

Advanced Module- Evidence and Reasoning

This advanced module on scientific argumentation focusing on evidence and reasoning can be executed as four sessions that are each 45-minutes, or fewer sessions that are longer (e.g. one 3-hour session). If held as four sessions, the agenda includes an extension section to encourage teachers to implement some argumentation aspect before the next session. The following session then begins with time for teachers to share their experiences, as well as artifacts of their students' argumentation (e.g. writing, video). These sections are optional.

The agenda below contains descriptions about the various activities that make up the module, as well as estimated lengths of time for each activity.

The goals for this advanced module on evidence and reasoning include:

- Teachers will understand the different and overlapping roles evidence and reasoning play in an argument (Session 1)
- Teachers will help students identify high quality evidence (Session 2)
- Teachers will support student use of evidence by providing feedback on evidence sufficiency, relevance, and source (Session 2)
- Teachers will encourage student use of reasoning by providing feedback on the connections students make between their evidence and the claim and their use of science ideas (Session 3)
- Teachers will evaluate the quality of student evidence and reasoning in argument (Session 2 & 3)
- Teachers will design activities targeting student challenges with evidence and/ or reasoning (Session 4)

Materials:

Small Group Discussion Transcript (Session 1)
Sample Student Argument Handout (Session 1)
Evidence Rubric (Session 2)
Evidence Rubric Sample Student Arguments (Session 2)
Reasoning Rubric (Session 3)
Reasoning Rubric Sample Student Argument (Session 3)
Supporting Activity Planning Tool (Session 4)

Session #1: How are evidence and reasoning similar and different?

Activity	Description	Time
Video: Introduction to Module	Introduce teachers to the module by watching a segment of a group discussion from the video Small Group Discussion (0:00-2:30) http://www.argumentationtoolkit.org/resources.html	10 min.

	<p>(Note: Provide teachers with a transcript of the discussion.)</p> <p>Ask teachers to think about the following questions while watching the video.</p> <ul style="list-style-type: none"> • What evidence do students use in their discussion? • How do students use this evidence? • What reasoning do students use in this discussion? <p>Then, ask teachers to do a think-pair-share guided by these questions, followed by a whole class discussion.</p> <p><i>Materials: Small Group Discussion Transcript</i></p>	
<p>Discussion: Evidence and Reasoning</p>	<p>Begin by asking teachers to come up with their own definition of evidence and reasoning. Guiding questions could include:</p> <ul style="list-style-type: none"> • How did you identify evidence in the previous activity? • How would you define evidence? • How did you identify reasoning in the previous activity? • How would you define reasoning? 	<p>5 min.</p>
<p>Presentation: Evidence and Reasoning, Definitions and Challenges</p>	<p>Emphasize that the purpose of this introductory session is to help teachers see what is considered evidence and reasoning. Later sessions will help teachers support student use of evidence and reasoning. In this brief presentation, provide teachers with a definition of high quality evidence and reasoning. Emphasize that both can be challenging for students and they will need support incorporating evidence and reasoning into their arguments. Highlight both are a justification for a claim. The distinction provides a framework that is helpful but can be difficult to distinguish in practice, eg. inference from evidence.</p>	<p>10 min.</p>
<p>Activity: Identify Evidence and Reasoning in a Written Argument</p>	<p>Provide teachers with the Sample Student Argument handout. Ask teachers to read through each of the 4 student samples.</p> <p>In pairs or small groups, ask teachers to respond to the following questions:</p> <ul style="list-style-type: none"> • Identify how students are using evidence and reasoning in their arguments • What challenges did you face in identifying student reasoning? • What challenges did you face in identifying student reasoning? • What challenges do your students have with evidence and reasoning? <p>After discussing in small groups (~10 minutes), share out to the whole group, particularly highlighting challenges.</p>	<p>15 min.</p>

	<i>Materials: Sample Student Argument Handout</i>	
Takeaways	<ul style="list-style-type: none"> Evidence is information about the natural world that is used to support a claim. In a scientific argument, evidence often consists of data, which can be measurements and observations. Evidence and reasoning are both part of the justification for a claim. There's not always a clear distinction between evidence and reasoning, but the important thing to focus on is the role they both play in supporting a claim. Reasoning is the process of making clear how your evidence supports your claim. Clear reasoning can include using scientific ideas or principles to make logical connections between evidence and a claim. 	5 min.
Extension- Try it with your students!	<ul style="list-style-type: none"> Ask teachers to engage their students in a written argumentation activity in which students need to use evidence and reasoning. In the next session, you will be asked to share an example, and identify the evidence and reasoning students used. Be prepared to discuss the challenges you encountered in identifying and distinguishing between evidence and reasoning in student written arguments. 	Optional

Session #2: How can you support student use of evidence in a scientific argument?

Activity	Description	Time
Extension- Try it with your students! Discussion	<p>If you asked teachers to reflect on the evidence and reasoning in arguments written by their own students, guide a discussion based around the following questions:</p> <ul style="list-style-type: none"> What evidence did students use? How did students use reasoning? What challenges did you encounter in reviewing your students' arguments? 	Optional
Video: Student Use of Evidence	<p>Watch a video of a student reading her argument at this link. Have a whole class discussion around the following questions.</p> <ul style="list-style-type: none"> What evidence did this student use in her argument? What feedback would you provide to her to improve her argument? 	5 min.
Presentation: Evidence Rubric	<p>Emphasize the goal of this session is to support student use of evidence by focusing on providing feedback on three critical areas: sufficiency, relevance, and source.</p> <p>Project and discuss the rubric. Talk through the organization of the rubric, and emphasize this rubric is a tool that can be used by teachers and students to provide feedback.</p>	15 min.

	<p>Project an example of a student argument. Then display the kinds of evidence students could use in the argument. After briefly discussing the types of evidence available, return to the student argument. Discuss how you would rate the argument using the rubric and the feedback they would provide to the student.</p> <p><i>This is an argument that took place during a pair discussion about where hurricanes are likely to occur.</i></p> <p>“The hurricanes occur, like hurricane Sandy, it was on the East Coast, and on the diagram, it showed, remember it was really red and warm, and so that probably means, and like there’s never hurricanes here in California it seems like because the water’s so cold you know, and so it’s probably the reason why hurricanes only occur where there is warm water.” 6th grade student</p> <p><i>(The teacher may ask this student to provide actual water temperatures in the two locations and then describe how water temperatures influence hurricanes.)</i></p> <p>Discussion Questions:</p> <ul style="list-style-type: none"> • How would you rate this argument using the Evidence Rubric? • What feedback would you provide? <p>Note: There are questions at the top of each category in the rubric. This can guide your focus as a teacher, but can also support students in providing feedback to each other on their evidence.</p> <p><i>Materials: Evidence Rubric</i></p>	
<p>Activity: Using the Evidence Rubric to Evaluate Student Arguments</p>	<p>Direct teachers to work in small groups to evaluate written student arguments using the rubric.</p> <p>Provide content and contextual background to teachers to help them evaluate the arguments. These 3 student arguments were written following an in class investigation in which students collected data using a simulation showing what a 1 lb ball would weigh if dropped on different planets. The question students answered was: How are the ball’s weight and mass affected when dropped on different planets?</p> <p>A. “The ball’s weight and mass are affected when dropped on different planets because of the gravity pull on that planet. The mas doesn’t change when dropped on a different planet because the ball does not change. It doesn’t get bigger or smaller. The only thing that changes the ball is its weight. Since the gravity is different on different planets, the weight</p>	<p>15 min.</p>

	<p>of the ball changes from the weight on Earth. The ball drops a certain speed on Earth because of Earth’s gravity. If the gravity changes the ball drop slower or faster than it did on Earth.” <i>(In this argument, the student is using science ideas to explain how weight is affected on different planets. This student does not include any of the evidence that was collected from the simulation. A teacher might explain to this student that including the actual evidence collected would make this argument stronger.)</i></p> <p>B. “The weight would change but the mass couldn’t. The weight would change depending on the gravitational pull of the planet or moon. The more mass the planet has the stronger the gravitational pull, as in Jupiter, being a gas giant, has 2.64 times more of a pull than Earth, causing a 1 pound Earth ball to be 2.64 lb. Though the weight changes the mass doesn’t. It doesn’t matter where you put that ball it will be made of the same items and have the same mass.” <i>(This student includes evidence collected in the simulation. A teacher might tell this student that he could make his argument even stronger by referencing additional evidence that was collected.)</i></p> <p>C. The ball’s weight would change if it was dropped on a different planet, but the mass would not change. In the simulation, I observed that a 1 pound ball on Earth would weigh 2.64 pounds on Jupiter because of the gravity. I saw the movie Gravity, and in outer space, away from a planet, objects float, and weigh nothing but would fall to the ground on Earth. <i>(This student incorporates evidence. A teacher might tell this student she could make the argument even stronger by considering the evidence source and whether or not the evidence is relevant to the argument.)</i></p> <p>Ask teachers to discuss the following questions:</p> <ol style="list-style-type: none"> 1. What strengths and weaknesses does the rubric help you identify in student use of evidence? 2. How does this help you provide feedback to students? 3. What are the limitations of using a rubric like this? <p>Following group work, bring the whole class together to reflect on their experience using the rubric.</p> <p><i>Materials: Evidence Rubric Sample Student Arguments Handout</i></p>	
<p>Video: Student Peer Review</p>	<p>Watch an excerpt of the video below, which shows students giving each other feedback. Strategy, Writing for a Hypothetical Audience (5:55-6:26) http://www.argumentationtoolkit.org/reasoning.html</p>	<p>5 min.</p>

	<p>Then, have a discussion guided by the following questions:</p> <ol style="list-style-type: none"> 1. What are the strengths and weaknesses of the feedback students provide? 2. How could this rubric be used as a tool to improve student feedback on evidence? 3. What are the other ways you could support students in giving each other productive feedback? <p>Note: Highlight each category includes a question that would help students direct their thinking.</p>	
Takeaways	<ul style="list-style-type: none"> • Common challenges students have with evidence are: relevance, sufficiency, and source. • A rubric is a helpful tool for supporting student use of evidence. • Students can receive feedback on their use of evidence by both their teacher and peers using the rubric. 	5 min.
Extension-Using the Evidence Rubric!	Ask teachers to use the Evidence Rubric to evaluate student use of evidence in a written or oral argument. In the next session, be prepared to share your experiences using the rubric, including how the rubric was helpful for your instruction and what was challenging.	Optional

Session #3: How can you support student use of reasoning in a scientific argument?

Activity	Description	Time
Extension Discussion-Using the Evidence Rubric!	<p>If you asked teachers to use the Evidence Rubric to evaluate student use of evidence in a written or oral argument, have a discussion guided by the following questions:</p> <ul style="list-style-type: none"> • What were the strengths of your student use of evidence? What were the weaknesses? • How could you use this information about student use of evidence to guide your instruction? • What challenges did you encounter in using the rubric? 	Optional
Video: Approach, Reasoning	<p>Watch the video below, which provides an overview of reasoning and the classroom activities that can encourage student use of reasoning.</p> <p>Approach, Reasoning http://www.argumentationtoolkit.org/reasoning.html</p> <p>Then, have a discussion around the following questions:</p> <ul style="list-style-type: none"> • How do the activities featured in the video encourage students to use reasoning? • What do your students encounter using reasoning? • What challenges have you encountered in providing feedback to students on their reasoning in arguments? 	10 min.

<p>Presentation: Reasoning Rubric</p>	<p>Emphasize the goal of this session is to focus supporting student reasoning by focusing on providing feedback using a rubric.</p> <p>Project and discuss the rubric. Talk through the organization of the rubric, and emphasize this rubric is a tool that can be used by the teacher and students to provide feedback.</p> <p>Project an example of a student argument. Rate the argument using the rubric. Discuss feedback they would provide to the student based upon the rubric.</p> <p><i>This excerpt is from a class discussion about data collected from a simulation of metabolic processes in athletes playing soccer at low and high altitudes. In this excerpt, a student is making an argument that soccer players at high altitude cannot play soccer as well as players at low altitude.</i></p> <p style="padding-left: 40px;">“For us we got the same thing, claim B, soccer players at high altitudes cannot play soccer as well as players at low altitude and well, our evidence, kind of the same as them, our sim extreme at low altitude it lasted for 1 minute and 15 seconds and breath rate was 44 and heart rate was 177 and then when it was high altitude it died and 44 seconds and the breath rate was 59 and the heart rate was 179.”</p> <p><i>(The teacher would ask this student to provide more reasoning, connecting the evidence to the claim and drawing upon science ideas. High altitude, less oxygen in the air, so you will get less oxygen in each breath. This is why the breath rate and the heart rate are higher at the high altitude. There is less oxygen in the blood so the heart needs to pump more to move the oxygen through the body. The body needs oxygen to go through respiration, which provides energy to a soccer player.)</i></p> <p>Discussion Questions:</p> <ul style="list-style-type: none"> • How would you rate this argument using the Reasoning Rubric? • What feedback would you provide? <p>Note: There are questions at the top of each category in the rubric. These can guide teacher feedback, but can also support students in</p>	<p>15 min.</p>

	<p>providing feedback to each other.</p> <p><i>Materials: Reasoning Rubric</i></p>	
<p>Activity: Using the Reasoning Rubric to Evaluate Student Arguments</p>	<p>Direct teachers to work in small groups to evaluate written student arguments using the rubric.</p> <p>Provide content and contextual background to teachers to help them evaluate the arguments.</p> <p>Content: igneous=volcanic rock; sedimentary= formed by the deposition and cementation of material; metamorphic= previously formed rock changed by heat and pressure</p> <p>Classroom: In this classroom activity, each student was assigned a different rock found near the Grand Canyon. Students observed rock samples in class and read scientific articles. They needed to write a scientific argument about the type of rock they were assigned.</p> <p>A. Claim: The Dox Sandstone is a sedimentary rock. Evidence: My first piece of evidence is that the Dox sandstone had many lines in it. The excerpt from “Geologic History of the Grand Canyon” said that the Grand Canyon was covered by sea. The sea must have taken sediment from other places and deposited it in layers. After it hardened, the different layers would be visible. The sample of the rock we saw had many visible lines. My second piece of evidence is that it has many different colors and rock sizes. The sea can’t choose what type of rock it will deposit, so many different types could have been used to make one rock. Many different colors and textures is a characteristic of sedimentary rock. I also don’t think it is Metamorphic, because then the stripes would probably be wavier. Our sample had straight lines.” <i>(This student offers clear reasoning and science ideas to explain how her evidence relates to the claim. A teacher might encourage this student to make her argument even stronger by including more explanation for why wavier lines would indicate that the rock is metamorphic.)</i></p> <p>B. “My claim is the Zoroaster Granite is an igneous rock. And my evidence is that it has luster and it’s shiny and it looks a lot like the rocks were melted into one. My reasoning is that it was deep in a canyon so it could have been heated by some lava just below the surface, but it may no longer be there</p>	<p>15 min.</p>

	<p>because there’s water there now, so it could have taken out the water. Or the water could have taken out the lava.” <i>(This student does not make her reasoning very clear, although she does include some explanation of how the evidence supports the claim. It would be more clear if she further explained that igneous rock is formed from cooling lava or magma. A teacher might recommend that the student use what she knows about igneous rock to be more explicit about how each piece of evidence supports the claim.)</i></p> <p>C. “The Zoroaster Granite is an igneous rock. It is pink and brown. It has large white and black mineral crystals that I could see with my eye. It was also found deep underground in the area by the Grand Canyon. The Grand Canyon is in Arizona. There are many different types of rocks found all over the world. One of the types is igneous, which is why I think the Zoroaster Granite is an igneous rock.” <i>(This student provides evidence, but does not connect the evidence to the claim. He restates the claim.)</i></p> <p>Ask teachers to discuss the following questions:</p> <ol style="list-style-type: none"> 1. What strengths and weaknesses does using this rubric help you identify in student reasoning? 2. How does this help you provide feedback to students? 3. What future class activities might support these students in better articulating their reasoning? <p>Following group work, bring the whole class together to reflect on the discussion questions.</p>	
<p>Takeaways</p>	<ul style="list-style-type: none"> • Common challenges students have with reasoning include connecting evidence with their claim and relating science ideas to the claim. • Classroom activities can support students in articulating their reasoning, such as: hands-on investigations, group discussions, and evidence card sorts. • Students can receive feedback on their reasoning by both their teacher and peers using the rubric. 	<p>5 min.</p>
<p>Extension- Using the Reasoning Rubric!</p>	<ul style="list-style-type: none"> • Ask teachers to use the Reasoning Rubric to evaluate student reasoning in a written or oral argument. In the next session, be prepared to share your experiences using the rubric, including how the rubric was helpful for your instruction and what was challenging. 	<p>Optional</p>

Session #4: How can you create classroom activities to target whole class challenges with evidence and reasoning?

Activity	Description	Time
Extension Discussion- Using the Reasoning Rubric!	<p>If you asked teachers to use the Reasoning Rubric to evaluate student use of evidence in a written or oral argument, have a discussion guided by the following questions:</p> <ul style="list-style-type: none"> • What were the strengths of your student use of reasoning? What were the weaknesses? • How could you use this information about student use of reasoning to guide your instruction? • What challenges did you encounter in using the rubric? 	Optional
Video: Student Argument	<p>Watch a video of a student reading his argument at this link. Have a whole class discussion around the following questions.</p> <ul style="list-style-type: none"> • What evidence does he use in his argument? • What reasoning does he use in his argument? • What feedback would you provide to improve his argument? 	5 min
Presentation: Supporting Activity Planning Tool	<p>Briefly review the focus of the previous three sessions. Session 1 supported the teacher in both recognizing and distinguishing between evidence and reasoning. Sessions 2 and 3 focused on providing individual feedback to students using a rubric on their use of evidence and reasoning, respectively, by targeting areas that are particularly challenging for students. In this session, we focus on how to support a whole class in overcoming challenges with evidence and reasoning. We will use the Planning Tool to help teachers choose and design activities targeting student challenges with evidence and reasoning.</p> <p>Project the tool. Explain that the tool features the elements of evidence and reasoning targeted in the rubrics from Session 1 and 2. The tool also includes potential argumentation activities included in other modules, mostly from the Introductory Module. Ask teachers to work in pairs or small groups to see how these activities could be used to support student challenges using evidence and reasoning. In reviewing the common challenges students have, teachers should think about how these activities could potentially help <i>their</i> students overcome those challenges. On the page, include notes explaining how the activity might address a particular challenge. Prompt teachers to keep these activities in mind as they design a lesson to</p>	10 min

	<p>support your class later in the session.</p> <p>Then, have a brief class discussion sharing highlights from group work. The facilitator should highlight that each of these activities could be used to support students, but different aspects of argumentation can be brought to the forefront depending upon how teachers present the activity to students.</p> <p>Note: The Evidence Gradient Tool is the only activity that might be unfamiliar to teachers because it was featured in the Advanced Module: Rich Argumentation Tasks, not in the Introductory Module.</p>	
Workshop: Design Your Own Activity	<p>Ask teachers to identify an element of either evidence or reasoning that is particularly challenging for their students. Based upon their completion of the planning tool, teachers will design an activity to support their students' argumentation in that area. Teachers may choose to work independently or with a peer/ in groups. During workshop time, teachers can be grouped by either the argumentation challenge or the activity to provide each other with support while they work.</p> <p>After 20 minutes of work, encourage teachers to share their activities with the class.</p> <p>Following the group discussion, share tips for how to design lessons that support student use of evidence and reasoning.</p> <ul style="list-style-type: none"> • Have evidence students don't need to use. This creates a need for reasoning (i.e. why did you not include one or more pieces of evidence?). • Make sure the question students are answering is not directly answered by the data. This requires students to make a connection between the data and the claim they are making. • Include different types of evidence sources and evidence of different quality. This requires students to be critical. 	25 min
Takeaways	<ul style="list-style-type: none"> • The evidence and reasoning rubrics can be used to identify the challenges classes face, as well as individuals. • The Supporting Activities Planning Tool can be used as a resource to help teachers plan activities targeting the challenges students encounter using evidence and reasoning. 	5 min