The Next Generation Science Standards (NGSS) are triggering an unprecedented change in U.S. science education, with the goal of preparing students to be proficient in the 21st century workforce. The NGSS identifies certain disciplinary core ideas (DCIs) and crosscutting concepts (CCCs) into the science standards of more than ¾ of U.S. schools will revolutionize how K-12 (and beyond) geoscience education is taught. The inclusion of the SEPs and CCCs into the science standards of at least 41 states stands to significantly improve the grounding geoscience education away from a dull set of classifications to a vibrant transdisciplinary interconnection of Earth Science Systems.

Guiding Principles of the Crosscutting Concepts

1. The CCCs can help students better understand the Disciplinary Core Ideas (DCIs) and Engineering Practices

2. The CCCs can help students better understand the Science and Engineering Practices (SEPs)

3. Repetition in different contexts is necessary to build familiarity

4. The CCCs can provide a common vocabulary for science and engineering

5. The CCCs should not be assessed separately from practices or core ideas

6. Students should address all seven CCCs over each of the K-5, 6-8, and 9-12 grade bands

7. The CCCs grow in complexity and sophistication across the grades; curricular materials should only incorporate grade-appropriate elements

8. Performance expectations focus on some but not all capabilities associated with a CCC (i.e., students need only focus on one element of a CCC, not the full grade- or grade-band description)

9. The CCCs are interconnected -- they work together

The NGSS Practice of Science and Engineering SEPs

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. Communicating their ideas to diverse audiences
9. Engaging in reflective practice
10. Engaging in research and development

The NGSS Practice of Engineering SEPs

1. Engineering Design Process
2. Systems
3. Energy and Matter
4. Structure and Function
5. Stability and Change
6. Systems and System Models
7. Feedback Loops
8. Cause and Effect
9. Stability and Change
10. Design and Innovation

The NGSS Practice of Science and Engineering Practices

5. Science and Engineering Practices: Take and Use Scientific Notes
7. Science and Engineering Practices: Ask and Answer Questions
8. Crosscutting Concepts: Cause and Effect

Common Groupings of the Crosscutting Concepts

1. System Structure: "Systems and System Models"
   - Scale, Proportion, and Quantity
   - Structure and Function
   - Cause and Effect
2. Component Structure: "Systems and System Models"
   - Energy and Matter
   - Stability and Change
3. System Processes: Common Groupings
   - Feedback Loops
   - Cause and Effect
   - Stability and Change

A holistic approach to science is exemplified by the crosscutting concepts of “Systems and System Models,” “Energy and Matter,” and “Stability and Change.” These all deal with understanding different aspects of nature by ascertaining how components of a system function together. Taken together, they can help students understand how systems operate.

Components, structures, and processes are interconnected. They work together, and the CCCs are the essential “glue” that holds it all together. When taken as a whole, the SEPs, DCIs, and CCCs support each other and can help students see how systems interact. This is in stark contrast to traditional memorization-centered methods. However, the benefits for STEM connections, reducing the risks from natural hazards, minimizing human impacts while obtaining natural resources, and reigniting in global warming. The NGSS identifies certain crosscutting concepts (CCCs) into the science standards of more than ¾ of U.S. schools will revolutionize how K-12 (and beyond) geoscience education is taught. The inclusion of the SEPs and CCCs into the science standards of at least 41 states stands to significantly improve the grounding geoscience education away from a dull set of classifications to a vibrant transdisciplinary interconnection of Earth Science Systems.

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