beetles
Science and Teaching for Field Instructors

Student Activity Guide

Evaluating Sources

A fundamental part of science is using information as evidence to support explanations. We are all exposed to information (reliable and unreliable) every day, and this information shapes our decisions and worldview. The ability to evaluate the quality of sources of information is an important part of constructing and critiquing scientific explanations (as well as an important life skill). Students, and even many adults, can sometimes base their explanations on evidence from unreliable sources and can learn to think critically about the reliability of sources and to cite their own sources of information whenever they share ideas. In this activity, students sort different sources of science information from most to least reliable, discuss their rationale with their peers, and come to a deeper understanding of what makes a source reliable. This skill prepares students for science discussions both in the classroom and in their outdoor science experience. This activity is designed to be done before an outdoor science experience, such as outdoor science school, but can also be done after such an experience.

Students will…

- **Brainstorm sources of information.**
- **Sort sources of science information based on their reliability.**
- **Discuss what makes a source more reliable or less reliable.**

Grade Level:
Grades 5–12. This activity can also be used with adults.

Timing:
55–60 minutes

Related Activities:
Classroom: *Evaluating Evidence*, Field: *NSI: Nature Scene Investigators, What Lives Here?, Argumentation Routine*

Materials:
See Materials and Preparation on page 3 for details.

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

NEXT GENERATION SCIENCE STANDARDS (NGSS)

This activity supports students in deepening their capacity to engage in the Science and Engineering Practices of *Constructing Explanations*; *Engaging in Argument from Evidence*; and *Obtaining, Evaluating, and Communicating Information*. For more information, see Instructor Support on page 10 of this guide.

For additional information about NGSS, go to page 12 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Evaluating Sources

ACTIVITY OVERVIEW

Evaluating Sources	Learning Cycle Stages	Estimated Time
Introducing the Activity and Brainstorming Sources	Invitation, Exploration	10 minutes
Sorting Cards	Exploration, Concept Invention	15–20 minutes
Discussing the Reliability of Sources	Concept Invention	15 minutes
Optional: The Monkey Business Illusion	Exploration, Concept Invention	10 minutes
Reflecting and Wrapping Up	Reflection	5 minutes
TOTAL:		**55–60 minutes**

TEACHING TIPS

Read the Instructor Support section. Beginning on page 10, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Listen to your students' ideas. This activity can reveal a lot about what your students think. Listen to their discussion as they evaluate various sources. Pay attention to the sources they trust, the ones they question, and the reasons behind their decisions. Use this information to decide which other activities could lead students to more deeply investigate the merits of specific sources for science (or other) information.

A tool for any source. After this activity, encourage students to make a habit of asking one another *What's your source?* whenever they share information. Remind them of this activity and ask them to use the class's evaluation of sources to evaluate the strength of their own sources.

Where's the application? This activity doesn't include an Application stage of the Learning Cycle because true application will take place when students use criteria for evaluating sources of information in future discussions and experiences.

Defining sources. Look at the Source Cards ahead of time, take notes about any kinds of sources with which your students might not be familiar, and take a few moments before distributing the cards to define any sources of information that might be new or confusing.

MATERIALS AND PREPARATION

MATERIALS

For the class

- whiteboard
- whiteboard markers

For each group of 3–4 students

- 1 set of Source Cards (See pages 17–21.)

PREPARATION

1. **Prepare sets of Source Cards.** Print and make enough copies of the Source Cards (on pages 17–21) for each group of 3–4 students to have one set. Print cards in color, single-sided, and cut apart cards.
2. **Optional: Prepare to show students *The Monkey Business Illusion* video.** Decide if you will show students this video. If you decide to show it, make sure you are connected to the Internet. Find the video by Googling "monkey business illusion" or going to the following URL: https://www.youtube.com/watch?v=IGQmdoK_ZfY
3. **Review the Teaching Tips on page 2 and the Instructor Support section on page 10.**

TEACHING NOTES

TEACHING NOTES

See BEETLES Discussion Routines resource on the BEETLES website for the logistics of *Turn & Talk* and other discussion routines.

Consider using an example from your students' brainstorm. If you can come up with an example of how one of the sources that students brainstormed is more reliable in one context than in another, use that instead of the mechanic/basketball player example.

Group Agreements for Science Discussions. Having specific group agreements for science discussions scaffolds important skills and supports student participation. If you have group agreements for discussions, review them here and remind students to put them into practice. If you don't already have agreements in place, see the BEETLES activity *Group Agreements for Science Discussions*. It includes the following Group Agreements, plus a protocol for introducing them to students: *Listen actively and share ideas; Share and ask for evidence; Take space, make space; Keep an open, curious mind; Build on others' ideas.*

Introducing the Activity and Brainstorming Sources

1. **Ask students to *Turn & Talk*, or do a *Quick-Write*, about the following questions with a partner:**
   - *If you wanted to understand something, where would you go to learn about it?* (If students seem stuck, suggest some possibilities such as a movie, a book, Wikipedia, a parent, a teacher, a friend.)
   - *Where do you think most people get their information?*

2. **Write "Sources of Information" at the top of the whiteboard.**

3. **Introduce sources of information. Explain:**
   - **a.** Everything you just talked about—newspapers, magazines, politicians, advertisements, other people, and so on—is a source of information.
   - **b.** There are sources of information *everywhere*, and you come across many different sources every day.

4. **Ask the class to brainstorm sources of information as you record their ideas.**
   - **a.** As students share sources of information, record their ideas underneath the "Sources of Information" heading on the whiteboard.
   - **b.** Keep this brainstorm brief—no longer than a few minutes.

5. **Ask students to *Turn & Talk* about one source they would trust, and one they wouldn't trust. Explain:**
   - **a.** Choose one source listed on the whiteboard that you would trust and explain to your partner why.
   - **b.** Do the same for a source you would not trust.

6. **Ask a few students to share their ideas.**
   - **a.** Which sources did you or your partner choose as trustworthy or untrustworthy and why?

7. **Write "reliable" on the whiteboard and discuss reliability. Explain:**
   - **a.** Sources that are more trustworthy are reliable.
   - **b.** A certain source may be reliable for certain kinds of information, but not for other kinds.
   - **c.** For example, an auto mechanic may be a very reliable source for information about cars but an unreliable source for basketball strategy.
   - **d.** A more reliable source for that might be a basketball player or coach.

8. **Explain some of the variations in reliability within each source:**
   - **a.** There are plenty of other factors that come into play when discussing reliability.
   - **b.** Going back to the car mechanic example, there's a whole range of reliability among mechanics.
   - **c.** Some have more experience and knowledge than others.
   - **d.** Some have higher standards for doing the best possible job.
   - **e.** Others may be more interested in making as much money as they can rather than in doing what's best for the customer.

9. **Review any class Group Agreements for Discussions.**
   - **a.** Take time to review discussion Group Agreements you've already established in your class.
   - **b.** You may choose to ask students to focus on a particular item under Group Agreements during this discussion.
   - **c.** If you have not used Group Agreements for Discussions with your class before, take the time to introduce them now. (See sidebar and BEETLES activity *Group Agreements for Science Discussions*.)

Sorting Cards

1. **Write "Least Reliable" on one side of the whiteboard and "Most Reliable" on the other side. Draw a horizontal line between them with arrows on both ends.**

   Least Reliable <——————————————> Most Reliable

2. **Show Source Cards and introduce the card sort activity. Explain:**
   - **a.** You will form groups of 3–4.
   - **b.** Each group will get a set of cards.
   - **c.** Each card shows a different source of science information.
   - **d.** Your task is to work together to organize the cards based on the reliability of the source, from least reliable to most reliable.

3. **Divide the class into groups, explain that discussion is the most important part of the activity, distribute sets of Source Cards, and have students begin sorting the cards. Explain:**
   - **a.** Find the most reliable and least reliable cards and place them at either end of the table.
   - **b.** Work together to sort the other cards.
   - **c.** Discuss your reasoning for the placement of the cards as you sort them.
   - **d.** It's not a race! It's fine if you can't agree.
   - **e.** The discussion of your reasoning is the most important part of this activity!
   - **f.** Respectfully disagree with your groupmates if you have different ideas from one another.

4. **Circulate, listen to students' ideas, and support any groups that are struggling.**
   - **a.** Mingle among groups, paying attention to discussions.
   - **b.** Encourage discussion among groups that could use help.
   - **c.** If a group isn't familiar with a certain kind of source, or is struggling to work together, support them.
   - **d.** Use this opportunity to listen to what students are saying about the reliability of different sources. Their ideas might be surprising!
   - **e.** In particular, pay attention to any disagreements so you can highlight these in your debrief.

TEACHING NOTES

Intentionally chosen Source Cards. The Source Cards in this activity are chosen intentionally to represent a broad range and quality of sources of scientific information. Include all cards in the sort, even if they are sources that students don't encounter in your classroom. It's important for students to think about and discuss a range of sources (not just those they would consult in an academic context), because they will confront other sources on a daily basis and may use them to construct their understanding of science ideas.

Equally reliable sources. If it comes up, let students know that they don't have to sort all cards in a line from least reliable to most reliable. They might decide that some sources are equally reliable (or equally unreliable), and they can place them alongside one another in the lineup.

Encouraging curiosity about the ideas of others. A good strategy for participating productively in discussions is when someone brings up a different idea or disagrees, students should become curious about that person's reasoning. Remind them of this throughout the discussion.

Modeling how to discuss the topic. For students who have less experience with this type of discussion, you may want to briefly model an example of the type of discussion they'll be having. This can help them better understand the task, as well as how to participate productively.

Supporting productive discussions. If students are having trouble working together or are not discussing their reasoning for card placement, consider providing sentence starters to help them engage in respectful, productive discussion. Useful sentence starters include: *I agree because...*; *I wonder if...*; *I disagree because...*; and *I'm not sure, but I think....* For more tips on supporting discussions, see BEETLES resources for "Encouraging Student Discussion and Productive Talk" on the BEETLES website.

5. **After about 15 minutes, ask students to do a gallery walk to see other groups' card sorts.**
   a. Walk around to see how other groups sorted the cards.
   b. Notice and discuss differences in how other groups sorted the cards.
   c. Notice and discuss patterns in what different groups thought were the most reliable sources.

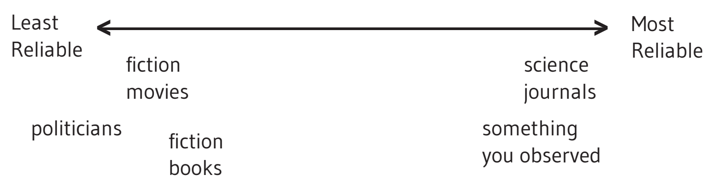
Discussing the Reliability of Sources

1. **Get students' attention and remind them of Group Agreements for Discussions.**
   a. After about 5 minutes of the gallery walk, get students' attention.
   b. Remind students of any group agreements you have for classroom discussion.
   c. Explain: You're probably going to disagree about how reliable some of the sources are, and that's okay.

2. **Record groups' ideas and lead a discussion about the most reliable sources.**
   a. Ask: "What do you think are the most reliable sources?"
   b. Hear from a few groups and record their ideas near the "Most Reliable" end of the line on the whiteboard.
   c. As students share, ask why they think those are the most reliable sources. Encourage others to agree or disagree.
   d. Ask follow-up questions and encourage respectful discussion.

3. **Record groups' ideas and lead a discussion about the least reliable sources.**
   a. Ask: "What do you think the least reliable sources are?"
   b. Again, ask students to share their reasoning and to agree/disagree.
   c. If you noticed particular cards about which students disagreed while you observed groups working, bring those up to discuss as a class.
   d. Keep encouraging respectful discussion.

   Note: You do not need to include all the sources on the whiteboard, but you should have several for least reliable and most reliable sources. Here's an example of how you might record students' ideas:



   You could also use two sheets of chart paper—with "Least Reliable" at the top of one sheet and "Most Reliable" at the top of the other sheet—and record students' ideas instead of placing their ideas along a gradient on a whiteboard.

TEACHING NOTES

Explaining the cards about scientists who study different topics or disciplines in science. If students are unfamiliar with various disciplines of science, give them an example to explain what the *cards for scientists who study the topic of interest* and *scientists who study other topics* are referring to. For example, you could say "If we wanted to learn about an animal in the ocean, a scientist in the discipline of study (hold up the *scientists who study the topic of interest* card) could be a marine biologist who studies animals that live in the ocean. A scientist of a different discipline (hold up the *scientists who study other topics* card) is someone who studies science, but not marine biology—a geologist who studies the solid part of Earth, an astronomer who studies outer space, or a chemist who studies what things are made of."

Behavior management for gallery walk. Model appropriate and engaged behavior for a gallery walk, set clear expectations for moving from one group's sort to the next, and emphasize the focus (to notice differences in groups' sorts). You could also focus students by asking them to record differences they noticed between different groups or questions that came up. This is a great opportunity for students to get up and move and to spur further discussion about the strength of evidence. However, you can skip this step if it doesn't make sense to do it for your class or context.

4. **Ask: "What makes a source reliable for science information, and what makes a source unreliable for science information?"**
   a. Allow the conversation to follow students' interests.
   b. If an interesting point comes up, consider giving your students approximately 1 minute to *Turn & Talk* about it. Then, break up the whole-group discussion, allow for more participation, and keep the discussion engaging for everyone.
   c. Here are some ideas that may come up or that you may want to introduce if the discussion dies down:
      - Reliable sources
         - come from people who study/are experts/have deep experience in the topic.
         - are evaluated by others (e.g., scientific articles that are peer-reviewed by other scientists).
         - include *all the available* evidence.
      - Unreliable sources
         - might gain something by lying to you (e.g., advertisers).
         - might try to make something more dramatic for entertainment value (e.g., movies and books).
         - have little experience in the topic.
         - include only evidence *chosen* to convince you of an opinion.

5. **Summarize the main points of the discussion.**
   a. Conclude the discussion by summarizing the main points or any conclusions the class came to.
   b. For example, "Some of us rated parents as reliable, and some rated them as unreliable. We realized that the reliability depended on the individual parents' expertise and on the specific topic of the question."
   c. Or, "We all agreed that there are so many different kinds of social media and so many different people who post on social media, that we all need to be super thoughtful when we're looking at science information on social media and not just accept what we think of as true right away."

6. **Explain that media can keep us informed, although some sources are either inaccurate or deliberately misleading:**
   a. Media sources can help us keep informed about important issues.
   b. However, some sources are biased, inaccurate, or deliberately trying to deceive and manipulate us.
   c. How can we know which sources to trust?

7. **Share ideas and resources for evaluating media while making connections to any media literacy learning that your class has already done. Explain:**
   a. There are tools we can use to think about media and news when we come across it.
   b. One way to think about media sources is to consider which of the following categories they fall into:
      - those that focus on presenting facts
      - those that share facts and analysis
      - pieces that include opinions
      - media mostly trying to entertain the audience

TEACHING NOTES

Pointing out some more reliable sources that encourage peer review. Your students may not have enough science background to understand that science journals, certain publications by government agencies or government websites ending in ".gov," and publications by universities or websites ending in ".edu" tend to be more reliable sources of information. No source is perfectly reliable, but these sources all encourage peer review of shared information.

Considering sources for science class and other kinds of information. If desired, have a discussion about one or both of the following questions:
- *Which sources for science information should we rely on as a class? Why should we prioritize these sources over other sources?*
- *If you were to re-sort these cards to evaluate how reliable these sources are for a different kind of information (e.g., history, current events), which sources would change position? Why? What other sources would you want to use for other kinds of information?*

Asking students which sources they should rely on in their classroom context gives them a chance to reflect on whether there is a distinction between generally reliable sources and reliable sources appropriate in an academic setting. Thinking about sources for different kinds of information allows them to apply their understanding of the reliability of sources to a new context, which may also be useful in other school subjects.

Other criteria for evaluating evidence. If you already taught the *Evaluating Evidence* activity, you may want to reference that as you wrap up this lesson. Remind students that when they make arguments or explanations, not only should they think about how reliable their sources of evidence are, they should also think about how closely their evidence connects to the claim they're trying to support and about how much evidence they have to support their claim.

TEACHING NOTES

More on media literacy. Media literacy is a huge and important topic, and this activity isn't meant to address everything students should consider as they encounter media. Give students other opportunities to build media literacy and to think about reliable sources of information. For more indications of how to tell if a media source isn't trustworthy, check out the following:

Media Smarts Digital Media Literacy Guide (http://mediasmarts.ca/digital-media-literacy/general-information/digital-media-literacy-fundamentals/media-literacy-fundamentals). Includes helpful questions to consider when encountering media, such as: *Who created this media?; What is its purpose? Is there a commercial purpose of this media product (How will it help someone make money?)? If no commercial purpose can be found, what other purposes might the media product have (for instance, to get attention for its creator or to convince audiences of a particular point of view)? How does this influence the content and how it's communicated? Who and what is shown in a positive light? In a negative light? Why might these people and things be shown this way? Who and what is not shown?*

The Maag Library at Youngstown State University Evaluating Media Sources Guide (http://maag.guides.ysu.edu/c.php?g=629496&p=4393747 and https://www.adfontesmedia.com/). Includes a collection of articles from reputable sources about how to recognize fake news stories, including "How to Spot a Fake News Article," "Skills and Strategies for Identifying Fake and Real News," etc.

Media Bias Chart (https://www.adfontesmedia.com/). Categorizes news media sources into several categories, including: fact reporting; complex fact analysis; opinion, fair persuasion; opinion, selective/unfair interpretation; propaganda. While different people may disagree with where individual news media sources are placed in this chart, the overall organization of the chart is useful to consider.

c. The goals of these different kinds of media are different, and we can think about how these goals might affect the reliability of the information shared.
d. Ask: "What might be clues you can be aware of when looking at a source to figure out the goal and impact it hopes to have on the audience?"

8. **Listen to students' suggestions and add more.**
   a. Listen to students' ideas.
   b. Add to what students bring up, using the list below (curated from the Maag Library Media Sources guide):
      - hyperbole
      - titles or claims in ALL CAPS!
      - evidence on only one side of an issue
      - a lack of citations
      - a seemingly persuasive headline that doesn't match the content of the article
      - quotes taken out of context
   c. Leave enough time for reflecting and wrapping up.

Optional: The Monkey Business Illusion

(If you choose not to do this section, skip ahead to Reflecting and Wrapping Up.)

1. **Share *The Monkey Business Illusion* video to challenge how reliable our own observations are. Explain:**
   a. I'm going to show you a video that will ask you to observe something.
   b. You'll have a chance to talk about the video afterward.
   c. Just silently observe and do what the video tells you to do as you watch.
   d. If you've seen this video before, let others have the experience without your commenting.
   e. Please don't say anything about it to anyone until later in this session.

2. **Show *The Monkey Business Illusion* video (1:41 minutes): https://www.youtube.com/watch?v=IGQmdoK_ZfY**

3. **After students watch the video, ask them to *Turn & Talk* about the following questions:**
   - *Why do you think some people don't notice the gorilla, the curtains' changing color, or the player leaving?*
   - *Does that change your thinking about how reliable your observations are as a source of science information? How?*

4. **Explain that observations can be an important source of science information, but we can all be fooled when our attention is focused on particular things. So, it's important to consider other or even multiple sources of information.**
   a. Some people trust their own observations more than they trust experts who have spent years studying something.
   b. While it's good to make your own observations, it's also important to realize that we can all make mistakes.

c. Thoughtful scientists recognize this, so they set up experiments to try to make sure their observations are as accurate as they can possibly be.

Reflecting and Wrapping Up

1. **Explain that whenever students come across information, they should think about the reliability of its source:**
   a. Every day, we are exposed to information.
   b. It's important to think about the reliability of the source of this information.
   c. This can help you make more accurate scientific explanations.
   d. It can also help you make more informed decisions in general.

2. **Encourage students to cite their sources when they discuss science ideas. Explain:**
   a. In future discussions we have, try to remember to state the source of your information when you share ideas in science class.
   b. Also think about the reliability of your sources.
   c. If someone forgets to say their source of information, gently ask them to share it.

3. **Ask students to *Turn & Talk* or write about one or both of the following questions:**
   - *Why do you think it's important to cite sources of science information? Why does the reliability of your source matter in science?*
   - *Have your ideas changed during the course of this activity? How or why did your ideas change?*

4. **If you asked your students to focus on a particular science discussion norm, ask them to discuss with their small group how they did with it.**

TEACHING NOTES

Challenging the reliability of observations. Students may rate their own observations above every other source, including scientists within the field of study of the information in question. If students have this perception of their own observations (and even if they don't), it's useful to show them that their own observations can be fallible. This helps to emphasize how having more than one source of evidence is important for building a strong scientific argument.

Remind students to cite and evaluate their sources. The point of this activity is to set up discussions in future activities and experiences for success. When at outdoor science school or in any science discussion after this activity, remind students to cite their sources and to evaluate how reliable a source they think it is. This habit can really catch on and become a part of the culture of discussion in your class.

This activity has encouraged students to point out weaker and stronger sources. Students usually pick up very quickly on the differences in the quality of various sources. It doesn't take much exposure for students to begin citing their sources and pointing out low-quality or high-quality sources. A higher-quality source that is often cited by students is a nature film. Before doing this activity, students often contribute information they have heard without volunteering the source. After reflecting on the quality of different sources, they still sometimes cite weak sources such as *I saw it on Sponge Bob*, but they may follow up with something such as *Oh, and that's not a very reliable source.*

TEACHING NOTES

Instructor Support

Teaching Knowledge

About explanations and arguments in science. A strong scientific explanation goes beyond just answering a question; it needs to make clear how different pieces of evidence support the answer to a question. The process that scientists use to decide which is the best possible explanation about something in the natural world is called argumentation. In this process, scientists propose possible explanations for something in the natural world and then identify the weaknesses and limitations of the various explanations in order to determine which explanation is best supported by all the available evidence. Argumentation is based on the idea that since science is a collaborative endeavor, argumentation is a crucial part of how science knowledge is generated.

Key Vocabulary

- **claim:** A proposed answer to a question.
- **data:** Factual information, such as observations, measurements, or test results.
- **evidence:** Data that help answer a question, form an explanation, or disprove an explanation.
- **explanation:** A nonfiction, evidence-based story about how or why something in the natural world appears or happens. A scientific explanation must connect data or phenomena with accepted scientific knowledge.
- **reasoning:** The process of showing how evidence supports a particular claim.

Useful criteria for evaluating the strength of evidence in making an explanation. This activity focuses on the first of the following three criteria for evaluating the strength of evidence in making an explanation or engaging in argument:

- **Quality of source.** A scientific paper is a higher-quality source for scientific information than an advertisement. Although that may seem obvious in this context, when people aren't thinking deliberately about the quality of the source of the information, they may place a higher value on evidence from the lower-quality source. The higher the quality and reliability of the source, the more sound the evidence, which results in a higher level of certainty. If you have a lot of evidence from a lower-quality source, it may not compare favorably with having less evidence from a higher-quality source. If you have evidence that is closely connected to the claim but a low quality of source, it may not be convincing.
- **Size of the assumption.** *How connected it is to the claim* is a more student-friendly term for a concept that is also sometimes referred to as *inferential distance*. For example, a student who sees a piece of scat and says it's coyote scat is making an assumption because they didn't actually see the scat emerge from a coyote. The smaller the assumption, the more likely the explanation. The bigger the assumption, the less likely the explanation. **Note:** The BEETLES *Evaluating Evidence* classroom activity supports students

in evaluating the strength of evidence and works well as a companion to this activity, either taught before or after.

- **Quantity of evidence.** Something that has been observed one time by one person is not as strong evidence as something observed multiple times by one person or multiple times by many different people. Increasing the amount of data often makes patterns and important details clearer. The more evidence we can collect through *reliable* sources, the more certain we can be about an explanation.

Scientists use reasoning to weigh all three of these criteria to evaluate the strength of an explanation.

Providing skills students can use at an outdoor science program. Teaching this activity *before* students go to an outdoor science school or any kind of outdoor science experience helps them develop skills they can use as they explore the natural world, setting them up for a more meaningful learning experience. In nature, you're surrounded by nature mysteries: *What caused the spots on this leaf? What left the line of silk on a branch or a rock? What made the hole in the acorn?* Outdoor science learning is a great opportunity for students to engage authentically in science practices as they try to understand the things that surround them in nature. With this activity's introduction to one important criterion for evaluating evidence—*evaluating the quality of a source of information*—students will be better prepared to construct strong arguments and explanations about the natural phenomena they see at outdoor science school. They'll also be more likely to pay attention to evidence of animals in the area, to question explanations that peers make (i.e., engage in scientific argument), and to come to a deeper understanding of the natural world by doing so!

Resources for teaching evidence-based explanation and argumentation. This activity is merely the tip of the iceberg for supporting students in constructing explanations and engaging in argument from evidence. Skills in evaluating evidence are a crucial foundation for making strong explanations, yet students will need much more support to actually engage deeply in argument and construct strong explanations. Here are some great resources to learn more about these practices and to support your students in using them:

- **The Argumentation Toolkit.** This free collection of online resources was developed to support middle school teachers in engaging their students in argumentation. The videos and other tools are also useful for a broader range of instructors. The argumentation toolkit can be found at: http://www.argumentationtoolkit.org/
- **Middle School Strategy Guides.** These free strategy guides introduce various approaches for engaging students in meaningful science learning opportunities. These guides were developed for middle school teachers but include approaches that could be adapted and used by a broader range of instructors. Several strategy guides particularly useful for engaging students in constructing evidence-based explanations or in practicing argumentation are listed below. All the strategy guides can be found at: http://learningdesigngroup.org/resources-strategy-guides

TEACHING NOTES

Connecting to your students' outdoor science program. Experiences in outdoor science schools tend to be very memorable and can even be life changing for students. The more opportunities that students have to connect what they are learning in the classroom to what they experience at outdoor science school, the more meaningful their outdoor experience will be and the more lasting the impacts are likely to be academically. This activity presents one way to connect classroom and outdoor learning through engaging in science practices. Think of other ways you can connect what students are learning at school to what they might experience in outdoor science school. Let instructors at the outdoor science school know the activities you've done with your students so you can better prepare the instructors for the experience.

TEACHING NOTES

About the Next Generation Science Standards (NGSS). The development of the NGSS followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote *A Framework for K-12 Science Education* that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The *Framework*—validated by science researchers, educators and cognitive scientists—was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further toward engaging students in the practices used by scientists and engineers and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas (DCI's). The DCI's are divided into four disciplines: Life Science (LS); Physical Science (PS); Earth and Space Science (ESS); and Engineering, Technology, and Applied Science (ETS).

Read more About the Next Generation Science Standards at http://www.nextgenscience.org/ and http://ngss.nsta.org/

- Engaging in Argumentation with a Science Seminar: Regional Climate in the Atacama Desert
- Reteaching Loop: Identifying Basic Components of Strong Argumentation Writing by Analyzing Student Work
- Reteaching Loop: Practicing Oral Discourse Skills
- Reteaching Loop: Understanding the Role of Relevant Evidence in Supporting a Claim
- Supporting Claims with Evidence by Using an Argumentation Card Sort: Fossils

- ***Seeds of Science/Roots of Reading*® Strategy Guides.** These free strategy guides were developed to highlight important instructional strategies that are embedded in the grades 2–5 *Seeds of Science/Roots of Reading*® integrated science–literacy curriculum. Since these strategy guides are connected to the curriculum, they reference books from that curriculum (which can be purchased separately). They also provide useful teaching tips and activities that can be employed more broadly. Some strategy guides that are particularly helpful for engaging students in constructing evidence-based explanations or in argumentation are listed below. All the strategy guides can be found at: http://scienceandliteracy.org/teachersupport/strategyguides
  - Teaching Scientific Explanations with *Gary's Sand Journal*
  - Teaching Scientific Explanation Writing with *Chemical Reactions Everywhere*
  - Using Discourse Circles with *What About Pluto?*
  - Using Roundtable Discussions with *Dragonfly Explanations*
  - Teaching About How Scientists Make Inferences with *Science You Can't See*
  - Teaching about the Nature and Practices of Science with *Why Do Scientists Disagree?*

Connections to Next Generation Science Standards (NGSS)

BEETLES student activities are designed to incorporate the three-dimensional learning that is called for in the Next Generation Science Standards (NGSS). Three-dimensional learning weaves together Science and Engineering Practices (what scientists do), Crosscutting Concepts (thinking tools scientists use), and Disciplinary Core Ideas (what scientists know). Students should be exploring and investigating rich phenomena and figuring out how the natural world works. The abilities involved in using Science and Engineering Practices and Crosscutting Concepts—looking at nature and figuring things out, using certain lenses to guide thinking, and understanding ecosystems more deeply—are mindsets and tools students can take with them and apply anywhere to deepen their understanding of nature, and they're interesting and fun to do!

The primary purpose of this classroom activity is to give students some foundational skills in the Science and Engineering Practice of *Obtaining,*

TEACHING NOTES

Evaluating, and Communicating Information that will help them engage in *Constructing Explanations* and *Arguing from Evidence* when they go to outdoor science school.

Engaging students in Obtaining, Evaluating, and Communicating Information. It's important for scientists and, according to the National Research Council's *A Framework for K–12 Science Education*, for students to encounter scientific information from many sources, to try to interpret this information, to communicate their own ideas in written and spoken form, and to discuss their observations and explanations with their peers. *Evaluating Sources* allows students to think through what constitutes a reliable source, which is an essential part of critically consuming science information. By engaging students in sorting and discussing many different sources of science information, this activity helps them recognize the importance of assessing the credibility and possible biases of different sources, including those they may encounter outside of school time.

Constructing Explanations and Engaging in Argument from Evidence. The *Framework* also states that (1) a major goal of science is to deepen human understanding of the world through making explanations about how things work, and (2) reasoning and argument are important processes that help scientists determine the best explanation for a natural phenomenon. Scientific knowledge evolves as scientists uncover new evidence and engage in argument about competing claims. Additionally, according to the *Framework*, engaging in argument is critical to students' understanding of the culture of science.

In order to construct a strong evidence-based explanation or to support an argument from evidence, students must be able to evaluate evidence effectively. In *Evaluating Sources*, while students do not construct explanations or engage in argument, they do learn a useful criterion for evaluating evidence, which they can then apply when given the opportunity to determine the strengths and weaknesses of a particular argument or to draw from different sources of information to construct an argument.

The table on the next page, from the NGSS, describes the aspects of argumentation in which students should become proficient as they progress from kindergarten to grade 12. Looking at the bullet points for each grade band makes it clear how developing the ability to evaluate evidence is a significant component of the Science and Engineering Practice of *Engaging in Argument from Evidence*.

TEACHING NOTES

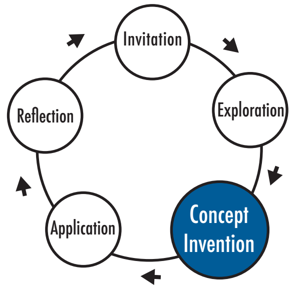
Engaging in Argument from Evidence			
Grades K–2	**Grades 3–5**	**Grades 6–8**	**Grades 9–12**
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). • Identify arguments that are supported by evidence. • Distinguish between explanations that account for all gathered evidence and those that do not. • Analyze why some evidence is relevant to a scientific question and some is not. • Distinguish between opinions and evidence in one's own explanations. • Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument. • Construct an argument with evidence to support a claim. • Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Compare and refine arguments based on an evaluation of the evidence presented. • Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation. • Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions. • Construct and/or support an argument with evidence, data, and/or a model. • Use data to evaluate claims about cause and effect.	Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. • Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully

(continued on next page)

TEACHING NOTES

Engaging in Argument from Evidence (continued)			
Grades K–2	**Grades 3–5**	**Grades 6–8**	**Grades 9–12**
	• Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	• Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints. • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	to diverse perspectives, and determining additional information required to resolve contradictions. • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).

TEACHING NOTES



Within a longer sequence of activities, *Evaluating Sources* functions as a Concept Invention activity.

Activity Connections

Evaluating Evidence, another classroom activity, would complement students' developing understanding of what strong evidence is and would further prepare students well for outdoor science. Almost all BEETLES activities engage students either in constructing explanations from evidence or engaging in argument. So nearly any BEETLES field activity would be a good follow-up to this activity. In particular, *NSI: Nature Scene Investigators*, *What Lives Here?*, and *Argumentation Routine* would provide great opportunities for students to deepen and apply the foundational skills that these classroom activities support.

Learning Cycle: *Evaluating Sources* includes an almost complete learning cycle as a discrete activity. What's missing is Application, which needs to take place as students apply ideas learned here during future science discussions. Within the sequence of many activities, *Evaluating Sources* is primarily a Concept Invention activity.

SOURCE CARDS

THE X FILES

Fiction TV Shows

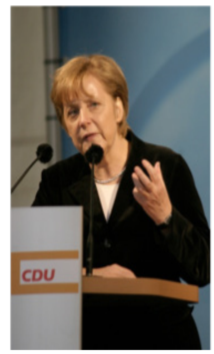
Evaluating Sources

Scientists Who Study Other Topics (and don't study the topic of interest)

Evaluating Sources

Scientists Who Study the Topic of Interest

Evaluating Sources



Politicians

Evaluating Sources

Publications by Universities or Websites Ending in .edu

Evaluating Sources

NOAA · NATIONAL INSTITUTES OF HEALTH · NSF · NASA · USGS science for a changing world

Publications by Government Agencies or Websites Ending in .gov

Evaluating Sources

SOURCE CARDS

Opinion and Persuasive News Media (e.g., newspapers, newsmagazines, news radio, news TV)

Evaluating Sources

Science Journals

Evaluating Sources

Network Science TV Shows

Evaluating Sources

Science Textbooks

Evaluating Sources

Something We Observed in Science Class

Evaluating Sources

Something Your Parent Said

Evaluating Sources

SOURCE CARDS

Science Books

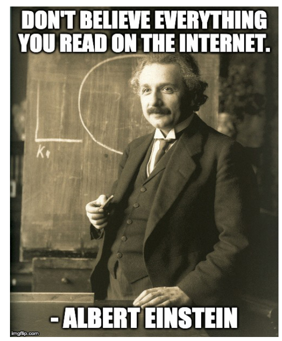
Evaluating Sources

Blogs

Evaluating Sources

Social Media

Evaluating Sources



An Internet Meme

Evaluating Sources

Fiction Movies

Evaluating Sources

Documentary Movies

Evaluating Sources

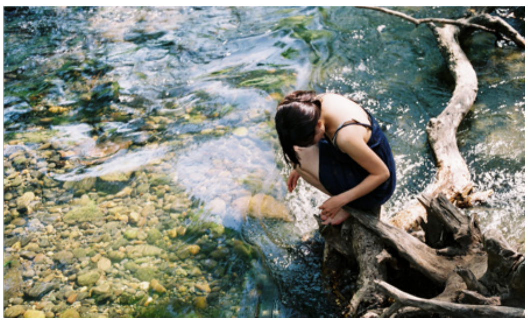
SOURCE CARDS

Something a Friend Says

Evaluating Sources

Fiction Books

Evaluating Sources



Something You Observe

Evaluating Sources

Wikipedia

Evaluating Sources

News Media (e.g., newspapers, newsmagazines, news radio, news TV) Focused on Fact Reporting

Evaluating Sources

News Media (e.g., newspapers, newsmagazines, news radio, news TV) Focused on Fact Analysis

Evaluating Sources

Advertisements/Infomercials

Evaluating Sources

SOURCE CARDS

Optional Cards

Many teachers attempt to avoid having explicitly partisan discussions with their students. However, if you think it would benefit your class to consider these specific categories of news sources (below) for science information, you might choose to include them in the card sorts. Students will likely disagree with where the specific media sources are placed on these cards (e.g., *Wait, I think* Time *magazine is partisan!*). If they do, encourage them to share their reasoning and evidence behind their statements. The whole point of this activity is to get students thinking, talking about, and analyzing the reliability of varying sources of information. As long as they're doing that, they're fulfilling the goals of the activity.

Minimally Partisan (left- or right-leaning) News Media

Source: Media Bias Chart /www.adfontesmedia.com/

Evaluating Sources

Highly Partisan News Media

Source: Media Bias Chart /www.adfontesmedia.com/

Evaluating Sources

Neutral News Media (minimal OR balanced bias)

Source: Media Bias Chart /www.adfontesmedia.com/

Evaluating Sources

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) provides environmental education programs nationally with research-based approaches and tools to continually improve their programs.

www.beetlesproject.org

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www.lawrencehallofscience.org

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The following programs contributed to the development of these materials by field testing and providing invaluable feedback. For a complete list of contributors and additional partners, please see beetlesproject.org/about/partners/

California: YMCA Camp Campbell, Rancho El Chorro Outdoor School, Blue Sky Meadow of Los Angeles County Outdoor Science School, YMCA Point Bonita, Walker Creek Ranch, Santa Cruz County Outdoor Science School, Foothill Horizons Outdoor School, Exploring New Horizons Outdoor Schools, Sierra Nevada Journeys, San Joaquin Outdoor Education, YMCA Camp Arroyo, Shady Creek Outdoor School, San Mateo Outdoor Education, Walden West Outdoor School, Westminster Woods.

Other locations: Balarat Outdoor Education, CO; Barrier Island Environmental Education Center, SC; Chincoteague Bay Field Station, VA; Eagle Bluff Environmental Learning Center, MN; Great Smoky Mountains Institute at Tremont, TN; Wellfleet Bay Wildlife Sanctuary Mass Audubon, MA; Mountain Trail Outdoor School, NC; NatureBridge (CA, WA, VA); Nature's Classroom (CT, MA, ME, NH, NY, RI); North Cascades Institute Mountain School, WA; NorthBay, MD; Outdoor Education Center at Camp Olympia, TX; The Ecology School, ME; UWSP Treehaven, WI; Wolf Ridge Environmental Learning Center, MN; YMCA Camp Mason Outdoor Center, NJ; and YMCA Erdman, HI.

Photos: Pages 1 and 2 by Kevin Beals. *Icons*: Backpack by Rémy Médard; Growth by Arthur Shlain; Cut by Nathan Thomson; Outside by Petr Holusa; Park by Antar Walker; &Time by Wayne Middleton all from The Noun Project.

Funding from 2012-2019 for BEETLES publications such as this one has been generously provided by the S.D. Bechtel, Jr. Foundation, The Dean Witter Foundation, Pisces Foundation, the Mary A. Crocker Trust, and the National Science Foundation under Grant No. 1612512. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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