The *Next Generation Science Standards*

In 2014, New Jersey adopted the *Next Generation Science Standards* with an implementation deadline of September 2016 for the secondary level. Based on the *Framework for K-12 Science* Education, the *Next Generation Science Standards* specify that each performance expectation must combine a relevant practice of science or engineering, with a core disciplinary idea and crosscutting concept, appropriate for students of the designated grade level. That guideline is perhaps the most significant way in which the NGSS differs from prior standards documents. Each of these components is explained below in more detail.

Science and Engineering Practices

The Framework uses the term "practices," rather than "science processes" or "inquiry" skills for a specific reason: 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. (NRC Framework, 2012, p. 30) The eight practices of science and engineering that the Framework identifies as essential for all students to learn and describes in detail are listed below:

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

Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.
The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study; the insights thus gained help them recognize that the work of scientists and engineers is a creative endeavor—one that has deeply affected the world they live in. Students may then recognize that science and engineering can contribute to meeting many of the major challenges that confront society today, such as generating sufficient energy, preventing and treating disease, maintaining supplies of fresh water and food, and addressing climate change. Any education that focuses predominantly on the detailed products of scientific labor— the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering. (NRC Framework 2012, pp. 42-43)

Crosscutting Concepts

The Framework identifies seven crosscutting concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. The seven crosscutting concepts presented in Chapter 4 of the Framework (NRC Framework 2012, p. 84) are as follows:

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Disciplinary Core Ideas

Disciplinary Core Ideas provide a scope and sequence for learning about the most important scientific concepts in one of four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science. These ideas should meet the following criteria:

1. Have a broad importance across multiple science or engineering disciplines or be a key organizing concept within 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 grade bands at an increasing level of depth and sophistication

(NRC Framework 2012, p. 31)

Performance Expectations

Performance expectations are the assessable statements of what students should know and be able to do (NRC Framework 2012, p. 218). These are written in a manner that integrates Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices into a statement addressing what students should be able to demonstrate or produce. Most of the performance expectations are followed by one or two additional statements in smaller type. These include clarification statements, which supply examples or additional clarification to the performance expectations; and assessment boundary statements, which specify the limits to large scale assessment.

The NGSS performance expectations should not limit the curriculum. Students interested in pursuing science further (through Advanced Placement or other advanced courses) should have the opportunity to do so. The NGSS performance expectations provide a foundation for rigorous advanced courses in science or engineering that some students may choose to take.