Welcome!

Making Sense of Three-Dimensional Teaching and Learning: Supporting All Students in Learning Science Day 2

Portland Public Schools
August 13-14, 2024
## Collection of Resources

**Portland Public Schools: Making Sense of Three-Dimensional Teaching and Learning Collection**

### Resources in “Portland Public Schools: Making Sense of Three-Dimensional Teaching and Learning” Collection

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<tr>
<th>Title</th>
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<tr>
<td>2. STEM Teaching Tool 42: Using Phenomena in NGSS-Designed Lessons &amp; Units</td>
<td>Web Page</td>
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<tr>
<td>3. STEM Teaching Tool 23: Conduits of Engagement</td>
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[bit.ly/ResourcesPPS](bit.ly/ResourcesPPS)
Lesson Plan

Why Don't the Dishes Move?
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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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?

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Change the End Position of the Penny

Scenario 1
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 may be pushed or pulled
- Card remains parallel to the table

How did you do it?
Identify Patterns

Alone Zone

• 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…

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

Partner Talk

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.

- What do many or most of our patterns have in common?
- What are areas of disagreement?

Be prepared to share your noticings with the whole group.
How might we communicate the relationship between the card pulling and the penny moving horizontally as a formula?
Can we use our pattern (mathematical relationship) to explain our observation and answer our question, “Does how fast he pulls the tablecloth matter?”

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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
## Class Notice and Wonder

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How might we investigate?
Where We’re Headed

Newton’s Second Law (Impulse)

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

\[ F = m \cdot \left( \frac{\Delta v}{\Delta t} \right) \]
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>Crosscutting Concepts</th>
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<td><strong>Using Mathematics and Computational Thinking</strong></td>
<td><strong>PS2.A: Forces and Motion</strong></td>
<td><strong>Patterns</strong></td>
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<td>● Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</td>
<td>● Newton’s Second Law accurately predicts changes in the motion of macroscopic objects.</td>
<td>● Patterns of change can be used to make predictions (Grades 3-5)</td>
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**Constructing Explanations**

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<td>● Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.</td>
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<td>● Patterns of change can be used to make predictions (Grades 3-5)</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.
Science Instructional Shifts

Shift 1.
**Explain phenomena and design solutions to problems**

Shift 2.
**Three-dimensional learning** *(Doing science)*

Shift 3.
**Coherent learning progressions over time**
Science/STEM and language integration is achieved through “doing science, using language”

1) Identify Compelling Phenomena or Problems

2) Engage Students in Disciplinary Practices

3) Engage Students in Productive Discourse and Interactions with Others

4) Encourage Students to Use Multiple Registers and Multiple Modalities

5) Leverage Multiple Meaning-Making Resources

6) Focus on How Language Functions in the Discipline
Science/STEM and language integration is achieved through “doing science, using language”

1) Identify Compelling Phenomena or Problems
2) Engage Students in Disciplinary Practices
3) Engage Students in Productive Discourse and Interactions with Others
4) Encourage Students to Use Multiple Registers and Multiple Modalities
5) Leverage Multiple Meaning-Making Resources
6) Focus on How Language Functions in the Discipline
How do we notice and leverage student resources?

“By attending closely to what students actually say and do in science, teachers can expand the relationships that are possible among themselves, their students, and science. In this way, they can begin to create more equitable opportunities to learn in science for historically underserved students.” (p. 33)

-Bang, Brown, Calabrese Barton, Rosebery & Warren (2017)
Students’ sensemaking resources

- “All students know things. However, they may not express their knowledge in academic language.” (Brown, p. 43)

- “If we fail to recognize the diverse nature of language and cognition, students who bring a wealth of knowledge but communicate it in vernacular language will never be heard because of classroom conversations privileges only one type of communication.” (Brown, p. 39)
Student Resources for Sensemaking

Examples of sensemaking resources

● non-academic language
● gesturing
● multiple modes of expression

Individually read and note any ideas you find powerful or interesting.
Student Sensemaking Resources
Examples
Context for Classroom Video

Forces at a Distance - Lesson 1

- During the lesson, the class develops a consensus model: What force(s) cause a speaker to vibrate?"

- Prior to this, students:
  - Experienced anchoring phenomenon - video of speaker vibrating, dissect speaker, build speaker
  - Developed initial model

- During the video, the class discusses their areas of agreement and disagreement.
Video Analysis and Reflection

Alone Zone

• What evidence of sensemaking resources do you see students using?

• How does using a resource support the student ("resource user") and the student’s classmates’ sensemaking?

• What did the teacher do (or not do) to help the classroom community see and value students’ sensemaking resources?
and what I'm thinking is that the magnet isn't the main thing that's making the sound.
Video Analysis and Reflection

Alone Zone

• What evidence of sensemaking resources do you see students using?

• How does using a resource support the student (“resource user”) and the student’s classmates’ sensemaking?

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Video Analysis and Reflection

Small Group

• What evidence of sensemaking resources do you see students using?

• How does using a resource support the student (“resource user”) and the student’s classmates’ sensemaking?

• What did the teacher do (or not do) to help the classroom community see and value students’ sensemaking resources?

Be ready to share key ideas from your small group.
Classroom Video Discussion

Small group:

- What evidence of sensemaking resources do you see student 3 using?
- How did it support her and her classmate’s sensemaking?
- What did the teacher do (or not do) to help the classroom community see and value the student’s sensemaking resources?

Whole Group: Share out key ideas from your small group
Equitable Sensemaking PD - 2.3 Teacher Reflection on Classroom Culture
Noticing Sensemaking Resources in Written Work

During lesson 4 of the weather unit, students collected temperature and light data above various outside surfaces. They were then asked to “draw and write” what they thought was happening in terms of reflection of light and temperature on both dark and light surfaces. Below are images of how three different students shared their current understandings.

Tyler’s Example

Brianna’s Example

Alma’s Example

Reflection Questions:
1. What sensemaking resources do you see evidence of students using?
2. How could these sensemaking resources support these students and their classmates better understand this phenomena?
3. What could a teacher do (or not do) to help the classroom community see and value the students’
Student Sensemaking Resources: Written Work

Noticing Sensemaking Resources in Written Work

During lesson 4 of the weather unit, students collected temperature and light data above various outside surfaces. They were then asked to "draw and write" what they thought was happening in terms of reflection of light and temperature on both dark and light surfaces. Below are images of how three different students shared their current understandings.

Consider:

- What parts/components did students include in their models?
- What relationships between parts did students represent?
- What mechanisms (science ideas) did students use to account for the relationships between parts?

Reflection Questions:
1. What sensemaking resources do you see evidence of students using?
2. How could these sensemaking resources support these students and their classmates better understand this phenomena?
3. What could a teacher do (or not do) to help the classroom community see and value the students’
Written Work Discussion

Small group:

● What sensemaking resources do you see evidence of students using?

● How could these sensemaking resources support these students and their classmates better understand this phenomena?

● What could a teacher do (or not do) to help the classroom community see and value the students’ sensemaking resources?

Whole Group: Share out key ideas from your small group
Transforming Science Learning: OpenSciEd’s Impact in Taunton (MA) Public Schools (these interviews reflect the impact of phenomena-driven, three-dimensional teaching and learning)
High Quality Instructional Materials

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

Quality Examples of Science Lessons and Units

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


[https://www.openscienced.org/curriculum/](https://www.openscienced.org/curriculum/)

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[https://www.nextgenscience.org/resources/examples-quality-ngss-design?page=0](https://www.nextgenscience.org/resources/examples-quality-ngss-design?page=0)
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*?
Students making sense of phenomena and scientists making sense of phenomena are almost indistinguishable.
Celebrate Sensemaking

What would you add to or change on your “What is Sensemaking” poster?

What questions can you now answer?

What questions remain?

Be prepared to share one “Aha!” on your way out the door.
END