[MUSIC PLAYING]

MARK WINDSCHITL: In this ninth grade classroom, Brian is starting a unit on the physics of sound.

BRIAN: Compared to the big one.

MARK WINDSCHITL: Because he wants to work on students' ideas over time, he has to know how they currently think about sound. He elicits this thinking by having his students listen to a few different musical instruments, then attempt an initial model of how musical sound is generated and is detectable by humans. Brian has become skilled at revealing the past experiences and pre-existing ideas his students draw upon.

As we listen we can, for example, hear a wide range of partial understandings his students are using in their sensemaking conversations.

AUDIENCE: For a grand piano, there's foot things. And you'll have a better sound if the piano is open there, forget what the top scored.

SPEAKER 2: OK. So we've seen how pianos are open, what's happening there?

AUDIENCE: The hammers--

AUDIENCE: The hammers hitting a note.

SPEAKER 2: OK. So once that note or the hammer hits the string, how does that sound get out to the audience? Like what do you guys envision happening there? How is it traveling?

AUDIENCE: If he hits a bass drum, the vibration, it travels through the floor, so you can actually feel it on your feet. So that's OK.

SPEAKER 2: So if somebody's out in the audience, do you think that they would feel it in the floor sometimes?

SPEAKER 2: Yeah. Sometimes if it's near. But, you know. As the instrument vibrates and hits the air particles, air particles vibrate off each other and--

AUDIENCE: You should draw a hand on it.

SPEAKER 2: And the molecules?

AUDIENCE: Spread outward. Molecules, air molecules.

[CHATTER]

AUDIENCE: Wherever.

SPEAKER 2: Are we doing it down here?

SPEAKER 3: It'll look fine once it's colored in.

SPEAKER 4: Don't color it in.

SPEAKER 5: Beautiful drawing. Beautiful something.

SPEAKER 6: No, we need to focus on writing.

SPEAKER 7: And then that air vibrates into our ears, which vibrates the bone inside our ear. And our ear transfers the sound to--

SPEAKER 8: Ah, drum. Drum, like drum set?

SPEAKER 7: Well, this is-- it's just something our brain can understand.

SPEAKER 9: OK, yeah. That just means sound waves travel to ears. You should get that part. Sound waves, ears. I don't know if I gotta label the ears for him because those are kind of funky looking.

SPEAKER 10: No, it's not a hole in the middle of the tambourine. It's covered up.

SPEAKER 11: This thing doesn't press down.

[CLASSROOM CHATTER]

MARK WINDSCHITL: The research literature confirms that no amount of enthusiastic instruction, nor scientific investigation, nor lab experience will fundamentally change how students think unless the teacher is able to make student reasoning visible and to incorporate these ideas and experiences into lessons that are aimed at sense making. In this video, we show the practices that allow teachers to reveal what students know and how to adapt instruction based on this information.

The first teaching practice in this set has the same name as the set itself, eliciting students' ideas. The second practice is selecting which of student ideas to make public for conversation. The third practice is adapting further instruction based on what you know about students' ideas and previous experiences.

One of the goals for this instruction is to activate in students' minds any prior experiences, or ideas, or language that might relate to the anchoring event. A second goal is to find out how students reason about just two or three fundamental aspects of the anchoring event, not everything. A third goal is to make instructional decisions that will either take advantage of or challenge students current thinking.

The first of these practices is eliciting ideas and activating students' prior knowledge. In Anna's seventh grade class, she wants to hear her students' ideas about phase change and energy. She uses a demonstration of how a soft drink can be distilled into what looks like pure water she sets the scene for her students to be at ease in offering ideas.

ANNA: What we're going to do is, we're going to turn these burners on pretty high, and we're going to see what happens. So just like we always do, before we start, I'm going to ask you to make a prediction about what you think will happen. And today is one of those days, if you saw the learning target and you wrote it down, I will be able to record and share my ideas. Today is one of those idea days.

MARK WINDSCHITL: In this classroom, we can hear students purposefully using prior knowledge to make meaning out of what is happening in this distillation. As we listen, we'll hear them drawing on many resources, including previously taught science ideas, everyday language, things they've seen on TV, and other experiences that they've had outside of school. They'll even generate their own analogies in an attempt to make sense of this anchoring event.

ANNA: Yeah, OK.

SPEAKER 12: So it's separating the food coloring and the sugar from the carbonated water.

ANNA: So how is that possible?

SPEAKER 13: It's like, eating it. It's making-- it's kind of like when you spray, it and it makes little bubbles that go through the tube and it's dropping in there.

SPEAKER 14: It's kind of like when the clouds of water from the ocean transfer over the Cascade Mountains.

ANNA: Zoom in circle there. Do you see how Delbert's drawn the level of the soda in when it's frozen? So now I want you to draw a zoom in circle that shows what the molecules would look like if you zoomed way, way in. That's fine. Just draw your little point. Show where you're drawing that zoom in from. And what do you think those molecules look like? So what's the movement like and how are they arranged? How much space is between them?

SPEAKER 13: Like this?

ANNA: Yep. Of that frozen Coke right there.

MARK WINDSCHITL: This lesson has activated students' prior knowledge and allowed Anna to hear what resources they were using to reason about the anchoring event.

In Bethany's sophomore biology class, the anchoring event is actually too complex to have students hypothesize about early in the unit, so she asks a more basic question that still reveals a lot about student thinking.

BETHANY: What do you think would happen to that population? So let's say we start right here. Time 0, we have 50,000. What do you think is going to happen after 1 year, and after 5 years, and after 10 years? How many would you have? And go ahead and explain your thinking for that.

MARK WINDSCHITL: Even with this straightforward question about an animal population, her students produce an amazing array of predictions and theories. She then asks her students to share their thinking so everyone can hear the reasoning of their peers.

BETHANY: Similar to kind of tell us what they were thinking. So let's start with the middle.

MARK WINDSCHITL: In my teacher education class, I used the tanker implosion scenario to help me model what an eliciting discussion sounds like. We always start with questions about observation. What did you see? What did you hear? Just as in Anna's and Bethany's classrooms, no technical vocabulary is introduced here nor is it required to participate in this discourse.

Following the "what" conversation is a "how" conversation in which we move to questions about what conditions might have influenced the tanker car to implode in a particular way. The final part of the conversation is asking students to model what they think is going on that's unobservable, events and processes that might account for the tanker collapse.

In this fifth grade class on the physics of sound, Carolyn asks her students to talk about observations of a unique phenomenon.

CARLOYN: And listen, and we're going to make some observations. So what do you see, what do you hear? And also any questions that you have like, how does he do that?

[VIDEO PLAYBACK]

[HIGH PITCHED VOCALIZATION]

- Number 93!

[END PLAYBACK]

MARK WINDSCHITL: To allow more opportunities to talk, Carolyn uses a pairing routine called A/B partners in which one student listens carefully to the ideas of another, ask questions about those ideas, and then prepares to represent their partner's idea in whole class discussion.

In the second practice of this set, teachers select ideas to make public so that students can see and hear the reasoning of their peers. In this biology class, Bethany has her students develop hypotheses about what might cause the rise and fall of a snowshoe hare population.

She uses a strategy that has proven valuable in making student thinking visible. She's provided a modest amount of information about the hares and their habitat so that students don't feel they're being asked to talk about something totally foreign to them.

SPEAKER 15: And this is the music, right?

BETHANY: OK. So can you show me how this graph you drew matches with what I think you just said? Does it say that?

MARK WINDSCHITL: The hypotheses that they develop will indicate to Bethany how students reason about population fluctuations, what might cause them, are they cyclic, are there combinations of factors that together influence the reproduction of the hares?

Students then place their hypotheses on the classroom wall and examine the range of explanations offered by their peers. All of the hypotheses contain the seeds of a final, elaborate, and accurate explanation to be developed later in the unit.

In Anna's seventh grade class, she uses a tool called a whole class consensus model. She has drawn a time lapse representation of the distillation apparatus the class had used to separate out parts of a soft drink. She asked students to offer just snippets of an explanation to be written on sticky notes. These notes are then affixed to the model in the right place and the right time.

Anna not only sees what language they are using to describe what's happening but also notices after class that very few students have ventured to explain what is happening in the right hand flask or in the tubing in the early stages of the distillation.

In this teacher education class, I demonstrate how to create a third kind of representation of ideas called, simply, the list of hypotheses. I start by showing sentence frames that help students know how to offer hypotheses for the implosion of a railroad tanker car.

Easiest sentence frame that kids can use to just try out an idea is the top one. Just saying, simply, I think that the tanker collapse had something to do with--

I then elicit hypotheses or fragments of an explanation I'm careful not to write everything that students say but to ask follow up questions that get students to add onto a peer's contribution. The list should be a negotiation between the teacher and the students.

SPEAKER 16: Pressure.

MARK WINDSCHITL: OK. Can you say a little bit-- does anybody want to add on to that? Because I think we would all agree that it's got something to do with pressure. Anybody want to add a little bit so I can fill out a little bit more, like a phrase or something?

SPEAKER 17: I think it has something to do with the pressure difference inside and outside the tank changing.

MARK WINDSCHITL: OK, pressure change, pressure differences inside and out. OK.

We end up with a list that will be added to and revised as we learn more throughout the unit. This reflects the authentic processes of science in using evidence to shape explanations.

The purpose of this is just to get four or five prevalent ideas out. They are very different grain size and scale. Like, this is very different. This is a mechanical thing on the tanker very different from this, which has got to do with inside outside air pressure. That's all OK.

The final practice in this set is adapting further instruction. As teachers, we are not listening for mistakes or whether students use technical vocabulary. These would tell us very little about their reasoning. Rather, we listen for partial understandings which are ideas that are not yet well formed, but they are resources that students are currently using to make sense of the anchoring phenomenon.

We also listen for everyday experiences that students relate to the subject matter. We listen for everyday language they use to talk about the phenomenon and any alternative understandings they have that clearly differ from a science explanation. These are the resources that students are reasoning with, and these are used in ambitious science teaching as levers to shift and expand student thinking.

Here is a list of what Anna heard as her students talked about the soft drink distillation. She heard them talking about partial understandings of previously instructed ideas, like the notion that molecules change somehow when heated. She heard everyday language, like steam, like sludge being left over in one of the flasks, and steam being pushed.

She heard them refer to outside of school experiences, like everyday knowledge of soda, that it contains sugar, carbonation, and food coloring. Her students also created self-generated analogies, like sweating or clouds passing over the Cascade Mountain range. Anna referred to these ideas repeatedly throughout the unit to help students make sense of the distillation.

One of the specific ways in which she adapted further instruction was to incorporate students' initial understandings into a cluster of hypotheses that she showed them the very next day. These were the students' ideas, and she asked them to take a stand on one of these hypotheses and to state why they believed it was true.

In the case study videos we have on this website, there are many additional examples of adapting instruction to take advantage of students' outside of school experiences, their ways of talking about science phenomena, and their existing knowledge from previous instruction.

In the fifth grade class studying sound, Carolyn notices that her students had not talked about the origins of sound energy produced by the singer. She decides the next day to have her students work on developing a model of how the lungs and the vocal cords work together to create loudness and pitch.

Eliciting students' ideas is central to the professional work of a teacher, and we've tried to show a variety of ways that this can be done. It is worth noting here that groups of committed teachers have created variations of these practices that have turned out to be more productive for young learners than anything we could have imagined just a few years ago. This is the benefit of having a shared vision and a common language about practice.

[MUSIC PLAYING]