A Guide to Developing Literacy Practices in Science

Supporting Claims with Evidence by Using an Argumentation Card Sort: Fossils

Strategy Guide

The Learning Design Group

THE LAWRENCE HALL OF SCIENCE

Earth Science

Grades 6–8

Overview

What's in this guide? This strategy guide introduces an approach for helping students learn to make a scientific argument. Sorting and discussing evidence provides students with rich opportunities to evaluate how well the evidence supports claims. This guide includes a plan for introducing students to supporting claims with evidence through an argumentation card sort, which draws on concepts about fossils as evidence for the evolutionary relationship between extinct animals and animals living today.

Why have students practice supporting claims with evidence? In order to help students understand scientific argumentation as a specialized way of thinking, talking, and writing, it is important for them to participate in the process of argumentation as well as to develop an understanding of the structure of a scientific argument. This approach to teaching argumentation is effective in helping students learn to support claims with evidence and explain their ideas in a logical way.

How This Fits Into Your Science Curriculum

The sessions presented in this strategy guide can fit into either an Earth science unit that focuses on Earth's history or into a life science unit on evolution. If you use this guide as part of an Earth science unit, students should have some understanding of how rocks (particularly sedimentary rocks) are formed. It is also helpful if students understand the principle of superposition, which will help them evaluate the evidence presented. If you use this guide as part of a life science unit, use these sessions to help students learn how anatomical features of fossilized organisms can provide evidence about evolutionary relationships.

Addressing Standards

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth: The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not absolute scale.

LS4.A: Evidence of Common Ancestry and Diversity: Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.

Crosscutting Concepts

Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Science and Engineering Practices

Engaging in Argument from Evidence: 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.

COMMON CORE STATE STANDARDS FOR ELA/LITERACY

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

WHST.6–8.1b: Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.

College and Career Readiness Anchor Standards for Speaking and Listening

SL #1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Science Background

Fossils are a topic of study in which the disciplines of life and Earth science overlap. Geologists study **sedimentary rocks** and **rock layers** to gather evidence about past life and past environments on Earth. When sedimentary rock forms in layers, the oldest layers are on the bottom, and the youngest layers are on the top. This principle is known as **superposition**—a central concept in geology. The three main categories of rocks—sedimentary, igneous, and metamorphic—form in different ways and thus have distinguishable characteristics. The depositional environments in which sedimentary rock forms allow the remains of plants and animals to be fossilized through a variety of processes. Compared to igneous and metamorphic rock, sedimentary rock forms in conditions with much less heat and pressure. This allows organic matter from an organism—such as bones or shells—to be preserved in the rock. In life science, fossils are used to provide information about organisms that no longer exist on Earth. Biologists can make claims about the evolutionary relationships between organisms preserved in fossils and organisms living today by examining the anatomical features found in fossils.

Getting Ready: Day 1

1. Make copies of the Evidence Cards for Claim 1 (8 cards/set) and the Category Cards (3 cards/set). Each pair of students will need one set of each, and you should set aside one set of each for yourself. Cut the cards apart and place one set of each in an envelope. Label the envelopes "Claim 1." (You will need to make additional copies of the Category Cards for the card sort in Day 2.)
2. On chart paper, record the Language of Argumentation and post it where it will be easily visible to all students.
3. Make sure you have a way to project the Mystery Fossil Tooth images.
4. On the board, write "Which kinds of objects can become fossils?"

Activating Background Knowledge (5 minutes)

1. **Pose question.** Have students think about the question you wrote on the board: *Which kinds of objects can become fossils?* Ask them to think about what they know that will help them answer this question.
2. **Students respond.** Ask students to record their ideas about the question individually. Alternatively, you could ask students to discuss their ideas with a partner.
3. **Debrief.** Lead a class discussion in which volunteers share their responses to the question. Explain that today, students will observe a picture of a fossil from an animal that lived a long time ago.

Introducing Scientific Argumentation (10 minutes)

1. **Set purpose.** Explain that students will think about a question about fossils in the way that scientists do. They will examine evidence in order to find what they consider to be the best answer to the question.
2. **Project Mystery Fossil Tooth.** Let students know that they will try to figure out the best answer to a scientific question: *From what kind of animal did this fossil tooth come?* Allow a moment for students to observe the fossil tooth and see what they notice.

Introducing Students to Argumentation

Scientific argumentation is a process of figuring out the best answer to a question from among several possibilities, based on the available and accepted evidence. The focus of this strategy guide is on helping students develop careful, critical thinking—not on quickly arriving at a right answer. The goal of the argumentation card sort is to allow all students to think carefully about evidence in order to determine which claim they think is the best supported claim. It is not necessary for all students to come to an agreement in the end. For this reason, the task is left deliberately open-ended. Students should come to see argumentation as a collective process of working together to figure out a question, rather than a competition for one person to win and others to lose. This sense of collaboration supports participation from all students and pushes students to become accountable to one another as they think, reason, and learn together.

3. **Project Mystery Fossil Tooth: Claim 1.** Have a student read the claim aloud: *This fossil tooth is from a prehistoric lion, which is related to mountain lions that live today.* (Keep this projected throughout the session so students can refer to it while they are working.)
4. **Define *claim*.** Explain that a claim is a suggested answer to a scientific question. The claim being projected is one possible answer to the question *From what kind of animal did this fossil tooth come?*
5. **Explain importance of evidence.** Point out that this claim is not very convincing all by itself. It needs to be supported with evidence. In order to convince others that a claim is the best one, scientists use evidence to support their claims. In science, it is important to think carefully about all the available evidence in order to determine how well it supports a claim.
6. **Give an example of evidence.** Hold up and read aloud the following evidence card, **"The fossil tooth was found in the mountains of Utah, an area where mountain lions live now."** Explain that this piece of information could be used as evidence to support the claim that the tooth is from a prehistoric lion.
7. **Think aloud.** Say, **"I think that this evidence supports the claim that this tooth is from a prehistoric lion. I think this because it's likely that if there are mountain lions living in an area today, they could have also lived there millions of years ago."**
8. **Provide language for students to use.** Refer to the Language of Argumentation poster and point out the first three sentence starters. Let students know that they may use this language, as you just did, to help explain why they think pieces of evidence support or do not support the claim.

Sorting Evidence (20 minutes)

1. **Explain the argumentation card sort.** Let students know that they will work in pairs to examine and sort evidence on cards to determine which evidence supports or does not support the claim that the fossil tooth is from a prehistoric lion.
2. **Distribute card sets.** Distribute one envelope labeled "Claim 1" to each pair of students. Direct students to find the three category cards and lay them on their desks.
3. **Emphasize the "Might support the claim" category.** Explain that sometimes, pairs may not come to a consensus about whether or not the evidence supports the claim and that this is expected and encouraged. Therefore, there is a 'Might support the claim" category. Students can place evidence cards under this category card if they have questions about a piece of evidence as they discuss it, just as they did when you discussed the evidence about where the fossil tooth was found.
4. **Restate purpose.** Finally, emphasize that the purpose of this activity is not to just place the cards in categories. The purpose is for students to discuss with one another reasons *why* the evidence supports or does not support the claim.
5. **Students sort and discuss.** Allow time for students to work with their partners to sort each evidence statement and decide under which of the three categories it should be placed. Circulate to encourage students to articulate their reasoning about where they are placing the evidence.

Discussing the Evidence (10 minutes)

1. **Set expectations.** When students have finished sorting the cards, regain their attention. Explain that students will now have a chance to discuss the evidence with the whole class.
2. **Encourage disagreement.** Point out that you noticed that students were disagreeing with one another and that this is great! Explain that disagreement is actually something that moves science forward, since discussing and figuring out the answer to a question together means that not everyone will view the evidence in the same way.

Supporting English Language Learners

Opportunities for ELLs to engage in conversations that are slightly above their language-proficiency levels can accelerate second-language learning and increase students' confidence when engaging in science discussions. During these sessions, ELLs can be paired with students who are at slightly higher levels of English proficiency so that partners can support each other as they begin to discuss scientific claims and evidence. Encourage partners to talk through as much of the evidence as they can, putting the focus on partners making sure they understand each other's ideas rather than on getting through all the evidence in one session.

3. **Remind students about language of argumentation.** Point out the Language of Argumentation poster again and encourage students to use the language provided to respectfully agree or disagree with one another. Note that they should explain the reasons why they agree or disagree when responding to someone else's ideas (I agree because . . . ., I disagree because . . . .).
4. **Discuss evidence.** Lead a discussion in which students discuss where they placed each piece of evidence and why. Try to let students respond to one another as much as possible.
5. **Conclude the discussion.** Point out that students have been considering evidence carefully and deciding which evidence best supports a claim, just as scientists do. Collect the envelopes with card sets.

Getting Ready: Day 2

1. Make copies of the Evidence Cards for Claim 2 (11 cards/set) and the Category Cards (3 cards/set). Each pair of students will need one set of each, and you should set aside one set of each for yourself. Cut the cards apart and place one set of each in an envelope. Label the envelopes "Claim 2."
2. Make sure you have a way to project the Mystery Fossil Tooth images.
3. On the board, write "How sure are you that the mystery fossil tooth is from a prehistoric lion? What evidence would you need to be more sure?"

Making Connections (5 minutes)

1. **Pose question.** Have students think about the questions you wrote on the board: *How sure are you that the mystery fossil tooth is from a prehistoric lion? What evidence would you need to you be more sure?* Ask them to think about the evidence they discussed in the previous session in order to help them answer these questions.
2. **Students respond.** Ask students to record their ideas about the question individually. Alternatively, you could ask students to discuss their ideas with a partner.
3. **Debrief.** Lead a class discussion in which volunteers share their responses to the question. Explain that today, students will consider another possible claim about from which animal the mystery fossil tooth may have come.

Introducing a New Claim (10 minutes)

1. **Set purpose.** Explain that when scientists make claims based on evidence, they often end up with more than one possible claim to answer a question. Scientists also evaluate which claims are best supported by the evidence. They may also explain why the evidence supports one claim over another. In today's session, let students know that they will continue to examine evidence to determine if it supports or does not support another claim.
2. **Introduce new claim.** Project Mystery Fossil Tooth: Claim 2. Have a student read the claim aloud: *This fossil tooth is from a prehistoric shark, which is related to sharks that live today.* Explain that this is another possible claim that can answer the question. This new claim is based on some of the evidence that students have already considered, as well as some additional evidence. (Keep this projected throughout the session so students can refer to it while they are working.)
3. **Highlight value of connecting of evidence.** Say, **"In the previous session, some of you may have put two evidence cards together to explain how this did or did not support the claim. When you connect one piece of**

Connecting to Standards

Supporting claims with evidence is an approach that capitalizes on the overlap between the science practices in the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) for English Language Arts. Argumentation is central to both the NGSS and the CCSS, as students are asked to construct and present arguments supported by empirical evidence and scientific reasoning (NGSS Science Practice 7: Engaging in Argument from Evidence) as well as evaluate arguments and specific claims based on the validity of the reasoning and the relevance and sufficiency of the evidence (CCSS Anchor Standard 8 for Reading). The argumentation card sort presented in this guide is a scaffolded way of introducing students to these skills. Through the discussion of evidence, students compare and evaluate competing claims and build on others' ideas to cooperatively identify the best explanation (NGSS Science Practice 7: Engaging in Argument from Evidence) as well as have the opportunity to respond to others' questions and comments with relevant evidence (CCSS Anchor Standard 1 for Speaking and Listening).

evidence to another piece, it can provide more information than one piece of evidence by itself."

4. **Give an example.** Hold up and read aloud the following evidence card, **"The fossil tooth is 5 centimeters long."** Ask, **"Does this evidence support the claim that the tooth is from a prehistoric shark? Why or why not?"** Have one or two students explain their thinking.
5. **Students connect evidence.** Hold up and read aloud the following evidence card, **"Sharks have teeth that are between 1 and 5 centimeters long."** Ask, **"Taken together, do both of these pieces of evidence support the claim?"** Have students explain their responses. Emphasize that connecting these two pieces of evidence together might change how well the evidence supports the claim.
6. **Review importance of reasoning.** Remind students that the purpose of sorting evidence is not to put the evidence in the right categories, but to carefully think through how the evidence supports the claim. Students should be sure to articulate the reasons why they think evidence belongs in one category or another.

Sorting Evidence for a New Claim (15 minutes)

1. **Distribute card sets.** Distribute one envelope labeled "Claim 2" to each pair of students. Direct students to find the three category cards and lay them on their desks.
2. **Students sort and discuss evidence.** Allow pairs time to sort and discuss evidence. Encourage students to connect more than one piece of evidence together if they can. As needed, refer students to the Language of Argumentation poster if they need help expressing their ideas.

Discussing Evidence and Evaluating Claims (15 minutes)

1. **Introduce questions.** Refer to the Language of Argumentation poster and point out the three questions at the bottom. Let students know that they may use these questions to prompt one another to explain their thinking in the discussion.
2. **Students discuss the evidence.** Ask students to discuss which pieces of evidence they think support the claim that the mystery fossil tooth is from a shark. As much as possible, allow students to guide the discussion themselves.
3. **Return to the question.** Project Mystery Fossil Tooth: Claim 2 again. Ask, **"Based on all the evidence you have considered, from which animal—a prehistoric lion or a prehistoric shark—do you think this tooth came?"**
4. **Students discuss the two claims.** Have students discuss which claim they think is best supported by the available evidence. Remind students that they should be discussing evidence with one another, not with you, so interject only if necessary.
5. **Conclude the discussion.** Wrap up by pointing out that students have just engaged in argumentation—figuring out the best answer to a scientific question, based on evidence. Be sure to emphasize that the purpose was not necessarily to agree on one right answer, but to consider both of the plausible answers carefully. Collect the envelopes with card sets.
6. **Extend learning.** As an extension or as homework, have students think about the ideas shared during the discussion, as well as the claims and evidence in the card sorts, to help them write a response to the question *From which animal did this fossil tooth come?* Remind students that it is important to explain their thinking rather than simply list their evidence. They should state the evidence and also give reasons why the evidence supports the claim. Encourage students to select what they think are the strongest two or three pieces of evidence to include in their written pieces.

Formative Assessment Opportunity

An important part of argumentation is logically connecting pieces of information together to support a claim. It is by making these connections that information becomes supporting evidence. The argumentation card sort allows students to explain these connections to their partners as they sort the evidence. While students are working, circulate and listen to whether they are talking about pieces of evidence as connected to one another and to the claim and how they explain their reasoning. As appropriate, prompt students to talk through how the evidence they are sorting is connected to other evidence or to the claim or why they think certain pieces of information are irrelevant.

Generalizing This Practice

Teaching students to support claims with evidence is an approach that can be used throughout your science curriculum with a variety of topics. A benefit of having students engage in an argumentation card sort is that by providing claims and evidence, you can remove some of the complexity of the task of making an argument yet still have students engage meaningfully with evidence. Argumentation card sorts can be used at different stages of teaching students about argumentation. As students' skills develop, the card sorts can be designed with added difficulty. For example, students can add evidence from their firsthand investigations. Over time, students can move toward gathering all the evidence to create their own card sorts. Use the following steps to prepare and implement an argumentation card sort with other science topics.

Preparing an Argumentation Card Sort

1. **Select an argumentation skill.** Choose a specific skill that students will work on during the argumentation card sort, based on your evaluation of your students' experience with argumentation and your understanding of areas where they need more support. Following are some possibilities.
   - Coordinating pieces of evidence to support a claim.
   - Identifying information as relevant or less relevant to a claim.
   - Recognizing that evidence can sometimes support more than one claim.
   - Coordinating evidence to support the multiple parts of a claim.
   - Deciding which claim is better supported by evidence from two or three choices.
2. **Write a question.** An argumentation card sort should support and deepen students' content understanding, so choose a topic that is an integral part of your science curriculum. Write a question for students to consider during the card sort.
3. **Write claims.** Depending on your goals, you may want students to work with one claim or with two or three claims. Sometimes, you will want students to consider possible claims and have everyone conclude that one claim is more accurate or better supported than the others. At other times, students can consider claims that could all be possible (as the claims presented in this guide).
4. **Create evidence cards.** Create 6–12 cards with pieces of information that can be used to support the claim(s). Ideally, this information should come from firsthand investigations, readings, and other sources with which students are familiar. Evidence cards can consist of text and/or images. You should also include information that does not support the claim (because it is irrelevant, supports a different claim, or is incorrect).

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Generalizing This Practice (continued)

Using an Argumentation Card Sort to Teach How to Support Claims with Evidence

1. **Introduce the question and claim.** Introduce the question that students are trying to answer and discuss the possible claims.
2. **Model the argumentation skill.** Introduce the evidence. Think aloud about how you would sort the evidence, emphasizing the skill that you selected as your instructional focus. For example, if you are focusing on having students identify relevant and less relevant evidence, show students how you would sort an example of each, explaining why you placed each card in a particular category.
3. **Emphasize thinking and discussion.** Remind students to explain their thinking as they work with partners. You may want to provide sentence frames to promote students' discussions.
4. **Students sort evidence.** Have students work in pairs to consider the evidence. Encourage them to focus on the specific argumentation skill on which you are working. Make note of students that do this as they are sorting and have them share their thinking and their strategies with the class when you discuss the claims.
5. **Debrief the card sort.** Have students explain how they think the evidence supports each claim.
6. **Discuss claims.** If you are working with multiple claims, lead a discussion in which students explain which claim they think is best supported by the the evidence, including the reasons they think so. Depending on your goals, this can be a time to encourage productive disagreement or you can ensure that all students understand why one claim is a better answer to the question than another claim.
7. **Encourage peer-to-peer discussion.** As the class discusses the claims and evidence, try to have students respond directly to one another as much as possible. Consider providing some language that students can use to help them express their ideas, such as sentence starters, key terms, or questions.
8. **Highlight the importance of argumentation in science.** Throughout the argumentation card sort and discussions, take opportunities to connect the thinking and reasoning that students are doing with how scientists make arguments in the field.

Category Cards

Supports the claim

Does not support the claim

Might support the claim

Evidence Cards for Claim 1

Mountain lions have sharp teeth.	The fossil tooth is sharp.
The fossil tooth is 5 centimeters long.	Mountain lions have side teeth that are between 3 and 5 centimeters long.
The fossil tooth was found in the mountains of Utah, an area where mountin lions live now.	The fossil tooth was found in sandstone, which is sedimentary rock made of layers.
Mountain lions eat mostly small animals, such as rabbits.	The fossil tooth is much flatter than a mountain lion's tooth.

Language of Argumentation

- This evidence supports the claim because . . . .
- This evidence does not support the claim because . . . .
- This evidence might support the claim because . . . .

- I agree because . . . .
- I disagree because . . . .

- What do you think?
- Do you think the evidence supports the claim? How?
- Do you agree? Why or why not?

Mystery Fossil Tooth

From what kind of animal did this fossil tooth come?

Wikimedia/Tribal Spirit

Mystery Fossil Tooth: Claim 1

This fossil tooth is from a prehistoric **lion**, which is related to mountain lions that live today.

Wikimedia/Tribal Spirit

NPS Photo by WL Miller

Evidence Cards for Claim 2

The fossil tooth is much flatter than a mountain lion's tooth.	The fossil tooth is sharp.
The fossil tooth is 5 centimeters long.	The fossil tooth was found in sandstone, which is sedimentary rock made of layers.
Sharks have sharp, flat teeth.	Sharks have teeth that are between 1 and 5 centimeters long.
Mountain lions have sharp teeth.	The fossil tooth was found in the mountains of Utah, an area where mountain lions live now.
Sharks eat fish, seals, and other ocean animals.	Mountain lions have side teeth that are between 3 and 5 centimeters long.
The sandstone around this fossil tooth also has many fossil shells from ocean organisms.	

Mystery Fossil Tooth: Claim 2

This fossil tooth is from a prehistoric **shark**, which is related to sharks that live today.

Wikimedia/Tribal Spirit

Wikimedia/Sharkdiver68

About Disciplinary Literacy

Literacy is an integral part of science. Practicing scientists read, write, and talk, using specialized language as they conduct research, explain findings, connect to the work of other scientists, and communicate ideas to a variety of audiences. Thus, the Next Generation Science Standards (NGSS) and the Common Core State Standards (CCSS) alike call for engaging students in these authentic practices of science. Through analyzing data, evaluating evidence, making arguments, constructing explanations, and similar work, students engage in the same communicative practices that scientists employ in their profession. Through supporting and engaging students in science-focused literacy and inquiry activities that parallel those of scientists, students master discipline-specific ways of thinking and communicating—the disciplinary literacy of science. Strategy guides are intended to help teachers integrate these disciplinary literacy strategies into the science classroom.

About Us

The Learning Design Group, led by Jacqueline Barber, is a curriculum design and research project at the Lawrence Hall of Science at the University of California, Berkeley. Our mission is to create high-quality, next-generation science curriculum with explicit emphasis on disciplinary literacy and to bring these programs to schools nationwide. Our collaborative team includes researchers, curriculum designers, and former teachers as well as science, literacy, and assessment experts.

The Learning Design Group

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