Important Information about the Second Public Draft of the Next Generation Science Standards

All documents associated with the January, 2013 release are DRAFTS.

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Goals of the January Public Draft Review

The goal of this public release is to share revisions based on the first public review and the college and career readiness review. The draft will be available for feedback from January 8, 2013 through January 29, 2013. 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 the final release of the Next Generation Science Standards in March of 2013.

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*. The *Framework* was 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. The second step in the process was the development of standards grounded in the NRC Framework. A group of 26 lead states and writers, in a process

managed by Achieve, has been working since the release of the Framework to develop K-12 Next Generation Science Standards. The standards have undergone numerous lead states and all state reviews as well as one public comment period. The final release of the NGSS will be in March of 2013.

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

The *Framework* outlines the 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

Organization of the Next Generation Science Standards

The standards are organized by grade levels in Kindergarten through fifth grade. The middle and high school standards are grade banded. For the purposes of this draft, a set of model courses for middle school and high school have been developed to initiate discussion. All reviewers are invited to submit feedback through the general comments portion of the online survey.

A real innovation to the NGSS is the overall coherence. As such, the Performance Expectations (the assessable component of the NGSS architecture) can be arranged in any way that best represents the needs of states and districts without sacrificing coherence. The May public draft web version of the standards allowed all performances to be sorted in many ways. For the January Public Draft, the lead states gave the writing team direction to arrange and code the performance expectations by disciplinary core ideas based on the arrangement of the Framework, in addition to providing the original topical arrangements. The topics are available both through the web and download, but a *new coding system has been implemented to better represent any configuration.* Finally, as directed by the Lead States, stand alone engineering performance expectations in middle school and high school have been integrated into the traditional sciences,

but are also still available in separate engineering standards. These performance expectations, designated by an asterisk, are listed in the both the disciplinary core idea and topic arrangements.

Appendices to the Second Public Draft

This latest iteration of the NGSS is the result of the first public feedback, lead state and non-lead state feedback, National Science Teacher Association (NSTA), and national and local critical stakeholder feedback. Since the public release, additional reviews have been conducted by members of convened college and career readiness meetings and by lead state teams. A short summary of each of the appendices to aid in reviewing the draft NGSS are located below.

Appendix A – Conceptual Shifts

The NGSS provide an important opportunity to improve not only science education but also student achievement. Based on the *Framework for K–12 Science Education*, the NGSS are intended to reflect a new vision for American science education. The lead states and writing teams have identified six "conceptual shifts" science educators and stakeholders need to make to effectively use the NGSS. The shifts are

1. K–12 Science Education Should Reflect the Real World Interconnections in Science.
2. The Next Generation Science Standards are student outcomes and are explicitly NOT curriculum.
3. Science Concepts Build Coherently Across K–12.
4. The NGSS Focus on Deeper Understanding and Application of Content.
5. Science and Engineering are Integrated in Science Education from K–12.
6. Science Standards Coordinate with English Language Arts and Mathematics Common Core State Standards.

Appendix B – Responses to May Public Feedback

The results of the May Public Feedback and the responses by the lead states and writing team can be reviewed for all areas of the NGSS. As a result of the May public review and subsequent state review, 95% of the performance expectations have been rewritten with more specific and consistent language used.

Appendix C – College and Career Readiness

A key component to successful standards development is to ensure the vision and content of the standards properly prepare students for college and career readiness. During the development of the NGSS, a parallel process to ensure the college and career readiness based on the available evidence has been ongoing. The process will continue through the completion of the NGSS development. The definition, process, and research are documented in this document. College and Career Ready Students can demonstrate evidence of:

1. Generating and using knowledge that blends Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas to make sense of the world and to approach problems not previously encountered by the student, including new situations, ill-structured problems, and new information,
2. Evaluating the use of blended knowledge through self-directed planning, monitoring, and evaluation,

3. Applying blended knowledge more flexibly within and across various disciplines through the exploration of the relevance of the application of additional Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas,
4. Employing valid and reliable research strategies, and
5. Exhibiting evidence of the effective transfer of mathematics and disciplinary literacy skills to science.

Appendix D – All Standards, All Students

The NGSS are being developed at a historical time when major changes in education are occurring at the national level. On the one hand, student demographics in the nation are changing rapidly, while science opportunity and achievement gaps persist.

The chapter highlights practicality and utility of implementation strategies that are grounded in theoretical or conceptual frameworks. It consists of three parts. First, it discusses both *learning opportunities and challenges* that NGSS presents student groups that have traditionally been underserved in science classrooms. Second, it describes effective strategies for *implementation* of NGSS in the science classroom, school, home, and community. Finally, it provides the *context* of student diversity by addressing changing demographics, persistent science opportunity and achievement gaps, and educational policies affecting non-dominant student groups.

Appendix E – Disciplinary Core Idea Progression in the NGSS

The NGSS have been developed in learning progressions based on the progressions identified by the grade-band endpoints in the *Framework*. Short narrative descriptions of the progressions are presented for each disciplinary core idea in each of the traditional sciences. These progressions were used in the college- and career-readiness review to determine the learning expected for each idea before leaving high school

Appendix F – Science and Engineering Practices in the NGSS

The *Framework* identifies eight science and engineering practices that mirror the practices of professional scientists and engineers. Use of the practices in the performance expectations is not only intended to strengthen students' skills in these practices but also to develop students' 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 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 science and engineering practices appear in the NGSS and supporting foundation boxes. A complete listing of the specific science and engineering practices used in the NGSS is shown in the document.

Appendix G – Crosscutting Concepts in the NGSS

The *Framework* also identifies seven crosscutting concepts that are meant to give students an organizational structure to understand the world and helps students make sense of and connect core ideas across disciplines and grade bands. They are not intended as additional content. Listed below are the crosscutting concepts from the *Framework*:

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter in Systems
6. Structure and Function
7. Stability and Change of Systems

As with the Science and Engineering Practices, the *Framework* does not specify grade-band endpoints 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 appear in the NGSS and supporting foundation boxes. A complete listing of the specific crosscutting concepts used in the NGSS is shown in the document.

Appendix H – Nature of Science in the NGSS

Based on the public and state feedback, as well as feedback from key partners like the National Science Teachers Association (NSTA), steps were taken to make the Nature of Science more prominent in the performance expectations. It is important to note that while the Nature of Science was reflected in the Framework through the practices, understanding the Nature of Science is more than just practice. As such, the direction of the lead states was to indicate Nature of Science appropriately in both Science and Engineering Practices and Crosscutting Concepts. A matrix of Nature of Science across K-12 is also included in this appendix.

Appendix I – Engineering Design, Technology, and the Applications of Science in the NGSS

The purpose of science education is to equip our students with the knowledge and skills essential for addressing society's needs, such as growing demand for pollution-free energy, to prevent and cure disease, to feed Earth's growing population, and maintain supplies of clean water. Just as these grand challenges inspire today's scientists and engineers, the intent of these new standards is to motivate all students to fully engage in the very active practices of science and engineering.

This appendix takes a deeper look at Engineering Design, Technology, and the Applications of Science and how they are treated in the NGSS.

Appendix J – Model Course Mapping in Middle and High School
The NGSS are organized by grade level for kindergarten through grade five, but as grade banded expectations at the middle school (6-8) and high school (9-12) levels. As states and districts consider implementation of NGSS, it will be important to thoughtfully consider how to organize these grade-banded standards into courses that best prepare students for post-secondary success. To help facilitate this decision-making process, several potential directions for this process are outlined in this appendix.

Appendix K – Consistency with the Common Core State Standards for Mathematics
Science is a quantitative discipline, which means it is important for educators to ensure that students' learning in science coheres well with their learning in mathematics.[1] To achieve this alignment, the NGSS development team has worked with Common Core State Standards in Mathematics (CCSSM) writing team members to help ensure that the NGSS do not outpace or otherwise misalign to the grade-by-grade standards in CCSSM. Every effort has been made to ensure consistency. It is essential that the NGSS always be interpreted, and implemented, in such a way that they do not outpace or misalign to the grade-by-grade standards in CCSSM. This includes the development of NGSS-aligned instructional materials and assessments. This appendix gives some specific suggestions about the relationship between mathematics and science in grades K-8.

Supporting Documents to the Second Public Draft

Why Standards Matter
The NGSS are being developed at a critical time in our history. This short document gives the high points of why the standards matter, what they are, how they are being developed, and the urgency for their development.

How To Read The Standards
The NGSS represent a major shift in science education. As such, the lead states and writing teams wanted to ensure that the document represented that shift. As such, the document does not represent the traditional list of standards statements to be interpreted and "unpacked." The architecture is a departure from the norm for the purpose of giving all users as much information as possible to ensure common understanding of the standards. Given the different nature, this document was put together to guide new readers on the architecture and the relationships between the different components.

[1] See page 16 of the *K-8 Publishers' Criteria for the Common Core State Standards for Mathematics*, available at www.corestandards.org.

How to Complete the Next Generation Science Standards Survey

The Next Generation Science Standards Survey has three main sections: Respondent Information; General Survey on ALL K-12 Standards; and the Science Standards.
In order to participate in the survey, you do not need to provide feedback on all the standards, you may provide feedback on a single standard, or just the general section, or for as many standards as you would like.

As with the web and PDF versions of the NGSS, the survey is available in both the topic and DCI arrangements.

To complete the survey, follow these five easy steps:

1. Enter your name and email address in the survey registration page to register. You can then continue on to the survey immediately. You will also receive an email with your unique participation code to allow you to reenter your saved survey at a later time.
2. Complete the Respondent Information (optional)
3. Complete the General Survey on ALL K-12 Standards (optional)
4. Complete the questions on individual standards
5. Submit your responses

A complete description of the process used to take the survey is included in a separate document.

Glossary of Terms

Many abbreviations and policy terms are used throughout the NGSS and its supporting materials. This document provides definitions and descriptions of these terms.