Twelve Core Ideas

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Over his career, Cary has directed more than 20 state and federal grant projects, including several that involved the development and testing of new curricula and methods of assessment.

The problem of too much to cover in too little time is a well-worn theme, but the issue has gained urgency in recent years due to high stakes tests that cover the entire range of topics included in a state's standards. This was one of the chief concerns on the minds of the committee members who developed *A Framework for K–12 Science Education* (NRC 2012) and the writing team of the Next Generation Science Standards (NGSS Lead States 2013). If our nation is going to have common science standards for all states, assessments will surely follow; and those of us involved in the process did not want to make the same mistake again by stuffing the standards with an impossibly large number of concepts, principles, laws, theories, and facts.

On the other hand, we also did not want to miss any of the really crucial ideas that everyone needs to understand in order to function in today's increasingly technological world. Creating that balance was a major challenge. The work of deciding on those core ideas fell to the committee that developed the *Framework.* In addition to choosing a small number of ideas, it was also important to pick the right ideas that would bring coherence to what had, until then, been a list of largely separate topics. The all-volunteer committee, which included educational leaders, scientists, and engineers (including two Nobel prize-winners) solicited input from colleagues in their respective fields, deliberated for many months, produced numerous drafts and listened to feedback, and eventually arrived at a small number of "core ideas" for K–12 science education.

The action then switched to the writing team for the Next Generation Science Standards (NGSS). The process of developing the NGSS was managed by teams from 26 states. And in contrast to the committee of scientists and engineers who formulated the *Framework,* approximately 50 percent of the writing team consisted of K–12 teachers with current teaching assignments. (The great majority of the rest of us on the team had been teachers at one time or another.) Consequently, we were careful not to expand the core ideas into an impossibly large number of things that students were expected to

learn. Here is the final list of 12 core ideas, adopted from the *Framework,* which underpinned the development of the NGSS.

Physical Sciences	Life Sciences	Earth and Space Sciences	Engineering, Technology, and Applications of Science
• Matter and its interactions • Motion and stability: Forces and interactions • Energy • Waves and their applications in technologies for information transfer	• From molecules to organisms: Structures and processes • Ecosystems: Interactions, energy, and dynamics • Heredity: Inheritance and variation of traits • Biological evolution: Unity and diversity	• Earth's place in the universe • Earth's systems • Earth and human activity	• Engineering design

In the rest of this short essay I have three comments about these core ideas: 1) They don't include everything, nor should they; 2) These ideas are intended to guide the K–12 science curriculum, but are not intended to limit what teachers teach; and 3) They should not all be taught or assessed every year.

Core ideas don't include everything, nor should they.

The most common criticism of the Next Generation Science Standards is that they fail to include a concept, principle, or theory that the critic considers to be important. Some of the most common topics that have been included in textbooks for decades are not to be found in the NGSS, and that is as it should be. In fact, not everything included in the *Framework* was included in the Next Generation Science Standards, because when we shared our drafts of the NGSS with the broad community of science teachers they told us just that: "Still too much!" So we trimmed, and in doing so we inevitably trimmed some people's favorite topics.

It's also worth adding that many of the most vocal critics were university professors who pointed out that the core ideas in the NGSS were not adequate to prepare their students to major in science. However, we noted that not all students major in science at college, and in fact, a fairly large number of students follow other pathways in life besides a four-year university. The NGSS is for everyone in our society—not just future scientists and engineers.

These ideas are not intended to limit what teachers teach.

Nonetheless, students who are interested in majoring in science at college do need to

learn more than is included in the NGSS. There is no intention to eliminate honors science courses in high school, accelerated programs for elementary and middle school students, science and engineering fairs, afterschool clubs, or summer science camps. We need these opportunities to get our students excited about science and engineering, and to prepare those who want to go on. We simply do not need to raise the bar so high that only a small number of students can graduate from high school.

There's another sense in which the NGSS is not enough, and that is for teachers and curriculum developers to think about the concepts and skills that students need to learn on their way to achieving the performance expectations. The performance expectations in the NGSS are intended to guide future assessments, not to spell out each step of a learning sequence, or to limit what all students need to learn. We trust in today's teachers and curriculum developers to make those decisions—as long as they are sure to include what is in the NGSS.

Core ideas should not all be taught or assessed every year.

If all 12 core ideas were taught to all students every year we would still have a science program that is a mile wide and an inch deep (Schmidt et al. 1997). The NGSS makes specific recommendations for what is to be taught each year from kindergarten to fifth grade and recommends how these ideas can be sequenced in middle and high school courses. Astronomy, for example, is taught in grades 1, 5, middle school, and high school. Although it's my favorite subject, astronomy should not be taught in the other grades (except as enrichment or outside of school) so that teachers at the other levels can devote sufficient time to teach the subjects assigned to them in depth.

While the 12 core ideas that form the basis of the NGSS may not make the teacher's job "easy," they are intended to make the job of teaching science doable, and the work of learning science both meaningful and coherent.

References:

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