Feature

From the National Academies: Overview of the National Research Council's Board on Science Education and Personal Reflections as a Science Teacher

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Over the past year the National Academies have established a Board on Science Education (BOSE). This marks a major restructuring of the portion of the National Research Council (NRC) that deals with science education. As the first chair of BOSE, I describe in this column the new structure and advantages of this board and discuss some of the agenda of BOSE that I think will be of interest to readers of *Cell Biology Education*. I also discuss some unofficial, personal goals for BOSE that stimulated me to take the position as chair. A hidden agenda of this note is to address the question in the minds of many people: "When Bruce Alberts ends his term as president of the National Academies of Science on June 30, 2005, will the National Academies forget about science education?" I hope that this column will give you some reassurance that, although it is unlikely that future leaders will match Bruce's passion (who can?!), science education is now widely accepted as an important concern of the Academies, and we will continue to devote a large amount of attention to it in the years to come.

THE NATIONAL ACADEMIES' BOARD ON SCIENCE EDUCATION

Prior to the creation of BOSE, science education at the NRC was primarily under two standing committees,¹ the Committee on Science Education K–12 and the Committee on Undergraduate Science Education. Although these commit-

tees had dedicated members and carried out a substantial body of good work, they suffered from a variety of limitations faced by many freestanding committees at the NRC, such as focusing on some smaller aspect of an issue without attending as much to the larger educational system. In addition, the NRC's Governing Board was interested in having one board oversee the whole of science education, early childhood through adulthood, as well as issues associated with science education in informal as well as school-based environments.

The new structure has merged the two committees into a board overseen by a director and senior program officer, Jean Moon, with a mandate to deal with all issues in science education. As a board, we seek through our membership the expertise and capacity to deal with all aspects of science education, or at least that is our (somewhat daunting) goal. At a structural level, BOSE is now equivalent to other NRC disciplinary boards, such as the Board on Life Sciences (BLS). The hope is that in the same way that Congress or any federal agency with a question about life sciences now naturally looks to BLS for expert advice, BOSE will serve in the same role for the numerous agencies involved in science education. The disciplinary boards such as BLS seldom carry out research activities or reach consensus directly, but they have the expertise to define and organize specialized studies that then respond to questions. They also can be proactive and generate activity where they recognize a clear national need within their general purview. BOSE will now take on a similar role in the area of science education. Of course, other NRC disciplinary boards already carry out some specialized education-related activities, and BOSE and the Center for Education of which it is a part have been and will continue to be involved in working jointly with them on many such projects (for a description of

¹ Many National Academies committees are ad hoc. They are formed to address a specific set of issues, prepare a report on their findings and recommendations, and then disband after the report is published. However, the Academies also maintain a number of standing boards and committees to oversee the development of work in specific disciplines. These boards and committees continue over many years, but their membership changes, with committee members being appointed to specific terms of service.

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some of these current activities, see Alberts, 2002; Labov, 2003a, b, c, 2004; Wood and Handelsman, 2004).

A quick examination of any science education issue as it is considered from a national policy standpoint reveals why a board-scale entity with an exceptionally broad range of expertise is needed. Nearly every issue involves at least three dimensions:

1. *Disciplinary*—Science education is meaningless without considering the specific ideas and understanding of the evolving nature of physics, biology, chemistry, earth, and astronomical sciences as disciplines and how that is translated into the science content of courses and curricula.
2. *Age and Setting*—Science education spans kindergarten through graduate school and beyond, and settings from the formal classroom to informal activities such as museums, the Web, and television. We also need to consider how recently emerging research on the human brain and cognition can inform teaching and learning in the disciplines.
3. *Implementation*—Teachers and their degree of expertise, organizational structures, resources, and politics all play major roles in nearly every aspect of science education, with a current emphasis on science education policy (e.g., science standards and the implications of the No Child Left Behind Act).

Many science education issues span large, interconnected segments of all of these dimensions. All too often, science education initiatives have floundered because they failed to address one or more of these multiple crucial aspects. For example, there are many times when dedicated expert scientists have become very involved in developing exciting new curricula that are soon abandoned and forgotten because they are so incompatible with teachers' backgrounds, institutional structures, or curricula mandated by standards. Correspondingly, there are examples of teacher education programs that have little impact because they overlook the need to enhance expertise in the relevant scientific disciplines. It is clear that for the National Academies to play a significant role in improving science education in this country, our efforts must be grounded in an awareness of all of these interconnected facets of education.

A brief summary of the topics discussed at recent BOSE meetings gives some idea of the broad scope of its activities.

1. Federal science education policy: What are the issues, questions, and activities? Discussions with high-level people from the Department of Education, National Science Foundation, and Congress.
2. Graduate education in the sciences: What are the needs? How well is the current system meeting these needs, and are there better alternative models? How can one make sense of the contradictory claims and data about graduate education?
3. Cognitive issues related to learning: How can early science teaching be better guided by an understanding of children's mental development? What would be a good demonstration example to illustrate how this could be done?
4. Education research in the science disciplines: What is the status and promise of discipline-based undergraduate educational research in physics, chemistry, earth sciences, and biology? What are the similarities and differences between educational research in these fields?

Descriptions of ongoing activities (consensus studies, planning meetings and workshops, and research-to-practice studies) currently being carried out under the auspices of the board can be seen at <http://www7.nationalacademies.org/bose/index.html>.

PERSONAL REFLECTIONS ON FINDING A "VISION" FOR SCIENCE EDUCATION

I would now like to throw off my chair's hat and offer some less formal views as to the vision I see for the transformation of science education and the role the National Academies can play in leading this process. The pursuit of this vision is largely the reason why I decided to take time away from a successful career in physics to serve as the chair of BOSE and help define its future agenda.

I am sure that I share with many of you the feeling that a greater appreciation and understanding of science is needed today by all people for a number of critical reasons. These reasons include the health of the economy and the need for a citizenry better able to make wise decisions on the many science-related societal questions with which our country is struggling, such as global warming, genetic modification, and stem cell research. For many years I lamented this unmet educational need and my own evident failings as a teacher to meet it in many of my own students, but this lament was with much the same sense of personal helplessness with which I viewed the lack of world peace.

However, over the past 15 years or so, I have become aware of a body of work that has suggested there is a different and far superior way to teach science than what I had seen. This could perhaps best be described as approaching the teaching of science as a "science" rather than a "religion." I discovered that there were people doing careful, detailed research on how people learn, and other people were applying these ideas and methodologies to the specific teaching of physics (e.g., Redish, 2003, and the excellent bibliography therein). The NRC has played an influential part in advancing this concept of research-based education with a number of superb reports, such as *How People Learn* (NRC, 2000) and *How Students Learn* (NRC, 2005). As I learned more about this research, I gained a greater understanding as to why, in spite of my trying many different ways to explain certain topics, many undergraduate students failed to grasp them. I also began to realize how aspects of the graduate student experience, by which I had seen my grad students regularly metamorphose from struggling novices into expert physicists who were my equals, matched with what research suggested was required for the learning of expert competence in physics or similar disciplines. This made me realize that teaching science could be approached like the experimental science I was used to; there was a body of research literature I could call on, there were guiding principles based on measurement and data that I could use to achieve better results, and there were more meaningful ways to measure what my students were and were not learning. The combination made it possible to improve results in a systematic, data-driven manner (see also Handelsman *et al.*, 2004). I even discovered that there were general cognitive principles that could be used to improve my technical physics talks so that they were better understood and appreciated.

A scientific approach to education, where one looks carefully at the evidence as to what does and does not work

and why, is clearly showing us the way to a major transformation of science education. BOSE offers a means for the National Academies, which are the recognized leaders in science, to push forward this transformation. Although there is the most extensive education research in physics, it is only a small part of what is needed for physics or any other science. Ultimately, we need detailed guidance for the most effective and cost- and time-efficient instruction at each level that is solidly based on research and takes full advantage of modern information technology. Then mechanisms for disseminating and implementing these principles and practices with a wide range of practitioners in different settings and with diverse student populations need to be established. This is a formidable task.

However, science itself languished for centuries until the Renaissance, when the “scientific method” of using theory grounded firmly in objective empirical data and advances in technology launched it on a trajectory of explosive progress. I see that science education is now on the verge of being launched on a similarly exciting trajectory, and I believe that this vision for science education is represented in much of the National Academies’ work, now and in the future.

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