

# Grand Challenges in Science Education

**Use technology to improve pedagogy, management, and accountability.**

Improve access to, and the quality of pre- and postprimary education.

Develop appropriate policies for regulating and supporting the private sector in education.

Develop an understanding of how individual differences in brain development interact with formal education.

**Adapt learning pathways to individual needs.**

Create online environments that use stored data from individual students to guide them to virtual experiments that are appropriate for their stage of understanding.

Determine the ideal balance between virtual and physical investigations for courses in different subject areas.

Identify the skills and strategies that teachers need to implement a science curriculum featuring virtual and physical laboratories.

Identify the underlying mechanisms that make some teacher professional development (PD) programs more effective than others.

Identify the kind of PD that will best prepare teachers to meet the challenges of the Next Generation Science Standards.

Harness new technologies and social media to make high-quality science PD available to all teachers.

Help students explore the personal relevance of science and integrate scientific knowledge into complex practical solutions.

Develop students' understanding of the social and institutional basis of scientific credibility.

Enable students to build on their own enduring, science-related interests.

Shift incentives to encourage education research on the real problems of practice as they exist in school settings.

Create a set of school districts where long-standing, multidisciplinary teams work together to identify effective improvements.

**Create a culture within school systems that allows for meaningful experimentation.**

Design valid and reliable assessments reflecting the integration of practices, cross-cutting concepts, and core ideas in science.

Use assessment results to establish an empirical evidence base regarding progressions in science proficiency across K–12.

Build and test tools and information systems that help teachers effectively use assessments to promote learning in the classroom.

## INTRODUCTION

# Plenty of Challenges for All

## WHY SHOULD ANYONE WHO IS NOT A SCIENTIST CARE ABOUT SCIENCE EDUCATION?

Professional scientists and educators may find the question insulting. Every culture has struggled to find the most effective ways to teach the uninitiated and translate that learning into productive skills. But if students and parents around the world don't see the need for a high-quality education in science, technology, engineering, and mathematics (the so-called STEM fields), or mistakenly think that they are already receiving satisfactory teaching in those areas, then calls from the scientific community to improve STEM education will fall on deaf ears.

In this special issue of *Science*, we have invited experts to tell us what they think are the most important challenges facing science education. Through a mixture of News, Reviews, Perspectives, Education Forums, and an Editorial, we explore the obstacles to progress, be they within the classroom, across the school system, or in the larger social arena. We also offer substantive suggestions on how to proceed. For example, distance education, online simulations as educational aids, and social networking tools are already part of science education. Many university faculty members are working to upgrade centuries-old approaches to instruction. And, with a new emphasis on the practice of science, promising assessment tools are being developed to improve learning.

The challenges covered in this special issue will be familiar to those who have devoted their lives and livelihoods to improving education. There is a huge and expanding literature on these topics and many others not covered in these pages. Yet convincing the public of the importance of STEM education will require more than explaining what the research shows or finding ways to scale up best practices to reach the billions of students who are entitled to a high-quality education. For scientists, advances in science and technology arrive at such a rapid clip that last year's knowledge barely scratches the surface of what is needed next year. At the same time, larger and more diverse student populations clamor for access to knowledge. Not only will the scientific workforce for the 21st century need skills and knowledge we haven't even heard of yet, but all global citizens, whether in their doctor's office or in a polling booth, need to be better informed. Turning the fire of the natural curiosity of students into effective, flexible, and well-grounded outcomes will take a concerted effort by many different actors. Among them, scientists must play a central role.

This is another grand challenge, and one that the scientific community ignores at its peril.

— PAMELA J. HINES, JEFFREY MERVIS, MELISSA MCCARTNEY, BRAD WIBLE

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# Science

## Plenty of Challenges for All

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