Eliciting and Interpreting Individual Students’ Thinking about Science

Description of Teaching Practice
To elicit individual students' thinking about science, teachers pose questions or tasks that provoke or allow students to share their thinking about science content in order to evaluate student understanding, guide instructional decisions, and surface ideas that will benefit other students. To do this effectively, a teacher draws out a student’s thinking through carefully-chosen questions and tasks, then considers and checks alternative interpretations of the student’s ideas and methods. In science teaching, it is also important to consider students will have ideas about both the science content and the science practices.

Advancing Justice
Eliciting and interpreting individual students' thinking enables teachers to learn about students' intellectual lives and tailor instruction to their interests, strengths, and needs. The practice positions students as capable, irreplaceable members of classroom communities where their ideas are respected, challenged, and refined as they develop facility with disciplinary discourses and connect content to their lives. Teachers who skillfully enact the practice enable students to realize their capacity to make meaning and affect change in their communities and beyond.

Why Work on Eliciting and Interpreting Individual Students' Thinking?
Teachers elicit students' thinking to gain insight into their students’ scientific beliefs and to prepare them to engage in scientific practices. Students have many alternative ideas that about scientific phenomena; by eliciting students’ ideas, teachers learn how to design instruction to respond to and build on those ideas. When teachers prompt students to share their thinking about science content or other students’ ideas, students develop the skills they need to make scientific arguments. When teachers practice eliciting students' thinking, they also build their skills at the related teaching practices of leading and facilitating scientific discussion and supporting students to construct scientific explanations and build arguments.

How Do Teachers Elicit and Interpret Individual Students’ Thinking?
Eliciting and interpreting students' thinking in science often takes place when students are just beginning to learn about a science topic and towards the end of learning about the topic when they are making sense of phenomena they have experienced and investigated. In a lesson about the function of the parts of plants, for instance, a teacher may ask students what function they think the leaves of a plant serve. The teacher may find that many students have the typical alternative idea that the leaves collect water for the plants to use. Because the teacher knew in advance that students often have this belief, they were better able to interpret student responses. They might then use this knowledge of their students’ ideas to design an investigation that would help students understand that leaves do not collect water. After conducting the investigation, the teacher would again elicit and interpret their students' thinking as the students make sense of their observations and data. In eliciting their ideas, the teacher may find that students have a difficult time articulating their thoughts clearly. To support classroom discussion, the teacher would need to be able to interpret what students are saying.
Decomposition

The practice can be broken down, or decomposed, into discrete, teachable parts, described in the diagram and table below.

![Diagram](image)

<table>
<thead>
<tr>
<th>Area of Work</th>
<th>Example of what this might involve</th>
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| 1) Formulating and posing questions designed to elicit and probe the student’s thinking, with sensitivity to how students might hear or respond to the questions. | • Developing general, open-ended questions  
• Choosing areas of the student’s expressed thinking or work to focus on, and developing appropriate questions  
• Developing hypotheses to test about the student’s thinking  

**In science:** Prompts for student thinking are tied to specific scientific phenomena or are related to a question that can be answered through an investigation. Questions often ask for students’ predictions about scientific phenomena. |
| 2) Listening to and interpreting the student’s responses. | • Giving the student plenty of time to speak  
• Paying close attention to what the student says, without unnecessary interruptions  
• Noticing specific features of the student’s thinking: common patterns, strengths, strategies, novel ideas, areas of particular interest or engagement, weaknesses, and errors  

**In science:** Teachers use research-based knowledge of typical alternative ideas that students have about scientific phenomena and their understanding about students’ funds of knowledge to anticipate and interpret their responses. |
| 3) Developing additional questions, prompts, and tasks to probe and unpack what students say. | • Identifying elements of the student’s thinking that they said little about, and probing further  
• Identifying particularly interesting or confusing (to the teacher) aspects of the student’s thinking and developing corresponding questions or prompts  
• Focusing on a particularly strategic aspect of the student’s thinking to probe further (i.e., a good starting point for the student, something they need to work on or develop more)  

**In science:** Probing questions typically ask students to consider evidence they have collected during an investigation and encourage them to tie their responses to the scientific investigation question. |
Supporting Novice Teachers

In working on this practice in teacher education, we focus on helping novice teachers recognize the importance of anticipating students’ ideas in planning. Some novice teachers may not feel comfortable with science content, and may have similar alternative explanations for the natural world as children do. Supporting novice teachers in anticipating these ideas ahead of time encourages a deeper understanding of the content they are teaching and can boost confidence in enactment by helping them to envision student responses.

Novice teachers also typically have difficulty knowing what kind of language to use when trying to elicit students’ ideas. We support them in this area by providing them with “talk moves” that can be adapted or used in a variety of contexts. In addition, novices may initially ask closed-ended, topic-based questions such as “What is soil?” or “What is a seed?” that elicit students’ fact-based knowledge about a topic, but not their ideas. Talk moves help novice teachers word open-ended questions that elicit students’ ideas about science content, not just their factual knowledge.

We also work with our novice teachers on designing tasks that give students authentic opportunities to share their ideas and not just repeat facts. We do this by teaching novices to use the Engage, Experience, Explain + Argue (EEE+A) framework to develop investigations that require students to engage with phenomena and come up with their own explanations based on the data they collect. In the Engage element, in particular, we support novices in framing an investigation question or problem that provides a context for sharing initial ideas or predictions.
The activities listed in this cycle need not be enacted in order, though it may make sense to go through the four quadrants sequentially. The most time-consuming of these for novices will be the field assignment where novices model for small groups in their classroom.

This cycle culminates in a full science lesson in the field. To focus on practicing eliciting and interpreting students’ thinking, we focus on the beginning of the science lesson in which students discuss their initial ideas and possibly make predictions about a phenomenon. In the cases where teaching a full science lesson in the field is impossible, the simulated teaching experience, or Peer Teaching Assignment, provides novices the opportunity to practice eliciting and interpreting students’ thinking. The full lesson can also be modified so that novices only teach the portion of the lesson in the field that focuses on eliciting their initial ideas. For more on modifying the Enact portion of the learning cycle see the Full Lesson in the Field Assignment.

Several of the activities in this learning cycle rely on the EEE+A framework, which is closely aligned with the claim-evidence-reasoning (CER) framework for teaching science lessons. In our program we use the book *What’s Your Evidence? Engaging Students in Constructing Explanations in Science* by Zembal-Saul, McNeill, and Hershberger as a resource for teaching the framework (see also the Supporting Students to Construct Scientific Explanations and Build Arguments Resource Guide). The videos referenced here accompany the text but can be replaced with similar videos of experienced teacher practice.

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Learning Cycle Part 1: Introducing the Practice

Activity 1: Talk Moves Video Activity
Novice teachers begin by learning about the purpose of eliciting students’ ideas in science and its importance in helping teachers design and teach lessons. The PowerPoint includes slides that introduce the practice.

Novice teachers are then introduced to the idea of “talk moves” as a means for eliciting students’ ideas. The teacher educator explains the Teacher Talk Moves Tool, and how different talk moves can support different portions of a science lesson.

Novice teachers then watch a video of an experienced teacher leading a whole group discussion. As they watch the video, they use the Teacher Talk Tracker Tool to monitor what talk moves the teacher uses, along with the purpose and outcomes of those talk moves.

**Materials Used:**
- Eliciting and Interpreting PowerPoint
- Talk Moves Tool
- Teacher Talk Tracker Tool

Activity 2: Becoming Aware of Students’ Ideas Activity
In these activities, novice teachers are given tools and strategies for interpreting what students say and understanding their thinking. The PowerPoint presentation addresses interpreting student thinking and introduces the concept of “alternative ideas” to novice teachers. In the Becoming Aware of Students’ Ideas Activity novice teachers complete an assessment to evaluate their own understanding of scientific phenomena and compare that understanding to research-based common alternative ideas using the Alternative Ideas Tool.

Next, novice teachers are given the Interpreting What Students Say or Do Tool to help them see common patterns in student thinking and typical alternative ideas that students have about different science content.

Novice teachers are given examples of work that demonstrates students’ thinking about scientific phenomena. The novices use the Interpreting What Students Say or Do Tool to analyze the students’ thinking and diagnose the alternative ideas and reasoning the students are using. Next, novice teachers watch the Private Universe video and again use the Interpreting What Students Say or Do Tool to analyze the students’ thinking in the video.

**Materials Used:**
- Eliciting and Interpreting PowerPoint
- Becoming Aware of Students’ Ideas Activity
- Alternative Ideas Tool
- Interpreting What Students Say or Do Tool

Activity 3: Decomposing the Engage Element
Novice teachers begin learning about the purpose of the Engage element and its importance in helping teachers design and teach lessons that prioritize student sensemaking through investigations. The PowerPoint includes slides that introduce the Engage element and connect the element to other teaching practices (e.g., eliciting and interpreting students’ thinking) and scientific practices (e.g. asking scientific questions).

Then, novice teachers watch a video of an experienced teacher leading students through the Engage element of an investigation-based lesson. As novices watch the video, they use the EEE+A Framework and the EEE+A Lesson Observation Form to monitor the teaching moves the experienced teacher uses (along with the purposes and outcomes of those moves) to support students to make sense of the scientific phenomenon.

**Materials Used:**
- EEE+A Framework Reference Tool
- EEE+A Framework PowerPoint
- EEE+A Lesson Observation Tool
What's Your Evidence? video 5.2

Activity 4: Preparing to Peer Teach the Engage Element
After novice teachers have been given ways of eliciting and interpreting student thinking, they use that knowledge and tools to plan a portion of a science lesson. An important part of the Engage element of science lessons (see document about EEE+A framework) is to activate students’ prior knowledge of science content and gather their predictions or initial ideas about a phenomenon. Novice teachers create their lesson plans using the Instructional Planning Template and can use the Teacher Talk Moves Tool and Interpreting What Students Say or Do Tool to plan what they will say during the discussion. They can also incorporate the Content Monitoring Tool into their plans to track students’ ideas. The peer teaching assignment is used to support practice with multiple high leverage practices and is included as part of the learning cycles for those HLPS as well. While our program focuses on eliciting and interpreting students’ thinking during the Engage Element, this practice can also be highlighted during the Experience element and the Explain and Argue Element. See the Peer Teaching Assignment for more detail.

Materials Used:
- Peer Teaching Assignment
- Peer Teaching PowerPoint
- Alternative Ideas Tool
- Instructional Planning Template Tool
- Identifying Big Ideas in Science Tool
- Equity Leverage Points Tool
- CER Scaffolding Tool
- General Rubric for Scientific Explanation Tool
- Talk Moves Tool
- Consideration Cards for Planning Science Lessons Tool
- Interpreting What Students Say or Do Tool
- Monitoring Tool
- Science Practices Scaffolding Continuum Tool

See Also:
- Leading a Discussion Resource Guide
- Supporting Explanation and Argumentation Resource Guide
- Adapting Curriculum Materials Resource Guide
- Norms and Routines Resource Guide

Learning Cycle Part 2: Prepare

Activity 5: Student Ideas Conversation (in the field)
The Student Ideas Conversation gives novice teachers an opportunity to practice eliciting and interpreting an individual student’s thinking. Novice teachers prepare for the conversation on their own, typically as homework, and then conduct a one-on-one interview with a student in the field. They then summarize and analyze their student’s responses for patterns of thought or common beliefs about science content.

Materials Used:
- Student Ideas Conversation Assignment
- Student Ideas Conversation PowerPoint
- Talk Moves Tool
- Interpreting What Students Say or Do Tool

Activity 6: Peer Teaching the Engage Element
In this class session, novice teachers teach the Engage element of the science lesson they planned in the previous session to a small group of novice teachers and a teacher educator. The novice teachers and teacher educator use the EEE+A Lesson Evaluation Form to provide feedback to one another.

Materials Used:
- Peer Teaching Assignment
- Peer Teaching Assignment PowerPoint
- EEE+A Lesson Observation Tool
Learning Cycle Part 3: Enacting the Practice

Activity 7: Science Lesson in the Field
In the field, novice teachers teach a full science lesson that follows the EEE+A framework. As with the Peer Teaching Assignment, novices create their lesson plans using the Instructional Planning Template and can use the Teacher Talk Moves Tool and Interpreting What Students Say or Do Tool to plan what they will say during the discussion.

As with the Peer Teaching Assignment, the Full Science Lesson in the Field Assignment supports the development of several high leverage practices. It can be used as a culminating activity to give novice teachers practice integrating these HLPs.

Materials Used:
- Science Lesson in the Field Assignment
- Science Lesson in the Field Assignment PowerPoint
- Alternative Ideas Tool
- Instructional Planning Template Tool
- Identifying Big Ideas in Science Tool
- Equity Leverage Points Tool
- CER Scaffolding Tool
- General Rubric for Scientific Explanation Tool
- Talk Moves Tool
- Consideration Cards for Planning Science Lessons Tool
- Interpreting What Students Say or Do Tool
- Monitoring Tool
- Science Practices Scaffolding Continuum Tool

See Also:
- Leading a Discussion Resource Guide
- Supporting Explanation and Argumentation Resource Guide
- Adapting Curriculum Materials Resource Guide
- Norms and Routines Resource Guide

Learning Cycle Part 4: Analyzing the Enactment of the Practice

Activity 8: Full Science Lesson Reflection
After completing their full lesson in the field, novice teachers reflect on their experience and analyze the video of their enactment. While the assignment supports multiple HLPs, novice teachers can focus on their enactment of the Engage element and, if desired, the Experience and/or Explain and Argue element, to assess how well they elicited and interpreted students' ideas. Novices can use the Teacher Talk Tracker Tool to identify when and how well they used those move in their enactment. The reflection is typically assigned as homework, but can also be adapted to happen in class.

Materials Used:
- Science Lesson in the Field Assignment
- Instructional Planning Template Tool
- Teacher Talk Tracker Tool
- Science Practice Scaffolding Continuum Tool