NASBE’s Webinar Series

Designing and Aligning Assessments for Next Generation Science Standards and Related State Policies

NASBE’s Center for College, Career and Civic Readiness

July 15, 2014
Presenters

- Dr. James Pellegrino, Learning Science Research Institute, University of Illinois at Chicago, Co-chair of the NRC’s Committee on Developing Assessments of Science Proficiency in K–12

- Dr. Francis Eberle, NASBE (moderator)
1. What Should State Boards Know About Assessment?
2. Activity: What Tools Do We Have Available for Quality Assessment?
3. Dr. James Pellegrino; The Next Generation Science Assessment
4. Activity: Implications for Policy
5. Q & A
6. Adjourn
Science Assessment: What Role Do State Boards Play?

1. Select student learning assessment
2. Set high school graduation requirements
3. Define parameters around learning opportunities such as dual enrollment or program of study
4. Set course requirements for teacher preparation
5. Oversee professional learning requirements for educators
Activity: Assessment is all around the science classroom

Considering your experiences and understanding of assessment what assessment is currently being used to determine student learning in science that is in policy?
Activity: Assessment is all around the science classroom

Considering your understanding of assessment what assessment do you think would be helpful to determine student learning in science?
Designing Assessments of K-12 Science Proficiency Consistent with the NGSS

Jim Pellegrino
Let’s Start at the Beginning by Highlighting Key Ideas Derived from the NRC Framework Report and the NGSS that have implications for assessment.
New Definition of Competence

• The NRC Science Framework has proposed descriptions of student competence as being the intersection of knowledge involving:
  – important disciplinary practices
  – core disciplinary ideas,
  – and crosscutting concepts with
  – performance expectations representing the intersection of the three.

• It views competence as something that develops over time & increases in sophistication and power as the product of coherent curriculum & instruction
NRC Framework’s Goals for Teaching & Learning

- Coherent investigations of core ideas across multiple years of schooling
- More seamless blending of practices with core ideas
- Performance expectations that require reasoning with core disciplinary ideas
  - explain, justify, predict, model, describe, prove, solve, illustrate, argue, etc.
Two Major Features of the NGSS

• Built on the idea of Progressions in the Sophistication of Student Understanding - as previously articulated in the NRC Framework

• Include a new “Architecture” with a focus on Performance Expectations that draw from the intersections of disciplinary core ideas, science and engineering practices, and cross-cutting concepts
Students who demonstrate understanding can:

4-LS1.1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lungs, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

4-LS1.2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal’s brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:
1. LS1.A (4-LS1-1); 1. LS1.D (4-LS1-1); 3. LS3.B (4-LS1-1); MS.LS1.A (4-LS1-1); MS.LS1.A (4-LS1-2); MS.LS1.D (4-LS1-2)

Common Core State Standards Connections:
- ELA/Literacy -
  - W.4.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (4-LS1-1)
  - SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-LS1-2)
- Mathematics -
  - 4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded across the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-LS1-1)
Pluses & Minuses of Relying on Performance Expectations

+ Avoid vague cognitive verbs – “know” & “understand”

+ Stated as claims about students in terms of what they are supposed to be able to do to demonstrate their knowledge

+ Identify progressions as part of expectations

- Don’t tell us how to get there – curriculum materials and instructional practices

- Need to be “unpacked” in terms of the forms of evidence needed to support the student claim
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 challenge of assessing three-dimensional science learning
• Principles for developing assessment tasks
• Developing classroom assessments
• Developing monitoring assessments
• Developing assessment systems
• Implementing the system
Report’s Main Messages

1. Assessment tasks should allow students to engage in science practices in the context of disciplinary core ideas and crosscutting concepts. This poses a significant design challenge.
   - Multi-component tasks that make use of a variety of response formats will be best suited for this.
   - Selected-response questions, short and extended constructed response questions, and performance tasks can all be used, but should be carefully designed to ensure that they measure the intended construct and support the intended inference.

2. Students will need multiple and varied assessment opportunities to demonstrate their proficiencies with the NGSS performance expectations.
Characteristics of NGSS-Aligned Tasks

- Include **multiple components** that reflect the connected use of different scientific practices in the context of interconnected disciplinary ideas and crosscutting concepts;

- Address the **progressive nature of learning** by providing information about where students fall on a continuum between expected beginning and ending points in a given unit or grade;

- Include an **interpretive system** for evaluating a range of student products that are specific enough to be useful for helping teachers understand the range of student responses and provide tools for helping teachers decide on next steps in instruction.
Earth Science Task:
Diverging Plate Boundary

The picture below shows a place on the ocean floor where two plates are moving apart. At this plate boundary (shown at the dotted line), rock material is rising to the surface.

A. Draw on the picture to show what is happening in the mantle that causes the plates to move apart.

B. What is happening in the mantle that helps to explain why the two plates are moving apart?

C. Put an X on the places in the picture above where the oldest rock can be found in the crust.

D. Explain your answer.
Highlighting the Contrast

The major movement of the plates and description of plate boundaries of the Earth are...

A. Convergent
B. Divergent
C. Transform
D. All of the Above

A. Draw a model of volcano formation at a hot spot using arrows to show movement in the model. Be sure to label all parts of your model.

B. Use your model to explain what happens with the plate and what happens at the hot spot when a volcano forms.

C. Draw a model to show the side view (cross-section) of volcano formation near a plate boundary (at a subduction zone or divergent boundary). Be sure to label all parts of your model.

D. Use your model to explain what happens when a volcano forms near a plate boundary.
Questions & Comments
3. A system of assessments will be required and should include classroom assessment, monitoring (large-scale) assessments, and indicators of opportunity to learn.

- Classroom assessment should be an integral part of instruction and should reinforce the type of science learning envisioned in the framework and NGSS.
Assessments in the Classroom

- Instruction that is aligned with the framework and NGSS will naturally provide many opportunities for teachers to observe and record evidence of students’ learning.
- Student activities that reflect such learning include
  - developing and refining models;
  - generating, discussing, and analyzing data;
  - engaging in both spoken and written explanations and argumentation;
  - reflecting on their own understanding.
- Such opportunities are the basis for the development of assessments of three-dimensional science learning.
- Report provides multiple examples of such assessments as they function in classroom teaching and learning (Chapters 2, 3 & 4)
Example Task: Biodiversity in the Schoolyard Zone

• This example describes a cluster of three tasks that ask 5th grade students to determine which zone of their schoolyard contains the greatest biodiversity.

• The tasks require students to demonstrate knowledge of:
  – Disciplinary Core Idea – biodiversity
  – Crosscutting Concept – patterns
  – Practices – planning and carrying out investigations, analyzing and interpreting data, and constructing explanations.

• This is an example of formative assessment: Results from these tasks can help teachers spot strengths and weaknesses in students’ understanding and modify their instruction accordingly.
Task 1: **Collect data on the number of animals (abundance) and the number of different species (richness) in schoolyard zones.** The students are broken into three teams, and each team is assigned a zone in the schoolyard. The students are instructed to go outside and spend 40 minutes observing and recording all of the animals and signs of animals seen in their assigned zone. The students record their information, which is uploaded to a spreadsheet containing all the students’ combined data.

**Purpose:** Teachers can look at the data provided by individual groups or from the whole class to gauge how well students can perform the scientific practices of planning and carrying out investigations, and collecting and recording data.
Task 2: Create bar graphs that illustrate patterns in data on abundance and richness from each of the schoolyard zones. Students are instructed to make two bar charts – one illustrating the abundance of species in the three zones, and another illustrating the richness of species in the zones – and to label the charts’ axes.

Purpose: This task allows the teacher to gauge students’ ability to construct and interpret graphs from data -- an important element of the scientific practice “analyzing and interpreting data.”
Task 3: Construct an explanation to support your answer to the question, “Which zone of the schoolyard has the greatest biodiversity?” Previously, students had learned that an area is considered biodiverse if it has both a high animal abundance and high species richness. In the instruction for this task, each student is prompted to make a claim, give his or her reasoning, and identify two pieces of evidence that support the claim.

Purpose: This task allows the teacher to see how well students understand the core idea of biodiversity and whether they can recognize data that reflects its hallmarks (high animal abundance and high species richness). It also reveals how well they can carry out the scientific practice of constructing explanations. This task could also be used as part of a “summative” end-of-unit assessment.
<table>
<thead>
<tr>
<th>Core Idea</th>
<th>Crosscutting Concepts</th>
<th>Practices</th>
<th>Purpose of Assessment</th>
<th>Target for Assessment: Performance Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS4.D Biodiversity and Humans</td>
<td>Patterns</td>
<td>Planning and carrying out investigations</td>
<td>Formative</td>
<td>Task 1. Collect data on the number of animals (abundance) and the number of different species (richness) in schoolyard zones.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyzing and interpreting data</td>
<td>Formative</td>
<td>Task 2. Create bar graphs that illustrate patterns in abundance and richness data from each of the schoolyard zones.</td>
</tr>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Constructing explanations</td>
<td>Summative</td>
<td>Task 4. Construct an explanation to support your answer to the question: Which zone of the schoolyard has the greatest biodiversity?</td>
</tr>
</tbody>
</table>
3. A system of assessments will be required and should include classroom assessment, monitoring (large-scale) assessments, and indicators of opportunity to learn.

- Classroom assessment should be an integral part of instruction and should reinforce the type of science learning envisioned in the framework and NGSS.
- Monitoring (large-scale) assessments will need to include an on-demand component and a component based in the classroom (classroom-embedded) in order to fully cover the breadth and depth of the NGSS performance expectations.
### Complex Space of Monitoring Functions

**TABLE 5-1 Questions Answered by Monitoring Assessments**

<table>
<thead>
<tr>
<th>Types of Inferences</th>
<th>Levels of the Education System</th>
<th>Questions</th>
<th>Questions</th>
<th>Questions</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion-referenced</td>
<td>Individual Students</td>
<td>Have individual students demonstrated adequate performance in science?</td>
<td>Have schools demonstrated adequate performance in science this year?</td>
<td>How many students in state X have demonstrated proficiency in science?</td>
<td>Has program X increased the proportion of students who are proficient?</td>
</tr>
<tr>
<td>Longitudinal and comparative across time</td>
<td>Schools or District</td>
<td>Have individual students demonstrated growth across years in science?</td>
<td>Has the mean performance for the district grown across years? How does this year’s performance compare to last year’s?</td>
<td>How does this year’s performance compare to last year’s?</td>
<td>Have students in program X increased in proficiency across several years?</td>
</tr>
<tr>
<td>Comparative across groups</td>
<td>Policy Monitoring</td>
<td>How does this student compare to others in the school/state?</td>
<td>How does school/district X compare to school/district Y?</td>
<td>How many students in different states have demonstrated proficiency in science?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Program Evaluation</td>
<td></td>
<td></td>
<td></td>
<td>Is program X more effective in certain subgroups?</td>
</tr>
</tbody>
</table>
Assessments for Monitoring I.

- It is not feasible to cover the full breadth and depth of the NGSS performance expectations for a given grade level with a single external (large-scale) assessment.

- The types of assessment tasks that are needed take time to administer, and several will be required in order to adequately sample the set of performance expectations for a given grade level.

- Some practices, such as demonstrating proficiency in carrying out an investigation, will be difficult to assess using conventional formats of on-demand external assessments.
States will therefore need to rely on a combination of two types of external assessment strategies for monitoring purposes:

**On-Demand Assessments**
- Developed by the state
- Administered at a time mandated by the state

**Classroom-Embedded Assessments**
- Developed by the state or district,
- Administered at a time determined by the district/school that fits the instructional sequence in the classroom
Options for the On-Demand Assessment Components

- Mixed item formats with written responses
  - Such as the AP Biology

- Mixed item formats with performance tasks
  - might involve both group and independent activities (NECAP example)
  - might involve some hands-on tasks, such as having students perform tasks at stations (NY example)

- Use matrix sampling, depending on the intended use and the need to report scores for individuals versus for groups.
Options for the Classroom-Embedded Assessments I.

- **Example assessment types:**
  - **Replacement units** *(curriculum materials + assessments)* developed outside of the classroom (by state or district)
  - **Item banks of tasks**, developed outside of the classroom
  - **Portfolio collections of work samples**, with tasks specified by state or district
Options for Classroom-Embedded Assessments II.

- Teachers administer them at a time that fits with the instructional sequence, possibly set by the school or district.
- Teachers receive training in how to administer them.
- Scoring can be done by teachers (trained to score them) or they can be sent to the district/state for scoring.
- Moderation and quality control procedures can be used to enhance the comparability of these assessments so they could support the desired inferences/comparisons needed for a monitoring purpose.
3. A system of assessments will be required and should include classroom assessment, monitoring (large-scale) assessments, and indicators of opportunity to learn.

- Classroom assessment should be an integral part of instruction and should reinforce the type of science learning envisioned in the framework and NGSS.

- Monitoring (large-scale) assessments will need to include an on-demand component and a component based in the classroom (classroom-embedded) in order to fully cover the breadth and depth of the NGSS performance expectations.

- Indicators of opportunity to learn should document that students have the opportunity to learn science in the way called for in the framework and NGSS and that schools have appropriate resources.
Indicators of Opportunity to Learn

• Indicators would document variables such as:
  – time allocated to science teaching,
  – adoption of instructional materials that reflect the NGSS and framework’s goals,
  – classroom coverage of content and practices outlined in these documents.
  – amount of support for teacher professional development

• Such indicators would be a critical tool for monitoring the equity of students’ opportunities to learn.
4. Implementation should be gradual, systematic, and carefully prioritized, beginning with classroom assessment and moving to monitoring assessment.
Implementation: Bottom Up Approach

• The assessment system recommended differs markedly from current practice and will take time to develop and implement.

• The committee encourages a developmental path for assessment development that is “bottom up” rather than “top down”: one that begins with the process of designing assessments for the classroom, perhaps integrated into instructional units, and moves toward assessments for monitoring.

• States should develop and implement new assessment systems gradually and establish carefully considered priorities. Those priorities should begin with what is both necessary and possible in the short term while also establishing long-term goals to implementation of a fully integrated and coherent system of curriculum, instruction, and assessment.
Main Messages (cont.)

4. Implementation should be gradual, systematic, and carefully prioritized, beginning with classroom assessment and moving to monitoring assessment.

5. Professional development, adequate support for teachers, and innovative applications of technology will be critical.
Professional Development is Critical to Success

It is critically important that states include adequate time and material resources in their plans for professional development to properly prepare and guide teachers, curriculum and assessment developers, and others in adapting their work to the vision of the framework and the Next Generation Science Standards.
States should support the use of existing and emerging technologies in designing and implementing an assessment system that meets the goals of the framework and NGSS.

New technologies hold particular promise for supporting the assessment of three-dimensional science learning, and for streamlining the processes of assessment administration, scoring, and reporting.
Activity: Policy to Practice

The design for assessment of a quality science program requires a more complex solution than the past.

- What features of an assessment system in science do you think should be outlined in policy at the state level.

(Please type your answer into the answer field.)
Additional Q&A
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**School Breakfast Policies** (Center of Safe and Healthy Schools) *(Sept 10)*