## Where We’re Headed Today…

<table>
<thead>
<tr>
<th>Segment 1</th>
<th>8:30-9:10</th>
<th>Welcome! Goals for Students in Science/STEM Goals for This Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment 2</td>
<td>9:10-9:45</td>
<td>What is Sensemaking?</td>
</tr>
<tr>
<td>Segment 3</td>
<td>9:45-11:30</td>
<td>Experience Sensemaking 1a 15-minute break Experience Sensemaking 1b</td>
</tr>
<tr>
<td>Segment 4</td>
<td>11:30-12:15</td>
<td>Productive Talk Goals and Moves</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:15 – 1:15</td>
<td></td>
</tr>
<tr>
<td>Segment 5</td>
<td>1:15 – 2:30</td>
<td>Experience Sensemaking 2 15-minute break</td>
</tr>
<tr>
<td>Segment 6</td>
<td>2:30 - 3:30</td>
<td>Revise Ideas about Sensemaking Close Day 1</td>
</tr>
</tbody>
</table>
Welcome!

Making Sense of Three-Dimensional Teaching and Learning

Day 1

June 18 and 19, 2024
### Where We’re Headed Today…

<table>
<thead>
<tr>
<th>Segment 1</th>
<th>8:30-9:10</th>
<th>Welcome! Goals for Students in Science/STEM Goals for This Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment 2</td>
<td>9:10-9:45</td>
<td>What is Sensemaking?</td>
</tr>
<tr>
<td>Segment 3</td>
<td>9:45-11:30</td>
<td>Experience Sensemaking 1a 15-minute break Experience Sensemaking 1b</td>
</tr>
<tr>
<td>Segment 4</td>
<td>11:30-12:15</td>
<td>Productive Talk Goals and Moves</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:15 – 1:15</td>
<td></td>
</tr>
<tr>
<td>Segment 5</td>
<td>1:15 – 2:30</td>
<td>Experience Sensemaking 2 15-minute break</td>
</tr>
<tr>
<td>Segment 6</td>
<td>2:30 - 3:30</td>
<td>Revise Ideas about Sensemaking Close Day 1</td>
</tr>
</tbody>
</table>
Collection of Resources

Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning Collection

PRIVATE

4 items

- Earth & Space Science
- Environmental Science
- Life Science
- Physical Science
- Elementary
- High School
- Kindergarten

Resources in “Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning” Collection

<table>
<thead>
<tr>
<th>Title</th>
<th>Resource Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A Framework for K-12 Science Education (pdf)</td>
<td>Web Page</td>
</tr>
<tr>
<td>2 Matrix for K-12 Learning Progression of Science and Engineering Practices Adapted from A Framework for K-12 Science Education and Appendix F of the Next Generation Science Standards</td>
<td>Web Page</td>
</tr>
</tbody>
</table>

bit.ly/TXRegion4
Meet Our Learning Community

Alone Zone (independent thinking time)
❖ Why do you think it is important for all students to learn science?
❖ What are your goals for your students in science?
Meet Our Learning Community

Alone Zone (independent thinking time)
❖ Why do you think it is important for all students to learn science?
❖ What are your goals for your students in science?

Small Group
❖ Share your thinking with your group.
❖ What is your group’s top science goal for students in your region?
❖ After sharing, record your goal on the paper strip and post.
A Framework for K-12 Science Education

The framework is designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

The learning experiences provided for students should engage students with their own fundamental questions about the world and with how scientists have investigated and found answers to those questions.
Meet Ms. Katsanos’ Third-Graders

Students experienced the phenomenon of kidney beans *germinating*. (The beans look like kidney beans one day and then a few days later some kidney beans look like plants.)

Students have completed an investigation in which kidney beans with water and kidney beans without water were placed in sunny places and dark places.
Students complete two tasks in this classroom video.

Task 1. **Reach a consensus** [using patterns in data] on what it means for a seed to *germinate* (0:24-3:25)

Task 2. **Make a claim** in answer to the question about the phenomenon, “What do kidney beans need to successfully *germinate*?” (3:40-6:25)
Alone Zone

1. What are the students doing?

2. What is the teacher doing?

3. Based on what you observed, what is sensemaking?

https://www.teachingchannel.org/video/lesson-claims-evidence-reasoning
Elementary Students Sensemaking
Elementary Students Sensemaking

Small Group

1. What are the students doing?

2. What is the teacher doing?

3. Based on what you observed, what is sensemaking?

https://www.teachingchannel.org/video/lesson-claims-evidence-reasoning
Sensemaking in a High School Classroom
High School Students Sensemaking

High school biology students explore the question, “Can nature change populations?” (populations change over time)

Task 1: Use a simulation to identify cause-and-effect relationships between an organism’s ability to avoid prey and changes in that organism’s population over time.

Task 2: Construct an explanation(s) using science ideas and cause-and-effect relationships to help answer the question about what causes population change. (2:53-7:11)
High School Students Sensemaking

Alone Zone

1. What are the students doing?

2. What is the teacher doing?

3. Based on what you observed, what is sensemaking?

2:53 - 7:11

Video not available to the public
What is Sensemaking?

Small Group

• Discuss with your group members:
  o What were the students doing?
  o What was the teacher doing?

  *Cite specific examples from the classroom video.*

• As a group, describe *sensemaking*.

Set your poster aside; we’ll revisit these ideas later.
Helium balloon hovering just above the floor
Student Hat/Teacher “Hat”

Student Hat: Think like a student.

Student/Teacher Hat: Think like a student, but note teacher guidance.

Teacher “Hat”: Reflect on student experience and educator moves.
Learning Community Norms

- We use and build on other’s ideas.
- We use evidence to support our ideas, ask for evidence from others, and suggest ways to get additional evidence.
- We are open to changing our minds.
- We challenge ourselves to think in new ways.

From OpenSciEd Classroom Norms
Notice

Helium balloon hovering just above the floor

Wonder

https://youtu.be/Fj0hj_28Iqs?t=133
https://drive.google.com/file/d/1kRTDQL_bMhOv2NaLTEPoMOCsIgLn2_SD/view?usp=drive_link
Phenomenon

Helium balloon hovering just above the floor

Partner Talk
Share with your partner
✔ Two observations
✔ One question

Be ready to share your question with the whole group.
Phenomenon

Helium balloon hovering just above the floor

Partner Talk
Share with your partner
- Two observations
- One question

Be ready to share your question with the whole group and what you observed that caused you to ask that question.
Materials for Investigation

Materials:
Per group of 4-ish

- 1 water bottle
- 2 cups
- ice water
- hot water
- bubble solution

How could we use these materials to find out more what might be going on with the birthday balloon?
Related Phenomenon: Investigation

We’re going to observe what happens to the soap-bubble film when the bottle is placed in warm water and in cold water.

Don’t forget to observe the bottle before you place it in the warm and cold water.
Create a group consensus model to explain your observations of the soap-bubble film when the bottle is on the table, in hot water, and in cold water.

Alone Zone
Make a “must have” list for this model. Consider

- What absolutely needs to be included in the model to explain your observations? (These are the parts of the model).
- What relationships between parts need to be included to help explain your observations?
Initial Consensus Models (Small Group)

Create a group consensus model to explain your observations of the soap-bubble film when the bottle is on the table, in hot water, and in cold water.

Use words, pictures, symbols, etc. to help communicate your thinking.

bottle on the table  bottle in hot water  bottle in cold water
Gallery Walk

Gather your group members and go on a gallery walk.

Look for 3 ideas that are the same as what you have included.

Look for 3 ideas that are different than your ideas.
Looking for Patterns

Place 1-3 pink notes on your own model to show ideas you had that most other groups had too.

Place 1-3 blue notes on your own model to show ideas that were different or that you didn’t include in your model.
Gather your group members and join the whole group in a scientists’ circle.

As we transition, consider....
What might need to happen in the circle for you to feel comfortable sharing an idea?
What might prevent you from sharing an idea?
Where We’re Going Next

Create a model to explain our observations of the balloon (formatively assess students’ understanding).

Connect the bottle with soap-bubble film consensus model and balloon individual models to what happens to air in contact with Earth’s surface as it warms up over the course of a day (weather science idea).
Science and Engineering Practices (SEPs)

1. Asking Questions (Science) and Defining Problems (Engineering)
2. Developing and Using Models

A focus on practices (in the plural) avoids the mistaken impression that there is one distinctive approach common to all science—a single “scientific method.”

6. Constructing Explanations (Science) and Designing Solutions (Engineering)
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information
Scientists use models ... to represent their current understanding of a system (or parts of a system) under study, to aid in the development of questions and explanations, and to communicate ideas to others.
K-12 Learning Progression for Developing and Using Models

GOALS
By grade 12, students should be able to:

- Construct drawings or diagrams as representations of events or systems—for example, draw a picture of an insect with labeled features, represent what happens to the water in a puddle as it is warmed by the sun, or represent a simple physical model of a real-world object and use it as the basis of an explanation or to make predictions about how the system will behave in specified circumstances.
- Represent and explain phenomena with multiple types of models—for example, represent molecules with 3-D models or with bond diagrams—and move flexibly between model types when different ones are most useful for different purposes.
- Discuss the limitations and precision of a model as the representation of a system, process, or design and suggest ways in which the model might be improved to better fit available evidence or better reflect a design's specifications. Refine a model in light of empirical evidence or criticism to improve its quality and explanatory power.
- Use (provided) computer simulations or simulations developed with simple simulation tools as a tool for understanding and investigating aspects of a system, particularly those not readily visible to the naked eye.
- Make and use a model to test a design, or aspects of a design, and to compare the effectiveness of different design solutions.

PROGRESSION
Modeling can begin in the earliest grades, with students' models progressing from concrete "pictures" and/or physical scale models (e.g., a toy car) to more abstract representations of relevant relationships in later grades, such as a diagram representing forces on a particular object in a system. Students should be asked to use diagrams, maps, and other abstract models as tools that enable them to elaborate on their own ideas or findings and present them to others [15]. Young students should be encouraged to devise pictorial and simple graphical representations of the findings of their investigations and to use these models in developing their explanations of what occurred.
## K-12 Learning Progression for Developing and Using Models

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling in K–2 builds on prior experiences and progress to include using and developing models (e.g., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</td>
<td>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</td>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).</td>
</tr>
<tr>
<td>• Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences. • Identify limitations of models.</td>
<td>• Develop a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analog, example, or abstract representation to describe a scientific principle or design solution. • Develop and/or use models to describe and/or predict phenomena.</td>
<td>• Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed. • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms.</td>
<td>• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.</td>
</tr>
<tr>
<td>• Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).</td>
<td>• Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.</td>
<td>• Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.</td>
<td>• Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.</td>
</tr>
<tr>
<td>• Develop a simple model based on evidence to represent a proposed object or tool.</td>
<td>• Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. • Use a model to test cause-and-effect relationships or interactions concerning the functioning of a natural or designed system.</td>
<td>• Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.</td>
<td>• Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.</td>
</tr>
</tbody>
</table>
Developing and Using Models

Creating scientific models (key features):

• **Components** (parts) needed to explain the phenomena.

• **Relationships** and/or **interactions** between the components.
  - What moves?
  - What changes?

• **Mechanisms** that account for relationships and/or interactions between components of the model (connections to science ideas).
Supporting Students in Developing Models

All-purpose back-pocket questions:

- What do you absolutely need to include model (parts/components) to explain the phenomenon?

- What is the relationship or interaction between component [x] and component [y]? How might you represent that?

- How or why are the components interacting (mechanism) in this way? How might you represent that?
Sensemaking Discussions

How can we support students in sensemaking discussions?
Each of the eight practices, as it is introduced and elaborated and experienced in the classroom, requires that students *externalize their reasoning*. It requires that they *work with the reasoning of other students*. …teacher and student talk is the *vehicle* by which every student can make his or her way into a deep and productive relationship with the science and engineering practices.
Productive Talk

Being able to identify and support productive talk is an important part of building a culture of equitable sensemaking.

Productive talk allows students to:

● make their thinking public
● reason about complex ideas
● develop arguments and evidence-based explanations
Goals for Productive Talk

- **Goal 1**: Help individual students share, expand, and clarify their own thinking
- **Goal 2**: Help students listen carefully to one another
- **Goal 3**: Help students deepen their reasoning
- **Goal 4**: Help students think with others
Goals and Talk Moves

Alone Zone

- Read through the Goals and Talk Moves Handout.
- Reflect: Have you observed an instance of one or more of these moves today?

<table>
<thead>
<tr>
<th>Productive Talk Goals and Moves</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal One: Help individual students share, expand, and clarify their own thinking</strong></td>
</tr>
<tr>
<td>1. Time to think: Partner talk; writing as think time; wait time</td>
</tr>
<tr>
<td>2. Say more: “Can you say more?”; “What do you mean by that?”; “Give an example”</td>
</tr>
<tr>
<td>3. So, are you saying...? “So, let me see if I’ve got what you’re saying. Are you saying...?” (always leaving space for the original student to agree or disagree and say more)</td>
</tr>
<tr>
<td><strong>Goal Two: Help students listen carefully to one another</strong></td>
</tr>
<tr>
<td>4. Who can rephrase or repeat?: “Who can repeat what Javan just said or put it into their own words?” (After a partner talk) “What did your partner say?”</td>
</tr>
<tr>
<td><strong>Goal Three: Help students deepen their reasoning</strong></td>
</tr>
<tr>
<td>5. Asking for evidence or reasoning: “Why do you think that?” “What’s your evidence?” “How did you arrive at that conclusion?”</td>
</tr>
<tr>
<td>6. Challenge or Counterexample: “Does it always work that way?” “How does that idea square with Sonia’s example?” “What if it had been a copper cube instead?”</td>
</tr>
<tr>
<td><strong>Goal Four: Help students think with others</strong></td>
</tr>
<tr>
<td>8. Add On: “Who can add onto the idea that Jamal is building?” “Can anyone take that suggestion and push it a little further?”</td>
</tr>
</tbody>
</table>

Other Observations:

Adapted from TERC (2012), Talk Science in the Inquiry Project
Goals and Talk Moves

Share with a partner:

- Which Goal (1, 2, 3, or 4) is most in use in your own classroom?
- Which Goal (1, 2, 3, or 4) is one you is newer to you?

### Productive Talk Goals and Moves

<table>
<thead>
<tr>
<th>Goal One: Help individual students share, expand, and clarify their own thinking</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Time to think:</strong> Partner talk; writing as think time; wait time</td>
<td></td>
</tr>
<tr>
<td>2. <strong>Say more:</strong> “Can you say more?”; “What do you mean by that?”; “Give an example”</td>
<td></td>
</tr>
<tr>
<td>3. <strong>So, are you saying...?</strong> “So, let me see if I’ve got what you’re saying. Are you saying...?” (always leaving space for the original student to agree or disagree and say more)</td>
<td></td>
</tr>
</tbody>
</table>

| Goal Two: Help students listen carefully to one another |
|---|---|
| 4. **Who can rephrase or repeat?** “Who can repeat what Javon just said or put it into their own words?” (After a partner talk) “What did your partner say?” |

| Goal Three: Help students deepen their reasoning |
|---|---|
| 5. **Asking for evidence or reasoning:** “Why do you think that?” “What’s your evidence?” “How did you arrive at that conclusion?” |
| 6. **Challenge or Counterexample:** “Does it always work that way?” “How does that idea square with Sonia’s example?” “What if it had been a copper cube instead?” |

| Goal Four: Help students think with others |
|---|---|
| 7. **Agree/Disagree and Why?** “Do you agree/disagree? (And why?)” “What do people think about what Ian said?” “Does anyone want to respond to that idea?” |
| 8. **Add On:** “Who can add onto the idea that Jamal is building?” “Can anyone take that suggestion and push it a little further?” |
| 9. **Explaining What Someone Else Means:** “Who can explain what Aisha means when she says that?” “Why do you think he said that?” |

Other Observations:

Adapted from TERC (2012), Talk Science in the Inquiry Project
Using the Talk Goals and Moves
Explore an Interesting Phenomenon

Make a chart on a blank page on the left side of your science notebook and record what you notice and wonder about.

<table>
<thead>
<tr>
<th>Mt. Everest Phenomena</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice</td>
</tr>
</tbody>
</table>

Watch these videos closely and record things you notice and wonder about.

- [Scary Day on Mt. Everest](#)
Scary Day on Mt. Everest

Michele Battelli
Climber

Smithsonian CHANNEL

- Scientists monitor using satellites (GPS)
- Everest has been moving NE at 4 cm/year
- Earthquake moved it 3 cm SW (same position as 9 months ago)
Explain how Everest grows and moves normally

Develop a model to show your thinking:

- How does Mt. Everest get 6-7 cm taller each year?
- How could Mt. Everest move to the northeast 4 cm each year?

<table>
<thead>
<tr>
<th>Mt. Everest Phenomena</th>
<th>Initial Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice</td>
<td></td>
</tr>
<tr>
<td>Wonder</td>
<td></td>
</tr>
</tbody>
</table>

Include words, pictures, and anything else to capture your thinking.
Observing Productive Talk

Record observations related to the Goals and Moves.

Video Context:
After previously creating individual models, students now share ideas and the class begins to develop their initial class consensus model. (Everest unit)

<table>
<thead>
<tr>
<th>Productive Talk Goals and Moves</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal One: Help individual students share, expand, and clarify their own thinking</strong></td>
<td></td>
</tr>
<tr>
<td>1. Time to think: Partner talk; writing as think time; wait time</td>
<td></td>
</tr>
<tr>
<td>2. Say more: “Can you say more?”; “What do you mean by that?”; “Give an example”</td>
<td></td>
</tr>
<tr>
<td>3. So, are you saying...? “So, let me see if I’ve got what you’re saying. Are you saying...?” (always leaving space for the original student to agree or disagree and say more)</td>
<td></td>
</tr>
<tr>
<td><strong>Goal Two: Help students listen carefully to one another</strong></td>
<td></td>
</tr>
<tr>
<td>4. Who can rephrase or repeat?: “Who can repeat what Javon just said or put it into their own words?” (After a partner talk) “What did your partner say?”</td>
<td></td>
</tr>
<tr>
<td><strong>Goal Three: Help students deepen their reasoning</strong></td>
<td></td>
</tr>
<tr>
<td>5. Asking for evidence or reasoning: “Why do you think that?” “What’s your evidence?” “How did you arrive at that conclusion?”</td>
<td></td>
</tr>
<tr>
<td>6. Challenge or Counterexample: “Does it always work that way?” “How does that idea square with Sonika’s example?” “What if it had been a copper cube instead?”</td>
<td></td>
</tr>
<tr>
<td><strong>Goal Four: Help students think with others</strong></td>
<td></td>
</tr>
<tr>
<td>8. Add On: “Who can add onto the idea that Jamal is building?” “Can anyone take that suggestion and push it a little further?”</td>
<td></td>
</tr>
</tbody>
</table>

Other Observations:

Adapted from TERC (2012), Talk Science in the Inquiry Project
Classroom Video Analysis

Alone Zone

- What talk moves do you notice from this video clip?
- What other strategies do you notice the teacher using?

Use the transcript as evidence of the talk or other moves.

Classroom Transcript: Make Sense of the Phenomenon

1. Teacher: Can somebody share out what they said was puzzling, but our partner said was puzzling about their model? As a way to show listening to our partners. [Student 1], go ahead.
2. Student 1: The tectonic plates make it grow bigger.
3. Teacher: What do you mean the tectonic plates?
4. Student 1: So how they shift and then points it up and the mountain forms?
5. Teacher: So I heard you say it was puzzling. And who did you say it was puzzling?
6. Student 1: [Student 2]
7. Teacher: Okay, so it was puzzling about tectonic plates you say? Great. Thank you for sharing about [Student 1].
8. Student 2: So this kind of I had two partners so both tectonic plates actually worked and like what they said.
9. Teacher: Okay, yeah. And to be honest with you too, the people saying, and looking at people’s initial is something we have to figure out about too. Go what did your partner say?
10. Student 3: I had two partners and [Student 4] said: though the mountain up because it would all call.
11. Teacher: Okay.
12. Student 3: And then [Student 4] said that it would be a raised mountain might go up a hill, and that’s how it’s right.
13. Teacher: Interesting. Those seem like different ideas. Right? And I see you guys laughing, why are you laughing?
14. Student 4: ‘Cause the ideas are not the best.
15. Teacher: Hold on a second, but we have to recognize, I know how this works. We have a lot of questions, different, are different ideas in our classroom.

Productive Talk Goals and Moves

<table>
<thead>
<tr>
<th>Goal</th>
<th>Observations</th>
</tr>
</thead>
</table>
| Goal One: Help students share, expand, and clarify their own thinking | 1. Time to think: Partner talk writing as think time; wait time.
| | 2. Say more: “I can say more?”; “What do you mean by that?”; “Give an example”.
| | 3. So, are you saying...? “So, let me see if I’ve got what you’re saying. Are you saying...?” (always leaving space for the original student to agree or disagree and say more).
| Goal Two: Help students listen carefully to one another | 4. Who can rephrase or repeat? “Who can repeat what Jason just said or put it into their own words?” (after a partner talk “What did your partner say?”)
| Goal Three: Help students deepen their reasoning | 5. Asking for evidence or reasoning: “Why do you think that? What’s your evidence? How did you arrive at that conclusion?”
| | 6. Challenge or Counterexample: “Does it always work that way?” “How does that idea work with our ideas?” “What if it had been a copper cube instead?”
| Goal Four: Help students think with others | 7. Agree/Disagree and Why?: “Do you agree/disagree? (And why?)” “What do people think about what I’m saying?” “Does anyone want to respond to that idea?”
| | 8. Add On: “Who can add onto the idea that...?” “Can anyone take that suggestion and push it a little further?”

Other Observations:

Adapted from TEIC (2012), Talk Science in the Inquiry Project.
Teacher: Interesting. Those seem like different ideas. Right. And that’s interesting and puzzling too, right?
Observing Productive Talk

Small Group:

- What talk moves do you notice from this video clip?
- What other strategies did you notice the teacher using?
- How did the talk moves and other strategies support all students in engaging in equitable sensemaking?
Observing Productive Talk

Small Group:

- What talk moves do you notice from this video clip?
- What other strategies did you notice the teacher using?
- How did the talk moves and other strategies support all students in engaging in equitable sensemaking?

Whole Group:

- Share some key ideas from your small group
Rationale for Talk Moves
Teacher Interview

Day 3: Teacher Reflecting on Discourse Norms - Curriculum Launch PL

A teacher reflects on her experience establishing classroom norms to support group discussion. This video is used in the Curriculum Launch teacher professional learning.

This video is part of the OpenSciEd Middle School Science Curriculum. For more information and to find the entire curriculum, visit www.openscied.org
Reflecting on Talk Moves and Other Strategies

What are talk moves and/or strategies you would like to try to support productive talk in your own classroom? Why?
In this video, a whole class is engaged in a scientist circle in Lesson 1 of Forces at a Distance. The class is ... In the PD, the video is used to look for specific examples of the 4 features of classroom culture that support equity.

This video is part of the OpenSciEd Middle School Science Curriculum. For more information and to find the entire curriculum, visit www.openscied.org
Equitable Sensemaking PD - 2.3 Teacher Reflection on Classroom Culture

This video includes an interview with a Forces at a Distance teacher about classroom culture. Videos of this teacher's lessons will also be used to facilitate discussion of goals and strategies for classroom culture in the next school year.

This video is part of the OpenSciEd Middle School Science Curriculum. For more information and to find the entire curriculum, visit www.openscied.org

Watch 0:47 - 2:26
https://youtu.be/E4NNvHbfYMw?si=TwDJB9lReyLLjkr

by
Sensemaking - High School Example

Lesson Plan

Why Don't the Dishes Move?
Student Hat/Teacher “Hat”

Student Hat: Think like a student.

Student/Teacher Hat: Think like a student, but note teacher guidance.

Teacher “Hat”: Reflect on student experience and educator moves.
Learning Community Discourse Norms

- We use and build on other’s ideas.
- We use evidence to support our ideas, ask for evidence from others, and suggest ways to get additional evidence.
- We are open to changing our minds.
- We challenge ourselves to think in new ways.

From *OpenSciEd Classroom Norms*
Mat Ricardo's Tablecloth trick v3.0

After creating my signature reverse tablecloth pull decades ago, I thought it was time to go one step further...

More about me at www.MatRicardo.com

Subscribe to see my newest tricks, shows and adventures!

https://youtu.be/o94Pm-Cty3M
Mat Ricardo's Tablecloth trick v3.0

After creating my signature reverse tablecloth pull decades ago, I thought it was time to go one step further...

More about me at www.MatRicardo.com

Subscribe to see my newest tricks, shows and adventures!
What do you notice? Wonder?

Partner Talk
Share with your partner
✔ Two observations
✔ One question
## Class Notice and Wonder

<table>
<thead>
<tr>
<th>Notice</th>
<th>Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both tables have dishes, cups, vases and a teapot.</td>
<td>• Are all the items on the table empty?</td>
</tr>
<tr>
<td>• Nothing fell off the table</td>
<td>• Why did everything stay on the table?</td>
</tr>
<tr>
<td>• Table setting of right table “mirror”/opposite of left table</td>
<td>• Why didn’t the tablecloth drag everything off the table?</td>
</tr>
<tr>
<td>• Everything on the tables moved slightly, in the same direction as the</td>
<td>• Does the material of the tablecloth matter for the trick?</td>
</tr>
<tr>
<td>tablecloth moved</td>
<td>• Does how fast he pulls the tablecloth matter?</td>
</tr>
<tr>
<td>• The tablecloth is made of a shiny material.</td>
<td>• Why did some things move further than others?</td>
</tr>
<tr>
<td>• The magician pulled the tablecloth fast.</td>
<td>• Did the things that moved further weigh less? (Were they empty?)</td>
</tr>
<tr>
<td>• Some of the things on the table moved further than others.</td>
<td></td>
</tr>
</tbody>
</table>

Many of us are wondering why the objects stayed on the table. Should we investigate this first?
Coin in the Cup Investigation

Do you think we can explain the coin in the cup trick using our knowledge of forces?

What forces are acting on the penny in the vertical direction in each of the pictured instances?
### Coin in the Cup Investigation

#### Notice
- Both tables have dishes, cups, vases and a teapot.
- Nothing fell off the table.
- Table setting of right table “mirror”/opposite of left table.
- Everything on the tables moved slightly, in the same direction as the tablecloth moved.
- The tablecloth is made of a shiny material.
- The magician pulled the tablecloth fast.
- Some of the things on the table moved further than others.

#### Wonder
- Are all the items on the table empty?
- Why did everything stay on the table?
- Why didn’t the tablecloth drag everything off the table?
- Does the material of the tablecloth matter for the trick?
- Does how fast he pulls the tablecloth matter?
- Why did some things move further than others?
- Did the things that moved further weigh less?
**Coin in the Cup Investigation**

Can we use the cup, index card and penny (coin) to help explain other observations?

<table>
<thead>
<tr>
<th>Notice</th>
<th>Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both tables have dishes, cups, vases and a teapot.</td>
<td>• Are all the items on the table empty?</td>
</tr>
<tr>
<td>• Nothing fell off the table</td>
<td>• Why did everything stay on the table?</td>
</tr>
<tr>
<td>• Table setting of right table “mirror”/opposite of left table</td>
<td>• Why didn’t the tablecloth drag everything off the table?</td>
</tr>
<tr>
<td>• Everything on the tables moved slightly, in the same direction as the tablecloth moved.</td>
<td>• Does the material of the tablecloth matter for the trick?</td>
</tr>
<tr>
<td>• The tablecloth is made of a shiny material.</td>
<td>• Does how fast he pulls the tablecloth matter?</td>
</tr>
<tr>
<td>• The magician pulled the tablecloth fast.</td>
<td>• Why did some things move further than others?</td>
</tr>
<tr>
<td>• Some of the things on the table moved further than others.</td>
<td>• Did the things that moved further weigh less?</td>
</tr>
</tbody>
</table>
Change the End Position of the Penny

Scenario 1

Partner Talk
Can you modify the *Coin in the Cup* trick to end with the penny in each of these three positions?

How did you do it?

Scenario 2

Scenario 3
Identify Patterns

**Alone Zone** (Reflection)

- Which of the four penny outcomes was closest to what you observed in the tablecloth trick?
- In which case did the sliding card cause the greatest change in the horizontal motion of the penny?
- In which case did the sliding card cause the least change in the horizontal motion of the penny?
- Can you identify a pattern we could use to predict how far the penny will move in the horizontal direction when the card is slid beneath it?
Identify Patterns

Small Group

• Share the pattern you identified that we could use to predict how far the **penny will move** in the **horizontal direction** when the card is slid beneath it.

• Provide feedback to group members
  o What do you mean when you say…?  
  o Are you saying…? That makes me think…
Identify Patterns

Small Group

• Share the pattern you identified that we could use to predict how far the **penny will move** in the **horizontal direction** when the card is slid beneath it.

• Provide feedback to group members
  o What do you mean when you say…? 
  o I hear you say… That makes me think…

• Reach consensus on a pattern to share with the whole group.
Identify Patterns

Whole Group Gallery Walk

Observe the pattern each group identified that could be used to predict how far the \textbf{penny will move} in the \textbf{horizontal direction} when the card is slid beneath it.

- As you view the posted patterns, notice and record:
  - What is the same about our patterns?
  - What is different about our patterns?
- Be prepared to share what you heard that was the same and different.
Identify Patterns

Whole Group
How might you describe or revise your pattern if you think about how long \((\text{time})\) the card pulls or pushes on the penny in the horizontal direction?
Identify Patterns

Whole Group
How might you describe or revise your pattern if you think about how long (*time*) the card pulls or pushes on the penny in the horizontal direction?

Using the Language of Mathematics
How might we communicate this same relationship mathematically?
The longer time the card is pulling (or pushing) on the penny, the farther the penny moves in the horizontal direction.

Using the Language of Mathematics
How might we communicate this same relationship mathematically?

What is a rule that could mathematically describe what effects how far the penny moves in the horizontal direction?
The *Real* Physics of the “Tablecloth Trick”
<table>
<thead>
<tr>
<th>Notice</th>
<th>Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both tables have dishes, cups, vases and a teapot.</td>
<td>• Are all the items on the table empty?</td>
</tr>
<tr>
<td>• Nothing fell off the table</td>
<td>• Why did everything stay on the table?</td>
</tr>
<tr>
<td>• Table setting of right table “mirror”/opposite of left table</td>
<td>• Why didn’t the tablecloth drag everything off the table?</td>
</tr>
<tr>
<td>• Everything on the tables moved slightly, in the same direction as</td>
<td>• Does the material of the tablecloth matter for the trick?</td>
</tr>
<tr>
<td>the tablecloth moved.</td>
<td>• Does how fast he pulls the tablecloth matter?</td>
</tr>
<tr>
<td>• The tablecloth is made of a shiny material.</td>
<td>• Why did some things move further than others?</td>
</tr>
<tr>
<td>• The magician pulled the tablecloth fast.</td>
<td>• Did the things that moved further weigh less?</td>
</tr>
<tr>
<td>• Some of the things on the table moved further than others.</td>
<td></td>
</tr>
</tbody>
</table>

How might we investigate?
Crosscutting Concepts

Recurring Themes and Concepts

This resource addresses the recurring themes and concepts through the lenses of both scientists and engineers. Scientists seek to develop scientific explanations, and engineers seek to develop designed solutions. The recurring themes and concepts provide a connective structure that supports students' understanding of science and the application of science through engineering.

The K-12 recurring themes and concepts strand introduces and spirals the recurring themes throughout each grade level's Texas Essential Knowledge and Skills (TEKS). In high school, the recurring themes and concepts connections are addressed more broadly to include structure and function, systems, models, and patterns. The high school course introductions explain that all systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. Models have limitations but provide a tool for understanding the ideas presented. Scientists and engineers analyze a system in terms of its components and how they relate to each other, the whole, and the external environment.

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Scientists</th>
<th>Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scientists questions may be generated when scientists observe a pattern of events or when something does not match an established pattern. Scientists can use patterns to classify objects or phenomena, for example, day and night, moon phases, life cycles, or other repeating designs.</td>
<td>Engineering use scientific knowledge to develop or improve objects, systems, or processes. Engineers use patterns found in scientific data to make data-informed decisions during the engineering design process. Engineers may diagnose patterns of failure in a designed system and improve the design or analyze patterns such as daily and seasonal use of power to design a system that can meet fluctuating needs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause and Effect Relationships</th>
<th>Scientists</th>
<th>Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause and effect relationships are relationships between two or more variables or phenomena whereby one variable or event leads to a predictable response. Events have causes, sometimes simple, sometimes multifaceted.</td>
<td>Scientists attempt to uncover and understand cause-and-effect relationships through scientific investigations. Scientists analyze the causes of the patterns they observe, including how and why phenomena occur and if the occurrence of the patterns are conditional. For example, scientists investigate cause and effect mechanisms in the motion of a single object, specific chemical reactions, population changes in an ecosystem or a society, and the development of holes in the polar ozone layers.</td>
<td>In engineering, the goal is to design a system to cause the desired effect. Engineers must understand the underlying causal relationships to devise and explain a design that can achieve a specified objective. They seek answers to the questions that explain system relationships. Engineers analyze how particular elements affect the functionality and cost of a design. The application's quality or solution can often be improved as knowledge of the relevant relationship is improved.</td>
</tr>
</tbody>
</table>

Resource #1

Resource #3

This toolkit was created for Lone Star STEM, a partnership between TEA, JFF, and UT Austin, funded by USDOE.
# Building Ownership of Science Ideas

## PS2: Motion and Stability: Forces and Interactions

<table>
<thead>
<tr>
<th>Grades K–2</th>
<th>Grades 3–5</th>
<th>Grades 6–8</th>
<th>Grades 9–12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PS2.A: Forces and Motion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-PS2-2)</td>
<td>• Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative, addition of forces are used at this level.) (3-PS2-1)</td>
<td>• For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law). (MS-PS2-1)</td>
<td>• Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)</td>
</tr>
<tr>
<td>• Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2)</td>
<td>• The patterns of an object’s motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)</td>
<td>• The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)</td>
<td>• Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS-PS2-2)</td>
</tr>
<tr>
<td>• All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)</td>
<td></td>
<td></td>
<td>• If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2), (HS-PS2-3)</td>
</tr>
</tbody>
</table>
What is Sensemaking?

Small Group

Revisit your initial ideas about sensemaking.

- What ideas might you want to add?
- What ideas might you want to say more about?
- What ideas might you want to change?
What is Sensemaking?

Whole Group Gallery Walk

● Observe each group’s poster.

● What are some patterns in our ideas about how we describe sensemaking?
### Collection of Resources

**Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning Collection**

- PRIVATE
- 4 items
  - Earth & Space Science
  - Environmental Science
  - Life Science
  - Physical Science
  - Elementary
  - High School
  - Kindergarten

### Resources in “Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning” Collection

<table>
<thead>
<tr>
<th>Title</th>
<th>Resource Type</th>
<th>Open in Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  A Framework for K-12 Science Education (pdf)</td>
<td>Web Page</td>
<td>Open in Library</td>
</tr>
</tbody>
</table>

- Adapted from A Framework for K-12 Science Education and Appendix F of the Next Generation Science Standards

Welcome!

Making Sense of Three-Dimensional Teaching and Learning

Day 2

June 18 and 19, 2024
## Where We’re Headed Today…

<table>
<thead>
<tr>
<th>Segment 1</th>
<th>8:30-8:45</th>
<th>Looking Back/Looking Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment 5</td>
<td>8:45 -9:45</td>
<td>Phenomena-Driven Instruction</td>
</tr>
<tr>
<td>Segment 6</td>
<td>9:45 - 11:45</td>
<td>Experience Sensemaking (Coherence from the Student’s Perspective) 15-minute break</td>
</tr>
<tr>
<td>Segment 6</td>
<td>11:45-12:30</td>
<td>Experience Sensemaking (continued)</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:30– 1:30</td>
<td></td>
</tr>
<tr>
<td>Segment 7</td>
<td>1:30– 2:40</td>
<td>Evaluate Student Artifacts Provide Feedback to Students</td>
</tr>
<tr>
<td>Segment 1</td>
<td>2:40 - 3:30</td>
<td>Reflecting on Ideas about Sensemaking Close Day 2</td>
</tr>
</tbody>
</table>
Collection of Resources

Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning Collection

PRIVATE
4 items

Earth & Space Science  Environmental Science  Life Science  Physical Science  Elementary
High School  Kindergarten

Resources in “Texas ESC Region 4 Making Sense of Three-Dimensional Teaching and Learning” Collection

<table>
<thead>
<tr>
<th>Title</th>
<th>Resource Type</th>
<th>Open in Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Framework for K-12 Science Education (pdf)</td>
<td>Web Page</td>
<td></td>
</tr>
<tr>
<td>Matrix for K-12 Learning Progression of Science and Engineering Practices</td>
<td>Web Page</td>
<td></td>
</tr>
</tbody>
</table>

bit.ly/TXRegion4
Our Ideas about Sensemaking

- Trying to figure out real-world, making connections
- Question, Investigate, Data, Evidence, Argument
- Thinking through it until it makes sense; learning from each other, multiple ways to learn, writing our thoughts
- Building concepts over time
- Teacher as facilitator, specific intended learning
Students experience a phenomenon;

engage in science and engineering practices and

share ideas to develop or apply the

science ideas and recurring themes and concepts (aka crosscutting concepts) needed to explain how or why the phenomenon occurs.
### Class Notice and Wonder

<table>
<thead>
<tr>
<th>Notice</th>
<th>Wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both tables have dishes, cups, vases and a teapot.</td>
<td>• Are all the items on the table empty?</td>
</tr>
<tr>
<td>• Nothing fell off the table</td>
<td>• Why did everything stay on the table?</td>
</tr>
<tr>
<td>• Table setting of right table “mirror”/opposite of left table</td>
<td>• Why didn’t the tablecloth drag everything off the table?</td>
</tr>
<tr>
<td>• Everything on the tables moved slightly, in the same direction as</td>
<td>• Does the material of the tablecloth matter for the trick?</td>
</tr>
<tr>
<td>the tablecloth moved</td>
<td>• Does how fast he pulls the tablecloth matter?</td>
</tr>
<tr>
<td>• The tablecloth is made of a shiny material.</td>
<td>• Why did some things move further than others?</td>
</tr>
<tr>
<td>• The magician pulled the tablecloth fast.</td>
<td>• Did the things that moved further weigh less?</td>
</tr>
<tr>
<td>• Some of the things on the table moved further than others.</td>
<td></td>
</tr>
</tbody>
</table>

How might we investigate?
Mat Ricardo's Tablecloth trick v3.0

After creating my signature reverse tablecloth pull decades ago, I thought it was time to go one step further...

More about me at www.MatRicardo.com

Subscribe to see my newest tricks, shows and adventures!
Using Mathematics and Computational Thinking

Mathematics and computation offer special ways to propose and investigate scientific relationships and to make predictions.

By exploring how mathematics and computation represent scientific ideas and help them become more precise, students can begin to understand how even the most complex mathematical formulas or computer simulations are fundamentally connected to observations, experiences, and ideas about the world around us and help us explain the natural and designed world.
Crosscutting Concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change
Reshaping

How did you experiences with this science idea today compare to your own school experiences with this science idea or similar ones?

THE FORCE DURING AN IMPACT IS INVERSELY PROPORTIONATE TO THE DURATION OF THE IMPACT.

When two objects collide, they apply forces to each other during the collision. The briefer the collision, the greater the forces they apply. The duration of the collision is often determined by the rigidity of the colliding objects: The more rigid they are, the shorter the duration of the impact. Why does it hurt more when you fall on a concrete floor than on a mattress? Because the mattress is padded (soft) and you do not stop suddenly when you fall on it but instead slow down gradually as the mattress deforms. By lengthening the time it takes you to stop (the duration of the impact), the force you apply to the mattress (and the mattress to you) becomes much smaller—small enough to keep you from getting hurt. Why do you bend your knees when landing after jumping? By bending your knees, you are instinctively lengthening the duration of the interaction between you and the ground, thereby decreasing the force of the impact and protecting your body. You can also apply these ideas to explain why we should wear seat belts when driving in a car or bicycle helmets when riding a bike.
Does our pattern (mathematical model) predict an object’s change in motion in the vertical direction?
In what ways did doing science and using patterns and cause and effect help you build pieces of the science ideas that explain the tablecloth trick?
What are phenomena?

Natural phenomena are *observable events* that *occur in the universe* and that we can use our *science knowledge to explain or predict*.

The goal of building knowledge in science is to develop general ideas, based on evidence, that can explain and predict phenomena.

- STEM Teaching Tool #42
Phenomena

- Seeds germinate
- Ice melts faster on metal than plastic
Think about the students in the bean video and your own experience with phenomena in our two lesson immersions.

How did experiencing the phenomenon create for you a need to engage in sensemaking?
We have questions!

How do kidney beans become plants?

Why did the helium balloon rise and fall?

Why don’t the dishes move off the table with the tablecloth?
Shifting Toward Sensemaking

Students sensemaking in a 4th-grade classroom.
Continuum of Science Instruction

Information Frame
• Teacher is focused on disseminating information.
• Students are focused on knowing information.
• Science is portrayed as a body of established facts.
• Assessments are focused on “right” answers.

Knowing about...

Sensemaking Frame
• Teacher is focused on developing conceptual understanding.
• Students are focused on understanding something.
• Science is portrayed as a way to make sense of something.
• Assessments are focused on use of evidence to support conclusions/generalizations.

Figuring out…
Continuum of Science Instruction

**Information Frame**
- Teacher is focused on disseminating
- Science is portrayed as a body of established facts.
- Assessments are focused on “right” answers.

**Sensemaking Frame**
- Teacher is focused on developing conceptual
- Science is portrayed as a way to make sense of something.
- Assessments are focused on use of evidence to support conclusions/generalizations.

**Knowing about..**
**Figuring out...**

From: Cynthia Passmore, NSTA Virtual PD, Nov. 15, 2014
Shifting Toward the Sensemaking

Information Frame  Sensemaking Frame

Less Like  More Like

Soils, Rocks, and Landforms
Choosing Phenomena

What phenomenon can I put in front of students that will get them to ask questions that require the targeted science ideas to answer?

That is, what phenomenon requires the targeted science ideas to explain how or why the phenomenon occurs?
Shifting Toward the Sensemaking

Information Frame

Sensemaking Frame

Less Like

More Like

Soils, Rocks, and Landforms
INVESTIGATIONS GUIDE

nsta
Phenomenon: Channeled Scablands

Video clip 02:56 – 04:52

https://vimeo.com/331335155
Phenomenon: Channeled Scablands

Alone Zone
What experiences do you have that might help you think about the Channeled Scablands phenomenon?
Where have you experienced something that reminds you of this phenomenon (the experience is similar but not quite the same)?

Whole Group
Please share your experience(s) with related phenomena.
Wonderings

• Review your own observations and the observations shared.

• Think about your own and shared related phenomena.

• Review the questions you recorded in the “I wonder” column of your table.

• Add new questions and/or revise questions you recorded while watching the video of the Channeled Scablands.

• Choose one or two questions that you think could most help us figure out the Channeled Scablands.
Phenomenon: Channeled Scablands

Video clip 02:56 – 04:52

https://vimeo.com/331335155
Targeted ESS Disciplinary Core Ideas

ESS1: Earth’s Place in the Universe

ESS1.C: The History of Planet Earth
- Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the

ESS2: Earth’s Systems

ESS2.A: Earth Materials and Systems
- Rainfall helps to shape the land and affects the number of living things found in a region. Water, ice, wind, living organisms, and gravity breaks rocks,
Targeted ESS Disciplinary Core Ideas

ESS1: Earth’s Place in the Universe

ESS1.C: The History of Planet Earth

- Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence of certain fossil types indicates the order in which rock layers were formed.

Do we need these science ideas to answer our questions about the Channeled Scablands?

ESS2.A: Earth Materials and Systems

- Rainfall helps to shape the land and affects the distribution of living things found in a region. Water, ice, wind, living organisms, and gravity breaks rocks, soils,
Phenomena

Using Phenomena in NGSS-Designed Lessons and Units

WHAT ARE PHENOMENA IN SCIENCE AND ENGINEERING?

- Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. The goal of building knowledge in science is to develop general ideas, based on evidence, that can explain and predict phenomena.
- Engineering involves designing solutions to problems that arise from phenomena, and using explorations of phenomena to design solutions.
- In this way, phenomena are the context for the work of both the scientist and the engineer.

WHY ARE PHENOMENA SUCH A BIG DEAL?

- Despite their centrality in science and engineering, phenomena have traditionally been a missing piece in science education, which often has focused on teaching general knowledge that students can have difficulty applying to real-world contexts.
- Anchoring learning in explaining phenomena supports student agency for wanting to build science and engineering knowledge. Students are able to identify an answer to “why do I need to learn this?” before they even know what the “this” is. In contrast, students might not understand the importance of learning science ideas that teachers and curriculum designers know are important but that are disconnected from phenomena.
- By centering science education on phenomena that students are motivated to explain, the focus of learning shifts from learning about a topic to figuring out why or how something happens. For example, instead of simply learning about the topics of photosynthesis and mitosis, students are engaged in building evidence-based explanatory ideas that help them figure out how a tree grows.
- Explaining phenomena and designing solutions to problems allow students to build general science ideas in the context of their application to understanding phenomena in the real world, leading to deeper and more transferable knowledge.
- Students who come to see how science ideas can help explain and model phenomena related to competing real-world situations learn to appreciate the social relevance of science. They get interested in and identify science as a way of understanding and improving real-world contexts.
- Focusing investigations on explaining phenomena can help sustain students’ science learning.

HOW ARE PHENOMENA RELATED TO THE NGSS AND THREE-DIMENSIONAL LEARNING?

- The Next Generation Science Standards (NGSS) focus on helping students use science to make sense of phenomena in the natural and designed world, and use engineering to solve problems.
- Learning to explain phenomena and solve problems is the central reason students engage in the three dimensions of the NGSS. Students explain phenomena by developing and applying the Disciplinary Core Ideas (DCIs) and Crosscutting Concepts (CCCs) through use of the Science and Engineering Practices (SEPs).
- Phenomena-centered classrooms also give students and teachers a context in which to monitor ongoing progress toward understanding all three dimensions. As students are working toward being

understanding of DCI ESS1.A, which, at the 5th grade level, focuses on the relationship between star brightness and distance from Earth.

- The process of developing an explanation for a phenomenon should advance students’ understandings. If students already need to know the target knowledge before they can inquire about the phenomenon, then the phenomenon is not appropriate for initial instruction (although it might be useful for assessment).
- Students should be able to make sense of anchoring or investigative phenomenon, but not immediately, and not without investigating it using sequences of the science and engineering practices. With instruction and guidance, students should be able to figure out, step by step, how and why the phenomenon works.
- An effective phenomenon does not always have to be flashy or unexpected. Students might not be intrigued by an everyday phenomenon right away because they believe they already know how or why it happens. It takes careful teacher facilitation to help students become dissatisfied with what they can explain, helping them discover that they really can’t explain it beyond a simple statement.

aka because it condenses.

- Authentic engagement does not have to be fun or flashy. Instead, engagement is determined more by how the students generate compelling lines of inquiry that create real opportunities for learning.
- Students need to be able to engage deeply with the material in order to generate an explanation of the phenomenon using target DCIs, CCCs, and SEPs.
- Phenomena (e.g., a sunburn, vision loss) are specific examples of something in the world that is happening—an event or a specific example of a general process. Phenomena are NOT the explanations or scientific terminology behind what is happening. They are what can be experienced or documented.
- Phenomena can drive the lesson, learning, and reflection/monitoring throughout. Using phenomena in these ways leads to deeper learning.
- Teaching science ideas in general (e.g., teaching about the process of photosynthesis) may work for some students, but often leads to decontextualized knowledge that students are unable to apply when relevant. Anchoring the development of general science ideas in investigations of phenomena helps students build more usable and generative knowledge.
- Phenomena are observable occurrences. Students need to use the occurrence to help generate the science questions or design problems that drive learning.
- Engagement is a crucial access and equity issue. Students who do not have access to the material in a way that makes sense and is relevant to them are disadvantaged. Selecting phenomena that students find interesting, relevant, and consequential helps support their engagement. A good phenomenon builds on everyday or family experiences: who students are, what they do, where they came from.

Resource #5
<table>
<thead>
<tr>
<th>Prior Thinking About Phenomena</th>
<th>Thinking About Phenomena Through the NGSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>If it’s something fun, flashy, or involves hands-on activities, it must be engaging.</td>
<td>Authentic engagement does not have to be fun or flashy; instead, engagement is determined more by how the students generate compelling lines of inquiry that create real opportunities for learning.</td>
</tr>
<tr>
<td>Anything students are interested in would make a good “engaging phenomenon”</td>
<td>Students need to be able to engage deeply with the material in order to generate an explanation of the phenomenon using target DCIs, CCCs, and SEPs.</td>
</tr>
<tr>
<td>Explanations (e.g., “electromagnetic radiation can damage cells”) are examples of phenomena</td>
<td>Phenomena (e.g., a sunburn, vision loss) are specific examples of something in the world that is happening—an event or a specific example of a general process. <em>Phenomena are NOT the explanations or scientific terminology behind what is happening. They are what can be experienced or documented.</em></td>
</tr>
<tr>
<td>Phenomena are just for the initial hook</td>
<td>Phenomena can drive the lesson, learning, and reflection/monitoring throughout. Using phenomena in these ways leads to deeper learning.</td>
</tr>
<tr>
<td>Phenomena are good to bring in after students develop the science ideas so they can apply what they learned</td>
<td>Teaching science ideas in general (e.g., teaching about the process of photosynthesis) may work for some students, but often leads to decontextualized knowledge that students are unable to apply when relevant. Anchoring the development of general science ideas in investigations of phenomena helps students build more usable and generative knowledge.</td>
</tr>
<tr>
<td>Engaging phenomena need to be questions</td>
<td>Phenomena are observable occurrences. Students need to <em>use the occurrence to help generate the science questions or design problems that</em> drive learning.</td>
</tr>
<tr>
<td>Student engagement is a nice optional feature of instruction, but is not required</td>
<td>Engagement is a crucial access and equity issue. Students who do not have access to the material in a way that makes sense and is relevant to them are disadvantaged. Selecting phenomena that students find interesting, relevant, and consequential helps support their engagement. A good phenomenon builds on everyday or family experiences: who students are, what they do, where they came from.</td>
</tr>
</tbody>
</table>
Choose one characteristic/description of thinking about phenomena that resonates with you.

How does the Channeled Scablands phenomenon exemplify this characteristic/description?

Be ready to share the connection you made between the description (#) and your experience with Channeled Scablands phenomenon.
Choose one characteristic/description of thinking about phenomena that resonates with you.

How does the Channeled Scablands phenomenon exemplify this characteristic/description?

Be ready to share the connection you made between the description (#) and your experience with Channeled Scablands phenomenon.
Phenomena: Equity

• Students have a common experience with the phenomenon (no one student is at an advantage or disadvantage).

• Students connect to the phenomenon through their experience with related phenomena.

• Students’ experience with related phenomena valued by learning community.

• In trying to explain the phenomenon, students recognize gaps in their knowledge which leads to questions they want to answer.
The point of using phenomena to drive instruction is to help students engage in practices to develop the knowledge necessary to explain or predict the phenomena.

It is the **phenomenon plus the student-generated questions** about the phenomenon **that guides the learning and teaching.**

STEM Teaching Tool 42
Alone Zone

Look and listen for evidence that students have been/are currently focused on explaining the phenomenon of the Channeled Scablands.

How is the teacher supporting students in tracking their own progress in explaining the phenomenon over time?
Sensemaking: Putting the Pieces Together
Phenomena and Coherence

Anchor Phenomenon

Investigative Phenomenon

Related Phenomenon

3D

The Story

Questions

Phenomena

Practices to Engage In

What We Figure Out
Students Build Understanding Piece by Piece
High Quality Instructional Materials

https://www.openscied.org/curriculum/

https://www.nextgenscience.org/resources/examples-quality-ngss-design?page=0

https://www.colorado.edu/program/inquiryhub/curricula

https://sprocket.educurious.org/home/curriculum
High Quality Instructional Materials (HQIM)

https://www.openscienced.org/curriculum/

https://www.nextgenscience.org/resources/examples-quality-ngss-design?page=0

Additional high quality instructional materials included in the collection of resources bit.ly/TXRegion4 (all labeled #20)

https://www.colorado.edu/program/inquiryhub/curricula

https://sprocket.educurious.org/home/curriculum
Lesson 1

Next Generation Science Storylines

Storylines
WHY DON'T ANTIBIOTICS WORK LIKE THEY USED TO?
HOW CAN SCIENCE HELP MAKE OUR LIVES BETTER?
HOW DO SMALL CHANGES MAKE BIG IMPACTS ON ECOSYSTEMS? (PART 1)
HOW DO SMALL

Why Do Dead Things Disappear Over Time?
[v1.4]

Unit Skeleton <
Lessons <
Material & Supply List <

Synopsis

https://www.nextgenstorylines.org/why-do-dead-things-disappear-over-time
Introducing an Interesting Phenomenon
Related Phenomena

- Flat rat
- Newborn mouse / see through skin
- Rat in the street w/ bones
- Fish in grass it was flat
- Squished squirrels in road w/ bones
- Squirrel on sidewalk could see insides
- Could see white worms in fur & inside
- 3 baby birds on sidewalk
- Big bird at park
- Dead chicken on hay
- Rat with hole in it, with insides out
- Rat flies all over
Developing an Initial Model

Use the Initial Model handout to draw and label your predictions of what you think the raccoon and surrounding area will look like over time. Include your thinking behind what is causing it to look the way you drew it.

<table>
<thead>
<tr>
<th>Q1: INITIAL MODEL</th>
<th>Draw and label your predictions of what you think the raccoon and the surrounding area will look like over time.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Raccoon and surrounding area after 2 days</strong></td>
<td><strong>Raccoon and surrounding area after 2 weeks (64 days)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What will cause it to look this way?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What will cause it to look this way?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What will cause it to look this way?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Q1) Draw and label your predictions of what you think the raccoon and the surrounding area will look like over time.

Raccoon after 2 days
- Stink

Raccoon after 2 weeks (14 days)
- Stink
- Spider
- Bee
- Fly

Raccoon after 2 months (~60 days)
- People
- Stink
- Big
- Fly
- Fly
- Bee
- Spider

What will cause it to look this way?
- The weather is poor and flies have noticed the stink.

What will cause it to look this way?
- It has been exposed for a long time and the smell gets stronger.
- Other insects have noticed it and more is getting ripped up.

What will cause it to look this way?
- It has been too long and now many other animals have found it.
Q1) Draw and label your predictions of what you think the raccoon and the surrounding area will look like over time.

Raccoon after 2 days

Raccoon after 2 weeks (14 days)

Raccoon after 2 months (~60 days)

What will cause it to look this way?

Because it just died but flies like cats.

What will cause it to look this way?

Movers are moving the raccoon away.

What will cause it to look this way?

There is no more raccoon.

Factory

Machine

Raccoon
Q1) Draw and label your predictions of what you think the raccoon and the surrounding area will look like over time.

**Raccoon after 2 days**

What will cause it to look this way?

The flies have broken it open and eaten the flesh inside of the raccoon.

**Raccoon after 2 weeks (14 days)**

What will cause it to look this way?

Then the raccoon rots and it gets infected so all of its fur is now gone on it's stomach.

**Raccoon after 2 months (~60 days)**

What will cause it to look this way?

The raccoon has now gone underground.
G. Turn and Talk

With a partner: How might the raccoon body change over time differently if you found the raccoon body on a different surface, like dirt or grass, or in a different area?

Why?

Be prepared to discuss with the class.
Something Seems Strange

We do know that everything dies eventually, yet we don’t see dead wildlife or plant lying around everywhere.

Are the bodies just disappearing? Or do the bodies go somewhere?
Do they get picked up by garbage men or special animal people?
What animals eat dead things?
Do some insects like dead animals? Why?
Would something different happen if the dead animal is on dirt vs. concrete?
Would something different happen if it’s in water or under a shelter or in a container?
Does temperature affect how fast a dead body changes?
Would big animals take longer to disappear?
Where should we go next?

Investigation Ideas

(To gather evidence for what happens to the body of a dead animal over a couple days or weeks)

- Field trip - pictures over time
- Bring dead animal into classroom
- Go pro in tree...
- Soil + dead fly in a cup - watch over time
- Put a rat trap out to catch a rat + observe
- Internet: look for pics + videos safest + legal!
- Soil + worms...
One of the goals of Lesson 1 is to raise at least a few different competing ideas for what happened to the raccoon.
Lesson 2

Storylines

Why don't antibiotics work like they used to?

How can science help make our lives better?

How do small changes make big impacts on ecosystems? (Part 1)

How do small

Why Do Dead Things Disappear Over Time? [v1.4]

UNIT SKELETON <

LESSONS <

MATERIAL & SUPPLY LIST <

SYNOPSIS

https://www.nextgenstorylines.org/why-do-dead-things-disappear-over-time
A. Revisiting the Dead Animal

Recap:
- What were we trying to figure out about this dead animal?
- How did we think we could investigate this?

Investigation Ideas:
- Field trip - pictures over time
- Bring dead animal into classroom
- Go Pro in tree...
- Soil + dead fly in a cup - watch over time
- Put a rat trap out to catch a rat to observe
- Internet: look for pics + videos safest + legal!
B. Sharing Initial Ideas

Share Out:
● What do you notice and wonder as you watch the video?
● What patterns did you observe over time?
Dead badger picked clean

A time-lapse video of a roadkill badger being recycled. Different speeds. One or two gaps. Natural light.

(Warning: British law says you shouldn't remove dead badgers from roads. If you do and you are found in possession of the badger's corpse, you might be prosecuted for badger-baiting. Daft? Yes. Take it seriously? Yes.)
C. Making Sense

Initial Model:

- How does the animal change?
- Why is it changing? In other words, what are the causes for the changes to occur?

Be prepared to share.
Prepare to compare any similarities and differences between the models that explain what is happening to the dead badger and the causes behind those changes.

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
E. Comparing Models

**Small Group Talking Stick Round 1:**
- Take your model and your Student Activity Sheet with you and meet with the small group you are assigned to.
- When given the start signal, pass around a pencil as talking stick to take turns having each person use their models to explain their answer to the question [1 minute per person].
- As each person shares, think about how this compares with other models you’ve seen (including your own).

**Small Group Talking Stick Round 2:**
- Pass the talking stick around again to have each person share at least one similarity and difference they noted between the models and explanations that were shared [20 seconds per person].

**Pause to individually record how the models compare**
- Record a list of all the similarities and differences between the models and causes for changes on your Student Activity Sheet.
F. Possible Causes

Possible Causes

Share with your group:

- What similarities did you and your group share about what was happening to the badger and the reasons behind these changes?

- What differences did you have?
G. Related Phenomena

Turn and Talk

What other living things besides animals die?
Individually

- Would you expect to see similar changes in plants or in parts of dead plants that fell to the ground over time? Explain.
- Would your prediction change if you found those dead plants on a different surface or in a different area? Why or why not?
I. New Questions and Investigation Ideas

What new questions do you now have?

How could we go about investigating the answers to our questions?

Record your ideas in Q5 & Q6 on your Student Activity Sheets
I. New Questions and Investigation Ideas

What new questions do you now have?
J. Finding All the Questions...

Write only one question per Post-it.

Write in marker—big and bold.

Put your initials on the front.

Look back at:

➔ Your Notice-Wonder chart about the dead raccoon,
➔ Your initial models for the raccoon and badger
➔ Our class’ related phenomena lists

Take a minute to review these to find questions that you have about ALL the phenomena we have explored so far (including any of our related phenomena).
K. Driving Question Board (DQB)

Take your sticky-notes with questions, along with your science notebooks, into our Scientist Circle.

Let’s Build our Driving Question Board

1. The first student reads his or her question aloud to the class, then posts it on the DQB.
2. Students should raise their hands if they have a question that relates to the question that was just read aloud.
3. The first student selects the next student whose hand is raised.
4. The second student reads his or her question, says why or how it relates, and posts it near the question it most relates to on the DQB.
5. The student selects the next student.
6. We will continue until everyone has at least one question on the DQB.
Break
Add to Investigation ideas

Take a few minutes to add investigation ideas for the new questions you have recorded after participating in setting up our DQB.

Be ready to share your investigation ideas!
# Grade 5 Ecosystems: “Why Do Dead Things Disappear Over Time?”

<table>
<thead>
<tr>
<th>Lessons</th>
<th>Days</th>
<th>Phenomena / Design Problems</th>
<th>What we figure out</th>
<th>How we represent it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson 1: What will happen to the body of this dead raccoon over time?</td>
<td>1</td>
<td></td>
<td>We had different predictions about what would happen to the body of a dead animal over time based on what surface it was on or what environment it was in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>Lesson 2: What happens to the bodies of dead things over time?</td>
<td>3</td>
<td></td>
<td>A few days after an animal died, insects started appearing on it, and then the body started “disappearing” a few days after that. We had lots of questions and ideas for investigations to pursue to help figure out what happens to all dead things (animals and plants) over time.</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Lesson 3-7

Lesson 3-4
We observe (photos and video) female flies lay eggs on body parts of dead things. The larva gain mass when they eat a dead animal. The total amount of matter in the system does not change.

Lesson 5-7
We directly observe closed systems of fruits and leaves. The fruits and leaves seem to change in containers that have dirt and worms. Fuzzy stuff forms which are spores from fungi.

We wonder why worm, flies, and fungi eat dead things. We find out raccoons eat plants and small animals.

We find out all food can be traced back to plants that were once alive. We wonder how plants gain weight.
Lesson 8
We think plants need light and water to grow, but we aren’t sure whether they need soil to grow. We set up controlled plant experiments.
### Grade 5 Ecosystems: “Why Do Dead Things Disappear Over Time?”

<table>
<thead>
<tr>
<th>Lessons</th>
<th>Days</th>
<th>Phenomena / Design Problems</th>
<th>What we figure out</th>
<th>How we represent it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson 1: What will happen to the body of this dead raccoon over time?</td>
<td>1</td>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>We had different predictions about what would happen to the body of a dead animal over time based on what surface it was on or what environment it was in.</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
</tr>
<tr>
<td>Lesson 2: What happens to the bodies of dead things over time?</td>
<td>3</td>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>A few days after an animal died, insects started appearing on it, and then the body started “disappearing” a few days after that. We had lots of questions and ideas for investigations to pursue to help figure out what happens to all dead things (animals and plants) over time.</td>
<td><img src="https://via.placeholder.com/150" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Lesson 8 - Initial Weight of Plants in Different Environments

<table>
<thead>
<tr>
<th>Environment</th>
<th>Plant</th>
<th>Weight of this plant on Week 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment #1</td>
<td>A</td>
<td>1.8g</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>2.2g</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>1.7g</td>
</tr>
<tr>
<td>Environment #2</td>
<td>E</td>
<td>2.0g</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.7g</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>1.4g</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>2.5g</td>
</tr>
<tr>
<td>Environment #3</td>
<td>I</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>J</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>2.6g</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>1.3g</td>
</tr>
<tr>
<td>Environment #4</td>
<td>M</td>
<td>2.6g</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2.2g</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>1.0g</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>1.9g</td>
</tr>
</tbody>
</table>
Lesson 9

Students analyze data from spider plants grown in a variety of different environments to determine if plants get the matter they need to grow from soil, water, light or something else from over a week after they were first put in those environments.
## Lesson 9 Investigation Results

<table>
<thead>
<tr>
<th>Environment</th>
<th>Plant</th>
<th>Weight of this plant on Week 0</th>
<th>Projected Weight of this plant on Week 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment #1</td>
<td>A</td>
<td>1.8g</td>
<td>2.8g</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1.6g</td>
<td>2.3g</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>2.2g</td>
<td>3.2g</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>1.7g</td>
<td>2.6g</td>
</tr>
<tr>
<td>Environment #2</td>
<td>E</td>
<td>2.0g</td>
<td>0.1g</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.7g</td>
<td>0.1g</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>1.4g</td>
<td>0.1g</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>2.5g</td>
<td>0.1g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environment</th>
<th>Plant</th>
<th>Weight of this plant on Week 0</th>
<th>Projected Weight of this plant on Week 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed system</td>
<td>I</td>
<td>1.6g</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>J</td>
<td>1.6g</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>2.6g</td>
<td>2.6g</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>1.3g</td>
<td>1.3g</td>
</tr>
<tr>
<td>Open system</td>
<td>M</td>
<td>2.6g</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2.2g</td>
<td>1.6g</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>1.0g</td>
<td>0.7g</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>1.9g</td>
<td>1.5g</td>
</tr>
</tbody>
</table>
Lesson 9 Arguing from Evidence

Students analyze data from spider plants grown in a variety of different environments to determine if plants get the matter they need to grow from soil, water, light or something else from over a week after they were first put in those environments.

Students use these results and results they recorded in Lesson 8 to identify which plants grew. They argued from evidence that plants do not need soil to grow, but do need water, air, and light.
How does figuring out that a plant needs water, air and light to keep growing make us think more about our original question: **Where does the plant get the matter it needs from?**
Lesson 10

Why Do Dead Things Disappear Over Time?

[UNIT SKELETON] [LESSONS] [MATERIAL & SUPPLY LIST]

SYNOPSIS

https://www.nextgenstorylines.org/why-do-dead-things-disappear-over-time
Lesson 10

How can we tell that an organism is taking in more and more matter so it can grow?
Lesson 10

We figured out that a plant needs water, air, and light to grow.

Now we want to figure out if all these things are providing the plant the matter it needs to grow.

Let’s start with water—how could we see if water is matter?
Lesson 10 - Is Water Matter?

What data do we need to collect?

How could we collect the data?

What tool(s) could we use to measure the data?

Can water provide matter to the plant that it needs to grow?
Lesson 10 - Is Water Matter?
Lesson 10 - Is Air Matter?

What data do we need to collect?

How could we collect the data?

What tool(s) could we use to measure the data?

Can air provide matter to the plant that it needs to grow?
Lesson 10 - Is Air Matter?
Lesson 10 - Is Light Matter?

What data do we need to collect?

How could we collect the data?

What tool(s) could we use to measure the data?

Can light provide matter to the plant that it needs to grow?
Lesson 10 - Is Light Matter?
Lesson 10 - Water, Air, and Light

What did we figure out about water, air, and light?

What questions do we still have? What new questions do we have?
Lesson 11

Students will develop and use a particle model of air to explain why the basketball gains weight as more air is pumped into it. They will explore the behavior of a syringe, to better visualize what is in the hand pump used to pump the basketball up. They will develop and use their particle model of air to explain how air can be compressed and expanded without adding or removing air from the syringe.
**Lesson 12: Where are plants getting the matter to grow?**

**Phenomenon:** After 20 weeks, plants in water (no soil) show visible growth - increase in size and number of leaves and roots - and a measurable increase in mass.

**Purpose:** Summative + Formative
Lesson 12 - Mid Unit Model

Phenomenon: After 20 weeks, plants in water (no soil) show visible growth - increase in length of leaves and roots - and a measurable increase in mass.

Lesson-Level Performance Expectation: Develop a model to explain why the spider plants that had no soil, but had their roots (structure) in water and leaves (structure) were in the air (open system) gained weight and grew over time.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop a model to explain a phenomena</td>
<td>Plants acquire their material for growth chiefly from air and water</td>
<td>Matter is transported into, out of, and within systems. A system can be described in terms of its components and their interactions.</td>
</tr>
</tbody>
</table>
Plant Matter Student Models

What are patterns of similarities and differences between these models?
Partners
Review the Plant Matter Model Rubric to become familiar with the organization and descriptions.

Be ready to share observations with the whole group.
Evaluate Student Model 2

Use the Plant Matter Rubric to evaluate Student Model 2.

Assign a score (1, 2, 3, or 4) for:

- components
- relationships
- mechanisms

**Evidence** means you can point to, highlight, and/or quote specific text, images, tables, etc., in the student work.
Evaluate Student Model 2

Student shows air going into the plant (arrows).

Wondering...However, no air particles are shown in the plant.

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown.

Student may understand that water is going into the plant - shows water particles inside and outside the plant - going into the plant.
Evaluate Student Model 2

Relationships: **Model** includes **one** of the following relational aspects: arrows that clearly show plant growth, where the water particles enter the plant, and where the air particles enter the plant. (Level 3)
Evaluate Student Model 2

Partners or Trios

Use the Plant Matter Rubric to evaluate Student Model 2.

Assign a score (1, 2, 3, or 4) for each of the three key features of a model:

- components
- relationships
- mechanisms
Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant.

Student shows air going into the plant (arrows). However, no air particles are shown in the plant.

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown.

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit.

Student does not explain why the phenomenon occurs (plant growth is not shown on the model).
Evaluate Student Model 2

Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant C.

Student shows air going into the plant (arrows). However, no air particles are shown in the plant. R

Student does not communicate by any means (words, pictures and/or symbols) that the plant is growing or has grown. R

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit. R

<table>
<thead>
<tr>
<th>Components</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationships</td>
<td>Level 2/3</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Level 1</td>
</tr>
</tbody>
</table>
Evaluate Student Models

Alone Zone

Use the Plant Matter Rubric to evaluate **Student Model 1, 3 or 4**.

- Your table will be assigned a “1”, “3”, “4”.
- Use the rubric to evaluate your assigned student model (components, relationships, and mechanism). *Be prepared to support your scores with evidence you can point to on the student model.*
Small Group - Part 1

- Compare your scores (components, relationships, and mechanism) with your group.
- Reach consensus on your scores.
Small Group - Part 2

- Meet with your new #1, 3, 4 team.

- Round 1: Share your findings for the student work you assessed.

- Round 2: What patterns do you observe across the four student models?
  - What knowledge (and skills) are students most secure with?
  - What knowledge (and skills) are students still developing (not all-the-way-there)?
Plant Matter Student Models

What is something the students (collectively) can do differently next time they create an explanatory model?
Providing Feedback

[The] majority of teacher’s feedback practice is not aligned with the recommendations on effective feedback by researchers. Instead of providing descriptive and prescriptive information, teachers often offered to their students evaluative information either as quantity of work (e.g., “more examples”) or the general level of understanding (e.g., “wow”, “unclear!”, a smiling face, or a question mark) as 20.34% and 40.4%, respectively. Therefore it is not a surprise that due to the lack of information on what can be done next, few students were able to take advantage of teacher comments to modify their work. (Li et al. 2010)

- Writing in Science in Action, p. 92
I noticed some of the models showed how the plant changed over time (grew) and some of the models did not.

- What do you like about how some of these models show change over time?
- How might we communicate in the models that some of the particles are causing the change over time (growth)?
I noticed some of the models used only words to explain how plants gained matter.

How could you show that the particles added the matter to the plant over time using symbols and pictures?

How could you show that it is the particles causing the leaves and roots to grow?
Providing descriptive feedback for your students includes identifying strengths and offering support to continue to develop targeted practices, science ideas, and/or crosscutting concepts (RCTs).

- **Strengths** (secure with knowledge and skills) with respect to the targeted elements as a statement or exclamation(!)

- Developing knowledge and skills framed as questions that scientist might have about the targeted elements that are missing, inaccurate or unclear.
Student Model 2

Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant.

Student does not explain why the phenomenon occurs (plant growth is not shown on the model).

Student shows air going into the plant (arrows). However, no air particles are shown in the plant.

Student does not communicate by any means (words, pictures, and/or symbols) that the plant is growing or has grown.

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit.
Feedback for Student Model 2

Student includes all components that are conceptual aspects used to represent important features of the phenomenon: water particles, air particles, and the plant C4

Good job using evidence from our investigations to identify the components that help explain how the plant kept growing!
Student shows air going into the plant (arrows). However, no air particles are shown in the plant. R

Feedback for Student Model 2

DEVELOPING

How might you show which particles start outside the plant and then move into plant?

Student may understand that water is going into the plant - shows water particles inside and outside the plant - but not explicit. R
As you watch the video, think about:

- What is the **phenomenon** scientists are trying to explain?
- Which **science and engineering practices** (SEPs) do they engage with to build or use **science ideas** (DCIs) to explain how or why the phenomenon occurred?
- What are some of the ways the scientists **share and build on other’s ideas**?
How does science work? Kind of like a pinball machine. Check it out! The Academy's Charles Griswold takes us through the process of science with an exciting new spider discovery.


About the Academy:
The California Academy of Sciences is the only place on the planet with an aquarium, a planetarium, a natural history ... one roof. It's a stunning architectural achievement with hundreds of unique exhibits and nearly 40,000 live animals.

Connect with us!
• Explore our website: http://www.calacademy.org
• Join our mailing list: http://bit.ly/AcademyList

For more:
• Like us on Facebook: http://bit.ly/CASonFB
• Follow us on Twitter: http://bit.ly/CASonTwitter
• Add us on Google+: http://bit.ly/CASonGoogle
Students-as-Scientists (and Engineers)

**Students** making sense of phenomena and **scientists** making sense of phenomena are almost indistinguishable.
Reshaping Science Ideas

How was assessment focused on sensemaking different from your school experiences with assessment?

How might this approach support students to explain a wide variety of observations/phenomenon using science ideas they build for themselves?
Celebrate Sensemaking

What would you add to your “What is Sensemaking?” poster to celebrate your new ideas or refined ideas or wonderings about sensemaking.

Be prepared to share a celebration about sensemaking.
Flip Upside Down!

**Information Frame**

Scientists and Teachers

Knowledge of Science Disciplines

Some Students

**Sensemaking Frame**

Students as Scientists and Engineers

Making Sense of Phenomena

All Students

Teachers Facilitate
thank you