Building Claims from Evidence

Throughout your research you will be collecting and working with many different types of evidence. You will be using this evidence to make claims based on scientific arguments. A claim is a suggested answer to a scientific question. Evidence is the information you use to build claims. In your research, the team will use many different types of evidence to build claims concerning the parts of the problem question, How do we ensure good nutrition for all?

Before beginning your research, it is important to understand and get practice building and assessing claims with evidence.

Objective

In this task, you are going to learn how to collect and use evidence to create and support claims. This will help the team get better at explaining how you know what you know.

1. Go to the Task 1-9 folder to get the Building Claims from Evidence activities. There are two versions of this task, FOOD A or FOOD B, in the task folder.
2. Follow the directions in the task documents to learn how to build and support claims from evidence.
3. Read the Ask the Team reading on what things are important when building claims. Identify and list some different things they use when making claims in their work.
4. After completing these tasks, as a team, discuss the questions:
   - Why is it important to always support your claims with evidence?
   - Why is it important to support decisions you make in your life with evidence?
   - Why is it important to listen to people who support different claims, even when you do not agree?
   - Why is it important to respect people, even when you do not agree?

Remember, in your research the team will use many different types of evidence to build claims concerning the parts of the problem question, How do we ensure good nutrition for all?

Hooray! You completed Task 1-9. Check it off the task list. Go to Task 1-10!
Task 1-9. Building Claims from Evidence—FOOD A

Just because someone asks a question or makes a claim about an object, organism, or event in nature does not necessarily mean that person is pursuing a scientific explanation. When discussing food and nutrition, you will hear many different claims from different people about the health benefits, or lack of benefits, of particular foods. Some of these claims and their associated explanations are considered scientific and some are not. Understanding what makes a claim or explanation scientific or not scientific is important when reading or talking with people about various claims and how they were developed.

For an explanation to be considered scientific, it must meet various conditions, including:

- **Scientific explanations are based on empirical observations or experiments.** The appeal to authority as a valid explanation does not meet the requirements of science. Observations are based on sense experiences or on an extension of the senses through technology.

- **Scientific explanations are made public.** Scientists make presentations at scientific meetings or publish in professional journals, making knowledge public and available to other scientists.

- **Scientific explanations are tentative.** Explanations can and do change. There are no scientific truths in an absolute sense.

- **Scientific explanations are historical.** Past explanations are the basis for contemporary explanations, and those, in turn, are the basis for future explanations.

- **Scientific explanations are probabilistic.** The statistical view of nature is evident implicitly or explicitly when stating scientific predictions of phenomena or explaining the likelihood of events in actual situations.

- **Scientific explanations assume cause-effect relationships.** Much of science is directed toward determining causal relationships and developing explanations for interactions and linkages between objects, organisms, and events. Distinctions among causality, correlation, coincidence, and contingency separate science from pseudoscience.

- **Scientific explanations are limited.** Scientific explanations sometimes are limited by technology—for example, the resolving power of microscopes and telescopes. New technologies can result in new fields of inquiry or extend current areas of study. The interactions between technology and advances in molecular biology and the role of technology in planetary explorations serve as examples.

*Modified from:* Teaching About Evolution and the Nature of Science, NAP (1998)
In addition, scientific explanations have three major components—known as CER:

- **Claim**: an assertion or conclusion that addresses the original question or problem
- **Evidence**: scientific data (which can take many forms)
- **Reasoning**: the link between the data and the claim, often referring to established scientific principles

Using argumentation, we evaluate explanations based on the presence, appropriateness, and sufficiency of the evidence and reasoning provided.

To learn more about the process of building a scientific claim from evidence, conduct the following Claim Cube activities.

**Claim Cube #1**

1. Cut out and assemble Claim Cube #1.
2. Place it on a table so the other members of the team cannot see the bottom.
3. Have the team form groups of three or four.
4. Place the cube in the center of a table where the groups can see the cube but not touch, turn, lift, or open the cube.
5. Present the question, *What is on the bottom of the cube?*
6. Tell the team that they will have to answer the question by proposing an explanation, and that they will have to convince the rest of the team that their answer is based on evidence. (Evidence refers to observations the group can make about the visible sides of the cube.)

**Make Observations**

Make a list of observations about the cube that can be used to develop a claim about what is on the bottom. Examples of observations:

- The cube has six sides.
- The numbers are black.
- The exposed sides have the numbers 1, 3, 4, 5, 6.

**Develop a Claim**

Develop a claim to answer the question, *What is on the bottom of the cube?*
Organize Your Reasoning
Document the reasoning to support your claim. Reasoning is what provides the link between the data (evidence) and the claim the group developed. Explain how the data supports the claim your group developed.

Share and Compare Explanations
Have groups share their claims, evidence, and reasoning used to support their claim to answer the question, What is on the bottom of the cube?

- Key points to remember are that science originates in questions about the world.
- Science uses observations to construct explanations (answers to the questions). The more observations you had that support your proposed explanation, the stronger your explanation—even if you could not confirm the answer by examining the bottom of the cube.
- Scientists make their explanations public through presentations.
- Scientists present their explanations and analyze the explanations proposed by other scientists.

Team Claim Consensus
Never reveal the bottom of the cube to the team! Scientists often have no way of actually seeing the phenomena they are investigating. In these situations, they use group scientific consensus to agree on an explanation. Scientific consensus implies general agreement, though not necessarily unanimity, concerning an explanation.

1. After all groups have shared, determine which, if any, claim(s) have the most consensus on the team.
2. If all groups came up with the same claim, then there is unanimous consensus about what is on the bottom.
3. If different groups came up with different claims, then two or more claims are possible.
   a. Here the team must assess how the observations, data, evidence, and reasoning are used to support or weaken different claims.
4. Remember, in science two or more claims can be equally consistent, given the data available. So not being able to come to a consensus given the data available is legitimate.

5. In all cases, it is important to discuss whether it is possible to tell who is right and who is wrong. If differing explanations are consistent with all the evidence available, is it possible to decide which explanation might correspond with the answer on the bottom of the cube, which we cannot see?

Repeat the process with Claim Cubes #2 and #3 for increasing complexity. You might want to match the difficulty levels to your team. You can also have different groups work on different cubes at the same time and then present their findings to other groups.

Claim Cube #1: The bottom is 2, which is missing from the sequence. The opposite sides of the cube add up to 7, and because 5 is on top, and $5 + 2 = 7$, 2 could be on the bottom.

Claim Cube #2: The bottom is 98. The pattern may seem as if opposite sides of the cube are double or half the other side, so a common answer may be the bottom is 32 or 128. The rule on this cube is only that the numbers must be a two-digit even number. Sometimes the observer can infer a pattern from a set of observations, but as more data is collected the pattern can be challenged or updated.

Claim Cube #3: The bottom is Francene. This cube has much greater complexity. Claims should address the color, numbers, and name on the bottom of the cube. This cube will take more time to work through, so consider that in your planning.
Question: What is on the bottom of the cube?

<table>
<thead>
<tr>
<th>Claim</th>
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</thead>
</table>

Observational evidence (data)

<table>
<thead>
<tr>
<th>Claim reasoning</th>
</tr>
</thead>
</table>

Team claim consensus and reasoning
Claim Cube #1

Claim Cube #2

44

20 64

88

98
Claim Cube #3

Task 1-9. Building Claims from Evidence—FOOD B

When scientists and other people make claims based on evidence, they often end up with more than one possible way to answer a question. Scientists must then evaluate which claims are best supported by the evidence. They may also explain and discuss why the evidence supports one claim over another.

Think, Vote, Pair, Share

1. Ask students if they have heard of the five-second rule about eating food that has fallen on the floor?
2. If they have not, explain that the five-second rule is a debated food hygiene concept that says there is a limited window (under five seconds) where it is permissible to pick up food (or sometimes cutlery) after it has been dropped and thus exposed to contamination.
3. **Think:** Have students think to themselves what they think about the five-second rule. Do they follow it? Do they ever eat food that has fallen on the floor?
4. **Team vote:** Tally how team members answer the question, *Do you follow the five-second rule?* Use the categories, Always, Sometimes, Never, Not sure. Compile the data and save it for later use.
5. **Pair:** After team members have had some time to think to themselves, ask them to turn and discuss the question with a partner.
6. **Share:** After pairs have had some time to discuss, share as a large group what people think about this.

Round One

1. Break the team into smaller groups of three to five people.
2. Each group will be provided a set of Building Claims from Evidence Card Sort Activity B Cards. Optional: Cut out the cards so you can move them around on the table.
3. Read the scenario together.
   
   Natasha was slicing a tomato for a salad on a cutting board on the countertop of her kitchen. As she was slicing, she realized some of the slices had fallen onto the tile floor. She was not sure exactly how long they had been there, but did not think it was very long, as it only took her 30 seconds to slice the entire tomato. When she picked up the slices, she wondered if it was safe to eat them if she picked them up quickly enough. She had heard of the five-second rule, but was not sure what to do.

One card has the problem question on it, *Is it safe to eat a sliced tomato you have dropped on a tile kitchen floor if you pick it up quickly enough?*

4. Find and put the three claim cards on the table underneath the problem question.
   
   **Claim 1:** Food that is dropped on the floor for longer than five seconds is safe to eat.

   **Claim 2:** Food that is dropped on the floor for longer than five seconds is not safe to eat.
**Claim 3:** Other Claim—neither claim 1 nor 2 have enough evidence to support them, and a new claim should be created. (In that case, create your own claim.)

5. You will be selecting one of these claims to support with evidence and reasoning. Place them under the problem question for now.

6. Cards A through E contain pieces of evidence.

7. In your group, your goal is to discuss and sort the evidence to determine which of the three competing claims you believe is best supported by the evidence.

8. Complete the round one section on your data sheet.
   - Which claim is best supported?
   - What evidence best supports this claim?
   - Why does this evidence best support this claim?

9. Explain that groups may not come to a consensus about which claim is best supported. This is normal and to be expected. This is why there is the category Other Claim.

10. If you have questions or are unsure about Claims 1 and 2, select Other Claim and provide your reasons, using evidence for support.

11. Have the groups or the whole team share and discuss which claim they think is best supported by the existing evidence, after looking at the round one evidence.
    Use the following sentence starters during the discussion.
    - I think this claim is best supported because . . .
    - I do not think this claim is best supported because . . .
    - I agree because . . .
    - I disagree because . . .
    - Why do you think that?

**Round Two**

1. Discuss how scientists are constantly making observations and gathering new data, which can become new evidence.

2. Provide each group with the round two evidence (cards F through J). Add this to the evidence from round one.

3. Use this new evidence, along with the evidence from round one, to determine which claim the team thinks is best supported by the existing evidence.

4. Complete the round two section in the data sheet.

5. Engage in team discussion. Have groups or the whole team share and discuss which claim they think is best supported and why, with the addition of the new evidence for round two.

Use the following sentence starters during the discussion.

- I think this claim is best supported because . . .
- I do not think this claim is best supported because . . .
- I agree because . . .
- I disagree because . . .
- Why do you think that?

6. Use the following discussion questions.
   - How were your discussions similar or different between round one and two?
• What did you talk about when you were discussing the evidence?
• Did your conversations about which claim is best supported change from round one to round two when you received the new evidence cards?
• Remember:
  o Often scientists develop competing claims about a particular phenomenon. They use evidence to decide which claim is stronger.
  o As new evidence emerges, scientists must reevaluate the strength of their claims.

Round Three

1. Discuss how scientists are constantly making observations and gathering new data, which can become new evidence.
2. Provide each group with the round three evidence (cards K through Q). Add this to the evidence from rounds one and two.
3. Use this new evidence, along with the evidence from previous rounds, to determine which claim your team thinks is best supported and why, given the existing evidence.
4. Complete the round three section in the data sheet.
5. Engage in team discussion. Have groups or the whole team share and discuss which claim they think is best supported by the existing evidence after round three.

Use the following sentence starters during the discussion
  o I think this claim is best supported because . . .
  o I do not think this claim is best supported because . . .
  o I agree because . . .
  o I disagree because . . .
  o Why do you think that?

6. Use the following discussion questions.
• Did your conversations about which claim is best supported change from rounds one and two, when you received the new evidence cards in round three?
• Remember:
  o Often scientists develop competing claims about a particular phenomenon. They use evidence to decide which claim is stronger.
  o As new evidence emerges, scientists must reevaluate the strength of their claims.

Whole Team Discussion

Remind the team that you will now engage in a discussion. When engaging in any type of meaningful discussion as a team, you must respect your team. Use these meaningful conversation starters in your discussion to respect your other team members.

  • I agree with ___________ because . . .
  • I disagree with _____________because . . .
  • I’d like to go back to what ______________ said about . . .
  • I’d like to add _______________
I noticed that . . .

Another example is . . .

A. Why is it important to support all claims with evidence?
B. Why is it important to reevaluate all claims when new evidence is collected?
C. Why is it important to engage in discussion when there are multiple claims for the same question?
Task 1-9. Building Claims from Evidence Card Sort Activity B Cards

Cut out the problem question, claims, and evidence support cards

**Scenario:** Natasha was slicing a tomato for a salad on a cutting board on the countertop of her kitchen. As she was slicing, she realized some of the slices had fallen onto the tile floor. She was not sure exactly how long they had been there, but did not think it was very long, as it only took her 30 seconds to slice the entire tomato. When she picked up the slices, she wondered if it was safe to eat them if she picked them up quickly enough. She had heard of the five-second rule, but was not sure what to do.

**Problem question:** Is it safe to eat a sliced tomato you have dropped on a tile kitchen floor if you pick it up quickly enough?

**Claim 1:** Food that is dropped on the floor for longer than five seconds is safe to eat.

**Claim 2:** Food that is dropped on the floor for longer than five seconds is not safe to eat.

**Claim 3:** Other Claim—neither claim 1 nor 2 have enough evidence to support them, and a new claim should be created. (In that case, create your own claim.)

<table>
<thead>
<tr>
<th>Evidence you think supports the claim</th>
<th>Evidence you think does not support the claim</th>
<th>Evidence you think has nothing to do with the claim</th>
</tr>
</thead>
</table>
### Task 1-9. Food B Evidence Cards

#### Round One Evidence Cards

<table>
<thead>
<tr>
<th>A. Natasha was inside her house when she dropped the food on the floor.</th>
<th>B. According to researchers at Aston University, food picked up just a few seconds after being dropped is less likely to contain bacteria than if it is left for longer periods of time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Food scientists at Rutgers University state that amateur scientific studies and televised “investigations” have confused the safety issue of dropped food by relying on experiments that are not scientific.</td>
<td>D. Natasha’s friend Ariel eats food off the floor after five seconds in her house and has never had a problem.</td>
</tr>
<tr>
<td>E. Research studying food that falls on the floor determined that it depends on the surface of the floor and what kind of bacteria you might pick up. For example, if you are in a hospital and you drop something, you probably don’t want to eat it.</td>
<td></td>
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</table>

#### Round Two Evidence Cards

<table>
<thead>
<tr>
<th>F. According to research at Aston University, bacteria is least likely to transfer to food when dropped on carpeted surfaces.</th>
<th>G. Research has shown that bacteria is much more likely to linger if moist foods make contact for more than five seconds with wood laminate or tiled surfaces.</th>
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<tbody>
<tr>
<td>H. A two-year study at Rutgers University concluded that no matter how fast you pick up food that falls on the floor, you will pick up bacteria with it.</td>
<td>I. Food scientists state that in most cases eating something that has picked up a little dust and floor bacteria is not likely to harm someone with a healthy immune system.</td>
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<td>J. Practicing good sanitation by keeping floors and surfaces clean has been show to be important for food safety.</td>
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#### Round Three Evidence Cards

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Part 1. Problem. Task 1-9B

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| K. A study published in 2015 reported high bacterial counts on sponges, cutting boards, countertops, and in the sink. |
| L. Natasha’s father said he had eaten food he dropped in the past, but now thinks about the situation before he makes his decision. |
| M. Research cited by the Centers for Disease Control found that surface cross-contamination was the sixth most common contributing factor out of 32 in outbreaks of food-borne illnesses. |
| N. In a survey of 2,000 people, 79% admitted to eating food that had fallen on the floor. |
| O. Natasha’s brother said he does not care and eats food he drops on the floor. |
### Task 1-9. Claim and Evidence Data Sheet

<table>
<thead>
<tr>
<th>Round</th>
<th>Claim</th>
<th>Evidence you think supports the claim</th>
<th>Evidence you think does not support the claim</th>
<th>Evidence you think has nothing to do with the claim</th>
<th>Claim you think is best supported (1, 2, or 3)</th>
<th>Reasons why you think this claim is best supported</th>
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What things are important when building claims in your work?

ANDREA the ANTHROPOLOGIST
National Museum of Natural History, Smithsonian Institution

We think about what is normal, or hypothesized to be normal, in the larger community of biological anthropology. Will our colleagues understand our project or our approach? And of course, we think about what might be best for the communities we work with. I want to see healthy wild animals, and healthy captive animals where no better alternative exists. This is reality for some animals right now, but not enough. I hope my work with the EMPHASIS project contributes to that goal.

ASHLEY the HISTORIAN
National Museum of American History, Smithsonian Institution

As a historian, I want to look at a diverse array of sources that come from formal and informal places. For example, I would want to look at reports from the U.S. Department of Health and Human Services as well as the American Heart Association. I would also want to look at fad cookbooks, blogs, e-mails, tweets, and oral histories. Then I can see how these different kinds of sources inform how everyday people understand nutrition.

CARLOS the GLOBAL HEALTH MANAGER
Johnson & Johnson, São Paulo, Brazil

Most of the decisions we make have to be based on science and research studies. It is also very important to collect as much data as possible and to analyze the results afterward. But never fail to follow your instincts and inspiration!
MIKE the ZOO NUTRITIONIST
Smithsonian National Zoological Park and Conservation Biology Institute

As nutritionists, we value: peer-reviewed literature, successful experience, and empirical evidence when making decisions. Keep in mind that just because something is peer-reviewed does not automatically mean it correct, let alone infallible. We also value experience in animal care and management, especially when that experience supports data (and vice versa). To some extent we also value empirical evidence (i.e. – there are a set of techniques that have proven successful with x species and no literature on the subject). Ideally, we will seek to discover the “whys” behind situations like that, but there is value in previous success.

SABRINA the CURATOR
National Museum of Natural History, Smithsonian Institution

The general public wants simple answers about what’s nutritious, so they can make easy choices they think are healthy for themselves and their families. However, nutrition is a complex topic and we have to be careful in how we perceive what’s “good” or “bad” for people who are so diverse in age, ancestry, lifestyle, environment, and life history.

JENNIFER the MUSEUM CURATOR
National Air and Space Museum, Smithsonian Institution

I tend to consider primary and secondary sources. Anything directly related to an artifact is a primary source. Inventory lists, flight history documents, photographs, and conservation reports can play a role in managing the artifact or selecting which one to use in an exhibit. Secondary sources are the writings of journalists, engineers, and other historians about food and what it means. These help me decide how to shape the story I will tell to an exhibit audience.