LIVE INTERACTIVE LEARNING @ YOUR DESKTOP

Using Students’ Ideas to Inform Instruction and Promote Learning

Presented by: Page Keeley

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Formative Assessment in Science:
Using Students’ Ideas to Inform Instruction and Promote Learning

Page Keeley
Maine Mathematics and Science Alliance
NSTA Past President
NSTA Press Author
During This Seminar You Will:

• Distinguish formative assessment from other types of assessment
• Learn about the research that supports formative assessment in science
• Examine a variety of formative assessment probes and FACTs
• Consider ways you will use formative assessment in your practice
What is the first word you think of when you see the word…. 
ASSESSMENT
Transformative Assessment

Assessment that fundamentally transforms teaching, learning, and the culture of the classroom
3 Types and Purposes of Assessment

- **Diagnostic** - To *identify and analyze* preconceptions (including misconceptions) and learning difficulties.
- **Formative** - To *inform* instruction *and provide feedback* to students on their learning.
- **Summative** - To *measure and document* the extent to which students have achieved a learning target.

*Note: Diagnostic assessment becomes formative when the assessment data is *used to inform instruction.*
The Dr. House Metaphor
Key Point #1

Assessment is not formative unless you use the information to plan or modify your instruction with the intent to support learning.
Why Formative Assessment?

Why are more and more educators touting the instructional virtues of formative assessment?
The Claim: Formative assessment, properly used in the classroom, improves learning.

This claim is supported with evidence from a meta-analysis of empirical data in which researchers conclude that student gains in learning triggered by formative assessment are “among the largest ever reported for educational interventions.” Black and Wiliam 1998
Support for Formative Assessment Continues to Grow…

- How Students Learn
- Assessment for Learning
- Taking Science to School
- Ready-Set-Science
“Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom”

How People Learn, Bransford, Brown & Cockling. pp 14-15
Wealth of Research
Poverty of Practice
Key Point #2

Formative assessment in science differs from other subject areas such as ELA due to its conceptual nature and the impact preconceptions have on student learning. For this reason, formative assessment cannot be a “one size fits all disciplines” generic approach. Science teachers must have access to specific tools for formative assessment that target the content they teach.
Formative Assessment Classroom Techniques (FACTs)

75 Practical Strategies for Linking Assessment, Instruction, and Learning
Tools and Resources
Key Point #3

“Misconceptions” are strongly held. It takes time and carefully designed instruction to help students give them up. Correcting students’ misconceptions before they have an opportunity to think through their ideas and modify them does not support conceptual change.
Naïve Conceptions
Alternative Conceptions
Preconceptions
Misconceptions
Frameworks
Schema
Students’ Ideas (Conceptions)

• Are strongly held
• Differ from expert conceptions
• Affect in a fundamental sense how students understand natural phenomena and scientific explanations
• Must be “overcome” in order for students to achieve scientific understanding
A probe is a purposefully designed, multi-grade level question that reveals more than just an answer. A probe elicits a response that helps teachers identify students’ ideas about phenomena or concepts. Probes are also used to engage students, encourage thinking, and promote sharing of ideas.
Summer Talk

Six friends were talking. They each had different ideas about why it is warmer in the summer than in the winter. This is what they said:

Werner: “It’s because the winter clouds block heat from the Sun.”
Ava: “It’s because the Sun gives off more heat in the summer than in winter.”
Raul: “It’s because Earth’s tilt changes the angle of sunlight hitting Earth.”
Fernando: “It’s because the Earth orbits closer to the Sun in the summer than in the winter.”
Shakira: “It’s because one side of Earth faces the Sun and the other side faces away.”
Susan: “It’s because the Northern Hemisphere is closer to the Sun in summer than in the winter.”

Which friend do you most agree with? ____________________

Describe your thinking about why it is warmer in the summer than in the winter. Provide an explanation for your answer.
Most Common Response

It’s because the Earth orbits closer to the sun in the summer than in the winter.

P-Prim: Closer- stronger
Representations- Earth’s exaggerated elliptical orbit
Tilt
Wet Jeans

Sam washed his favorite pair of jeans. He hung the wet jeans on a clothesline outside. An hour later the jeans were dry.

Circle the answer that best describes what happened to the water that was in the wet jeans an hour later.

A  It soaked into the ground.
B  It disappeared and no longer exists.
C  It is in the air in an invisible form.
D  It moved up to the clouds.
E  It chemically changed into a new substance.
F  It went up to the Sun.
G  It broke down into atoms of hydrogen and oxygen.

Describe your thinking. Provide an explanation for your answer.
Representations can contribute to misconceptions
3 Minute Pause
Egg Timer Talk

Use the chat to post any comments or questions so far....
Key Point #4

Probes and FACTs are assessments for learning–they differ from summative assessments in that they not only inform instruction, they also promote learning. For that reason, they should NOT be graded.
Juicy Question
Chicken Eggs

The students in Mrs. Bartoli’s class were studying how chickens develop from an egg. The students put a dozen freshly laid, fertilized chicken eggs in an incubator. They wondered what would happen to the mass of an egg as the chick inside developed. This is what the students thought:

**Group A:** “We think an egg will gain mass. An egg’s mass is more just before hatching than when the egg was laid.”

**Group B:** “We think an egg will lose mass. An egg’s mass is less just before hatching than when the egg was laid.”

**Group C:** “We think the mass of an egg stays the same as the chick develops inside.”
Poll Question

A. I think an egg will gain mass just before hatching.
B. I think an egg will lose mass just before hatching.
C. I think the mass of an egg stays the same as the chick develops inside.
Human Scatter graph

Gain

Lose

Same

Low confidence → High confidence
Prior knowledge of:

- Food - what it is and what it is used for
- Transformation of matter
- Growth and development (including experience incubating eggs)
- Conservation of matter
- Open versus closed systems
- Permeability of materials
- Gas exchange
Key Point #5

To use formative assessment effectively, you must establish a safe classroom environment where all students’ ideas, regardless of whether they are right or wrong, are encouraged, respected, and valued.
Giant Sequoia Tree

The giant sequoia tree is one of the largest trees on earth. It starts as a small seedling and grows into an enormous tree. Five children can stretch their arms across the width of the trunk of one of the large sequoia trees!

Where did most of the matter that makes up the wood and leaves of this huge tree originally come from? Circle the best answer.

A sunlight
B water
C soil
D carbon dioxide
E oxygen
F minerals
G chlorophyll

Explain your thinking. How did you decide where most of the matter that makes up this tree came from?
Use clip art to indicate the best choice for where most of the matter that makes up a large tree comes from.

<table>
<thead>
<tr>
<th>A. Sunlight</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Water</td>
<td></td>
</tr>
<tr>
<td>C. Soil</td>
<td></td>
</tr>
<tr>
<td>D. Carbon dioxide</td>
<td></td>
</tr>
<tr>
<td>E. Oxygen</td>
<td></td>
</tr>
<tr>
<td>F. Minerals</td>
<td></td>
</tr>
<tr>
<td>G. Chlorophyll</td>
<td></td>
</tr>
</tbody>
</table>
FACT: Commit and Toss
FACT: Sticky Bars
Key Point #6

Formative assessment is *purposeful*. Probes and FACTs are always linked to a teaching and learning outcome. Collect formative assessment data with intention and act on it *purposefully*. 
“Where did most of the matter that makes up a huge tree originally come from?”

LET'S KEEP THINKING

A = sunlight
R = water
G = soil
D = air (diode)
E = oxygen
F = minerals
G = chlorophyll
Elementary Goal

Plants need:
- water
- sunlight
- air

Plants make their own food
Middle School Goal
High School

6CO₂ + 6H₂O → sunlight → C₆H₁₂O₆ + 6O₂

nutrients

Organic
compounds
“The world looks so different after learning science…

For example, trees are made of air, primarily. When they are burned, they go back to air, and in the flaming heat is released the flaming heat of the sun which was bound in to convert the air into tree. And in the ash is the small remnant of the part which did not come from air, that came from the solid earth, instead. These are beautiful things, and the content of science is wonderfully full of them. They are very inspiring, and they can be used to inspire others.”

Richard Feynman
Key Point #7

Formative assessment probes and FACTs support development of communication skills. Use formative assessment to provide opportunities for students to share their thinking and engage in argumentation using claims and evidence-based reasoning.
Can It Reflect Light?

What types of objects or materials can reflect light? Put an X next to the things you think can reflect light.

___ water
___ gray rock
___ leaf
___ mirror
___ glass
___ sand
___ potato skin
___ wax paper
___ tomato soup
___ crumpled paper
___ shiny metal
___ dull metal
___ red apple
___ rough cardboard
___ the Moon
___ rusty nail
___ clouds
___ soil
___ wood
___ milk
___ bedsheet
___ brand new penny
___ old tarnished penny
___ smooth sheet of aluminum foil

Explain your thinking. Describe the “rule” or the reasoning you used to decide if something can reflect light.
FACT: Card Sort

Things that can reflect light
Things that can’t reflect light
Don’t agree or Need more information
Most common “rules”

- Shiny
- Smooth
- Light-colored

Where did these commonly held ideas come from?

How would this inform your instruction?
3 Minute Pause
Egg Timer Talk

Use the chat to post any comments or questions so far....
Key Point #8

Formative assessment is used continuously throughout an instructional cycle: before teaching—to elicit students’ ideas, throughout an instructional unit—to monitor learning and provide feedback, and at the end—for reflection.
10 Purposes Linked to Instruction

- Elicit and identify preconceptions
- Engage and motivate students
- Activate thinking and promote metacognition
- Provide stimuli for scientific discussion
- Initiate inquiry
- Formal concept development and transfer
- Improve questioning and responses
- Provide feedback
- Peer and self-assessment
- Reflection
Initiate Inquiry: P-E-O Probes

- Predict
- Explain
- Observe

Revise Explanation
Solids and Holes

Lance had a thin, solid piece of material. He placed the material in water and it floated. He took the material out and punched holes all the way through it. What do you think Lance will observe when he puts the material with holes back in the water? Circle your prediction.

A  It will sink.

B  It will barely float.

C  It will float the same as it did before the holes were punched in it.

D  It will neither sink nor float. It will bob up and down in the water.

Explain your thinking. Describe the “rule” or reasoning you used to make your prediction.
8th Grade Responses

• A- Because there are holes in it and things that have holes will sink. If a boat has a hole in the bottom then it will sink.

• B- I think that the material will barely float. I think that it will barely float because the holes in it will allow some water to go through, but not enough for it to sink.

• C- This is because the holes are two-sided. This means that the water can’t fill up the holes and make the material sink, so it has to float.

• D- It will bob up and down because if there are holes in it then it will just be at the surface but it will also sink from time to time.
Teacher Notes

- Key Idea from National Standards: Density is a characteristic property of matter that is independent of shape or size of sample.

- Consideration for Instruction: Distinguishing “mixed density” from “solid density”

Related Research: Students take into account 4 factors when considering how objects float. The role played by:
1) material and weight
2) shape, cavities, and holes
3) air
4) water

Even when taught that holes through solid objects do not change the object’s ability to float, the idea was still firmly held by students.
Questioning and Response Strategies

• No Hands Questioning
• Hot Seat Questioning
• Popsicle Stick Inner Cup Questioning
• Wait Time
• Volley Ball Not Ping Pong
• Answer a Question- Ask a Question
Reflection FACT

I used to think ______________________
But now I know ______________________

Use the chat to complete your own “I used to think __ but now I know ___”
As it pertains to anything you learned tonight.
Final Key Points

#9- Formative assessment yields greater results in a collaborative school culture where teachers share student learning data, and work together to refine their use of formative assessment.

#10- Start small- pick one probe or FACT, try it out, and evaluate its success before trying multiple strategies.
Coming Soon! (July 2011)

Visit the uncoveringstudentideas.org web site for more tips, strategies, and information on science formative assessment.
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