PDI-4: Developing Next Generation Science Assessments

NSTA Professional Development Institute

Wednesday, March 11, 2015
<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
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<tbody>
<tr>
<td>9:00 - 9:30</td>
<td>Overview of the Day and Introductions</td>
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<tr>
<td>9:30 - 10:20</td>
<td>Task Analysis Activity</td>
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<tr>
<td>10:20 - 10:35</td>
<td>BREAK</td>
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<tr>
<td>10:35 - 10:45</td>
<td>Designing Next Generation Science Assessments</td>
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<tr>
<td>10:45 - 11:30</td>
<td>Analyzing Science Practices: Constructing Explanations, Developing and Using Models</td>
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<tr>
<td>11:30 – 12:00</td>
<td>Building an Assessment Argument</td>
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<td>Time</td>
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<tr>
<td>12:00 - 1:00</td>
<td>LUNCH</td>
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<td>1:00 - 1:30</td>
<td>Building an Assessment Argument (Part 2)</td>
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<td>1:30 – 3:30</td>
<td>Designing Assessments and Building Rubrics (Break in middle)</td>
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<td>3:30 – 4:00</td>
<td>Connecting to Classroom Assessment Practice</td>
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<td>4:00</td>
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Materials

http://learndbir.org/bundles/nsta-pdi-developing-next-generation-science-assessments
Global Competition? U.S. ranks only 23\textsuperscript{rd} among all nations in science (PISA, 2012); US share of global high tech exports and technology patent production has declined \textsuperscript{1}

\textsuperscript{1} http://www.nsf.gov/statistics/seind12/c6/c6h.htm#s3; http://www.nsf.gov/statistics/seind12/c6/c6h.htm#s4

Proficiency on Academic Tests? Only 32% of 8\textsuperscript{th} graders scored at or above proficient on the 2011 National Assessment in Science

Access, Equity, and Innovation. Preparing all students to be the next generation of innovators
A great majority of the so-called educated people do not think logically and scientifically....Education must enable one to sift and weigh evidence, to discern the true from the false, the real from the unreal, and the facts from the fiction.

Dr. Martin Luther King, Jr.
*The Purpose of Education* (1947)
From the earliest grades, students must have opportunities to
• ask, investigate and answer questions that impact their lives
• experience coherent and sequenced instruction
• demonstrate understanding through science practices

Knowing how to think empowers you far beyond those who know only what to think.

Neil deGrasse Tyson
Director, Hayden Planetarium
Coherence

Emphasis on building and applying ideas within and across disciplines through the science practices.
How the NGSS Promote Coherence Through the 3 Dimensions

1. Building on disciplinary core ideas over time
2. Practices as iterative, connected and interactive
3. Explicit attention to crosscutting concepts
4. Integration of 3 dimensions through Performance Expectations
## Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>Life Science</th>
<th>Physical Science</th>
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<tr>
<td><strong>LS1:</strong> From Molecules to Organisms: Structures and Processes</td>
<td><strong>PS1:</strong> Matter and Its Interactions</td>
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<tr>
<td><strong>LS2:</strong> Ecosystems: Interactions, Energy, and Dynamics</td>
<td><strong>PS2:</strong> Motion and Stability: Forces and Interactions</td>
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<td><strong>LS3:</strong> Heredity: Inheritance and Variation of Traits</td>
<td><strong>PS3:</strong> Energy</td>
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<tr>
<td><strong>LS4:</strong> Biological Evolution: Unity and Diversity</td>
<td><strong>PS4:</strong> Waves and Their Applications in Technologies for Information Transfer</td>
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<tr>
<th>Earth &amp; Space Science</th>
<th>Engineering &amp; Technology</th>
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<tr>
<td><strong>ESS1:</strong> Earth’s Place in the Universe</td>
<td><strong>ETS1:</strong> Engineering Design</td>
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<tr>
<td><strong>ESS2:</strong> Earth’s Systems</td>
<td><strong>ETS2:</strong> Links Among Engineering, Technology, Science, and Society</td>
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<td><strong>ESS3:</strong> Earth and Human Activity</td>
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PS 3: Energy

By the end of High School
HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

By the end of Middle School
MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

By the end of Grade 4
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Ways of knowing and understanding our world

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
Ask a question
Develop initial model to predict what will happen and why it will happen
Plan and carry out an investigation to test model
Analyze and interpret data
Use evidence to explain
Revise own model and compare with classmates’ models
Engage in argument using evidence
Revise own model
Explicit Attention to Crosscutting Concepts

Crosscutting Concepts have application across the disciplines and, as such, they are a way of linking the different domains of science and engineering.

- Patterns
- Cause and effect
- Scale, proportion and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change
Content and Practice Work Together to Build Understanding: 3-Dimensional Learning

NGSS calls for students to become proficient in science and engineering:

- Practices and content work together to form usable knowledge.
- Requires integration of 3 dimensions – not separate treatment of “content” and “inquiry”
- Need to pay attention to how we build understanding over time and across the disciplines
Scientific ideas are important, but not enough!

• Understanding content is inextricably linked to engaging in practices: *science proficiency means being able to use what you know*

• Science is both a body of knowledge and the process that develops and refines that body of knowledge: *Understanding both is essential for progress in science and in learning science*

• The learning of science is similar for all learners, whether children or scientists: *in order to learn science, you need to do the work of science*
An Analogy between 3-Dimensional Learning and Cooking

Kitchen Tools & Techniques (Practices)

Basic Ingredients (Core Ideas)

Herbs, Spices, & Seasonings (Crosscutting Concepts)

Preparing a Meal (Three dimensional Learning)
How NGSS is Different

- Standards expressed as **performance expectations**:  
- Combine practices, core ideas, and crosscutting concepts into a single statement of **what is to be assessed**
- Requires students to demonstrate **knowledge-in-use**
- Performance Expectations are not instructional strategies or objectives for a lesson
- Intended to describe the end-goals of instruction
Core idea LS4.C: Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.

Performance Expectation:
HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
Core idea PS1.B: Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change.

Performance expectation: MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
Assessment should aim for the Performance Expectations

How do we design assessments that provide evidence of 3-dimensional learning?