Thinking About Waves

Ruben R. Puentedura, Ph.D.
Redefinition
Tech allows for the creation of new tasks, previously inconceivable

Modification
Tech allows for significant task redesign

Augmentation
Tech acts as a direct tool substitute, with functional improvement

Substitution
Tech acts as a direct tool substitute, with no functional change

Podcasts on iTunes U: http://tinyurl.com/aswemayteach
History – Guiding Criteria

- Does the question represent an important issue to historical and contemporary times?
- Is the question debatable?
- Does the question represent a reasonable amount of content?
- Will the question hold the interest of students?
- Is the question appropriate given the materials available?
- Is the question challenging for the students you are teaching?
- What organizing historical concepts will be emphasized?

History – Core Concepts

- Causality
- Chronology
- Multiple Perspectives
- Contingency
- Empathy
- Change and Continuity Over Time
- Influence/Significance/Impact
- Contrasting Interpretations
- Intent/Motivation


<table>
<thead>
<tr>
<th>Social</th>
<th>Mobility</th>
<th>Visualization</th>
<th>Storytelling</th>
<th>Gaming</th>
</tr>
</thead>
<tbody>
<tr>
<td>200,000 years</td>
<td>70,000 years</td>
<td>40,000 years</td>
<td>17,000 years</td>
<td>8,000 years</td>
</tr>
</tbody>
</table>

Iconic

Enactive

Symbolic

Understanding Science: How Science Works

EXPLORATION AND DISCOVERY
- Making observations
- Asking questions
- Opening data and ideas
- Finding inspiration
- Exploring the literature
- New technology
- Practice problems
- Curiosity
- Personal motivation
- Serendipity
- Surprising observation

GATHERING DATA
- Hypotheses
- Expected results/observations
- Actual results/observations
- New technology
- Curiosity
- Surprising observations
- Serendipity
- Personal motivation
- Practical problems
- Personal motivation
- Revised/new assumptions
- Innovative hypotheses
- Revised hypotheses

INTERPRETING DATA
- Supportive, contradictory, surprising, or inconclusive data may...
- Hypotheses
- Expected results/observations
- Actual results/observations
- New technology
- Curiosity
- Surprising observations
- Serendipity
- Personal motivation
- Practical problems
- Personal motivation
- Revised/new assumptions
- Innovative hypotheses
- Revised hypotheses

TESTING IDEAS
- Feedback and peer review
- Replication
- Theory building
- Publication
- Discussion with colleagues
- Coming up with new questions/ideas
- New technology
- Curiosity
- Surprising observations
- Serendipity
- Personal motivation
- Practical problems
- Personal motivation
- Revised/new assumptions
- Innovative hypotheses
- Revised hypotheses

BENEFITS AND OUTCOMES
- Build knowledge
- Satisfy curiosity
- Solve everyday problems
- Address societal issues
- Develop technology
- Personal motivation
- Surprising observation
- Personal motivation
- Practical problems
- Personal motivation

COMMUNITY ANALYSIS AND FEEDBACK
- Personal motivation
- Surprising observation
- Personal motivation
- Practical problems
- Personal motivation

www.understandingscience.org
© 2008 The University of California Museum of Paleontology, Berkeley, and the Regents of the University of California
TESTING IDEAS

Gathering data
- Hypotheses
- Expected results/observations
- Actual results/observations

Interpreting data
- Supportive, contradictory, surprising or inconclusive data may...
  - ...support a hypothesis.
  - ...oppose a hypothesis.
  - ...inspire revised/new hypothesis.
  - ...inspire revised assumptions.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are Waves?</td>
<td>Record observation, interference</td>
</tr>
<tr>
<td>Types of Waves</td>
<td>Math connection, simulation</td>
</tr>
<tr>
<td>Observing Wave Properties of a Slinky and Rope</td>
<td>Procedure and replication</td>
</tr>
<tr>
<td>What is sound? Pitch</td>
<td>Measurement</td>
</tr>
<tr>
<td>Sound Waves (Making a string phone)</td>
<td>Exploration, explanation</td>
</tr>
<tr>
<td>The Ear</td>
<td>Music exploration</td>
</tr>
<tr>
<td>Introduction to Concepts in Light</td>
<td>Geometry and projection</td>
</tr>
<tr>
<td>Transparent, Translucent, Opaque</td>
<td>Light diffraction</td>
</tr>
<tr>
<td>Bouncing/Reflecting Light</td>
<td>Kaleidoscopes, funhouses</td>
</tr>
<tr>
<td>Bending Light</td>
<td>Fiber optics, exploring materials</td>
</tr>
<tr>
<td>Optics</td>
<td>The eye and vision correction</td>
</tr>
<tr>
<td>Colors</td>
<td>The eye and color perception</td>
</tr>
</tbody>
</table>