Science Formative Assessment

Summer 2016 MSP Grant
Digging Deep into Science Literacy

Colgate's Advertising Campaign

- What do you notice in these 3 pictures?


Colgate
Total
NOT EVEN THAT EXTRA HAND GETS MORE ATTENTION THAN A MOUTH WITHOUT CARE.


Colgate
Total
NOT EVEN
THAT SIX-
GETS MORE
ATTENTION


Colgate

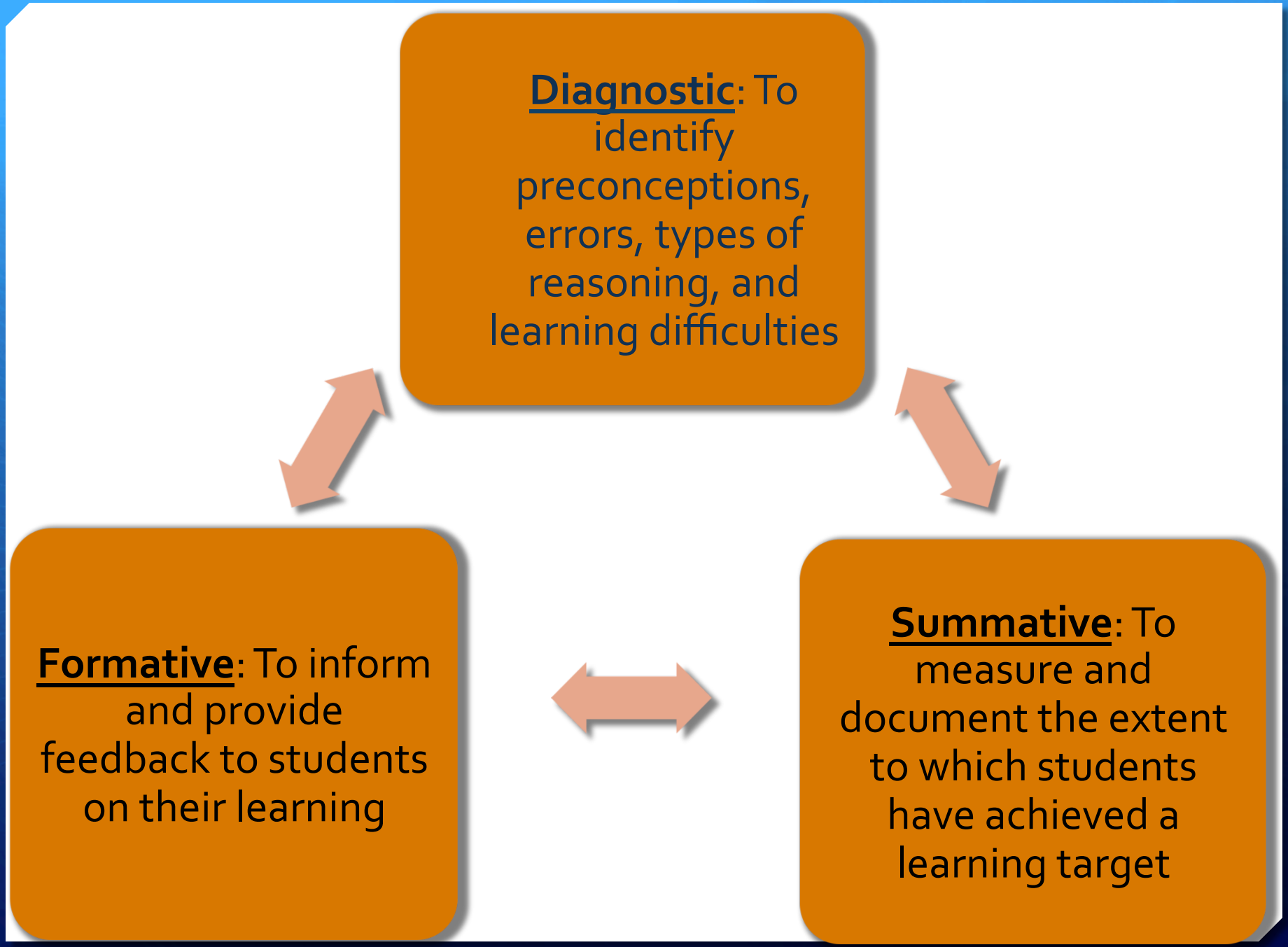
Misconceptions….

- What can we be missing in our own classrooms because we aren't looking or asking the right questions?

Assessment Card Sort

- Summative
- Formative

Sort the descriptors into the two categories


Diagnostic: To identify preconceptions, errors, types of reasoning, and learning difficulties
Formative: To inform and provide feedback to students on their learning
Summative: To measure and document the extent to which students have achieved a learning target

Formative Assessment in a Nutshell

- Systematic process of collecting evidence about students' thinking and learning to inform instruction and provide feedback to the students while simultaneously promoting learning. It happens during the learning process.
- It is assessment **for** learning rather than assessment **of** learning, and it can also be assessment **as** learning!

Guiding Resources

- **Science Formative Assessment Volume 1: 75 Practical Strategies for Linking Assessment, Instruction, and Learning 2nd Edition**. By Page Keeley; NSTA Press 2016
- The 75 Strategies are known as Formative Assessment Classroom Techniques or FACTs

Purposes for using FACTs

1. Activate thinking and engage ss in learning
2. Make ss' ideas explicit to themselves and the teacher
3. Challenge ss' existing ideas and encourage intellectual curiosity
4. Encourage continuous reflection on teaching and learning
5. Help ss consider alternative viewpoints
6. Provide a stimulus for discussion and scientific argumentation
7. Help ss recognize when that have learned or not learned something
8. Encourage ss to ask better questions & provide thoughtful responses

Purposes for using FACTs (cont.)

9. Provide starting points for student investigations
10. Signal readiness to transition to formal concept development
11. Determine if ss can apply scientific ideas and practices to new situations
12. Differentiate instruction for individuals or groups of ss
13. Promote the use of academic language in science learning
14. Evaluate the effectiveness of a lesson.

Purposes for using FACTs (cont.)

15. Help ss develop self- & peer-assessment skills
16. Give and use feedback (s-s; T-s; & s-T)
17. Encourage social construction of ideas in science
18. Inform immediate or later adjustments to instruction
19. Encourage and include participation of all learners
20. Increase comfort in making one's own ideas public

How People Learn – 3 Core Principles Support FACTs

- **Principle 1**: If their (ss') initial understanding is not engaged, they may fail to grasp new concepts and info presented in the classroom, or they may learn them for purposes of a test but revert to their preconceptions
- **Principle 2**: To develop competence in an area of inquiry, ss must (a) have a deep foundation of factual knowledge, (b) understand facts & ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application
- **Principle 3:** A "metacognitive" approach to instruction can help ss learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them

FACTs - Strengthen link between Assessment, Instruction, and Learning

- Think like a diagnostician
- Make students' thinking explicit during scientific inquiry
- Create a classroom culture of ideas, not answers
- Develop a discourse community
- Encourage students to take risks
- Encourage students to listen carefully
- Use a variety of FACTs in a variety of ways
- Use a variety of grouping configurations
- Encourage continuous reflection

FACTs support Common Core ELA

- Construct effective arguments
- Request clarification
- Ask relevant questions
- Build on others' ideas
- Question assumptions & premises
- Assess the veracity of claims
- Assess the soundness of reasoning
- Cite specific evidence
- Make their reasoning clear
- Constructively evaluate others' use of evidence
- Evaluate others' POV critically and constructively
- Express and listen carefully to ideas
- Cite specific text evidence to support conclusions
- Participate in a range of conversations and collaborations with diverse partners
- Express ideas clearly and persuasively

FACTs linked to K-12 Framework

- Tables 3.1 pg. 44-48
- Includes examples of a specific *Disciplinary Core Idea* for each FACT including a reference to the grade level

FACTS linked to K-12 Framework Table 3.2 pg. 49-52 **SEPs**

1. Asking ?s and defining problems
2. Developing and using models
3. Planning & carrying out investigations
4. Analyzing and interpreting data
5. Using math and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Table 3.4 Purposeful Use in Teaching & Learning with FACTs

1. Elicit & Identify Preconceptions
2. Engage and motivate students
3. Activate thinking and promote metacognition
4. Provide stimuli for scientific discourse
5. Initiate scientific inquiry and idea exploration
6. Formal concept development & transfer
7. Improve questioning and Responses
8. Provide Feedback
9. Peer & Self-Assessment
10. Reflection

Misconceptions about Misconceptions

- All science misconceptions are the same
- All science misconceptions are major barriers to learning
- Only "those" student have misconceptions
- Misconceptions must be fixed right away
- Misconceptions are a bad thing
- Misconceptions come mostly from experiences outside the classroom
- Identifying misconceptions is formative assessment.

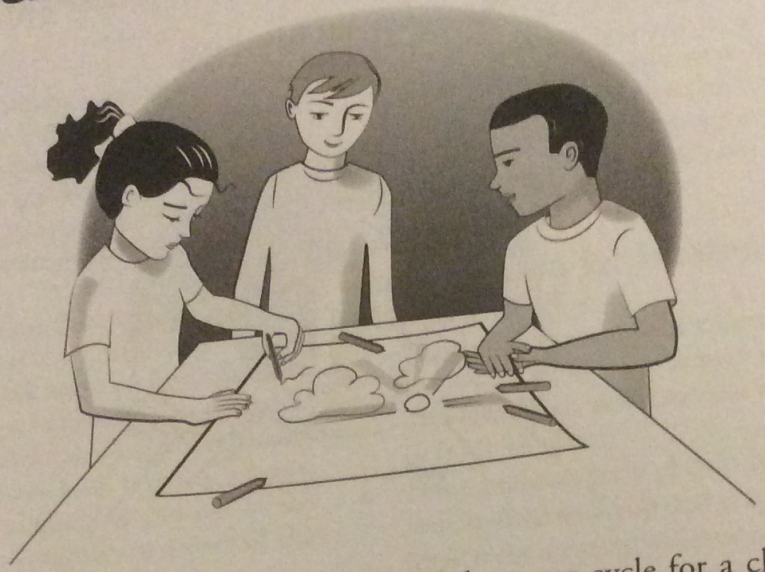
FACT Layout

- Description
- How the FACT Promotes Student Learning
- How the FACT Informs Instruction
- Design and Administration
- Connection to *A Framework for K-12 Science Education (NRC, 2012)*
- General Implementation Attributes
  - Ease of Use
  - Time Demand
  - Cognitive Demand
- Modifications
- Caveats
- Use with Other Disciplines

Annotated Student Drawings

- Student-made, labeled illustrations that visually represent and describe students' thinking about a scientific concept.
- Access knowledge and visually represent thinking.
- Draw and label a sketch/diagram of the water cycle.

Water Cycle Diagram



Three students were working on a drawing of the water cycle for a class project. They each had different ideas about what needed to be in their drawing to show the water cycle. This is what they said:

Rema: There has to be an ocean in a water cycle diagram.

Van: There always has to be a body of water in a water cycle diagram. It doesn't have to be an ocean. It can be an ocean, lake, river, pond, or stream.

Lamar: A water cycle diagram doesn't have to have a body of water. We can draw it without an ocean, lake, river, pond, stream, or other body of water.

Which friend do you agree with the most? _____ Explain why you agree.

Fishbowl Think Aloud

- In this FACT, a small group of students talk together in front of the class as the class listens. The students on the outside, those who make up the "fishbowl," observe the ones in the center and prepare for a discussion. After the students in the center finish discussing their subject, the whole class participates in a discussion.
- *Discuss …*
- *What is the Inside of the Earth Like?*

What Is the Inside of Earth Like?

Five friends were talking about Earth's interior. They each had different ideas about what the inside of Earth was like. This is what they said:

Rudy: I think we would see layers. Most of the inside of Earth will be hot liquid.

Lizette: I think we would see layers. Most of the inside of Earth will be solid.

Zara: I think we would see three layers with a giant magnet in the center of Earth.

Mateo: I don't think there are layers. Earth is made up of rocks and dirt with hot liquid found in the cracks.

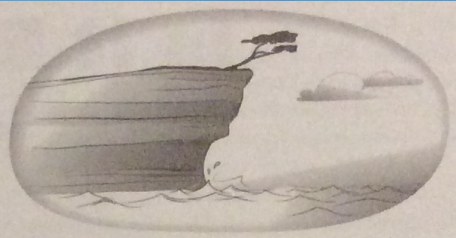
Haliaka: I think we would see sections of solid and liquid Earth with gaps in between.

Who do you think has the best idea? _____ Explain your thinking. You may draw a picture to show what you think the inside of Earth is like.

Agreement Circles

- Kinesthetic way to activate thinking and engage students in scientific argumentation. Students stand in a circle as the teacher reads a statement. The students who agree with the statement step to the center of the circle.
- Students turn & face each other in small groups of those who agree and disagree – discuss positions.
- Goal is to get everyone either inside the circle or on the circumference.

Is It Erosion?



Erosion is a process that changes the surface of Earth. Put an X next to the changes you think are examples of erosion.

___ **A.** soil from a riverbank being carried downstream

___ **B.** rock steps worn down from millions of visitors

___ **C.** a rock breaking into smaller pieces when water freezes in the cracks

___ **D.** a huge boulder transported by a glacier

___ **E.** mud sliding down a hill during a landslide

___ **F.** sand deposited on a beach from the ocean

___ **G.** a tunnel formed in soil by a burrowing animal

___ **H.** a rock shattered by a large rock that fell on it

___ **I.** soil from a cliff being washed into the ocean

___ **J.** fragments of rock sliding down a mountain cliff

___ **K.** a sharp rock in a stream slowly getting smoothed out and rounded

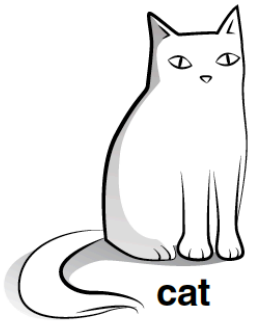
___ **L.** desert sand being carried by the wind

___ **M.** plant roots expanding a crack in a rock

___ **N.** the date on a 200-year-old gravestone worn away

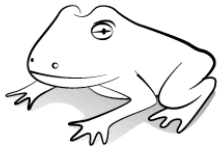
Explain your thinking. What rule or reasoning did you use to decide which processes are examples of erosion?

Is It Living?



cat

seed



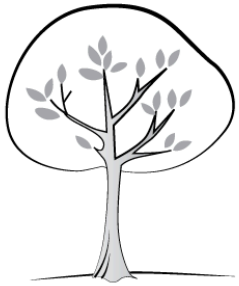
frog

fire

grass

river

rock



tree

cloud

What are you thinking?

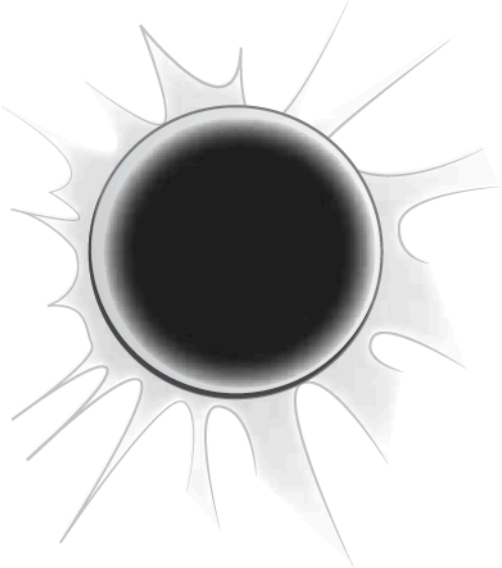
Four Corners

- Four Corners provides an opportunity for students to make their ideas public. It is used with selected-response questions to identify and group students who have similar responses to the question asked.

When Is the Next Full Moon?

What are you thinking?

Moon Phase and Solar Eclipse



During a solar eclipse the Moon appears to completely cover the Sun. What phase is the Moon in just before and after a solar eclipse? Circle the answer that best matches your thinking.

A full Moon

B new Moon

C first quarter Moon

D last quarter Moon

E It can be in any phase.

Describe your thinking. Provide an explanation for your answer. _____

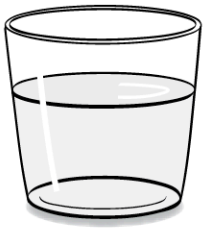
Human Scattergraph

- Ss position themselves around the room according to their response to a question and their confidence level.
- Creates a visual graph of results.
- Choose selected response questions with at least 3 and no more than four choices.
- Label the wall (Y-axis) on one side of the room with the choices, A, B, C, D.
- Label the adjacent wall (X-axis) with a range of low confidence to high confidence.

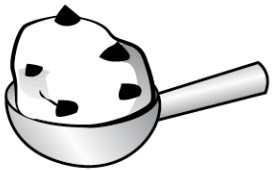
Back and Forth

Which changes can go back and forth?

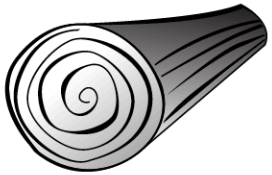
☐ Ice to water.
☐ Water to ice.



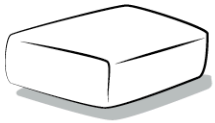
☐ Batter to cookie.
☐ Cookie to Batter.



☐ Wood to ashes.
☐ Ashes to wood.

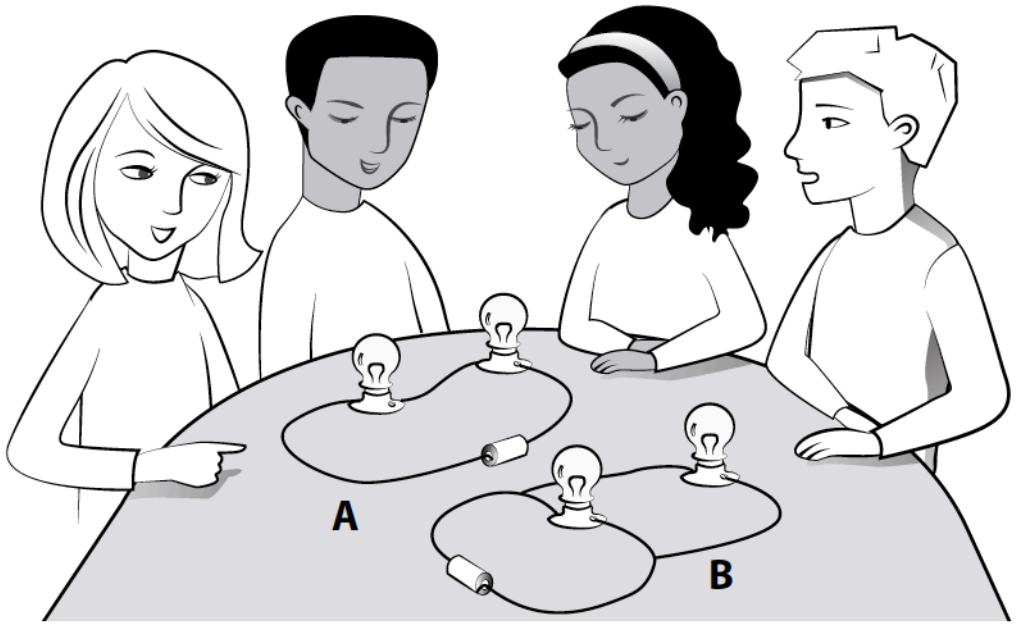


☐ Hard butter to melted butter.
☐ Melted butter to hard butter.



What are you thinking?

Which Burns Brighter?



A group of students built two different types of circuits in their science class. They wondered if the type of circuit made a difference in how brightly the bulbs burned. This is what they said:

Carlos: I think the bulbs in circuit A will burn the brightest.

Margaret: I think the bulbs in circuit B will burn the brightest.

Gwen: I think the first bulb in circuit A will burn as bright as the bulbs in circuit B, but the second bulb in circuit A will be dimmer.

Olaf: I think both bulbs will be the same brightness.

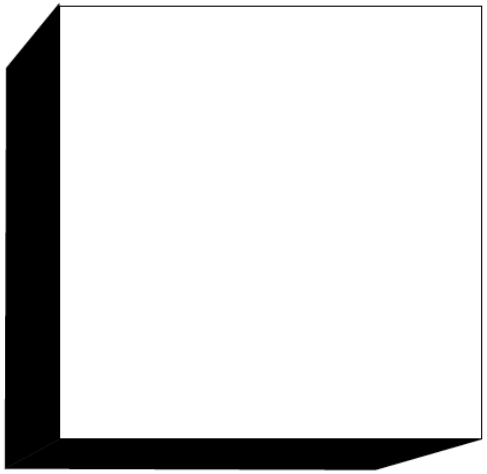
With which student do you agree the most? _____ Explain why you agree.

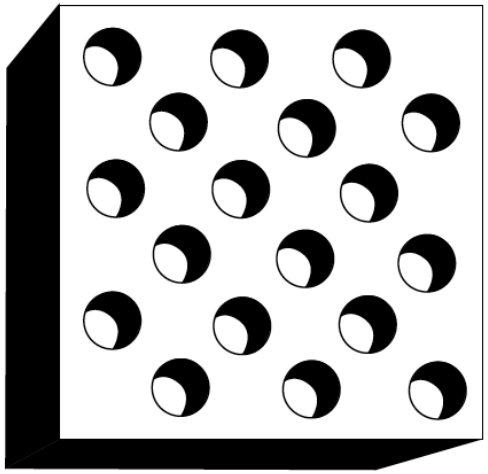
Sticky Bars

- Low-tech version of personal response systems (clickers).
- Present ss with a selected response question.
- The answer is anonymously recorded on a Post-It note and passed to the teacher.
- The teacher or a student arranges the sticky notes on the wall or board as a bar graph representing the different responses.

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.

FACT Samples Provided on Wiki

- A&D Statements
- Human Scatter Plot – Pillbugs
- Concept Cartoon – Cells, Heat
- Justified List
- Question Generating
- Synectics
- Familiar Phenomenon Probe

FACTs used commonly in Probe Books

- Familiar Phenomenon Probes
- Friendly Talk Probes
- Justified List
- P-E-O Probes (Predict, Explain, Observe)
- Thought Experiments