Instructional Sequence Matters
Explore - Before - Explain
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Presentation Overview

- What is explore-before-explain?
- How can I transform my lessons?
  - Shifting Mindsets
  - Iteration vs. invention
- How can I better address the NGSS?
What is explore-before-explain?

- Engaging prior ideas
- Constructing evidence-based claims
- Explaining underlying scientific principles
BIG IDEA:
We must truly believe that all students can learn at high levels and construct conceptual understanding.
MODEL LESSON

Grades 6-8:
Thermal Energy Transfer
Have you ever been told “shut the refrigerator door, you’ll let the cold out” or in the winter “shut the front door, you are letting the heat out?” Which way does heat transfer--Hot to cold, cold to hot, or both?
Melinda filled two glasses of equal size half-full with water. The water in one glass was 50 degrees Celsius. The water in the other glass was 10 degrees Celsius. She poured one glass into the other, stirred the liquid, and measured the temperature of the full glass of water. What do you think the temperature of the full glass of water will be after the water is mixed? Write down your prediction (Keeley, Eberle, & Tugel, 2007)

A. 20  B. 30  C. 40  D. 50  E. 60

“Average”  “Subtraction”  “Overriding”  “Addition”
Sticky Charts: “what patterns exist in student ideas”

Q’s?: Is it worth exploring the idea?

Yes! As a group we are not sure what the answer is
Preconceptions

- Average: 21% Elementary, 33% Middle Level, 30% Elementary Methods, 58% Secondary Methods
- Subtraction: 57% Elementary, 55% Middle Level, 58% Elementary Methods, 33% Secondary Methods
- Overriding: 8% Elementary, 8% Middle Level, 8% Elementary Methods, 8% Secondary Methods
- Addition: 13% Elementary, 13% Middle Level, 13% Elementary Methods, 13% Secondary Methods
- Other: 12% Elementary, 12% Middle Level, 12% Elementary Methods, 12% Secondary Methods
<table>
<thead>
<tr>
<th>Group</th>
<th>Cold</th>
<th>Hot</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>84</td>
<td>49</td>
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<td>90</td>
<td>55</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>90</td>
<td>56</td>
</tr>
</tbody>
</table>
EXPLORE-BEFORE-EXPLAIN

- Drawing and building on prior experience
- Learning by doing science
“We know that when two different temperatures of water are mixed the end result is the average temperature... but how does energy transfer? “
It was a hot summer day. Mattie poured herself a glass of lemonade. The lemonade was warm, so Mattie put some ice in the glass. After 10 minutes, Mattie noticed that the ice was melting and the lemonade was cold. Mattie wondered what made the lemonade get cold. She had three different ideas. Which idea do you think best explains why the lemonade got cold? Circle your answer.

A The coldness from the ice moved into the lemonade.

B The heat from the lemonade moved into the ice.

C The coldness and the heat moved back and forth until the lemonade cooled off.
Use colors and arrows to draw your prediction

- Red=Hot
- Blue=Cold
Student’s predictions

“Cold to Hot”

“Hot to Cold”

“Hot to Cold” and “Cold to Hot”
Teacher Preconceptions

- Cold to Hot: 22%
- Hot to Cold: 44%
- Both Ways Simultaneously: 33%
Translating opens up more possibilities for student ideas
Use colors to draw your prediction
Red=Hot
Blue=Cold

Questions:
• How does the assessment probe relate to our model (i.e., the picture)
• Which component represents the ice?
• Which component represents lemonade?
Translating Student’s Predictions to Models
Quick Summary

• Developing Conceptual understanding
• Evidence-based claims
• Promoting transfer learning (patterns, model based reasoning)
We have data that serves as evidence that thermal energy transfers from “hot” to “cold” but what is the underlying explanation?
Textbook readings

**Convection**
- The transfer of heat through a fluid (liquid or gas) caused by molecular motion.

**Conduction**
- The transfer of heat or electric current from one substance to another by direct contact.

**Radiation**
- Energy that is radiated or transmitted in the form of rays or waves or particles.
Developing explanations and reasoning

<table>
<thead>
<tr>
<th>hot object</th>
<th>cold object</th>
</tr>
</thead>
</table>
| ![Diagram of heat transfer from hot to cold objects over time](image)

Time
Quick Summary:
• Allowing students to explain underlying ideas
• Introducing academic vocabulary (DCIs)
2A

How can you transform your Lessons?

Shifting Mindsets
BIG IDEA:

✓ We have to understand our own beliefs about teaching and learning in order to make sense of new pedagogical practices.
Lesson Study: Cultural Phenomenon

Explain
Tell ideas

Investigate/Observe
Verify Ideas

Practice
Rehearse Ideas

K-16 Apprenticeship of Observation
Thinking about Our Cultural Lesson Model?

What understandings do students have to incorporate ideas?

Explain
Tell ideas

Investigate/Observe
Verify Ideas

Practice
Rehearse Ideas

Is telling enough to overcome misconceptions?

Will verifying and practice develop conceptual understanding?

Use and think with idea

State in own words

Create a model with it

Find a metaphor or analogy for it

What will students be able to do with ideas in later grades?
How important is foundational understanding?

Vs.
How can you transform your Lessons?
Iteration vs. Invention
BIG IDEA:

- We must have a manageable plan to implement our vision of reform. We have difficulty implementing overly challenging or multiple unrelated plans.
- We need to rethink current structures as opposed to adding on to what currently exists.
Planning Step 1

• Pinpoint the evidence-based experience you will use with students
Planning Step 1: Evidence-Based Experience

Focus on learning by doing (Think --Backwards Design)

- Demonstration or simplified lab (use what you have and know works)
- Talk with students about data → evidence → claims (help students formulate clear lines of arguments)
- Allows students to make an evidence-based claim

- Blend of DCIs, SEPs, and CCs (NGSS-minded)
- Creates a conceptual framework for understanding
- Models the Nature of Science (accumulation of data serves as evidence for sense making)
What evidence-based experience can students have?
Planning Step 2

• Elicit student ideas around an observable phenomenon
Create a need to know situation with students
• Use an Understanding Student Ideas (USI) probe (see Keeley) or create your own
  • Selected response: Correct answer and typical incorrect ideas
  • Ask for reasons for thinking (“rules”)
• Have students make a prediction before a demonstration or investigation (“what do I wonder?”)
• Celebrate variation in ideas as a worthwhile topic for exploration (Do not grade!)
How can I better know students incoming ideas?

**Mixing Water**

Melinda filled two glasses of equal size half full with water. The water in one glass was 50 degrees Celsius. The water in the other glass was 10 degrees Celsius. She poured one glass into the other, stirred the liquid, and measured the temperature of the full glass of water.

What do you think the temperature of the full glass of water will be after the water is mixed? Circle your prediction.

A. 20 degrees Celsius  
B. 30 degrees Celsius  
C. 40 degrees Celsius  
D. 50 degrees Celsius  
E. 60 degrees Celsius

Explain your thinking. Describe the "rule" or reasoning you used for your answer.

**Ice-Cold Lemonade**

It was a hot summer day. Marlie poured herself a glass of lemonade. The lemonade was warm, so Marlie put some ice in the glass. After 10 minutes, Marlie noticed that the ice was melting and the lemonade was cold. Marlie wondered what made the lemonade get cold. She had three different ideas. Which idea do you think best explains why the lemonade got cold? Circle your answer:

A. The coldness from the ice moved into the lemonade.  
B. The heat from the lemonade moved into the ice.  
C. The coldness and the heat moved back and forth until the lemonade cooled off.

Explain your thinking. Describe the "rule" or reasoning you used for your answer.
Planning Step 3

- Sophistical understanding
- Readings, discussions, simulations
- Academic vocabulary
**PLANNING STEP 3: EXPLAIN**

Connect students evidence-based claims with underlying principles.

- Readings (textbook and trade books), discussions, and lectures
  - Introduce academic vocabulary in light of students firsthand experiences
- Computer simulations can allow for exploration not easily accessible from firsthand (think subatomic).
How can students Explain Underlying Principles?
## Explore-Before-Explain Priority Planning

<table>
<thead>
<tr>
<th>Steps</th>
<th>Description</th>
<th>Example</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select evidence-producing experience</td>
<td><img src="image1.png" alt="Example Image" /></td>
<td>Macroscopic observation and data that thermal energy transfers from hot to cold and when combining two different temperature of water; the result is the average temperature.</td>
</tr>
</tbody>
</table>
| 2     | Choose or adapt a USI probe to initiate the evidence-based experience | - "Mixing Water" (Keeley, Eberle, and Tugel 2007)  
- "Icy-Cold Lemonade" from *Uncovering Student Ideas in Science, Volume 2* (Keeley, Eberle, and Tugel 2007) | Elicit students ideas about transfer of energy from place to place. |
| 3     | Select explanations that can help students explain underlying principles | ![Example Image](image2.png) | Provides explanation-type experiences so students can visualize energy transfer on the molecular level. |

**Planning vs. Implementation**

- **Planning**: Determining the learning objectives and designing activities to achieve those objectives.
- **Implementation**: Executing the planned activities in the classroom.

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45
BIG IDEA:

✓ Curriculum, instruction, assessment practices, and ties to other areas (e.g., mathematics, English Language Arts, etc.) must be aligned with considerable consistency.
How can I better address the NGSS?
Disciplinary Core Ideas

PS3.A: Definitions of Energy
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

PS3.B: Conservation of Energy and Energy Transfer
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.
## Key Takeaways

### Session Objectives

<table>
<thead>
<tr>
<th>What is explore-before-explain?</th>
<th>Creating conceptual coherence and asking students to do the hard intellectual work</th>
</tr>
</thead>
<tbody>
<tr>
<td>How can I transform my lessons?</td>
<td>Flipping the instructional script to focus on conceptual understanding</td>
</tr>
<tr>
<td>How can I better address the NGSS?</td>
<td>The best learning occurs at the nexus of science practices, logical thinking, and concepts</td>
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- Engaging prior ideas
- Constructing evidence-based claims
- Explaining underlying scientific principles
Thank you! Reach out to me at:

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