New Science Framework Paves Way for Standards

By Erik W. Robelen

With the goal of sparking big changes in K-12 science education across the country, an expert panel convened by the **National Research Council** today issued **a framework** to guide the development of new national standards in the subject.

Top priorities include promoting a greater emphasis on depth over breadth in understanding science and getting young people to continually engage in the practices of both scientific inquiry and engineering design as part of the learning process. Another goal is to promote what the panel calls greater "coherence" in the teaching of science as students progress through school, with the core scientific concepts revisited at multiple grade levels to build on prior learning and help facilitate a deeper understanding.

Now that the framework is complete, Achieve, a nonprofit organization based in Washington, will work with states and outside experts to craft a set of what's being billed as "next generation" science standards for elementary and secondary education, expected out by fall 2012. Organizers say they hope that states from coast to coast will ultimately choose to adopt the standards to replace existing ones.

The effort comes amid strong and growing concerns about the need to improve student achievement in the STEM fields—science, technology, engineering, and mathematics—and as the 45 states that adopted **common-core standards** in math and English/language arts attempt to implement them.

"Many of those states are feeling, if we're doing common things in math and English/language arts, why not in other areas?" said Helen R. Quinn, who chaired the NRC panel and is a professor emeritus of physics at the Stanford Linear Accelerator Center at Stanford University.

"The goal is better science education, and I would say, certainly at the early grades, more science, too," said Ms. Quinn, who laments that the subject "has almost disappeared" at the K-3 level.

The framework is built around three major dimensions: scientific and engineering practices; cross-cutting concepts that unify the study of science and engineering; and core ideas in four disciplinary areas—physical sciences, life sciences, earth and space sciences, and engineering, technology, and the applications of science.

Funding to develop both the framework and the new standards comes from the Carnegie Corporation of New York. (The foundation also underwrites coverage of district and high school reform in *Education Week*.)

The congressionally chartered NRC issued a draft last summer, but made significant revisions in response to public feedback, though Ms. Quinn emphasized that the final product still keeps to the core agenda for revamping science education.

The **National Science Teachers Association**, based in Arlington, Va., issued a statement praising the framework as holding the potential to bring about "transformational changes" in science education, especially with the focus on better engaging students and bringing close attention to the practices of science.

That said, Francis Q. Eberle, the group's executive director, cautioned that there's plenty of work ahead to see if the framework really can spur widespread change.

"That's the big question," he said in an interview. "It really will depend on the ways in which it gets implemented. There are many steps: articulation into standards, then what happens for teachers, teacher preparation, for curriculum, for assessments. We're at the beginning of a journey here."

The NRC panel itself was mindful of those challenges.

"The committee emphasizes that greater improvements in K-12 science and engineering education will be made when all components of the system ... are aligned with the framework's vision," the document says.

Advances in Learning

An **18-member committee** that included experts in education and science from a variety of disciplines designed the framework. It lays out the broad ideas and practices that students should learn and that are intended to serve as the foundation for the new standards.

The new science framework comes more than a decade after the NRC first issued a set of national science education standards in 1996. Separately, in 1993, the American Association for the Advancement of Science published its Benchmarks for Science Literacy. Both documents, which experts say have a lot in common, are seen as having had considerable influence on state science standards. At the same time, the documents have encountered criticism, including the complaint that they contain too many learning objectives for students.

In a foreword to the new document, leaders at the National Academies explained the rationale for undertaking the work.

"This project capitalizes on a major opportunity that exists at this moment," with most states having recently adopted common standards in math and English/language arts, write Ralph J. Cicerone, the president of the National Academy of Sciences, and Charles M. Vest, the president of the National Academy of Engineering.

They also note that "not only has science progressed" since the national documents on science content were produced in the 1990s, but "the education community has learned important lessons from 10 years of implementing standards-based education." Furthermore, they point to a "new and growing body of research" on science learning itself.

"We've learned an awful lot about how children learn and ways to develop environments to support science learning, and this is our chance to reflect [that]," said Brian J. Reiser, a member of the NRC committee and a professor of learning sciences at Northwestern University, in Evanston, Ill. "The research points us to what is possible and helps us articulate this vision for what really effective science education should be."

In setting the stage for the framework, the committee points to its concerns about the current state of science education in the United States.

"It is not organized systematically across multiple years of school, emphasizes discrete facts with a focus on breadth over depth, and does not provide students with engaging opportunities to experience how science is actually done," the document says. "The framework is designed to directly address and overcome these weaknesses."

Mr. Reiser drew special attention to the committee's attempt to bring better coherence across elementary and secondary education in learning science by promoting the idea that

key concepts—such as energy or forces and motion in the area of physical sciences—should be revisited at various grade spans, whether K-2, 3-5, and so on.

"Each of our core ideas appears in each of these grade bands," he said. "We're trying to articulate a way that children can develop more and more sophisticated ideas building on these prior ideas."

Mr. Reiser added: "This is not a dramatically new idea, but unfortunately, there are lots of obstacles in our education system that ... work against coherence."

The framework also contains a strong emphasis on engineering and technology.

"Engineering and technology are featured alongside the natural sciences ... for two critical reasons: to reflect the importance of understanding the human-built world, and to recognize the value of better integrating the teaching and learning of science, engineering, and technology," the NRC document says.

It later elaborates on that matter, saying that engineering and technology were included in the framework to "provide a context in which students can test their own developing scientific knowledge and apply it to practical problems." The panel adds that, at least at the K-8 level, those topics typically do not appear elsewhere in the curriculum.

'A Lot of Transparency'

Work is now starting to get under way by **Achieve**, a group governors and business leaders created in 1996, to translate the conceptual framework into a set of standards.

The organization has already assembled a team of 36 writers with expertise across science and education to craft the standards, said Stephen L. Pruitt, the vice president for content, research, and development at Achieve. Mr. Pruitt, who will take the lead in overseeing the process, said the list of writers would be made public in coming weeks.

Although Mr. Pruitt emphasized that all states will have a chance to weigh in on the standards at various points, a group of approximately six to eight states will serve as "lead state partners" in their development. Achieve is inviting states to apply to participate in that capacity, he said, and the organization will rely on a group of outside experts to help make a final decision, with the goal of having a diverse group of states both geographically and in how they currently organize their science standards.

"It is going to be truly a state-led effort," said Mr. Pruitt, a former state official in the Georgia education department—including as a science supervisor—with a dozen years of experience teaching high school science.

In addition, a broad-based "stakeholder group" will provide feedback throughout the process, he said.

"We've got about 700 names on that list so far, from K-12 educators to prominent scientists, industry leaders, a group that we wanted to be very representative of the country," Mr. Pruitt said. "This is an effort that is going to require a lot of transparency and a lot of people being engaged in the process throughout."

There will be some notable differences between the effort to develop science standards and the recent work on common standards in math and English, he said. Achieve also played a key role in crafting the common core.

For one, unlike with the math and English standards, participating states will not be required to make a prior commitment to adopt the science standards. Also, Mr. Pruitt said no plan exists to his knowledge for the federal government to create any particular incentives for states to adopt the standards, as is the case with the math and English standards.

Mr. Pruitt himself was a member of the NRC framework panel, though he had to step down from that position when he joined Achieve's staff last summer.

Even as the framework emphasizes the importance of scientific practice, he said, that in no way should be interpreted as backing away from the notion that students should have a clear understanding of critical scientific concepts.

"I want to be real clear that there is going to be plenty of content, but also [a focus on] how scientists use it," he said. "So we want it to be more than just students memorizing facts, but we recognize that science is a body of knowledge."

The framework document itself explains the governing philosophy behind its approach to science content.

"The continuing expansion of scientific knowledge makes it impossible to teach all the ideas related to a given discipline in exhaustive detail during the K-12 years," it says. "But given

the cornucopia of information available today virtually at a touch—people live, after all, in an information age—an important role of science education is not to teach 'all the facts' but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own."

Stepping back, the report's authors say that the ultimate goal of the framework is to ensure that by the end of 12th grade, all students have "some appreciation of the beauty and wonder of science," have sufficient knowledge of science and engineering to engage meaningfully in public discussions, are careful consumers of scientific and technological information, and have the skills to enter careers in science, engineering, and technology if they wish.

Students should "see how science and engineering are instrumental in addressing major challenges that confront society today, such as generating sufficient energy, preventing and treating diseases, maintaining supplies of clean water and food, and solving the problems of global environmental change," the committee says.

In addition, the panel expressed its hope that the vision of change in science education laid out in the document will "motivate and inspire" more people, and a better representation of the nation's diverse population, to pursue careers in science and engineering.