Three Things Science Coordinators Need to Know About NGSS

Full implementation of Next Generation Science Standards (NGSS) requires science classrooms to incorporate instructional practices that may not have been evident prior to NGSS. There are three instructional practices that are essential to implementing NGSS with fidelity. Science coordinators will need to support teachers in new and different ways throughout this transition.

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1. FOCUS ON THREE-DIMENSIONAL LEARNING.

A hallmark of NGSS is the focus on three-dimensional learning. NGSS require the interweaving of science and engineering practices, disciplinary core ideas, and crosscutting concepts in teaching and learning. Students are expected to use science and engineering practices connected to crosscutting concepts in science to investigate natural phenomena. Through investigation, students develop a deeper understanding of the core ideas of the major sub-disciplines of science.

Science and Engineering Practices

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

Crosscutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

  

NGSS require lessons in which science concepts are interwoven with at least one of the eight practices and at least one of the seven crosscutting concepts. This three-dimensional approach deepens student understanding of the major concepts in the physical sciences, life sciences, earth and space sciences, and in engineering, technology, and applications of science. Developers of the NGSS created standards that could only be achieved fully when all three dimensions of science (practices, crosscutting concepts, and disciplinary core ideas) are integrated. Each science standard is stated as a performance expectation and each performance expectation identifies the science and engineering practices, disciplinary core ideas, and crosscutting concepts used in its development.

As curriculum is designed, curriculum writers will make decisions about which activities and resources best support this focus on three-dimensional learning. Until districts make decisions about new NGSS curriculum, science teachers will need to redesign lessons to be sure they reflect the coming together of practices and crosscutting concepts in support of student understanding of disciplinary core ideas.

For students to achieve the performance expectations, they need to be routinely engaged in instruction that brings together science and engineering practices and crosscutting science concepts to help develop their understanding of disciplinary core ideas. For example, Standard 1-LS1-1 states: Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. When first graders investigate and explore the parts of plants and animals and then work to design a solution to a human problem that mimics the plant and/or animal strategy, they deepen their understanding of animal and/or plant structure and function, develop their understanding of one way engineers approach problem solving, and begin to understand the crosscutting concept that speaks to the relationship between structure and function in both the designed and the natural world. Giving students the time they need to learn in this way leads to another key instructional practice in NGSS classrooms.

2. SUPPORT DEPTH OVER BREADTH.

In designing NGSS, developers consciously worked to avoid devising a long list of detailed and disconnected facts for students to memorize.
A major criticism of previous generations of K-12 science curricula has been the tendency to be "a mile wide and an inch deep."[1] In contrast, NGSS identifies a limited number of foundational concepts from the sub-disciplines of science. Students are expected to develop their understanding of these concepts over a period of years. Therefore, NGSS developers have identified learning progressions that help educators know what should be taught in each grade, kindergarten through high school. When the framework is implemented well, teachers guide students to more scientifically based views of the world and they deepen student understanding of how scientists and engineers do their work.

Researchers studying how students learn science have found that children develop their own conceptions of how the world works long before they participate in formal instruction in science at school.[2] For most children, developing science literacy involves replacing childish preconceptions of how the world works with more scientifically accurate, evidence-based views of natural phenomena. "Everyday experience provides a rich base of knowledge and experience to support conceptual changes in science."[3] Because science teachers are encouraged to teach for conceptual change, they are also encouraged to use experiences that come from the everyday lives of their students.

Teachers in NGSS classrooms focus on developing student understanding of a limited number of concepts that are truly foundational to scientists' current understanding of how the world works. There are multiple opportunities to illustrate the connections among life science, physical science, earth and space science, and engineering, technology, and applications of science. The emphasis on fewer topics makes it possible for students to take the time needed to engage fully in scientific inquiry and engineering design.

3. TREAT STUDENTS AS SCIENTISTS AND ENGINEERS.

In NGSS classrooms, engineering design is raised to the same level as scientific inquiry and is interwoven appropriately throughout each grade/course. In addition, core ideas of engineering and technology are given the same importance as the core ideas of other subdisciplines of science.

Within NGSS Appendix A, the authors of the standards provide two reasons for this shift. First, it is hoped that students will be inspired to pursue careers in science and engineering. Second, by using engineering design practices, students have an opportunity to apply what they are learning and thus deepen their understanding of many of the concepts of science.

The NGSS classroom is a dynamic environment that supports students in three-dimensional learning, focuses on deepening student understanding of core concepts in science, and integrates engineering and technology fully into science instruction. As curriculum coordinators retool curriculum and supports for teachers, focusing on these three shifts will be essential.

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[1]Schmidt, W., McKnight, C., & Raizen, S. (2002). Executive Summary. In A splintered vision an investigation of U.S. science and mathematics education. New York, NY: Kluwer Academic

[2]Kyle, W., & Shymansky, J. (1989). Enhancing Learning Through Conceptual Change Teaching. Research Matters to the Science Teacher, 8902. Retrieved November 10, 2015, from https://www.narst.org/publications/research/concept.cfm

[3]National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academy Press. (p. 284)

[4]The Next Generation Science Standards. (n.d.). Retrieved November 11, 2015 from www.nextgenscience.org/sites/ngss/files/Appendix A - 4.11.13 Conceptual Shifts in the Next Generation Science Standards.pdf