May 2012 NGSS Public Draft
Front Matter

All documents associated with the May release are DRAFTS.

Goals of the May Draft Review

The goal of this public release is to distribute and receive feedback from interested stakeholders and create a transparent process. The draft will be available from May 11, 2012 through June 1, 2012. ***The release is fully intended to receive feedback from the public for the purposes of revising the draft. In no way should any statement within the draft be viewed as final.*** At this stage of development, not all portions of the draft standards have been completed. The focus at this point is on what has been developed and shapes the thinking of the state partners and writers as they move toward a more complete version for the second public release expected in the fall of 2012.

Next Generation Science Standards for Today's Students and Tomorrow's Workforce.

Through a collaborative, state-led process, new K–12 science standards are being developed that will be rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education.

Background

The National Academy of Sciences, Achieve, the American Association for the Advancement of Science, and the National Science Teachers Association have embarked on a two-step process to develop the *Next Generation Science Standards* (NGSS). The first step of the process was led by The National Academies of Science, a non-governmental organization commissioned in 1863 to advise the nation on scientific and engineering issues. On July 19, 2011, the National Research Council (NRC), the functional staffing arm of the National Academy of Sciences, released the *Framework for K-12 Science Education*. This *Framework* is a critical first step because it is grounded in the most current research on science and science learning and it identifies the science all K–12 students should know.

Organization of the Standards

The standards are organized into grade by grade in Kindergarten through fifth grade. For the purposes of the first public draft, the middle and high school standards are grade banded. As the process moves forward, the NGSS will provide model course pathways that allow students to meet the standards in different ways.

Points of Emphasis for the Public Draft

Audience for the NGSS
The NGSS have been written with teachers and curriculum/assessment developers as the intended audiences.

All Standards, All Students
The draft NGSS represent a higher threshold for all students. The intent is for all students to have the opportunity to access these standards. The NGSS are meant to prepare students for scientific literacy and prepare them for higher levels of understanding of science and engineering. The standards are not currently arranged into courses.

Use of Science and Engineering Practices and Crosscutting Concepts in the Draft NGSS
It is essential to understand that the emphasis placed on a particular Science and Engineering Practice or Crosscutting Concept in a performance expectation is not intended to limit instruction, but to make clear the intent of the assessments. Classroom instruction should include Science and Engineering Practices and Crosscutting Concepts throughout each school year.

Clarity and Integration of Crosscutting Concepts
Crosscutting concepts are meant to be the connective tissue across disciplines. They are not intended to be additional content. The Framework states,

> *"These crosscutting concepts were selected for their value across the sciences and in engineering. These concepts help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world.*
>
> *Although crosscutting concepts are fundamental to an understanding of science and engineering, students have often been expected to build such knowledge without any explicit instructional support. Hence the purpose of highlighting them as Dimension 2 of the framework is to elevate their role in the development of standards, curricula, instruction, and assessments.*
>
> *These concepts should become common and familiar touchstones across the disciplines and grade levels. Explicit reference to the concepts, as well as their emergence in multiple disciplinary contexts, can help students develop a cumulative, coherent, and usable understanding of science and engineering."* (NRC 2011, p. 83)

Care was taken in the development of the draft NGSS to focus on two to three crosscutting concepts per topic. This should not restrict instruction in making additional connections; it was simply to focus the performance expectations.

***Framework for K-12 Science Education* Dimensions**

The *Framework* outlines three dimensions that are needed to provide students a high quality science education. The integration of these three dimensions provides students with a context for the content of science, how science knowledge is acquired and understood, and how the sciences are connected through concepts that have universal meaning across the disciplines. The following excerpt is quoted from the *Framework.*

Dimension 1: Practices

Dimension 1 describes (a) the major practices that scientists employ as they investigate and build models and theories about the world and (b) a key set of engineering practices that engineers use as they design and build systems. We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice.

Similarly, because the term "inquiry," extensively referred to in previous standards documents, has been interpreted over time in many different ways throughout the science education community, part of our intent in articulating the practices in Dimension 1 is to better specify what is meant by inquiry in science and the range of cognitive, social, and physical practices that it requires. As in all inquiry-based approaches to science teaching, our expectation is that students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves.

Dimension 2: Crosscutting Concepts

The crosscutting concepts have application across all domains of science. As such, they provide one way of linking across the domains in Dimension 3. These crosscutting concepts are not unique to this report. They echo many of the unifying concepts and processes in the National Science Education Standards, the common themes in the Benchmarks for Science Literacy, and the unifying concepts in the Science College Board Standards for College Success. The framework's structure also reflects discussions related to the NSTA Science Anchors project, which emphasized the need to consider not only disciplinary content but also the ideas and practices that cut across the science disciplines.

Dimension 3: Disciplinary Core Ideas

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. 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. —An education focused on a limited set of ideas and practices in science and engineering should enable students to evaluate and select reliable sources of scientific information, and allow them to continue their development well beyond their K-12 school years as science learners, users of scientific knowledge, and perhaps also as producers of such knowledge.

With these ends in mind, the committee developed its small set of core ideas in science and engineering by applying the criteria listed below. Although not every core idea will satisfy every one of the criteria, to be regarded as core, each idea must meet at least two of them (though preferably three or all four).

Specifically, a core idea for K-12 science instruction should:

1. *Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline.*
2. *Provide a key tool for understanding or investigating more complex ideas and solving problems.*
3. *Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge.*
4. *Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. That is, the idea can be made accessible to younger students but is broad enough to sustain continued investigation over years.*

In organizing Dimension 3, we grouped disciplinary ideas into four major domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science. At the same time, true to Dimension 2, we acknowledge the multiple connections among domains. Indeed, more and more frequently, scientists work in interdisciplinary teams that blur traditional boundaries. As a consequence, in some instances core ideas, or elements of core ideas, appear in several disciplines (e.g., energy, human impact on the planet). – NRC Framework for K-12 Science Education 2-5 – 2-6

The standards are written as student performance expectations. This is a key difference in the NGSS compared to current standards. These statements each incorporate a practice, a disciplinary core idea, and a crosscutting concept. The performance expectations are the assessable components of the NGSS architecture. Performance expectations are lettered with lowercase letters, and each combines Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas into a performance expectation. A key understanding of the architecture is the purpose of the Foundation Boxes. These are meant to supply more detail and connect the NGSS to the *Framework.* The goal is to provide enough information in order to not require the standards to be "unpacked."

Progression of the Standards

Following the vision of the *Framework*, the NGSS are intended to increase coherence in K-12 science education. The following excerpt from the *Framework* explains the approach in more detail:

"First, it is built on the notion of learning as a developmental progression. It is designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. The goal is to guide their knowledge toward a more scientifically based and coherent view of the natural sciences and engineering, as well as of the ways in which they are pursued and their results can be used.

Second, the framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines. The committee made this choice in order to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented. Delimiting what is to be learned about each core idea within each grade band also helps clarify what is most important to spend time on, and avoid the proliferation of detail to be learned with no conceptual grounding.

Third, the framework emphasizes that learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus the framework seeks to illustrate how knowledge and practice must be intertwined in designing learning experiences in K-12 science education." - NRC Framework for K-12 Science Education, 1-3

The *Framework* identifies eight science and engineering practices that mirror the practices of professional scientists and engineers. These are intended to strengthen students' skills in these practices at the same time as they develop their understanding of the nature of science and engineering. Listed below are the science and engineering practices from the *Framework*:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology, and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in Argument from evidence
8. Obtaining, evaluating, and communicating information

The *Framework* does not specify grade-band endpoints for the practices, nor for the crosscutting concepts, but instead provides a summary of what students should know by the end of grade twelve and a hypothetical progression for each. To assist with writing the NGSS, grade-band endpoints were constructed for the science and engineering practices and crosscutting concepts that are based on these hypothetical progressions and twelfth-grade endpoints. These representations of the crosscutting concepts and practices appear in the NGSS and supporting foundation boxes. A complete listing of the specific science and engineering practices and crosscutting concepts used in the NGSS are shown in Appendices A and B.