A New Vision for State Science Standards

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Objectives of this Presentation

1. Investigate The National Research Council’s (NRC) Framework for Science Education
2. Understand the Three Key Dimensions of the NRC Framework – Practices, Crosscutting Concepts, Core Ideas
3. Gain Insight into the Process for Development of Next Generation Science Standards from the Framework
Science documents used by states to develop standards are about 15 years old

- National Research Council’s *National Science Education Standards* were published in 1996
- American Association for the Advancement of Science’s *Benchmarks for Science Literacy* were published in 1993

Call for new, internationally-benchmarked standards

- Students in the U.S. have consistently been outperformed on international assessments such as TIMSS and PISA
- States across the country will soon engage in a science revision
Why New Science Standards?

– Science, engineering and technology are cultural achievements and a shared good of humankind

– Science, engineering and technology permeate modern life

– Understanding of science and engineering is critical to participation in public policy and good decision-making

– National need
Introduction to the Framework for K-12 Science Education
The Framework has a new vision of science learning that leads to a new vision of teaching.
“The Framework is designed to help realize a vision for education in the sciences and engineering in which (all) students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.” (emphasis added, page 1-2)
Principles of the Framework

- Children are born investigators
- Understanding builds over time
- Science and Engineering require both knowledge and practice
- Connecting to students’ interests and experiences is essential
- Focusing on core ideas and practices
- Promoting equity
Who developed the Framework?

- The National Research Council (NRC) is the staff arm of the National Academy of Sciences.
- NRC team of 18 nationally and internationally known individuals in their fields, including practicing scientists, two Nobel laureates, cognitive scientists, science education researchers, and science education standards and policy experts.
- Four design teams, in physical science, life science, earth/space science, and engineering developed the framework for their respective disciplinary area.
- A public draft was released in July of 2010. The NRC reviewed comments and considered all feedback prior to releasing the final Framework on July 19, 2011.
The framework is motivated in part by a growing national consensus around the need for greater coherence—that is, a sense of unity—in K-12 science education.

Develop students’ understanding of the practices of science and engineering, which is as important to understanding science as is knowledge of its content.

Framework 1-3
Move science education toward a more coherent vision in three ways:

1. Built on the idea of learning as a developmental progression
2. Expectation that students engage in scientific investigations and argumentation to achieve deeper understanding of core science ideas
3. Emphasizes that learning science and engineering involves integration of the knowledge of scientific explanations (content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus, illustrating how knowledge and practice must be intertwined when designing learning experiences in K-12 science education.
Goals for Science Education:

Prepare today’s students for tomorrow’s workforce.

The Framework’s vision takes into account two major goals for K-12 science education:

1. Educating all students in science and engineering.
2. Providing the foundational knowledge for those who will become the scientists, engineers, technologists, and technicians of the future.
Science Education

All students will:

- Understand science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential.
- Value and use science as a process of obtaining knowledge based upon observable evidence.

CCSS Literacy

All students will gain skills to:

- Communicate effectively using science language and reasoning.
- Use writing as a tool for learning.
- Use writing as a tool to communicate ideas; write for a variety of purposes and audiences.

CCSS Literacy Standards
The Framework for K-12 Science Education contains three dimensions:

- Dimension 1 – Scientific and Engineering Practices
- Dimension 2 – Crosscutting Concepts
- Dimension 3 – Disciplinary Core Ideas
Scientific and Engineering Practices
Scientific and Engineering Practices

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 and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Framework 3-28 to 31
Describes behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.

The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge specific to each practice.

NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires.
Dimension 1: Practices

- Although engineering design is similar to scientific inquiry, there are differences:
  - scientific inquiry involves the formulation of a question that can be answered through investigation,
  - engineering design involves the formulation of a problem that can be solved through design.

- The engineering aspects of the NGSS clarify the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.
Dimension 1: Practices

- Science Practices are the process and habits of mind specific to doing science.
- Science Practices distinguish science from other ways of knowing.
- When students actively engage in science practices they deepen their understanding of core science ideas.
- This vision of the core ideas and practices in science provides the utility students need to engage in making sense of the natural and design worlds.
Using Evidence

- Value and use science as a process of obtaining knowledge based on observable evidence.
- Supporting science argumentation with evidence is a key practice of science.
- Using models and core ideas to make sense of novel phenomena is an essential aspect of science.
- Connects to ELA Common Core State Standards
Science Argumentation

- Providing empirical evidence to support assertions
- Listening to others’ arguments and analyzing the evidence
- Evaluating arguments based on evidence and reasoning
- Making thinking visible
- Connects to ELA Common Core State Standards
Crosscutting Concepts
Dimension 2: Crosscutting Concepts

- Crosscutting concepts have application across all domains of science. They are a way to link the different domains of science. They include:
  - Patterns, similarity, and diversity;
  - Cause and effect;
  - Scale, proportion and quantity;
  - Systems and system models;
  - Energy and matter;
  - Structure and function;
  - Stability and change.

- These concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.
Dimension 2: Crosscutting Concepts

- Cross disciplinary boundaries and contribute to the sense making that leads to students valuing and using science and engineering practices.
- Have value in supporting understanding of the natural sciences and engineering.
- The utility of students’ science knowledge depends upon their ability to use science to explain novel phenomena.

Framework page 4-1
Disciplinary Core Ideas
Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas focus K–12 science curriculum, instruction, and assessments on the most important aspects of science. Disciplinary ideas are grouped in four domains:

- the physical sciences;
- the life sciences;
- the Earth and space sciences;
- and engineering, technology and applications of science
Dimension 3: Disciplinary Core Ideas

To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline;
- Provide a key tool for understanding or investigating more complex ideas and solving problems;
- Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge;
- Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.
1. Chapter Title: Physical Sciences PS
   Introduction and overview of concepts

2. Core ideas: **CORE IDEA PS3: ENERGY**
   Essential Question: *How is energy transferred and conserved?*

3. Sub Section PS3.B: Conservation of Energy and Energy Transfer
   Introduction and overview of concepts
   Essential Questions: *What is meant by conservation of energy?*
   *How is energy transferred between objects or systems?*

4. Grade-bands 2, 5, 8 and 12: **Grade Level Endpoints for PS3.B**
   By the end of grade 2. *Sunlight warms Earth’s surface.*
   By the end of grade 5. *Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions,*
Disciplinary Core Ideas: Physical Sciences

- PS1  Matter and its interactions
- PS2  Motion and stability: Forces and interactions
- PS3  Energy
- PS4  Waves and their applications in technologies for information transfer
Disciplinary Core Ideas: Life Sciences

- LS1 From molecules to organisms: Structures and processes
- LS2 Ecosystems: Interactions, energy, and dynamics
- LS3 Heredity: Inheritance and variation of traits
- LS4 Biological evolution: Unity and diversity
Disciplinary Core Ideas: Earth and Space Sciences

- ESS1  Earth’s place in the universe
- ESS2  Earth’s systems
- ESS3  Earth and human activity
Disciplinary Core Ideas: Engineering, Technology and Applications of Science

- ETS1  Engineering design
- ETS2  Links among engineering, technology, science and society
Developing the Next Generation Science Standards
Vision for Next Generation Science Standards

- Collaborative, state-led process, rich in content
- Arranged in a coherent manner across grades
- Provide all students access to a challenging science education
- Based on the Framework for K-12 Science Education
- Will integrate all 3 dimensions
- Anticipated to be completed in late 2012
The Framework for K-12 Science Education contains three dimensions:

- **Dimension 1** Scientific and Engineering Practices
- **Dimension 2** Crosscutting Concepts
- **Dimension 3** Disciplinary Core Ideas
Phase II – Development of the Next Generation Science Standards

Process:
In Phase II, Achieve will engage states and other key stakeholders in the development and review of the new standards

Timeline:
Late 2012

Validation:
NRC Study Committee members will check the fidelity of the standards to the framework
NGSS Writing Team

- Will write the standards based on the NRC’s *Framework for K-12 Science Education*

- 41 members with expertise in teaching at all grade levels, working with students with disabilities, English language acquisition, state level standards/assessment, workforce development, engineering, technology, and life, earth and physical science

- Includes prominent scientists and academics that have working knowledge of science standards

- Selected based on recommendations from various groups including NSTA and the Council of State Science Supervisors

- Led by the education community
Critical Stakeholders

- Represent education, science, business and industry and who have interest in the NGSS, are from all 50 states, and have expertise in: elementary, middle and high school science from both urban and rural communities
  - Cognitive science, life science, physical science, Earth/space science, and engineering/technology
  - Business, industry, and workforce development
  - Postsecondary education
  - Informal education and non-profit foundations
  - Special education and English language acquisition
  - Mathematics, literacy, and CTE
  - Education policy, state standards, and assessments

- Will critique confidential drafts of the standards and provide feedback to the writers and states, giving special attention to their areas of expertise.
Public Feedback

- The standards will be open for two rounds of public feedback to help guide the writing team.
- Feedback will be aggregated and made public.
- The first draft of the standards will be available on nextgenscience.org in early 2012.
About NGSS

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. The NGSS will be based on the Framework for K-12 Science Education developed by the National Research Council.

Latest News

States to Lead Effort to Write New Science Standards
September 20, 2011

Maine Picked to Help Develop New Science Standards
September 14, 2011

National Research Council Releases Science Framework
July 19, 2011