It’s not just what we know …

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Are we listening?

- The optometrist
- The Duracell competition
- Two objects falling in a vacuum
- The cord of wood
Brief History of Assessment

• When did it all begin?
  – IQ tests
  – PhD orals
  – Socrates
And God said, “Let there be light” … and it was good
And God created humans ..... and it was very good
How do we assess?

• List 3 ways you assess student’s knowledge?
Classroom Assessment

The Grade Book
Tests
Quizzes
Homework
Class participation (?)
Lab reports
Attendance (X)
Projects

The Final Exam
Individual vs. department wide

These are often treated as summative though they do inform as formative.

Other formative assessments include:
–Questions in class
–Practice tests
Challenges

• Identify who are we testing
  o Students
  o Teachers
  o Schools and districts
Challenges

- Identify for what purpose (from Classroom Assessment and the NSES, NRC)
  - Help students learn
  - To illustrate and articulate the standards for quality work
  - To inform teaching
  - To guide curriculum selection
  - To monitor programs
  - To provide a basis for reporting concrete accomplishments to interested parties
  - For accountability
  - Certification
    - Reporting individual achievement
    - Grading
    - Placement
    - Promotion
    - Accountability
      - Parents to taxpayers

(from High Stakes Assessments, NRC)
Challenges

• Are we trying to use ONE instrument
  • for all (students, teachers, schools)?
  • for all purposes?

• Understanding vs. belief
  ○ Mazur student taking FCI
Classroom Assessment and the National Science Education Standards (2001)
Center for Education

Knowing What Students Know: The Science and Design of Educational Assessment (2001)
Center for Education
Today’s Discussion

• Assessment as a tool for helping people learn
  – Assessment should be more about what we want to know
  – Assessment is difficult
  – Assessment should focus on what we value and think is important
What do we ask students?

• Please discuss
What do we ask friends?

• *Please discuss*
School Questions vs Real Questions

• What is your favorite color?

• How do I get to the wedding?
Conclusion 1

• Students do not want to give the “wrong” answer.

• Ask questions because you want to know what students think and why they think that way – not because you want to test them.
An assessment

• Please complete the top of the form.
Simplify the fraction:

\[
\frac{16}{64}
\]

**ANSWER A:**

\[
\frac{16}{64} = \frac{1}{4}
\]

**ANSWER B:**

\[
\frac{16}{64} = \frac{1\emptyset}{\emptyset4} = \frac{1}{4}
\]
Simplify the fractions:

\[
\begin{array}{ccc}
\frac{16}{64} & \frac{13}{39} & \frac{25}{75} \\
1 & \frac{1}{3} & \frac{1}{3}
\end{array}
\]

\[
\begin{array}{ccc}
\frac{16}{64} & \frac{13}{39} & \frac{25}{75} \\
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Review results of survey

• Student A vs. Student B (5 points)
• Student C vs. Student D (5 points)
• Student E vs. Student F (15 points)
• Student G vs. Student H (15 points)

• What do these results tell us?
What Goes Wrong?

Tests that do not correlate with understanding
- Force Concept Inventory (FCI)
- Regents exam question on moving galaxies
- Private Universe videotapes
What Goes Wrong?

Tests that do not correlate with understanding
  • Force Concept Inventory (FCI)
  • Regents exam question on moving galaxies
  • Private Universe videotapes

We’re not testing what we teach
  • Harris cartoon of mouse and maze
"Then, as you can see, we give them some multiple choice tests."
What Goes Wrong?

Tests that do not correlate with understanding
- Force Concept Inventory (FCI)
- Regents exam question on moving galaxies

We’re not testing what we teach
- Harris cartoon of mouse and maze

We’re not teaching what we test
- “Waldo” phenomenon
What Goes Wrong?

Tests that do not correlate with understanding
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We’re not teaching what we test
• “Waldo” phenomenon

What can we do? What are our next steps?
Conclusion 2

• Assessment is difficult
  – 16/64
  – Test what is valuable
  – Listen to their response (Waldo phenomenon)
The Assessment Triangle

cognition, observation, and interpretation—must be explicitly connected and designed as a coordinated whole. If not, the meaningfulness of inferences drawn from the assessment will be compromised.
The Assessment Triangle

cognition, observation, and interpretation—

The Optometrist Story
Assessment #1

- Question: What was the date of the battle of the Spanish Armada?
  - Answer: 1588 [correct].

- Question: What can you tell me about what this meant?
  - Answer: Not much. It was one of the dates I memorized for the exam. Want to hear the others?
Assessment #2

• Question: What was the date of the battle of the Spanish Armada?
  – Answer: It must have been around 1590.

• Question: Why do you say that?
  – Answer: I know the English began to settle in Virginia just after 1600, not sure of the exact date. They wouldn’t have dared start overseas explorations if Spain still had control of the seas. It would take a little while to get expeditions organized, so England must have gained naval supremacy somewhere in the late 1500s.
Comparison

• Most people would agree that the second student showed a better understanding of the Age of Colonization than the first, but too many examinations would assign the first student a better score.

• When assessing knowledge, one needs to understand how the student connects pieces of knowledge to one another. Once this is known, the teacher may want to improve the connections, showing the student how to expand his or her knowledge.
Not in vain

• When studying about veins and arteries, for example, students may be expected to remember that
  – arteries are
    • thicker than veins,
    • more elastic, and
    • carry blood from the heart;
  – veins carry blood back to the heart.
Sample test item

• Arteries
  – a. Are more elastic than veins
  – b. Carry blood that is pumped from the heart
  – c. Are less elastic than veins
  – d. Both a and b
  – e. Both b and c
The new science of learning

• does not deny that facts are important for thinking and problem solving.
• Research on expertise in areas such as chess, history, science, and mathematics demonstrate that experts’ abilities to think and solve problems depend strongly on a rich body of knowledge about subject matter (e.g., Chase and Simon, 1973; Chi et al., 1981; deGroot, 1965).
Facts are not enough

• However, the research also shows clearly that “usable knowledge” is not the same as a mere list of disconnected facts.

• Experts’ knowledge is
  – connected and organized around important concepts (e.g., Newton’s second law of motion);
  – “conditionalized” to specify the contexts in which it is applicable;
  – supports understanding and transfer (to other contexts) rather than only the ability to remember.
Vein and artery experts

• Know the facts in the mc question
• also understand why veins and arteries have particular properties.
  – They know that blood pumped from the heart exits in spurts
  – That the elasticity of the arteries helps accommodate pressure changes.
  – They know that blood from the heart needs to move upward (to the brain) as well as downward and that the elasticity of an artery permits it to function as a one-way valve that closes at the end of each spurt and prevents the blood from flowing backward.

• They are better able to transfer
  – Design an artificial artery strong enough to handle pressure with or without elasticity (Bransford and Stein, 1993).
Questions that foster deep understanding rather than questions that ask for repetition of memorized information and conclusions. (Jim Minstrell and Emily van Zee)

• Ask or promote questions to open an inquiry and elicit students’ initial understanding and reasoning.
• Ask or promote questions to interpret and make sense of data in order to generate new knowledge and understanding.
• Ask or promote questions to clarify or elaborate on observations and inferences.
• Ask or promote questions to encourage learners to justify their answers and conclusions or to explain their reasoning to go beyond a mere stating of an answer.
• Ask or promote questions to extend or apply learned ideas.
• Ask or promote questions that help learners monitor their own learning.

Creation of question.
What are our goals as science teachers?

- Higher student achievement
- Engaged students
- Appreciation (love?) of science in the world
- Critical thinking

- Five years later: what is science?
  - e.g. Chemistry responses
Bloom’s Taxonomy

- **Knowledge** (define, describe, identify…)
- **Comprehension** (give examples, summarize…)
- **Application** (demonstrate, predict, solve…)
- **Analysis** (analyze, compare & contrast, …)
- **Synthesis** (modify, create …)
- **Evaluation** (evaluate, conclude…)
4 Q Assessment Model
The Essential Questions

• What does it mean?
  » Newton’s 2nd Law: \( F = ma \)
  » Energy is conserved
  » The Earth goes around the Sun
  » The atom has a nucleus
  » Mitochondria are the power house of the cell
  » \( H_2O \) is a polar molecule (angle of 104)
4 Q Assessment Model
The Essential Questions

• What does it mean?

• How do we know?
  » Newton’s 2nd Law:  \( F = ma \)
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  » The atom has a nucleus
  » Mitochondria are the power house of the cell
  » \( \text{H}_2\text{O} \) is a polar molecule (angle of 104°)
4 Q Assessment Model
The Essential Questions

• What does it mean?
• How do we know?

• Why should I believe? (When do I not believe?)
  » Newton’s 2nd Law: $F = ma$
  » Energy is conserved
  » The Earth goes around the Sun
  » The atom has a nucleus
  » Mitochondria are the power house of the cell
  » $H_2O$ is a polar molecule (angle of 104)
4 Q Assessment Model
The Essential Questions

• What does it mean?
• How do we know?
• Why should I believe?

• Why should I care?
  » Newton’s 2\textsuperscript{nd} Law:  F = ma
  » Energy is conserved
  » The Earth goes around the Sun
  » The atom has a nucleus
  » Mitochondria are the power house of the cell
  » H\textsubscript{2}O is a polar molecule (angle of 104)
Shavelson & Li

- Declarative knowledge (knowing that)
- Procedural knowledge (knowing how)
- Schematic knowledge (knowing why)
- Strategic knowledge (knowing when and where to apply knowledge)
4 Q Assessment Model

• What does it mean?

• How do we know?

• Why should I believe?

• Why should I care?

Post these in front of the room and reap unanticipated benefits.
Conclusion 3

• Assessment can drive the curriculum
• Assessment should focus on what we value and think is important
  – Essential Questions
Summary

• The assessment triangle: cognition, observation, interpretation
  – Confusion over what we assess (optometrist)
  – Difficulty in assessing (16/64)
• What do we want students to know
  – Essential Questions and organizing principles
• Obstacles to be aware of
  – Are we testing what we teach? (Mice in maze)
  – Are we teaching what we test? (Waldo phenomenon)
Where is the knowledge we have lost in information…
Where is the knowledge we have lost in information…
Where is the wisdom we have lost in knowledge?

T.S. Eliot
Center of Science and Math In Context  
COSMIC

• Please check out our website:  
  www.cosmic.umb.edu  
for a copy of the power point.

Or email with questions:  
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