



Assessing the Three Dimensions of the Next Generation Science Standards

ELEMENTARY SCIENCE

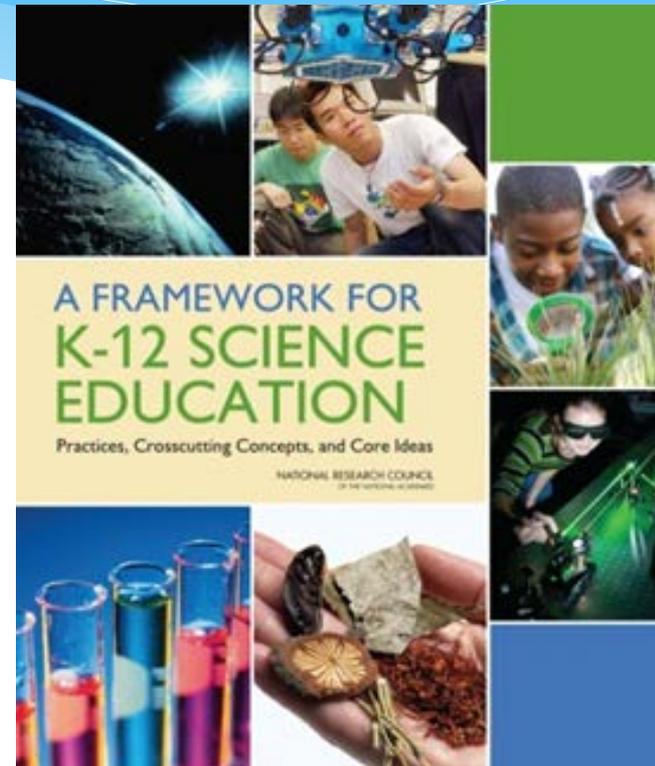
Career & College Readiness Conferences

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?



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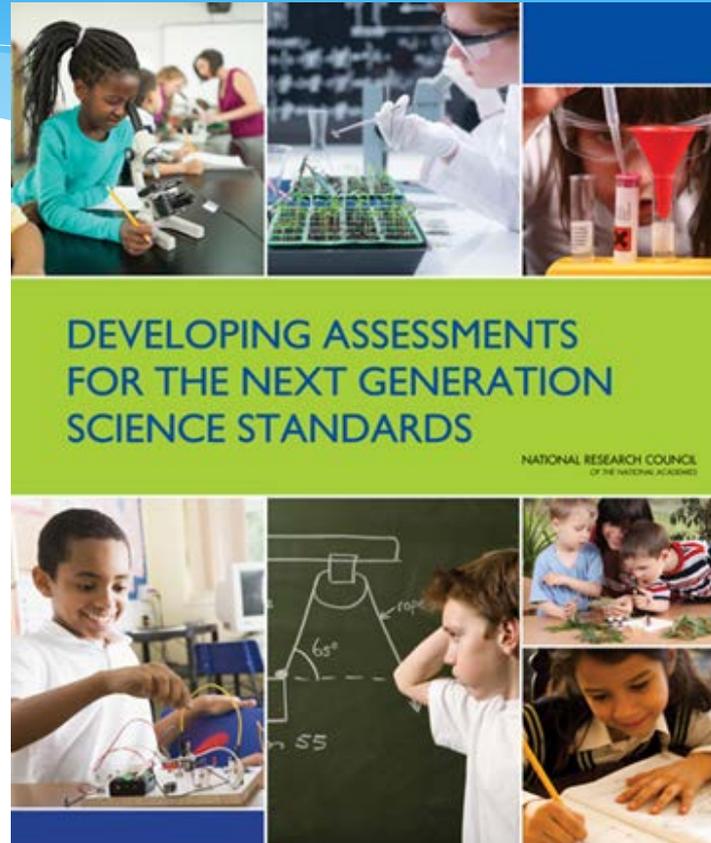
How about this one?

- 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.



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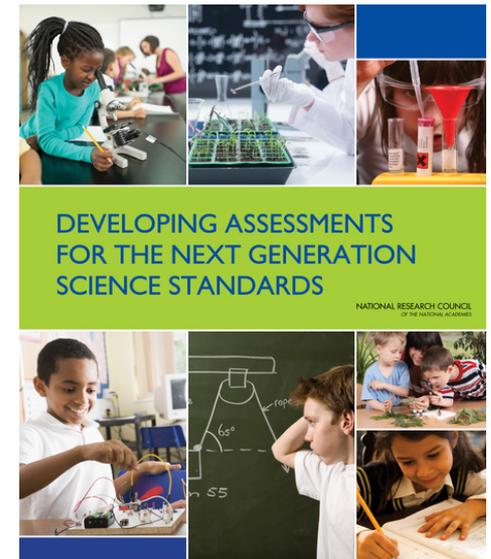
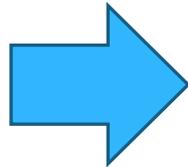
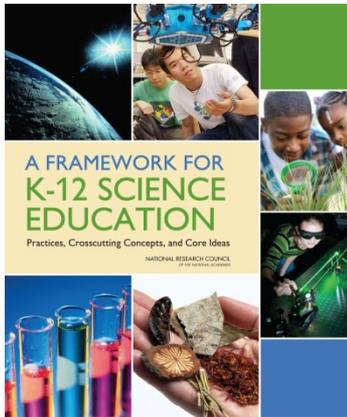
Outcomes

- * 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



Developing Assessments for the Next Generation Science Standards

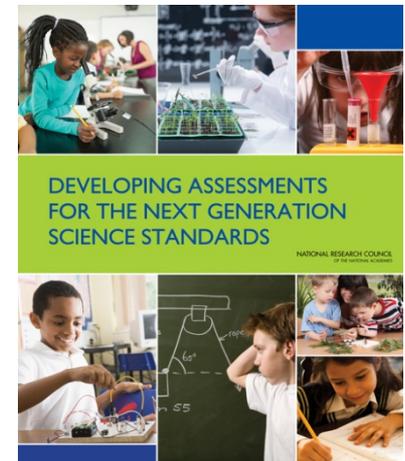
Committee on the Assessment of K-12 Science Proficiency



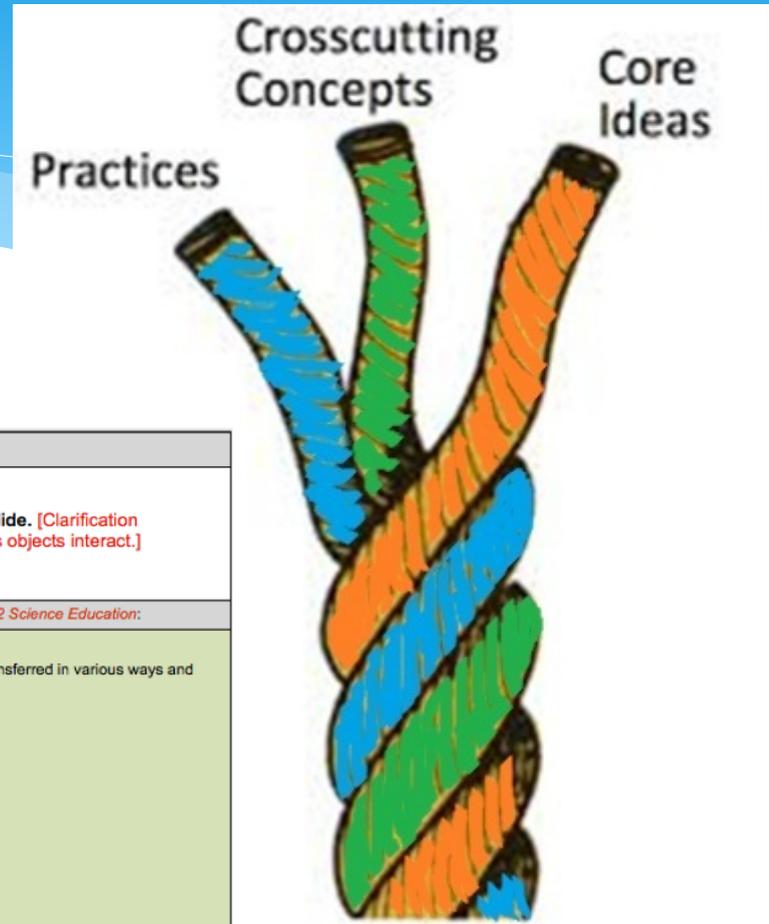
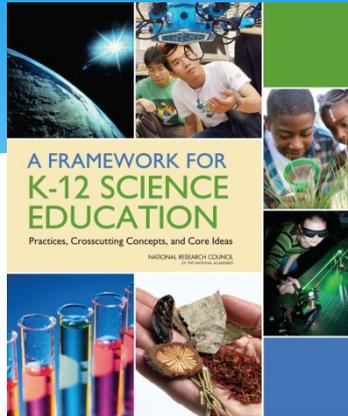
Board on Testing and Assessment
and
Board on Science Education
National Academy of Sciences

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.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

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

Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.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.

PS3.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:

K.PS2.B ; 3.PS2.A ; MS.PS2.A ; MS.PS3.A ; MS.PS3.B ; MS.PS3.C

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)



NGSS Assessment Messages

- * **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?



<http://nces.ed.gov/nationsreportcard/itmrlsx/default.aspx>

Focus on Formative Assessment





Assessment Designed to Guide Instruction

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 Assessment Challenge

- * 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.



Assessment Challenge

2-PS1 Matter and its Interactions

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Students who demonstrate understanding can:
2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.]
2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

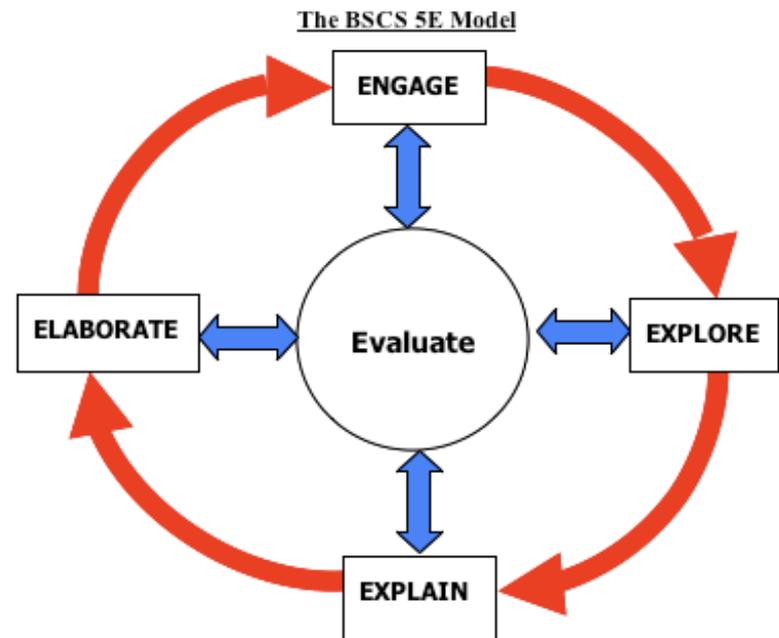
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. <ul style="list-style-type: none">Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1) Analyzing and Interpreting Data Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. <ul style="list-style-type: none">Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2) Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.	PS1.A: Structure and Properties of Matter <ul style="list-style-type: none">Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)A great variety of objects can be built up from a small set of pieces. (2-PS1-3) PS1.B: Chemical Reactions <ul style="list-style-type: none">Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	Patterns <ul style="list-style-type: none">Patterns in the natural and human designed world can be observed. (2-PS1-1) Cause and Effect <ul style="list-style-type: none">Events have causes that generate observable patterns. (2-PS1-4)Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2) Energy and Matter <ul style="list-style-type: none">Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3) <hr/> <i>Connections to Engineering, Technology, and Applications of Science</i>

It will not be feasible to assess all of the performance expectations for a given grade level during a single assessment occasion.

Multiple assessments

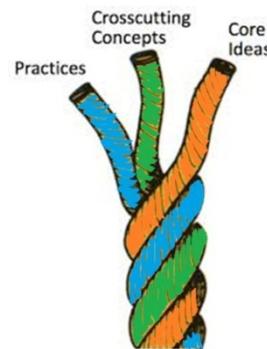
Students will need multiple—and varied—assessment opportunities to demonstrate their competence on the performance expectations for a given grade level





3-D Tasks

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.



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

Utilize the Practices

- * 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



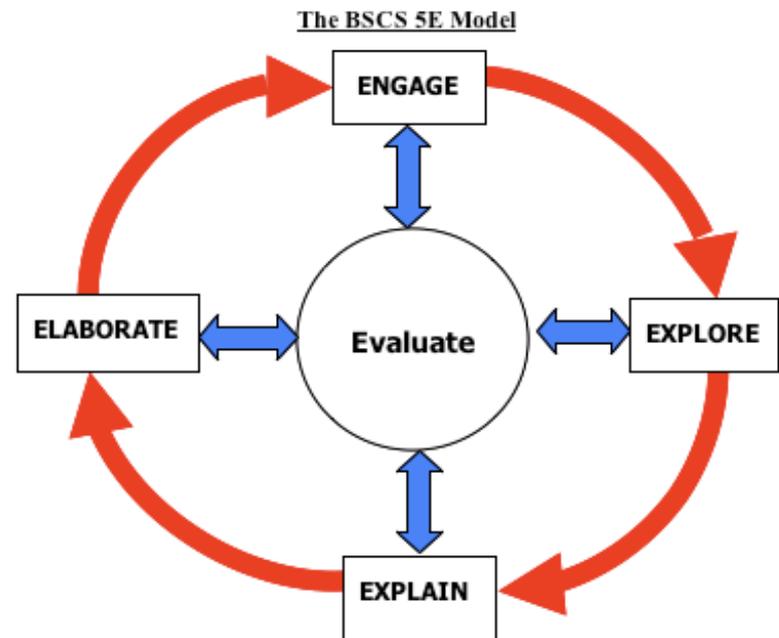


Challenges and Opportunities

- * 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

Multiple assessments

Students will need multiple—and varied—assessment opportunities to demonstrate their competence on the performance expectations for a given grade level



Opportunity

- * 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

Explore!

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-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

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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.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) <p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</p> <ul style="list-style-type: none"> Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1) 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> Plants depend on water and light to grow. (2-LS2-1) Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> 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) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Events have causes that generate observable patterns. (2-LS2-1) <p>Structure and Function</p> <ul style="list-style-type: none"> The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

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)



Performance Expectation

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?

5E	Practices	DCIs	Crosscutting
Engage			
Explore			
Explain			
Elaborate			
Evaluate			

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



Assessment System Challenges

- * 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

NGSS Main Messages

- * New types of assessment are needed
- * State monitoring assessments must move beyond traditional forms
- * NGSS assessment should start with the needs of classroom teaching and learning
- * States must create coherent systems of assessment that can support both classroom learning and policy monitoring functions

Outcomes

- * Reviewed the process of developing NGSS
- * Discussed the implications of teaching and assessing in the three Dimensions of NGSS
- * Explored teaching and assessing through Science and Engineering Practices
- * Identified opportunities for formative assessment during instruction
- * Discussed the structure of an assessment system for science

Resources

**A Framework for K-12 Science Education:
Practices, Crosscutting Concepts, and Core Ideas (2012)**

http://www.nap.edu/catalog.php?record_id=13165#

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

<http://nces.ed.gov/nationsreportcard/itmrlsx/default.aspx>

TIMSS Released Items

<http://nces.ed.gov/timss/educators.asp>

PISA Released Items

<http://nces.ed.gov/surveys/pisa/educators.asp>

Exit Slip

- * 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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