Assessing the Three Dimensions of the Next Generation Science Standards

ELEMENTARY SCIENCE
Career & College Readiness Conferences
Summer 2014
To what extent have you interacted with this document?

A. I’ve read it thoroughly.
B. I’ve skimmed it for general information.
C. It’s on my bookshelf.
D. Huh?

http://www.nap.edu/catalog.php?record_id=13165
How about this one?

A. I’ve read it thoroughly.
B. I’ve skimmed it for general information.
C. It’s on my bookshelf.
D. No clue
Or this one?

A. I’ve read it thoroughly.
B. I’ve skimmed it for general information.
C. It’s on my bookshelf.
D. It’s the first time I’ve seen it.

http://www.nap.edu/catalog.php?record_id=18409
Outcomes

* Review the process of developing NGSS
* Discuss the implications of teaching and assessing in the three Dimensions of NGSS
* Explore teaching and assessing through Science and Engineering Practices
* Identify opportunities for formative assessment during instruction
* Examine student activities for assessment tasks
* Discuss the potential structure of an assessment system for science
Committee on the Assessment of K-12 Science Proficiency

Board on Testing and Assessment and Board on Science Education

National Academy of Sciences
Topics Addressed in the Report

* The challenges of assessing three-dimensional science learning
* Principles for developing assessment tasks
* Developing classroom assessments
* Developing monitoring assessments
* Developing assessment systems
* Implementing the system
Three-Dimensional Science Learning

4-PS3-3 Energy

Students who demonstrate understanding can:

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.]

The performance expectation above was developed using the following elements from the NRC document A Framework for K-12 Science Education:

- Asking Questions and Defining Problems
- P3.A: Definitions of Energy
  - Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
- P3.B: Conservation of Energy and Energy Transfer
  - 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, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- P3.C: Relationship Between Energy and Forces
  - When objects collide, the contact forces transfer energy so as to change the objects’ motions.

Energy and Matter
- Energy can be transferred in various ways and between objects.

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:

Common Core State Standards Connections:
- ELA/Literacy
  - W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-3)
  - W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-3)
New types of assessment are needed

NGSS assessment should start with the needs of classroom teaching and learning

State monitoring assessments must move beyond traditional forms

States must create coherent systems of assessment that can support both classroom learning and policy monitoring functions
What should assessment look like?

Focus on Formative Assessment
To develop the skills and dispositions to use scientific and engineering practices needed to further their learning and to solve problems, students need to experience instruction in which they

* use multiple practices in developing a particular core idea and

* apply each practice in the context of multiple core ideas.
The NGSS describe specific goals for science learning in the form of *performance expectations*, statements about what students should know and be able to do at each grade level.

Each performance expectation incorporates all three dimensions, and the NGSS emphasize the importance of the connections among scientific concepts.
It will not be feasible to assess all of the performance expectations for a given grade level during a single assessment occasion.

http://www.nextgenscience.org/2-ls4-1-biological-evolution-unity-and-diversity
Students will need multiple—and varied—assessment opportunities to demonstrate their competence on the performance expectations for a given grade level.
To adequately cover the three dimensions, specific components may focus on individual practices, core ideas, or crosscutting concepts. Assessment tasks will need to contain multiple components, i.e., a set of interrelated questions.

3-D Tasks

- Individual and/or group investigation
- Observations in tables and/or graphs
- Constructed responses
- Selected responses
- Electronic drag and drop, ordering, etc.

http://concord.org/stem-resources/grade-level/elementary-school
Student activities that reflect such learning include the Practices of:

* Developing and refining models
* Generating, discussing and analyzing data
* Engaging in both spoken and written explanations and argumentation
Instruction that is aligned with the Framework will naturally provide many opportunities for teachers to observe and record evidence of student learning.

Incorporate teacher and student reflection into the process.
Students will need multiple—and varied—assessment opportunities to demonstrate their competence on the performance expectations for a given grade level.
Use a set or cluster of interrelated questions to generate evidence of NGSS knowledge

Specific questions may focus on Practices, Disciplinary Core Ideas and/or Crosscutting Concepts

The parts need to support students’ three-dimensional science learning as described in a specific Performance Expectation
Use the magnifying glass app to observe chia seeds.

- Which “practices” are you using?
- What questions do you have about the chia seeds?
- What variables could students manipulate to investigate sprouting of the seeds?
Ch-Ch-Ch-Ch-Chia Science!

Students utilize chia seeds to interact with the three Dimensions of the NGSS.
### Three Dimensional Assessment

#### 2-LS2 Ecosystems: Interactions, Energy, and Dynamics

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td>Planning and Carrying Out</td>
<td>Plants depend on water and light to grow. (2-LS2-1)</td>
<td>Events have causes that generate observable patterns. (2-LS2-1)</td>
</tr>
<tr>
<td>Investigations</td>
<td>Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)</td>
<td>Structure and Function</td>
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<tr>
<td></td>
<td>ETS1.B: Developing Possible Solutions</td>
<td>The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)</td>
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<td>Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2)</td>
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</tbody>
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Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-bands: K.LS1.C (2-LS2-1); K.ESS3.A (2-LS2-1); K.ETS1.A (2-LS2-2); 5.LS1.C (2-LS2-1); 5.LS2.A (2-LS2-2)

**Common Core State Standards Connections:**

- **ELA/Literacy –**
  - W.2.7: Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1)
  - W.2.8: Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1)
  - SL.2.5: Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (2-LS2-2)

- **Mathematics –**
  - MP.2: Reason abstractly and quantitatively. (2-LS2-1)
  - MP.4: Model with mathematics. (2-LS2-1), (2-LS2-2)
  - MP.5: Use appropriate tools strategically. (2-LS2-1)
  - 2.MD.D.10: Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems. (2-LS2-2)
Students who demonstrate understanding can:

2-LS2-1
Plan and conduct an investigation to determine if plants need sunlight and water to grow.

[Assessment Boundary: Assessment is limited to testing one variable at a time.]
ID the Assessment Opportunities in the 5Es

- Engage
- Explore
- Explain
- Elaborate
- Evaluate
## Assessment Opportunities?

<table>
<thead>
<tr>
<th>5E</th>
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<th>DCIs</th>
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Assessment System

- Performance assessment tasks developed within the classroom
- Portfolio of classroom work samples with tasks specified by district and/or state
- Units (curriculum materials and assessments) developed outside of the classroom (district and/or state)
- Item banks of NGSS-aligned tasks, developed outside of the classroom, from which schools and teachers select
A single, external large-scale assessment cannot cover the full breadth and depth of NGSS.

Performance Expectations with suitable assessment tasks take time to administer and several will be required to adequately sample NGSS PE’s.

Some practices are difficult to assess, e.g., carry out an investigation, using conventional formats of external, on-demand assessments.
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Developing Assessments for the Next Generation Science Standards
http://www.nap.edu/download.php?record_id=18409

NSTA
http://ngss.nsta.org/access-standards/

NAEP Released Items

TIMSS Released Items
http://nces.ed.gov/timss/educators.asp

PISA Released Items
http://nces.ed.gov/surveys/pisa/educators.asp
Write two statements that describe the implications for assessing student understanding in YOUR classroom.

1) Ah-hah! statement
2) Action(s) statement
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