Welcome!

Making Sense of Three-Dimensional Teaching and Learning: Designing High-Quality Instructional Materials

June 24, 2024
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# Collection of Resources

## Making Sense of 3D Teaching and Learning: Designing HQIM Collection

- **PRIVATE**
- 6 items
- Long Beach Public Schools, June 24, 2024

### Resources in “Making Sense of 3D Teaching and Learning: Designing HQIM” Collection

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

[https://my.nsta.org/collection/zuK67kgYaFo_E](https://my.nsta.org/collection/zuK67kgYaFo_E)
Meet Our Learning Community

**Alone Zone** (independent thinking time)

- Why do you think it is important for all students to learn science/STEM?
- What are your goals for your students in science/STEM?
Meet Our Learning Community

**Alone Zone** (independent thinking time)

- Why do you think it is important for all students to learn science/STEM?
- What are your goals for your students in science/STEM?

**Small Group**

- Share your thinking with your group.
- What is your group’s top science/STEM goal(s) for students in Long Beach Public Schools?
- After sharing, record your goal(s) and post.
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.
Learning Goals

● Build an understanding of what three-dimensional teaching and learning looks like, feels like, and sounds like in the classroom.

● Be able to foster a community of evidence-based thinkers and position students as the “knowers” in the classroom.

● Gain strategies to leverage students’ assets (experiences, prior learning, curiosity, etc.) to learn science.

● Be able to apply workshop experience to identify characteristics of high-quality instructional materials.
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
What do you notice? Wonder?

https://youtu.be/o94Pm-Cty3M
What do you notice? Wonder?

Partner Talk
Share at least
✔ Two observations
✔ One question
## Class Notice and Wonder

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<td>• Did the things that moved further weigh less? (Were they empty?)</td>
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Many of us are wondering why the objects stayed on the table. Should we investigate this first?
Related Phenomenon
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?

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Change the End Position of the Penny

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

Ground rules
● Cup remains on the table
● Card remains parallel to the table

How did you do it?
“Back-Pocket” Questions

• How is the **motion of the penny** different [in this scenario] from the motion of the penny in the *Coin in the Cup* trick?

• What **force(s)** is **acting on the penny** in the horizontal direction [in this scenario]? Is this force acting on the penny in *all* of the scenarios? Why do you say so?

• How is the **force acting on the penny** in the horizontal direction [in this scenario] different from [that scenario]?
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.

• Help clarify and/or build on each other’s ideas
  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.

• Help clarify and/or build on each other’s ideas
  o What do you mean when you say…?
  o Are you saying…? 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 penny will move in the 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.
Using Mathematics to Represent Patterns

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?
Can we use our pattern (mathematical model) to explain our observation and answer the question “Does how fast he pulls the tablecloth matter?”

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Using Mathematics to Represent Patterns

The *Real* Physics of the “Tablecloth Trick”
Where We’ve Landed

The pattern your class reaches consensus on may not look quite like this, but the components and relationship between the components will likely be the same.

amount of time the pull is happening

\[ F \cdot \Delta t \approx \Delta v \]

pull (and push?)

equal to? proportional to?

change in the horizontal motion

nstap
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How might we investigate?
Newton’s Second Law (Impulse)

\[ F \cdot \Delta t = m \cdot \Delta v \]
Newton’s Second Law

\[ F = m \cdot \frac{\Delta v}{\Delta t} \]
Does our pattern (mathematical model) predict an object’s change in motion in the vertical direction?
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.
## Connection to NGSS

**Phenomenon:** Dishes stay on the table when the tablecloth underneath the dishes is removed.

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<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tr>
<td><strong>Using Mathematics and Computational Thinking</strong>&lt;br&gt;● Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</td>
<td><strong>PS2.A: Forces and Motion</strong>&lt;br&gt;● Newton’s Second Law accurately predicts changes in the motion of macroscopic objects.</td>
<td><strong>Patterns</strong>&lt;br&gt;● Patterns of change can be used to make predictions (Grades 3-5)</td>
</tr>
<tr>
<td><strong>Constructing Explanations</strong>&lt;br&gt;● Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.</td>
<td></td>
<td><strong>Scale, Proportion and Quantity</strong>&lt;br&gt;● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).</td>
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**Building toward** HS-PS2-1. Analyze data to support the claim that Newton’s Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
Critical Attributes of Sensemaking

- Students experience a phenomenon;
- engage in science and engineering practices and
- share ideas to develop or apply the
- science ideas and crosscutting concepts needed to explain how or why the phenomenon occurs.
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.

**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.

*Knowing about...*

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

**Figuring out...**

From: Cynthia Passmore, NSTA Virtual PD, Nov. 15, 2014
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Figuring out...
Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict.

STEM Teaching Tool 42
Shifting Toward Sensemaking

Students sensemaking in a 4th-grade classroom.
Shifting Toward the Sensemaking

Information Frame

Sensemaking Frame

Less Like

More Like

Soils, Rocks, and Landforms

INVESTIGATIONS GUIDE

nstaa
Shifting Toward the Sensemaking

Information Frame

Sensemaking Frame

Less Like

More Like

Soils, Rocks, and Landforms

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nstaa
Choosing Phenomena

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

That is, what phenomenon requires the targeted science ideas to explain how or why the phenomenon occurs to the students’ satisfaction?
Phenomenon: Channeled Scablands

Video clip 02:56 – 04:52

https://vimeo.com/331335155
Attempt to Make Sense

Create a model to explain how the Channeled Scablands formed.
Identify Related Phenomena

What experiences do we have that might help us 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)?
Questions

• Review your own observations of the Channeled Scablands and the observations shared.
• Review our areas of agreements and disagreements on our class initial consensus model.
• Think about the shared related phenomena and the patterns identified.
• 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 your top two questions to share.
Phenomenon: Channeled Scablands

Our wonderings about the Channeled Scablands

- **Why is it so flat?!**
- **How did the layers get there?**
- **Why was the geologist trying to split the rocks?**
- **Was there water there? Where did it go?**
- **Is there different matter in the different layers?**
- **Where did the boulders come from?**
- **How did they know the water fall was there?**
- **Why did the waterfall dry up?**
- **What kind of wildlife or living organisms are there?**
- **Are there fossils in the rock?**
- **How long did it take to form the Scablands?**
- **How did the ash get there? Was there a volcanic eruption?**
# Targeted ESS Disciplinary Core Ideas

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<tr>
<td><strong>Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.</strong> (2-ESS1-1)</td>
<td>• 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 order in which rock layers were formed. (4-ESS1-1)</td>
<td>• The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)</td>
<td>• Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)</td>
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<td><strong>Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.</strong> (HS-ESS1-5)</td>
<td>• Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. (HS-ESS1-6)</td>
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## ESS2: Earth’s Systems

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<td><strong>Wind and water can change the shape of the land.</strong> (2-ESS2-1)</td>
<td>• Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)</td>
<td>• All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the Sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms. (MS-ESS2-1)</td>
<td>• Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), (HS-ESS2-2)</td>
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<td><strong>Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.</strong> (5-ESS2-1)</td>
<td>• The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future. (MS-ESS2-2)</td>
<td>• Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth’s surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, and a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth’s interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3)</td>
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<td><strong>The geologic record shows that changes to global and regional climate can be caused by interactions among changes in the Sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (Ice ages) to very long-term tectonic cycles.</strong> (HS-ESS2-4)</td>
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### Targeted ESS Disciplinary Core Ideas

#### ESS1.C: The History of Planet Earth

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<th>Grades 3–5</th>
<th>Grades 6–8</th>
<th>Grades 9–12</th>
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<td>- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the solar system’s energy cycle, as well as from Earth’s internal energy. (MS-ESS3-5)</td>
<td>- Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS3-5)</td>
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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 order in which rock layers were formed.

ESS2: Earth’s Systems

ESS2.A: Earth Materials and Systems
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity breaks rocks, soils, and sediments into smaller particles and move them around.
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 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 types of living things found in a region. Water, ice, wind, living organisms, and gravity breaks rocks, soils, and sediments into smaller particles and move them around.
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 too 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 "why" 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, 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 with science as a way of understanding and improving real-world contexts. Focusing investigations on competing 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 a context in which to monitor ongoing progress toward understanding all three dimensions. As students are working toward being able to explain and model the phenomena of interest, they are also working toward understanding the science ideas that explain the phenomena.

**EXAMPLE:**
A 5th grade lesson on the changing seasons explains the phenomenon that the Earth is tilted slightly as it revolves around the sun. Students are given the opportunity to describe the changes in seasons and to use this knowledge to explain the Earth's tilt. This helps students understand the science ideas behind the phenomenon and move toward being able to explain why changes in seasons occur.

**Understanding of DCI ESS1A, 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 a phenomenon, but not immediately, and not without investigating it using evidence from diverse 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 phenomena does not always have to be flashy or unexpected. Students might not be intrigued by an everyday phenomenon right away because 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.

**Code because it condenses.”**

<table>
<thead>
<tr>
<th>PROBLEM THINKING ABOUT PHENOMENA</th>
<th>THINKING ABOUT PHENOMENA THROUGH THE NGSS</th>
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<td>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>
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<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>
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<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. Phenomena are NOT the explanations or scientific terminology behind what is happening. They are what can be experienced or documented.</td>
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<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>
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<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. Connecting the development of general science ideas to investigations of phenomena helps students build more durable and generative knowledge.</td>
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**Engaging phenomena need to be questions.**
- Student engagement is a nice optional feature of instruction, but is not required.
- 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 at a disadvantage. 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.

Published September 2014

Resource #7
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<td>Phenomena are observable occurrences. Students need to use the occurrence to help generate the science questions or design problems that drive learning.</td>
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<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>
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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.
Phenomena

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
Shifting Toward Sensemaking

Students sensemaking in a 4th-grade classroom.
Shifting Toward the Sensemaking

Information Frame  Sensemaking Frame

Less Like  More Like

Soils, Rocks, and Landforms
INVESTIGATIONS GUIDE
Shifting Toward the Sensemaking

Information Frame  Sensemaking Frame

Less Like

More Like

Soils, Rocks, and Landforms

INVESTIGATIONS GUIDE

nstia
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 building an explanation for the phenomenon over time?
Sensemaking in a 4th-Grade Classroom
The water picked up and carried away tiny pieces of rock over and over again.

Water eroded the rock.
Science and Language Integration

Traditional Views and Contemporary Views

• Vocabulary is a precursor or prerequisite for doing science: Pre-teach and frontload vocabulary
  – Instead, language is a product of use

• Vocabulary is language
  – Instead, language is more than vocabulary and includes using language to engage in disciplinary practices and learn disciplinary content

• Simplify content, simplify language
  – Instead, keep content, amplify language (both support and challenge MLs)
Phenomena and Coherence

Anchor Phenomenon

Related Phenomenon

Investigative Phenomenon

The Story

3D

Questions

Phenomena

Practices to Engage In

What We Figure Out

Anchering Phenomenon

Driving Questions

What We Figure Out
Anchoring Phenomenon Routine

Element #1: Explore the phenomenon

Element #2: Attempt to make sense

Element #3: Identify related phenomenon

Element #4: Questions and next steps
Students Build Understanding Piece by Piece
B.4 Natural Selection & Evolution of Populations

How does urbanization affect nonhuman populations, and how can we minimize harmful effects?
High School Students Sensemaking

Setting the context

- Students used a simulation to collect population data.
- Students, working in pairs, analyzed their data to identify the cause-and-effect relationships between an organism’s ability to survive and changes in that population of organisms.
- Students next engage in a whole-group consensus discussion.
High School Students Sensemaking

Play 2:53 - 7:11
### Phenomenon: Populations change over time

### Lesson Level Performance Expectations:
Use evidence from a simulation to support an explanation about how different traits (number of flagella) could cause some bacteria to have a competitive advantage affecting the variation of traits within a population.

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<td><strong>PS4.B: Electromagnetic Radiation</strong></td>
<td><strong>Cause and Effect</strong></td>
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<td>● Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena.</td>
<td>● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.</td>
<td>● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
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**Building toward** HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
1st-Grade Students Sensemaking

Unit 1: Reading Under Cover (Waves: Light)

Field Test Fall 2023
1st-Grade Students Sensemaking

Setting the context:

- Students investigated what happens when they shine the same light on different materials.
- Students read a section of a book as a whole class and are introduced to specialized language to make describing material properties more efficient.
- Students decide together what should be included in their models based on what they have figure out so far.

Plan to model

Turn and talk

What should we include in our models to explain why it is brighter or dimmer under different cover materials?
Develop and share models

1. Create your model.

2. Tell your partner how your model explains why it is brighter or dimmer under different cover materials.
In the box below, use words and drawings to create a model to explain why it is brighter or dimmer under the three covers. Use the lines to write about your ideas.
**Connection to NGSS**

<table>
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<th>Phenomenon: Light is more bright under some cover materials than others.</th>
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<td><strong>Lesson Level Performance Expectations:</strong> Use evidence from investigations to create a model that explains the effect of placing objects made of different materials in the path of a beam of light.</td>
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| **Develop and Use Models**  
- Develop a simple model based on evidence to represent a proposed object or tool. | **PS4.B: Electromagnetic Radiation**  
- Some materials allow light to pass through them, others allow only some light through, and still others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. | **Cause and Effect**  
- Events have causes that generate observable patterns. |

**Building toward 1-PS4-3.** Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
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
Transforming Science Learning: OpenSciEd’s Impact in Taunton (MA) Public Schools

Pay special attention to Sophia’s experience with phenomenon-driven, three-dimensional learning (sensemaking). Sophia is an honors student.
“A major goal for science education should be to provide all students with the background to systematically investigate issues related to their personal and community priorities. They should be able to frame scientific questions pertinent to their interests, conduct investigations and seek out relevant scientific arguments and data, review and apply those arguments to the situation at hand, and communicate their scientific understanding and arguments to others.” (p. 278)