EDUCATION WEEK
Published Online: May 23, 2012

New Science Standards: Bound for Glory, or Running Behind?

By Arthur H. Camins

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Physics teaches us that speed, acceleration, direction of movement, and time are all relative to a reference point. This principle, related to objects and motion, is worth considering as a metaphor for education policy. It is particularly poignant in thinking about the promise and challenges of the National Research Council's framework for K-12 science education and the just-released draft of the **voluntary Next Generation Science Standards**, or NGSS.

The metaphor struck me while riding the train to work recently. Glancing to my right at the passing scenery, I was confident that my train was rapidly moving toward my destination. But then, I experienced a moment of perturbation. My attention was drawn to my left with the passage of a faster train headed in the same direction. Suddenly, I had the brief sense of moving backward. Relative to the station I left behind, I was still making progress. However, relative to the faster-moving train, I was losing ground.

As a nation, we remain highly focused on performance on current high-stakes accountability tests. For the most part, they tend to measure progress with respect to what is behind us: mastery of a fixed body of information that is easily tested. Even growth measures are about increasing the distance from the past, i.e., prior achievement levels. The higher the stakes, the more we tend to look over our shoulders and the more we fail to look ahead to new destinations, or even to notice whether those moving more quickly are using very different education strategies.

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Recent research suggests that the problem with student learning in the United States is not so much declining performance, but rather failure to set new learning targets, make the same rate of progress as some other nations, or mediate the nonschool effects of increasing income disparity. My train ride had me wondering about what we need to do to prepare students for a future in which they are engaged and successful as participating citizens, in careers, as socially responsible, contributing members of their communities and families, and as individuals. A preparation for that future-oriented learning perspective suggests that students will need to develop the inclination and expertise to:

- Integrate knowledge across multiple domains to solve unexpected problems;
- Collaborate across diverse experiences and perspectives to solve problems;
- Generate explanations grounded in evidence;
- Revise explanations in light of new evidence and alternative arguments; and,
- Consider, evaluate, and imagine innovative and creative solutions.

It also means that we need to nourish a mindset that problems and challenges can be met and solved through effort.

With these priorities in mind, mastery of disciplinary knowledge does not lose importance. Rather, it shifts the instructional focus from testable content mastery being the primary goal to developing expertise in learning how to access knowledge and use it to design and carry out solutions.

At the **Center for Innovation in Engineering and Science Education at Stevens Institute of Technology**, where I work, we have been developing curriculum, engaging teachers in professional learning, and conducting research to help promote this shift. Advances in the learning sciences embodied in the framework and the NGSS draft leave us optimistic that we have an opportunity to counter the backward-looking pressures generated by increasingly test-focused federal and state policy. It is not that we believe that standards or assessments will magically yield improvement. Rather, we are encouraged by the draft standards' and framework's vision for several reasons.

First, the framework begins with the premise that while the natural and human-made worlds are intrinsically fascinating, the value of science and engineering is in improving our lives. Therefore, our interpretation is that the goal is not new parameters for accountability testing, but rather a more compelling values-driven agreement about what knowledge and abilities we want to nurture in young people so that they can make a difference in the world.

Second, the NGSS draft defines learning performance as the product of the interaction of the framework's three dimensions: scientific and engineering practices, crosscutting concepts, and core disciplinary ideas. Learning-outcome expectations in current state standards are typically expressed in factual knowledge statements, such as "recognize that ..." Alternatively, for each core idea, the NGSS states: "Students who demonstrate an understanding can ..." and follows with such phrases as "construct explanations of..." "develop models to represent ..." "collect and generate evidence to ..." and "design and evaluate solutions that ..." This clarifies that students should not only know about the natural world, but rather be able to engage in and use the practices of scientists and engineers. We are optimistic that this approach can provide students with intellectual tools to prepare them for careers, citizenship, and personal decisionmaking.

Third, the framework and the NGSS also draw attention to the interdependence between science and engineering in the products and processes that permeate every aspect of our lives. Understanding the systematic process of engineering includes consideration of constraints, optimization, trade-offs, and unintended consequences as we evaluate competing solutions to such issues as sustainable energy production, climate change, and health care. Situating learning in problems that have social and personal meaning for students has the potential to engage students who are all too often disengaged.

This potential will only be realized if the National Research Council's framework and the Next Generation Science Standards are used as springboards for research and experimentation. Both preparation for future learning and the deeper integration of science and engineering instruction signal significant changes in curriculum and instruction. For example, in the real world, disciplinary experts collaborate to solve problems. By contrast, students are relative novices. Therefore, it will be a challenge to select meaningful but accessible problems in which to engage students so their learning is not superficial.

Given the significance of this change, it is far too early to talk about "best practices" or "model curricula." We need space for multiple approaches, missteps, and iterative improvement. We need to develop assessments to inform our knowledge and practice, but we must resist the temptation to rush to their consequential use, which will only shut down the analysis, reflection, and reinvention necessary for meaningful improvement.

If we trivialize the Next Generation Science Standards as yet another program or initiative to be unpacked and implemented, it will fail. We have a long history of pursuing ambitious goals while ignoring contradictory policies and practices. I recently attended several presentations on the NGSS at the National Science Teachers

Association's annual conference. I shared in the palpable excitement there among science educators, and I am also encouraged that there is significant overlap with the common-core standards.

I remain deeply concerned, however, that in schools across the country, teachers and administrators are still viewing these developments through the distorting prism of highly consequential tests. I am worried that these pressures will keep us looking at the station we should have left behind, rather than innovating and imagining what we need to do to make progress in preparing young people to be shapers of a yet-to-be-defined future.

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