look forward to continuing our service to you with our e-newsletters, workshops, and valuable instructional tips—not to mention the most inquiry-oriented textbooks on the market!

Redefining Science Education (from page 1)

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 is Editor-in-Chief of *Science*, published by AAAS.

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

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

This editorial appeared in *Science*, 323 (23 January 2009), p.437. www.sciencemag.org. It is reprinted here with permission from AAAS.

End note: If you are interested in purchasing the two books mentioned in the editorial, *Ready, Set, Science!* and *Taking Science to School: Learning and Teaching Science in Grades K-8*, they can be read and ordered at www.nap.edu.

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Summer 2009 SCI Workshop Dates Announced

Whether you've taught science for years or are just starting out, we've prepared summer workshops that will benefit both you and your students! But don't just take our word for it. Here's what 2008 workshop participants had to say...

I learned how to perform the labs myself!

The workshop showed me how to use effective questioning to help students extract knowledge from their observations.

I will use this information on a daily basis.

The workshop emphasizes an approach that teaches students the "method" of science as well as the "discoveries." Thanks! Thanks!

I learned how to have students derive science principles from their data.

Doing the labs and talking with other teachers was extremely valuable. Discussions with staff were great!

The most significant thing I learned from the workshop was the importance of truly understanding the science behind the concepts and that it is important to give students hands-on experience.

I learned ways to use data from labs to draw conclusions about concepts, as opposed to using labs to demonstrate concepts.

Save the dates for your workshop! For more information, visit http://sci-ips.com/ips/workshops_golden.html.

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Introductory Physical Science (IPS) National Workshops

IPS Workshop #1 **July 26 through August 7, 2009**

Location: Colorado School of Mines (Golden, Colorado)

Instructors: Graden Kirksey and staff

This workshop covers the entire 8th Edition of *IPS*.

IPS Workshop #2 **July 26 through July 31, 2009**

Location: Colorado School of Mines (Golden, Colorado)

Instructors: Graden Kirksey and staff

This workshop covers Chapters 1-5 of the 8th Edition of *IPS*.

IPS Workshop #3 **August 2 through August 7, 2009**

Location: Colorado School of Mines (Golden, Colorado)

Instructors: Graden Kirksey and staff

This workshop covers Chapters 6-10 of the 8th Edition of *IPS*.

To enroll in this workshop, you must have already taken a workshop covering Chapters 1-5.

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Introductory Physical Science (IPS) Regional Workshop

IPS Workshop #4 **July 27 through August 7, 2009**

Location: King Philip Middle School (Norfolk, Massachusetts)

Instructor: Bill Atherton

This workshop covers the entire 8th Edition of *IPS*.

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Force, Motion, and Energy (FM&E) National Workshop

Force, Motion, and Energy (FM&E) Workshop **July 19 through 24, 2009**

Location: Colorado School of Mines (Golden, Colorado)

Instructor: Bob Stair

This workshop covers the entire *FM&E* textbook.

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Writing Test Questions for Science Courses National Workshop

Writing Test Questions for Science Courses **July 27 through 31, 2009**

Location: Colorado School of Mines (Golden, Colorado)

Instructor: Bob Stair

This workshop covers how to write good multiple-choice, essay, and lab test questions that have potential for diagnosing students' misconceptions and driving subsequent instruction. *Diagnostic Analysis* software for the analysis of the results of multiple choice questions is also discussed.

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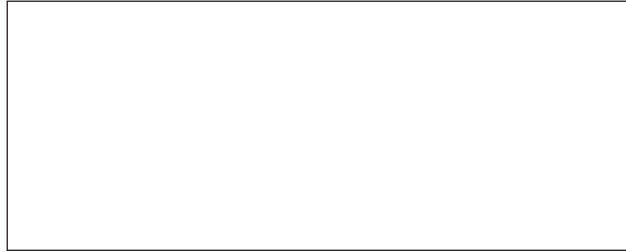


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New Orleans - March 19 - 21!***

You can find us at Booth #1401.