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PRESIDENT'S Column

Inquiry-based Science Education for Primary Schools

Why We Should Care

I believe that every child is, or could be, a scientist. By this I don't mean that every child should grow up to work in a laboratory. I mean that it is important that we give all young people the opportunity to discover the wonder of the world around them, while acquiring valuable scientific habits of mind. The "every child a scientist" movement that I advocate would be aimed at ensuring that every child's education includes a substantial amount of meaningful time spent in scientific explorations.

What might science look like for five-year-olds? In some U.S. kindergarten classes, the teacher hands each child a clean white sock to wear while walking around the school yard. Back in the classroom, she tells the children to collect all the black specks stuck to the socks and sort them into two piles; they are to figure out which are seeds and which are dirt. To help with this task, each child is given a $3 plastic "microscope" and asked to make a drawing of each speck, gently coached to notice if any of the specks have regular shapes, and encouraged to plant both specks, while hypothesizing which specks are seeds and might develop into plants.

Bruce Alberts

Imagine an education that includes solving hundreds of such challenges over the course of the 13 years of schooling that lead to high school graduation—challenges that increase in difficulty as the children age. Outstanding curricula of this type already exist, having been developed and refined in the U.S. for 50 years. I believe that children who are encouraged to investigate their world in this way would be great problem solvers in the workplace; they'd have the analytical abilities and the can-do attitude needed to be competitive in the global economy. Even more importantly, they would be more rational human beings—people better equipped to make wise judgments for their families, communities, and nations.

The Importance of Scientific Habits of Mind

A science education that nourishes scientific attitudes and values is also the best tool we have for reducing the dogmatism that threatens the world today with deadly conflicts. Scientists across the world are able to work together across a wide range of cultures; we share a common way of reaching conclusions that is based on logic and evidence. Scientists are also optimists, seeing remarkable progress being made in our own fields of work—be it biology or astrophysics—and therefore able to believe in the possibility of progress more broadly. Our ways of thinking are founded not only on strong respect for evidence and logic, but also on honesty and an openness to new ideas. These are important habits of mind that can be learned when children do inquiry-based science in school.

How far are we from this ambitious goal? We are doing well in kindergarten, but less well after that. If one visits almost any kindergarten class, the five-year-olds are doing something that looks like science. For example, the teacher might have them cut open an apple and look at it carefully. They've eaten lots of apples, but they have never looked at them in this way before. They get excited by exploration and trying to make arguments based on evidence. They begin to learn how to listen to their classmates' opinions and ideas, and, hopefully, to build new ideas together. This is what we want them to do at this age—and mostly, in my opinion, what kindergarten should be about.

The Effect of Fact-laden Science Curricula

It is critical that we maintain the exploratory and collaborative spirit of a kindergarten class throughout all years of schooling, but as students

progress through primary school, either they are likely to have no science at all, or they might be assigned a textbook from which they memorize 10 kinds of whales, parts of the body, and so on. This kind of activity is almost universally passed off as science, but it's not. We don't need to teach kids thousands and thousands of facts about science; why, for example, should they learn the words "endoplasmic reticulum," "Golgi apparatus," and "mitochondrion" at age 12? Far too often our science teaching is a mile wide and an inch deep, and it makes science no different from any other subject with large amounts of information to be memorized. In fact, analyses have revealed that there are more new words to be learned in some science courses than in a foreign language class.

It should be no surprise that teaching science as thousands of facts turns most students away from science. I have been examining textbooks for K–12 science ever since I became involved in science education reform. At first glance, they look great, with beautiful photographs and drawings scattered about on every page. But take any chapter in the middle of the book and sit down and read it carefully. See if it is interesting, and put yourself in the place of a naïve student; can you understand the concepts behind the boldface words? Once you have spent a few hours on such an exercise, you will have a better sense of the mind-numbing "science" our grade-school children are expected to study.

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The Central Role of Public Schools

For our societies to be humane and successful, a different type of science education needs to reach all our children, and therefore must become deeply embedded in all public schools. It bothers me that so many of my colleagues send their children to private schools today, since I believe we need their active involvement as parents to keep our public schools effective. I keep thinking of the wonderful opinion pieces produced by Warren Buffet and Bill Gates in opposition to President Bush's push to abolish the inheritance tax in the U.S. several years ago. Their most telling argument for keeping the tax was the importance of leveling the playing field for future generations. As they pointed out, reducing financial inequalities will give the U.S. the best chance of selecting the most able and deserving people in the next generation to run the various aspects of a modern society—from our businesses to our elected officials.

It is in the public schools that the future leaders of our nation must be nourished, because it is critical that we cast a net as wide as possible for the talent and energy it takes to create a healthy society. For this purpose, high-quality, inquiry-based science education for all is essential. Why? Because it gives every student a chance to excel at tasks that mimic those that make a difference in the real world, regardless of a student's home background or language skills. Major improvements in science education are thus more important than most people think: They are critical for the future vitality of the U.S., and every other country, as a land of opportunity, a land where those with the most talent and energy succeed. ■

Comments are welcome and should be sent to president@ascb.org.

Resources for Building Partnerships

In response to "Science in a World at War" by Mark Peiffer (*ASCB Newsletter,* July 2007) about the challenges for scientists in the Middle East, two readers called attention to several ongoing efforts to build bridges between Palestinian and Israeli scientists.

- The United States-Israel Binational Science Foundation has issued a call for proposals for $50,000 grants to support workshops bringing together Israeli, American, and Palestinian scientists to develop partnership research projects (www.bsf.org.il).
- The Israeli-Palestinian Science Organization (IPSO) also has programs that fund joint scholarly and scientific projects (www.ipso-jerusalem.org; the IPSO's U.S. partner's website is www.fipsousa.org).