Engaging Students in Science Assessment Tasks

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What is the purpose of science assessment in the classroom?

“one of the most important best practices that has come to the forefront is diagnostic and formative assessment for the purpose of understanding student thinking and making decisions based on where students are conceptually in their understanding”

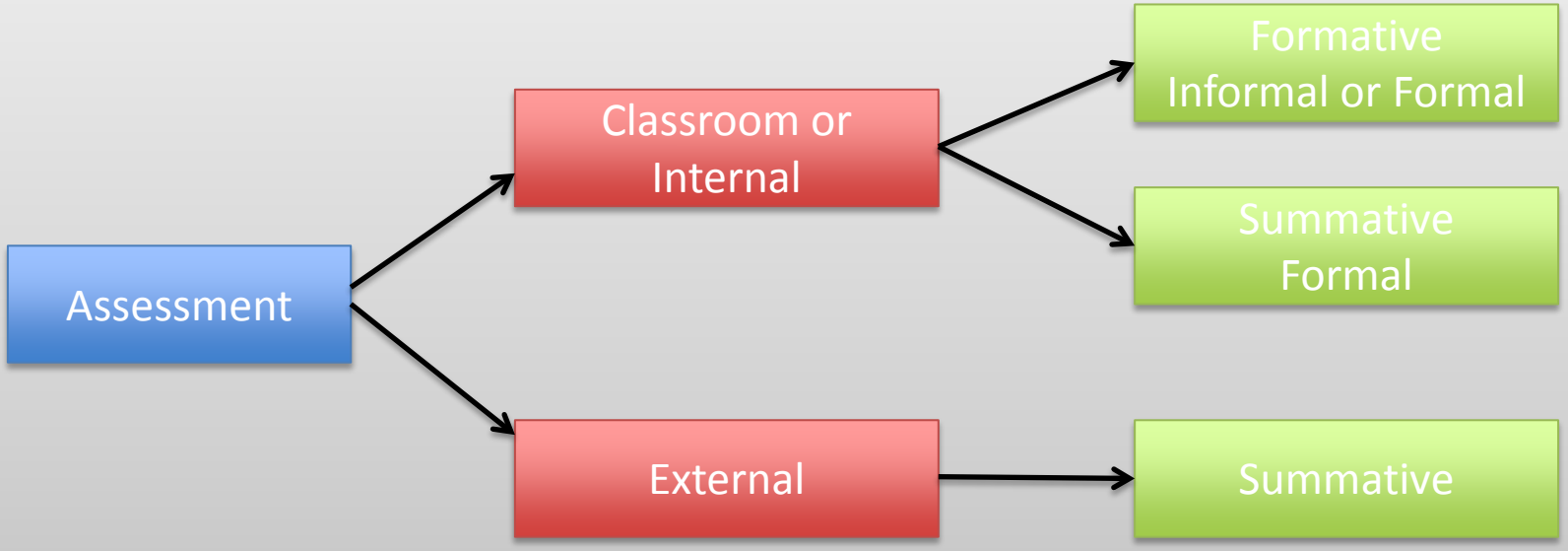
– Konicek-Morgan & Keeley, 2015

“it is evident that unless teachers know where their children are in their current conceptual development, they cannot plan for helping their students make changes in thinking as they design and facilitate instruction.”

-Konicek-Morgan & Keeley, 2015

In order to do this, “we have to give them a chance to tell us about their thinking and explain their ideas.”

- Konicek-Morgan & Keeley, 2015


Assessment
Classroom or Internal
External
Formative Informal or Formal
Summative Formal
Summative

Formative Assessments – *not a type of assessment as much as the purpose for which the assessment is given.*

Summative Assessments – *generally more removed in time or context from instruction.*

Dimension 1: Science and Engineering Practices

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. Obtaining, evaluating, and communicating information

Dimension 2: Crosscutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Dimension 3: Disciplinary Core Ideas

Physical Science
PS1: Matter and Its Interactions
PS2: Motion and Stability: Forces and Interactions
PS3: Energy
PS4: Waves and Their Applications in Technologies for Information Transfer

Life Science
LS1: From Molecules to Organisms: Structures and Processes
LS2: Ecosystems: Interactions, Energy, and Dynamics
LS3: Heredity: Inheritance and Variation of Traits
LS4: Biological Unity and Diversity

Earth and Space Sciences
ESS1: Earth's Place in the Universe
ESS2: Earth's Systems
ESS3: Earth and Human Activity

5-PS1-1 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **Developing and using models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. • A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects.	**5-PS1-1** *Students who demonstrate understanding can:* **Develop a model to describe that matter is made of particles too small to be seen.** **Clarification Statement:** Examples of evidence that could be utilized in building models include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water. **Assessment Boundary:** Assessment does not include atomic-scale mechanism of evaporation and condensation or defining the unseen particles.

Crosscutting Concepts: Scale, Proportion, and Quantity
• Natural objects exist from the very small to the immensely large.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

What students are expected to do to demonstrate their understanding of science concepts and ability to explain them or make application of them.

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Making Thinking Visible

Pair the young animal and/or plant with the adult. **Describe the things** about the young plants and animals that help you match the young with the adult.

What **patterns** do you see across all of the young animals that helps you know which animal is the young of the parent?

Sample Student Responses

- Student: “The pictures of the dog and the puppy have the **same number of legs and both have ears** that look the same. The **puppy is a different color**; <u>but sometimes the baby animal is a different color</u>.”

- Student: “The animals that look alike are the babies.” Teacher: “Can you **explain** what you mean or tell me more about a **pattern** you see?” Student: “**Babies look like the parent**.”

Sample Student Responses

- Student: “The animals that are most similar are of the same kind.” Teacher: “Can you **explain** what you mean or tell me more about a **pattern** you see?” Student: “The dog is the adult, the puppy is the young. The puppy **has similar shapes, number of legs, and ears**. The **pattern** I see is that they **have the same parts** (structures) that make me think they are the same. It would be hard to decide if a fox is different from a dog <u>because they are similar</u>, but the fox has a bushy tail and the dog does not. They both have four legs to run with; <u>but the fox puppy will not become a dog”</u>

1-LS3-1 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

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)**
   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.
   - **Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.**
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Inheritance of Traits:
- Young animals are very much, but not exactly like, their parents.
- Plants also are very much, but not exactly, like their parents.

Variation of Traits:
- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

Performance Expectations

1-LS3-1

Students who demonstrate understanding can:

Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Clarification Statement:
Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.

Assessment Boundary:
Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.

Crosscutting Concepts: Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

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In an investigation, students measured the weight of some objects before and after they changed. Students placed a few ice cubes in small plastic bags and sealed them so nothing could get in or out of the bags. The students then weighed the bags and ice. The students left the bags out for an hour and the ice melted. The students weighed the bags after the ice melted. Data for the first weighing before melting is provided in the table below.

Student Data Table for Ice and Water Investigation		
	Weight of Bag and Ice at the Beginning	Weight of Bag and Water After an Hour
Bag and Ice 1	122.4 grams	
Bag and Ice 2	144.5 grams	
Bag and Ice 3	133.2 grams	
Bag and Ice 4	105.4 grams	

1. Predict the weight of each bag and water after the change (ice melting) and record predictions to complete the chart above.
2. Does the data you placed in the chart provide evidence to support the idea matter is conserved? _____ Y/N
3. Develop an argument for why the data you predicted for the investigation **provides evidence** or **does not provide evidence** that matter is conserved?

Score is 3 if the student responds to: #1 by placing the same numbers from the middle column in the last column, and #2 response is yes, and #3 response includes a **description of the idea that matter is conserved** and **provides supporting evidence** that the mass of the bag and water is the same as the bag and ice because all of the matter is still in the bag. **When matter changes state (melts), it does not change the amount of matte present.**

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3. Develop an argument for why the data you predicted for the investigation **provides evidence** or **does not provide evidence** that matter is conserved?

Score is 3 if the student responds to: #1 by placing numbers that are slightly greater in the last column, and #2 **explanation** includes that **water vapor form the air may have condensed on the cold bag making the bag weigh more**, and #3 **response indicates that the matter inside of the bag would have the same weight/mass so it could be evidence that matter is conserved,** however, **the water vapor condensed from the air makes the evidence less clear**.

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3. Develop an argument for why the data you predicted for the investigation **provides evidence** or **does not provide evidence** that matter is conserved?

Score is 2 if the student places the same numbers in the chart but the **description does not reference the conservation of mass as supporting evidence.**

Score is 1 if the student places the same numbers in the chart **but does not provide an explanation.**

Score is 0 if the student responds no to #2, but **does not provide explanations** that account for potential problems with the investigation.

5-PS1-2 Matter and Its Interactions

Science & Engineering Practices

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 Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.**
   - **Measure and graph quantities such as weight to address scientific and engineering questions and problems.**
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Properties of Matter:
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.

Chemical Reactions:
- No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

Performance Expectations

5-PS1-2

Students who demonstrate understanding can:

Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

Clarification Statement:
Examples of reactions or changes could include phase changes, dissolving, and mixing that forms new substances.

Assessment Boundary:
Assessment does not include distinguishing mass and weight.

Crosscutting Concepts: Scale, Proportion, and Quantity

- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

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Place Holder for Additional Examples after the Blueprint and Item Specification Meeting 2nd Week in June

Implementation Timeline

Summer 2014
OAS-Science
Adopted

2014-2015
Assessments
aligned to
PASS

2015-2016
Assessments
aligned to
PASS

2016-2017
Assessments
aligned to the **new**
OAS-Science

Formative Assessment Probes

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What's in the Bubbles?

Hannah is boiling water in a glass tea kettle. She notices bubbles forming on the bottom of the kettle that rise to the top and wonders what is in the bubbles. She asks her family what they think, and this is what they say:

Dad: "They are bubbles of heat."

Calvin: "The bubbles are filled with air."

Grandma: "The bubbles are an invisible form of water."

Mom: "The bubbles are empty—there is nothing inside them."

Lucy: "The bubbles contain oxygen and hydrogen that separated from the water."

Which person do you most agree with and why? Explain your thinking.

_____

_____

_____

_____

_____

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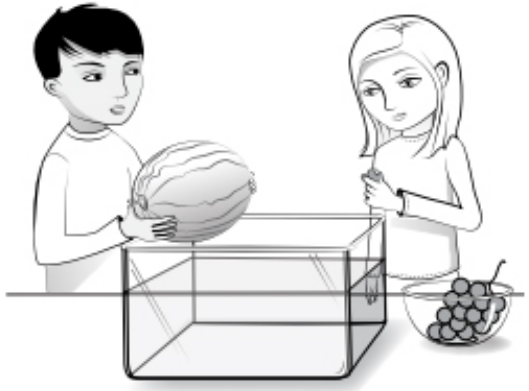
Watermelon and Grape



The watermelon will sink.

The grape will sink.

The watermelon will float.

The grape will float.

What are you thinking?

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Phenomenon Tasks

Group Performance

1. Make Prediction about how the *system* of two balloons connected by a tube will *change* when the valve is opened.
2. **Ask questions** to gather information to **develop an investigation** of the *system.*
3. Formulate questions and investigate **explanations** for what causes *changes in the system*.
4. Develop **evidence** and **use Core Ideas** to support **explanations** for the *change in the system*.

Individual Performance

5. Write in your journal or on your device your individual **explanation** that may be used to explain this phenomena to others. Use a **model to communicate** the **explanations**. Include **evidence** to support your **explanation** for the *changes in the system.*

Group Discussion

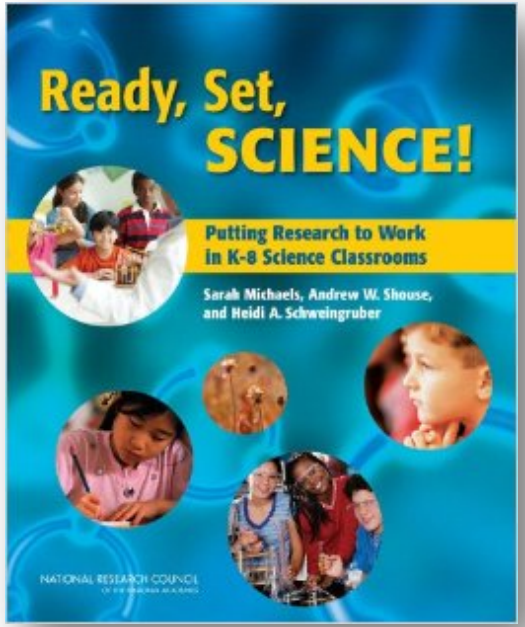
Reflection

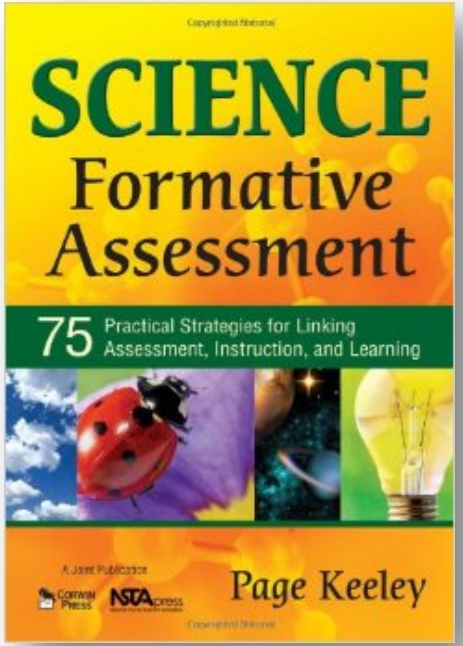
6. Reflect on the nature of science instruction that leads students to use the practices to: a) Gather information through **Exploring phenomena,** b) develop **explanations** based on **evidence,** and c) communicate using **models and writing**.
7. Reflect on the **Core Ideas** that were needed to make sense of the phenomenon.

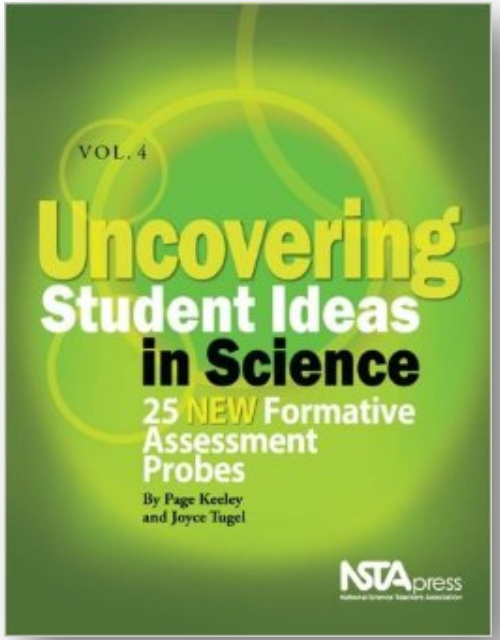
Crosscutting Concept Question Stems

Grade Level Brainstorming

Resources


Ready, Set, SCIENCE!
Putting Research to Work in K-8 Science Classrooms
Sarah Michaels, Andrew W. Shouse, and Heidi A. Schweingruber
NATIONAL RESEARCH COUNCIL


SCIENCE Formative Assessment
75 Practical Strategies for Linking Assessment, Instruction, and Learning
A Joint Publication
Corwin Press
NSTA press
Page Keeley


VOL. 4
Uncovering Student Ideas in Science
25 NEW Formative Assessment Probes
By Page Keeley and Joyce Tugel
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Questions