Bruce Alberts is Editor-in-Chief of *Science*.

Teaching Real Science

IN THIS ISSUE OF *SCIENCE*, WE ARE PUBLISHING THE FIRST OF 15 WINNING ENTRIES FOR the 2011 *Science* Prize for Inquiry-Based Instruction (p. 418), a laboratory module entitled Light, Sight, and Rainbows. Created for introductory college science courses, each module can be readily used in many different settings and schools. The winning modules were selected by a jury of more than 70 scientists and science teachers, and the subjects include physics, math, chemistry, geology, molecular biology, plant science, and evolution. Throughout 2012, each will be published as a two-page printed synopsis supplemented by online material that contains the details needed to teach it.

Our goal is to make it much easier for teachers everywhere to provide their students with laboratory experiences that mirror the open-ended explorations of scientists, instead of the traditional "cookbook" labs where students follow instructions to a predetermined result. To this end, we are announcing a second year of the contest, now broadened to include engineering in addition to science, as well as courses at the advanced high-school level (see www.scim.ag/inquiryprize). We hope that these contests will help support a rethinking of science education that is consistent with the new *Framework for K-12 Science Education* (precollege) from the U.S. National Academies, as well as with one of the central goals in the international Programme for International Student Assessment (PISA) Science Competencies: "Understands the characteristic features of science as a form of human knowledge and enquiry."*

Although our 2011 contest focused on college science teaching, the same goals can be applied even to early years of schooling. Consider, for example, an article published by the U.S. National Science Teachers Association, *Growing Seeds and Scientists*, which describes a science lesson for kindergarten students (age 5).† The students are presented with seeds of very different sizes and shapes—an avocado seed, a corn kernel, a marigold seed, and so on—mixed with objects such as pebbles and shells. For three times a week over the course of 6 weeks, the students explore the question, "How do we know if something is a seed?", forming a "scientists' conference" to share ideas respectfully and learn from each other as real scientists might in a laboratory. Thus, after the students discover that they disagree about what makes an object a seed, the class is asked to come up with ways in which they might test their ideas, again modeling the behavior of scientists. Through experiments that they suggest and perform on their own, the class discovers which objects are seeds. Finally, the students dissect some of the seeds and examine them with a magnifying glass, finding the tiny embryo inside and its source of food. Compare this exercise with a more traditional approach, which would at best give the students a seed and step-by-step instructions on how to grow it, bypassing the scientific process of facing a question, proposing solutions, and testing one's theories.

Last week, I described how current school science often resembles a game in which the participants are challenged to recall boring, incomprehensible facts.‡ How might the world recover from this destructive form of science education? We should begin by teaching science to young children with a curriculum like that described in *Growing Seeds and Scientists*, which might require a total of only 20 hours of the school year. And we should aim for an education system in which every child is exposed to at least this many hours of high-quality science inquiry in each year of elementary and middle school, supported by carefully prepared science specialists. In this way, "science education" would be redefined, with a laser-sharp focus on gaining the scientific habits of mind that will be needed by everyone to successfully negotiate his or her way through our increasingly complex, crowded, and confusing societies.

– Bruce Alberts

10.1126/science.1219216

*For *Framework*, see www.nap.edu/catalog.php?record_id=13165; for PISA, see www.oecd.org/dataoecd/15/13/39725224.pdf. †D. C. Smith, J. L. Cowan, A. M. Culp, *Science & Children* **47**, 48 (2009); www.nsta.org/pdfs/ScienceAndChildren_200909_48-51.pdf. ‡B. Alberts, *Science* **335**, 263 (2012).

Science

Teaching Real Science

Bruce Alberts

Science **335** (6067), 380.
DOI: 10.1126/science.1219216

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. The title *Science* is a registered trademark of AAAS.