This presentation available at:
https://education.uw.edu/people/faculty/mwind

When the stops are released he is pulled upward because the helium is lighter than the air and it has an upward force. There is enough helium to pull the weight of the chair and his body up.

9th grade unit on forces: A student’s initial model

The forces acting directly on Eric are gravity pulling him to the earth and the normal force of the chair preventing him from falling by pushing up on him. The helium balloons are providing buoyant forces but the balloons are only directly acting on the ropes. The ropes have a tension force that is holding the chair up. Only the chair is acting directly on Eric. In the experiment with the ball and the water, the ball floated on top of the water because it was like the balloons because it had a buoyant force.
Ambitious Science Teaching: a coherent VISION of how to support learning

- Students routinely incorporate new ideas into revisions of explanations and models for complex phenomena.
- Teachers use students’ ideas and everyday experiences as ways to understand the science.
- Teachers create opportunities, every day, for students’ sense-making talk.
- Student thinking is made visible, so that it can be critiqued and/or become a resource for others in the classroom.

Anchoring events link learning to student experiences, create curiosity and the motivation to know/use new information

- Sophomore biology: Why did my aunt get breast cancer and will it spread?
- Kindergarten: How can someone little push someone big off the end of a slide?
- 5th grade: Why are solar eclipses predictable and so rare?
- 2nd grade: An apple tree starts to grow on a hillside, where did it come from?
- AP Chemistry: Where does the heat go when I pour out my coffee and why?
- 8th grade: Why are killer whale populations in Puget Sound declining?

How could the re-introduction of a small number of wolves cause dramatic changes in the Yellowstone ecosystem?

**Ecosystems: Yellowstone**

- Habitats
- Carrying capacity
- Energy pyramids: Who eats whom?
- How species occupy niches
- Inter-dependence of different species
- Changing population data

**Equity:** a participation lens

1. Create links between science topic and students’ everyday experiences, use their ideas as resources.
2. Make student thinking visible, use multiple modalities.
3. Make explicit 1) the structure of authentic science practices, 2) “hidden rules” about science talk.
4. Provide opportunities for students to use new academic language in the context of science conversations (don’t front-load vocabulary).
5. Design safe spaces for talk in small groups and whole class settings.

Can I participate? Will I participate? Can I see my interests in the science? Will people care about my ideas?
Studying the “energy story” behind sound

How are auditoriums built to make voices & music clear?
Can ultrasound help us see hidden things?
How bats and dolphins use sound to find prey?
How can “booming” speakers make me shake?
Can technology help us overcome hearing loss?
How do neighborhoods cut down on noise pollution?
Can a person who is blind echo-locate?
What makes noise vs. music?
How can “booming” speakers make me shake?
Your own questions...

Inside Ashley’s 6th grade classroom

- Diverse urban K-8 school
- 80% Low income, 47% English Learners
- 20% Homeless

Before Ashley asks students for observations, she scaffolds...

BEFORE, DURING, AFTER
- Before anything happened, I noticed this...
- While ___ was happening, I noticed this...
- After it happened, I noticed...

SAW, HEARD, FELT
- I saw something happen...
- I heard this...it sounded like...
- I felt this...

SHAPE, COLOR, SIZE
- Something was this shape, this color, this size, it was in front of, it was behind...

HOW FAST IT HAPPENED
- Something happened slow...
- Something happened fast...

SMALL DETAILS
- I saw a detail, maybe it’s not important but I want to state it anyway...
- Something seemed missing...

CONNECTIONS TO YOUR EXPERIENCE
- It was like something else I had seen before...

Show singer
“Straw inside the glass was freaking out.”

“Flicked the glass, that maybe made a crack…”

“Sound of his voice vibrated the cup and straw.”

Let’s develop a list of “starter” ideas:
Under what conditions would the glass break?

- “We think it has something to do with _____.
- “We think _________ caused the glass to break.”
- “We are wondering _________.”

A/B Partner Talk or “structured talk”
This is both a routine and a type of scaffolding

Modeling to make thinking visible
Is this share-out more than just sharing?

- How might the teacher framing be thought of as an equity move—increasing participation?
- What are the elements of the sharing routine?
- Any ideas or puzzlements from Kelanie that could be used as resources for reasoning by her peers?
There are some science ideas students cannot “discover”. We might use interactive direct instruction followed by lab activity to teach this idea.

How can a teacher “visit tables” and press for sensemaking?
Kikan-shidō in 180 seconds

Kikan-shidō translates to “between desks instruction”

Talk moves...

**PROBING:** What do you think about...?

**REVOICING:** What I think I hear you saying is...

**PRESSING:** What evidence do you have for that?

**FOLLOW-UPS:** Can you say more about that?

**LEAVING QUESTION:**
- “I heard a couple things from you that might affect sound and echoes: Whether the space is big, and if the space is empty.”
- “Do both of those matter? Why?”

Supporting Student Reasoning Through Talk: A Taxonomy

BPQs (back pocket questions)

**For students who are moving along:**
- Can you share your thinking about THIS part of your model?
- Can you say more about what you think is happening HERE that we can’t see?

**For students who may be stalling out:**
- Let’s just say out loud what we saw and heard in the video, maybe that will jumpstart us.
- Do you think there is anything going on in this space (point between glass and mouth)?

**Generic follow-ups:**
- Can you say more about that?
- Do you agree with your partner?
- Do you want to add on?
- Is there something you’ve seen or heard before outside of school that makes you say that?

Notes on which partners have ideas or questions that could be brought out to whole class.
Day later—puzzlement about sound moving through box, but not air particles.

In this video...

- Who has opportunities to talk in this routine?
- What groundwork for talk has likely been laid by the teacher earlier this year? Is there scaffolding or structuring of this conversation that you see evidence for?

Summary Table: Whole class sense-making

<table>
<thead>
<tr>
<th>Activity</th>
<th>What trends or patterns did we see?</th>
<th>What caused those trends, patterns?</th>
<th>How does it help explain the anchoring event?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency and amplitude</td>
<td>Oscilloscope showed string vibrated at higher freq when tightened, more times per second. Higher pitch.</td>
<td>Bow makes string vibrate, which makes air vibrate too at same frequency. We hear it as higher pitch when more waves per second. Amp is just volume.</td>
<td></td>
</tr>
<tr>
<td>Compression waves</td>
<td>Push on slinky makes coil &quot;crunch together,&quot; the compressed part moves down the slinky.</td>
<td>Must be different kinds of waves, some are up-down (like water), some are dominoes that push a wave of energy from one pace to another. &quot;The wave&quot; in stadium.</td>
<td></td>
</tr>
<tr>
<td>Decibels at a distance study</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resonance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example of student-generated sentence-starters

(Ask a clarifying question)
Revising models: How has our thinking changed?

Revise: We think [evidence from activity/reading] supports PART of our model, but we want to change _____ to make it more accurate.

Add: We think [evidence from summary table] supports PART of our model, but we want to add _____ to make it more accurate.

Remove or find out more: We think [evidence from activity/reading] contradicts _______ in our model, and we want to remove it or find out more about it.

Questions: We still have questions about _________.
To answer the question by drawing this model and writing our explanations: how did this singer break the glass with his voice?

Directions:
1. In the three panels below, draw what is happening that you can and cannot see that is causing the glass to shatter.
2. Use the drawings to help you write an explanation about what is happening at each point in time.
3. For each panel, be sure to include ideas from the Gotta-Have Checklist:
   - How compression waves move energy
   - How frequency and amplitude play a role in breaking the glass
   - The full story of energy transfer from person to glass
   - How resonance plays a role in the story
4. After completing your model, provide evidence from one class activity that supports one of your claims. Write the evidence on a sticky note and place on the relevant drawing.

Names: ____________________________
Period: _____________________

End of unit: Transferring knowledge to a new situation

Kikan-shidō! Harder press for accountability

POSSIBLE CLASSROOM TALK NORMS BY CATEGORY

Preparation: We come prepared for discussion with notes, examples, stories, our readings.

Responsible learners: We are responsible for our own learning. This means we speak, request clarification, show agreement or confusion, verify, ask others to repeat.

Pushing ourselves: We push ourselves and each other to think beyond the obvious, to disagree with ideas, draw out comments from classmates, and we are open to changing our minds.

Focus: Our comments and stories will stay on topic, and we have the right to explain how our contribution connects with the science.

Hearing from all: Everyone deserves to be heard.

Air time: Don’t monopolize the conversation, a.k.a. “Watch your air time.”

Priority to newcomers: We’ll give priority to those who have not had chances to talk yet.

Time to think: The teacher will give “think time” before asking for our ideas.

Civil participation: No put-downs—ever.

Impulse control: Don’t interrupt or talk over your classmates when they have the floor.

Fair critique: We, students and teacher, can critique ideas of others, but personal attacks are out of bounds.