ACTIVITY 1

Skipton's Water

CARD-BASED INVESTIGATION

ACTIVITY 1

Skipton's Water

ACTIVITY SUMMARY

Students are introduced to a fictional scenario about providing clean drinking water for a town. They make a decision based on available information. They are then provided with additional data and revisit their decision. Students discuss the role of evidence in decision-making. The concepts of relevance, accuracy, and reliability of evidence are introduced.

ACTIVITY TYPE

CARD-BASED INVESTIGATION

NUMBER OF 40–50 MINUTE CLASS PERIODS

2

KEY CONCEPTS & PROCESS SKILLS

Scientific knowledge and explanations are based on evidence and strengthened by multiple lines of relevant, accurate, and reliable evidence.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. *(Science and Engineering Practice: Engaging in Argument from Evidence)*

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

accuracy
closeness of a measured value to a true or standard value

contaminant
(assumed prior knowledge)
any physical, chemical, biological, or radiological substance in water (as defined by the U.S. Safe Water Drinking Act)

data
(assumed prior knowledge)
information gathered from an experiment or observations

evidence
information that helps support or refute a claim or leads to the development of a new claim

relevant
(assumed prior knowledge)
closely connected to the idea or question being considered

reliable
able to be reproduced consistently

trade-off
an exchange of one valued outcome for another by giving up something that is a benefit or advantage in exchange for another benefit that may be more desirable

BACKGROUND INFORMATION

Background information is intended to provide instructional support to the teacher and is not intended to be shared with students. In some cases, it may provide information that can give away the problem that students are being asked to consider in the activity. Be sure to review an activity in its entirety before communicating background information with your class.

Shared External Reality

One of the basic assumptions of science is a shared external reality. This is the idea that there is a shared external reality that affects everyone, even when people disagree about what that is. For example, new species of organisms, such as fish or bacteria, are discovered and described almost every year. These organisms exist in a shared external reality, whether or not they are known to people or whether all people believe in their existence.

See Teaching Step 7 for another example of shared external reality.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 1.1 "Developing Communication Skills" (OPTIONAL)
- VISUAL AID 1.2 "Scoring Guide: Evidence and Trade-Offs (E&T)" (OPTIONAL)
- VISUAL AID 1.3 "Understanding Conceptual Tools" (OPTIONAL)
- ITEM-SPECIFIC SCORING GUIDE: Activity 1 Build Understanding item 3

FOR EACH GROUP OF FOUR STUDENTS

- SET OF 16 DATA CARDS (provided in two sets: 1–8 and 9–16)

FOR EACH STUDENT

- STUDENT SHEET 1.1 "Plan for Skipton's Water"
- STUDENT SHEET 1.2 "Evaluating Data"
- STUDENT SHEET 1.3 "Writing Frame: Evidence and Trade-Offs" (OPTIONAL)
- STUDENT SHEET 1.4 "Unit Concepts and Skills" (OPTIONAL)
- VISUAL AID 1.2 "Scoring Guide: Evidence and Trade-Offs (E&T)" (OPTIONAL)

PLANNING AHEAD

Activity 4, Testing Local Water, is a field trip that involves visiting a local water body such as a lake or large pond that is optically deep (has a water depth where the light reflection from the bottom does not influence the light leaving the surface). The field trip also requires the use of smartphones with a turbidity app installed, which will only work onsite if there is a signal. You may wish to begin preparing for this activity by identifying a local site; providing students with permission slips; having students download the app; arranging transportation for the class; and organizing a teacher substitute, if necessary. If you are not able to arrange for a field trip or have other challenges completing the activity as written, see Activity 4, Advance Preparation, for alternatives.

Activity 9, Water quality Design Challenge, requires numerous everyday materials, such as 500 mL plastic bottles. Review the materials list for Activity 9. Calculate the amount of materials needed based on the number of class periods and group size you have. Make a plan to gather materials.

TEACHING NOTES

Suggestions for **discussion questions** are highlighted in gold.

Strategies for the **equitable inclusion** are highlighted in blue.

GETTING STARTED (10 MIN)

1 **Elicit students' prior knowledge about water by constructing a class concept map about water.**

- Students may have personal experience with and prior knowledge of issues related to the use of water in society, such as lack of water availability due to dry wells or contamination of drinking water. Engaging students about their experiences can create a stronger foundation for learning. Support students, particularly those with varied life experiences, in sharing their prior knowledge of and personal experiences with this issue. Specifically validate funds of knowledge (not just textbook knowledge, but also family or cultural insights, practices, and personal histories) by eliciting students' observations and experiences as assets to building understanding. Throughout this course, encourage students to respond to any topics or questions that arise to which they feel a personal connection—during small-group or class discussions, when students respond to relevant Build Understanding items, and when they write reflections in their science notebooks.

- Elicit student prior knowledge about water by first brainstorming a list of key words or ideas associated with water. Ask, What do you know about water? What words do you associate with water when you think about water in science or the use of water in society? Students may describe familiarity with ideas and words related to water use (such as *drinking* and *swimming*), words related to states of water (such as *snow* or *ice*), words related to bodies of water (such as *rivers* and *ocean*) and words related to water treatment (such as *filtration* or *boiling*).

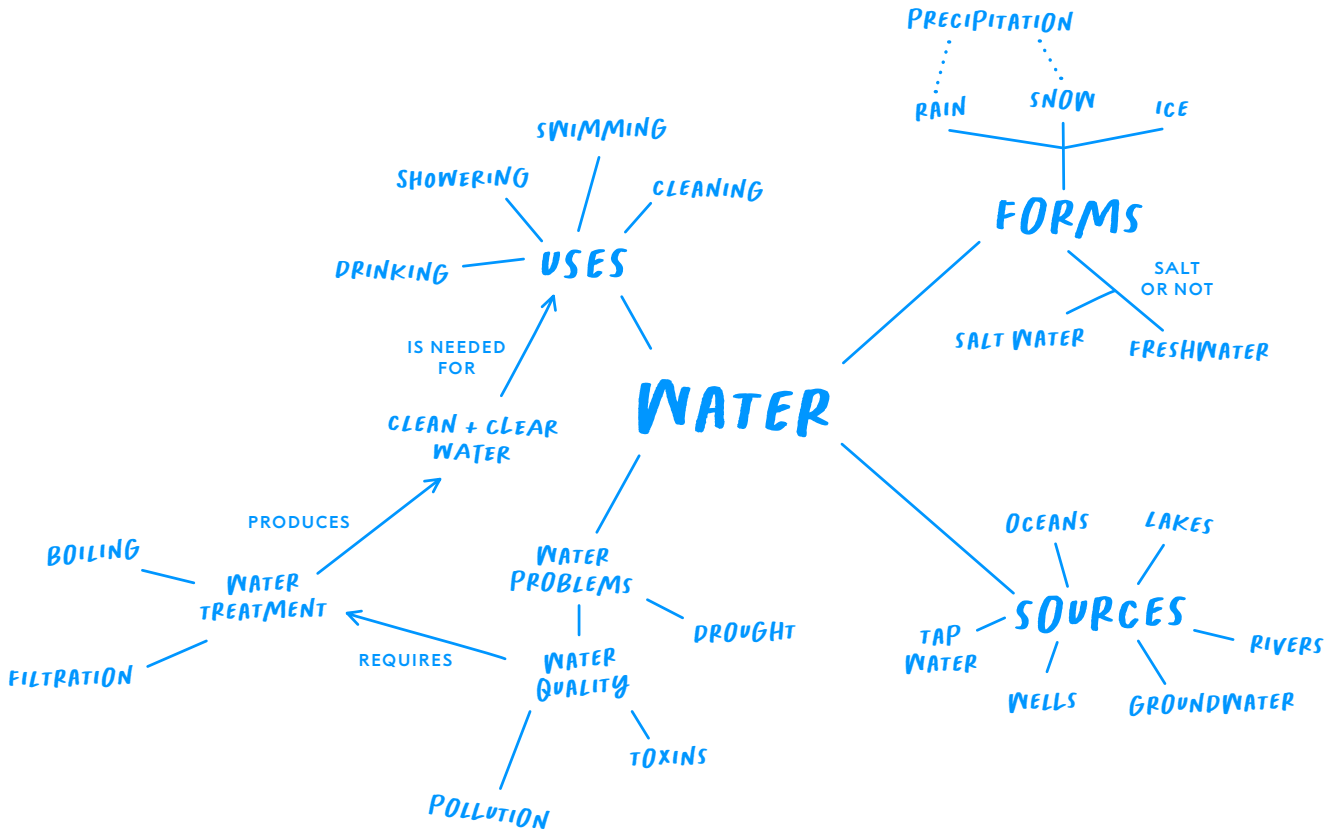
- Use the brainstormed word list to construct a concept map about water based on student thinking. Concept maps demonstrate students' understanding of connections between topics. You will revisit this concept map in the last activity of the unit, so consider posting it or otherwise maintaining access to it for later use.

- Depending on your student population, you may find it helpful to provide a starting list of terms that can be included in the concept map or provide the beginning of an incomplete concept map to spark students' responses. Terms that may help students get started include: drinking, swimming, showering, cleaning, cooking, water quality, clean water, pollution, ice, rain, snow, precipitation, groundwater, rivers, lakes, freshwater, saltwater, water treatment, filtration, boiling, tap water, wells.

2 Introduce the unit focus on water by reading the Student Book introduction.

- Read the introduction to Activity 1 in the Student Book, either as a class or individually. Connect students' prior knowledge and ideas about water to the information provided in the Student Book introduction. Student ideas most likely included a greater breadth of topics related to water than is addressed in the introduction. Point out that the introduction highlights the particular focus of this unit.

- As a class, work together to add additional information from the introduction to the concept map. A sample concept map is provided here:



PROCEDURE SUPPORT (30–40 MIN)

3 Present the scenario of Skipton found in Procedure Part A.

- Part A has students make a decision about the town of Skipton. The scenario presented in Step 1 can be shared with the class in multiple ways: Read it aloud to the class (using a storytelling approach), have individual students read a paragraph aloud to the class while others follow along with the text, or have students read it individually or cooperatively in their groups of four.

- Depending on your student population, use oral storytelling to support diverse learners in decoding scientific ideas and constructing meaning and ask questions about the main points of the scenario to ensure comprehension. Students can refer to the text in the Student Book as needed.
- Aspects of the nature of scientific evidence (with regard to accuracy and reliability) are brought up in Build Understanding and do not need to be introduced here. For now, allow students to use a working definition of evidence, to be followed up after the procedure.
- Provide each student with a copy of Student Sheet 1.1, "Plan for Skipton's Water," and Student Sheet 1.2, "Evaluating Data." After students discuss their thinking with their groups, each student can record their own ideas on Student Sheets 1.1 and 1.2—there does not need to be agreement among group members.
- On Student Sheet 1.1, students record:
  - their initial decision about the proposal.
  - evidence that supports their decision.
  - any questions they have.
- On Student Sheet 1.2, students record:
  - whether the evidence is relevant to the decision.
  - whether the evidence supports or refutes the use of the Mizu River.
- Depending on your student population and the emphasis on other science standards such as claims, evidence, and reasoning, you may wish to ask students to also describe how the evidence supports their decision (reasoning).
- Sample student responses for both student sheets are located at the end of this activity.

4 When students are ready for Procedure Step 4, provide the class with Data cards.

- Provide students with Cards 1–8 from the set of 16 Data cards.

> TEACHER'S NOTE: Do not provide students with all 16 cards in Step 4. Cards 9–16 are provided in Student Book Procedure Step 9 (see Teaching Step 5).

- Have student groups work together to share their ideas. You may wish to use Visual Aid 1.1, "Developing Communication Skills," to help guide student interactions. The Developing Communication Skills Visual Aid is a tool to help students effectively participate in class discussions by providing sentence starters that students can use to initiate a conversation and express their ideas.

5 When students are ready for Procedure Step 8, provide the remaining Data cards 9–16.

Students record updated recommendations (even if it remains the same), additional evidence that supports their decisions, and any new questions they have.

6 Procedure Step 12 asks students to share their decision-making and evidence with the class.

- You may wish to call on individuals or groups to share their decision-making and evidence with the class. Alternatively, have students indicate with a show of hands whether they initially thought Skipton should use water from the Mizu River, what they decided after receiving the first sets of Data cards, and what they decided after receiving the second set of Data cards.

- Ask, How can people with access to the same set of evidence sometimes still disagree? Have students who came to different decisions share the evidence that supported their thinking. They may recognize that disagreement is more likely when people value different pieces of information differently; for example, some people may be more concerned about potential water contaminants when residents of a community become ill.

- Ask, Were you able to revise your thinking based on new evidence? Why or why not? Discuss the role of scientific data in decision-making and project what kinds of future outcomes or evidence could change minds. Students may recognize that it is difficult to change one's mind when one is already heavily invested in a decision.

7 Introduce the concept of a shared external reality.

- Introduce the idea of **shared external reality**. This is the idea that there is a shared external reality that affects everyone, even when people disagree about what that is. For example, a poisonous berry will make people sick whether or not they believe it is poisonous. The poison in the berry is part of a shared external reality. Even when people do disagree, they are only able to talk about that disagreement in the context of some shared agreement. For example, in a disagreement about whether the berry is poisonous, people can agree that it is a berry, that it is possible to eat it, that poisonous things cause sickness, etc. This background of agreement is what makes disagreement about details meaningful.

- Skipton's water quality is part of a shared external reality. Discuss whether having only partial evidence initially affected the actual water quality of Skipton's tap water. Point out that, whether people agree on its quality or not, water can still cause illness if it is contaminated. Science can provide tools and techniques to understand water quality more accurately.

- Another example of shared external reality is provided in the Teacher Background Information.

- Ask, Is there a shared external reality even when data is incorrect? Or when people disagree about the importance of evidence? Highlight the variability in interpretations of the cloudiness of the water and how that influenced the most likely explanations for the sickness of Skipton residents. Skipton's water quality was the same (existed in a shared external reality) whether or not tests detected the presence of contaminants, or whether people valued evidence differently.

- Students may have varied ideas about the concept of a shared external reality based on family or

cultural insights, practices, and personal histories. Acknowledge funds of knowledge as assets to building understanding. Encourage students to respond to this topic or questions that arise from it by sharing their ideas during small-group or class discussions, or by writing reflections in their science notebooks.

- Guide students to the understanding that science is based on the idea of a knowable shared external reality and that the process of scientific investigation is to gather data on that reality.

SYNTHESIS OF IDEAS (10–15 MIN)

8 Review the concepts of accuracy and reliability of data, using Build Understanding items 1 and 2.

- Have students respond to Build Understanding items 1 and 2 and provide guidance as needed. You may wish to discuss the experiences of Skipton residents. Everyone but the residents who had cloudy water were likely to rely on test results. People's personal experience of their tap water could influence whether they thought the tests were accurate. Residents who got sick might consider their observations to be more accurate than the tests because they indicate that something was not right about the water.

- Support students, particularly English learners (ELs), in sensemaking and language acquisition by reviewing the terms accuracy and reliability and supporting the construction of a word wall. You may want to model a sample response as a class to help scaffold student understanding. You may want to extend Build Understanding item 2 by introducing additional examples of accuracy and reliability. For instance, some water bottles have a mark to indicate the amount of liquid they contain, such as 1 liter. Students could measure the amount of water in a bottle by using scientific equipment, such as graduated cylinders or beakers, to investigate if the mark is accurate. Taking repeated measurements could provide reliability. This type of experimental design is reproducible, since other students could use the same method to get similar results.

9 Review the role of evidence in the activity.

- In Build Understanding item 3, students are introduced to a formal definition of *evidence*, which is a central concept in the unit. Clarify with students the difference between evidence, information, and a claim. **Evidence** is information that helps support or refute a claim or leads to the development of a new claim. Information, such as observations or raw data, is not evidence until it has been interpreted for the purpose of supporting or refuting a claim. In general, a **claim** is a statement that asserts something is true. In science, scientists make claims based on experimental results or other evidence. Students will further explore the concept of a claim in Activity 6, "Claims and Evidence," when a formal definition of claim is provided in the Student Book introduction.

- If the topic comes up, distinguish evidence from opinion. Explain that evidence is a set of observations that supports a claim. In contrast, an opinion is a view that someone takes about a certain

issue based on their own judgment. An opinion might not be based on evidence. An informed opinion might be based on evidence; however, another person may have a different opinion based on the same evidence.

10 Introduce the concept of trade-offs.

- Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs. In Build Understanding item 3, students make a decision about Skipton's use of water from the Mizu River. The units of this course include issues that relate to science and/or engineering, which may lead to decisions about the best solutions for solving problems. Decision-making in the context of trade-offs includes the following key ideas:
  - Decisions often involve trade-offs.
  - Identifying trade-offs involves analyzing evidence.

  The concept of trade-offs will be used throughout the units of this course, especially as part of the decision-making focus of the course.

- The Scoring Guide: Evidence and Trade-Offs (E&T) assesses students' understanding of these concepts. This Scoring Guide can be shared with students to help them develop a response and to communicate what is expected of them. The item-specific Scoring Guide, however, is not intended to be shared with students. Its purpose is to guide teachers while scoring a specific prompt, such as Build Understanding item 3 in this activity.

- A **trade-off** is a desirable outcome given up to gain another desirable outcome. In a decision involving trade-offs, something positive (or desirable) is given up to gain another positive (or desirable) outcome. Since many decisions involve trade-offs, students should understand that a perfect choice that maximizes all goals is often not possible. It is possible, however, to recognize and analyze the trade-offs associated with each decision.

- Provide an example of a trade-off. For example, when choosing to purchase a disposable or reusable water bottle, there are several benefits and trade-offs to consider. A consumer who chooses the disposable water bottle may want a cheap option that doesn't need to be cleaned or maintained. Disposable bottles are also easily shared with others, since they are not expected to be returned. However, in choosing the disposable water bottle, the consumer is contributing to environmental problems, such as increased energy use and higher amounts of solid waste in landfills if the bottle is not recycled. A consumer choosing to purchase a reusable water bottle may do so to save money over time, to save bottles from ending up in a landfill, and—by their example—to encourage others to purchase reusable bottles. However, this option has trade-offs as well, such as the increased upfront cost of the reusable bottle and the need to clean and maintain the bottle. Neither choice is ideal, and both choices have positives and negatives. Identifying the trade-offs helps clarify the reasoning that is being applied to make a decision.

- Develop some examples of trade-offs in students' lives by brainstorming with the class a list of decisions they make every day that involve trade-offs. Choose one and talk through the associated trade-offs of deciding one way or another. This practice will familiarize students with ways to identify and consider trade-offs in this and subsequent activities.

- Build Understanding item 3 applies the concepts of evidence and trade-offs. A writing frame can support diverse learners, particularly ELs, in decoding scientific ideas, constructing meaning, sense-making, and language acquisition. This strategy, which has been deemed effective for ELs, was built on and adapted from strategies for English-proficient learners. In this activity, use Student Sheet 1.3, "Writing Frame—Evidence and Trade-Offs" as a scaffold for students to write their responses to Build Understanding item 3. A sample student response can be found at the end of this activity

- You can use Visual Aid 1.2, "Scoring Guide: Evidence and Trade-Offs (E&T)" to assess Build Understanding item 3. Point out the scoring levels (0–4) and review the criteria for each score. Explain that the scores are based on the quality of students' responses and reflect student growth over time. The scores do not correspond to letter grades. A Level 3 response is complete and correct. A Level 4 response signifies that the student has both achieved and exceeded the acceptable level of response. At first, many students will write Level 2 responses, and they should strive to achieve Level 3 or Level 4 responses. Let students know that you would like them to improve by at least one level as they progress through the unit. As a class, discuss what a Level 4 response to Build Understanding item 3 would include. You may develop a Level 4 exemplar as a class or share with students the Level 4 responses from the provided sample responses. To help students better understand the three levels, discuss how they are different and ask students for ideas about how to improve from Level 2 to Level 3 and from Level 3 to Level 4. A sample Level 4 response is included in Sample Responses to Build Understanding and on Student Sheet 1.3.

11 Highlight opportunities for metacognition here and throughout the unit.

- Connections to Everyday Life item 4 provides an opportunity for students to practice metacognition— thinking about and understanding one's own thought processes. Research has found that students show greater improvements in their learning when they are given opportunities to determine and evaluate their own learning.

- Highlight these opportunities here and throughout the unit. Ask, In what ways could knowing about your thinking process influence your decision-making skills? Encourage students to share their ideas. Some students may note that being more aware of their own thinking may make them more likely to be more open to limitations in their thinking or make them more likely to change their minds. They may also enhance their skills at communicating their ideas.

12 Review the idea that scientific knowledge and explanations are strengthened by multiple lines of relevant, accurate, and reliable evidence.

- Use Student Sheet 1.1 to discuss comments and questions that students had about the evidence.

- Address the quantity and quality of evidence as a factor in their decision-making. Having multiple lines of evidence strengthens an argument and having evidence that is relevant, accurate, and reliable makes the argument more convincing. In science, knowledge and explanations are developed as a result of many people producing relevant, accurate, and reliable evidence. When evaluating evidence, scientists consider the source, quality, and quantity of the evidence available.

- Ask, Do you have enough information to know for sure (that is, with 100% confidence) whether Skipton's water was contaminated with Cryptosporidium? Discuss how the evidence can lead to an inference, a conclusion based on evidence and reasoning vs. explicit data.
- Highlight the idea that scientific knowledge can change over time as more evidence is gathered. Discuss what effect this may have on decision-making.

12 Introduce the conceptual tool of multiple lines of evidence.

- Use Build Understanding item 5 to discuss the role of **multiple lines of evidence** as a tool in a student's scientific toolkit. The scientific toolkit is intended to be a set of conceptual tools that can be applied to everyday life. Students will add conceptual tools to their toolkit with each new unit. Depending on your student population, use Visual Aid 1.3, " Understanding Conceptual Tools" to review the use of the word tool—an implement used to carry out a particular function. The word is commonly used to refer to construction tools such as hammers, levels, and tape measures. In a science classroom, examples of scientific tools include beakers, graduated cylinders, and microscopes; in this unit, scientific tools and technology are used to gather evidence. In this course, students consider conceptual tools, such as multiple lines of evidence, as a way of exploring the application of science to everyday life.
- As students build understanding about the importance of having multiple lines of evidence in a scientific argument or explanation, they will build a conceptual tool about this idea in their minds and develop skills to utilize it at various points in the unit. You may wish to use Student Sheet 1.4, "Unit Concepts and Skills," to help students organize their learning. This course organizer is designed to help students reflect on their understanding of the conceptual tool, consider how they have used it to analyze problems throughout the unit, and how it may influence their decisions about unit topics.
- While a sample completed course organizer is provided in this activity, students will not be able to complete it at this time; the ideas in the sample response will be built over the course of the unit. At the end of this activity, students can add information about the role of multiple lines of relevant, accurate, and reliable evidence in supporting an explanation. The Skipton scenario is an example of when students had an opportunity to analyze information related to this idea, as well as make a decision.

EXTENSION (10 MIN)

13 Use the Extension as an opportunity for advanced learning.

Students can connect the scenario to the source of water in their own community. They can research local water sources and treatment, as well as any recent news about the local water supply, prior to sharing their findings with one another. Alternatively, you can pre-select the research and share it with the class.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

The Build Understanding and Connections to Everyday Life questions are intended to guide your understanding. Some of these questions may be discussed with a partner, be part of a class discussion, or require an individual written response. Your teacher will guide you as to how these questions will be used in your class.

① **How did Skipton's residents' observations of the water compare with the results of water-quality tests?**

Some residents observed some cloudiness in their tap water, while the water-treatment tests of water quality met national standards.

② **In Skipton, many of the water quality tests, such as pH, did not indicate any change in water quality over time. Scientific explanations depend on relevant, accurate, and reliable data.**

- **Data is relevant if it is closely connected to or related to the idea or question being considered. For example, your body temperature and how you feel are both relevant to whether you are well. The price of a thermometer is not relevant to your health.**
- **Data is considered reliable if it can be reproduced consistently. For example, if you take your temperature at three different times and each time it is 100°F, your temperature data is reliable.**
- **Accuracy is the closeness of a measured value to a true or standard value. For example, your parent feels your forehead and says you have a fever. When you take your temperature with a thermometer, it shows a reading of 101°F. Based on data from both human senses and a scientific tool, your temperature data is accurate.**

Were the Skipton water quality test results reliable, accurate, both, or neither? Explain your reasoning.

The tests were repeated multiple times, so the tests could be considered reliable. Yet people got sick, probably from the water. So that means that tests were probably not accurate.

③ E&T Scoring Guide

You found out more about the town of Skipton's decision from the Data cards. Did you agree with the town's decision about water from the Mizu River?

Support your answer with at least three pieces of evidence from this activity and identify the trade-offs of your decision. Evidence is information that helps support or refute a claim or leads to the development of a new claim. A trade-off is an exchange of one valued outcome for another by giving up something that is a benefit or advantage in exchange for another benefit that may be more desirable.

Following is a sample student response, which can also be found on Student Sheet 1.3, Sample. Student Response at the end of this activity.

LEVEL 4 RESPONSE

I agree with Skipton's decision to get water from the river. The town has already saved a lot of money. Water quality tests do not show any change, and cloudiness levels meet standards for water quality. While some residents have gotten sick, there is no evidence that it is from the drinking water. The trade-off of my decision is that if the Cryptosporidium is in the water, more people may get sick. Some people might not think saving money is worth the risk.

LEVEL 3 RESPONSE

I agree with Skipton's decision to get water from the river. The town has saved money, the water quality tests haven't changed, and the cloudiness levels meet standards. The trade-off of my decision is that there might be Cryptosporidium in the water.

LEVEL 2 RESPONSE

I agree with Skipton's decision to get water from the river. The water quality tests are okay, but people might get sick.

LEVEL 1 RESPONSE

I agree with Skipton's decision to get water from the river because river water is clean and good for you.

CONNECTIONS TO EVERYDAY LIFE

④ **In this activity, the Skipton scenario provided an opportunity to conduct a thought experiment by testing ideas about drinking water without doing additional experiments or your own research. This is a common approach used in many fields of study prior to doing real-world work. What are some situations in your daily life where it might be useful for you to conduct thought experiments?**

Sometimes I think about what might happen if I don't study for a test (how it might affect my grade), what would happen if my team wins a game (how it would affect us getting into league championships), and what my month might look like if I spend most of my money at the beginning of the month (what I could or couldn't do with my friends).

⑤ **In this activity, you began to investigate the role of multiple lines of evidence in supporting or refuting an idea. Consider what role evidence plays in your own decision-making. Imagine that your friend just told you that caffeinated energy drinks are great for breakfast because they help kids focus. On days when she stays up late and doesn't have an energy drink for breakfast, she sometimes falls asleep in class. Did she provide enough evidence for you to choose having an energy drink for breakfast? Explain why or why not.**

No, I hate energy drinks, so the evidence she gave isn't enough for me. I would want data from more kids than just her because everyone is different. The drink might have a different effect on different people. If she experimented with having and not having the drink and had data that showed how often she stayed awake in both situations, that would provide more evidence that might convince me.

REFERENCES

World Wildlife Fund. (2022). Water scarcity overview. Retrieved from https://www.worldwildlife.org/threats/water-scarcity#:~:text=As%20a%20result%2C%20some%201.1,and%20other%20water%2Dborne%20illnesses

DATA CARD 1

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

Many residents report that their tap water looks and smells fine.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 2

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

Repeated bacterial tests of the water do not indicate any changes in water quality.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 3

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

The pH tests of the water do not indicate any changes in water quality.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 4

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

Many residents enjoy drinking fresh orange juice at breakfast.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 5

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

Some residents have recently complained that their tap water is cloudy, not clear.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 6

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

A few residents are worried about the quality of their drinking water.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 7

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

Sales of bottled water have increased.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 8

The town of Skipton decided to move forward with using water from the Mizu River for residential use. Two months have passed.

The city has already saved $500,000.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 9

One month later:

Numerous tests of the water do not indicate any changes in water quality.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 10

One month later:

Residents of one area of Skipton have observed increased water cloudiness over a period of two weeks.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 11

One month later:

The water has undergone multiple additional measurements of cloudiness beyond those required by law, and the water meets national treatment standards.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 12

One month later:

Thousands of town residents have experienced stomach upset and diarrhea over a period of several weeks.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 13

One month later:

A stool sample of a sick patient contains *Cryptosporidium*. *Cryptosporidium* is a microscopic parasite that causes watery diarrhea. It can be found in water, food, soil, or on surfaces that have been contaminated with the feces of humans or animals infected with the parasite.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 14

One month later:

***Cryptosporidium* cannot be detected by most standard tests of water quality.**

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 15

One month later:

Reusable water bottles are on sale at local stores.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

DATA CARD 16

One month later:

***Cryptosporidium* cannot be killed with chlorine at the concentrations used in routine water treatment.**

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 1

	MY DECISION	EVIDENCE SUPPORTING MY DECISION	QUESTIONS I HAVE
INITIAL PROPOSAL			
AFTER DATA CARDS 1–8			
AFTER DATA CARDS 9–16			

SAMPLE STUDENT RESPONSE A

	MY DECISION	EVIDENCE SUPPORTING MY DECISION	QUESTIONS I HAVE
INITIAL PROPOSAL	*Yes, use water from Mizu River for 2 years.*	*Saves money.* *Water is clear and has no odor.* *The pH is in the right range.* *Low level of microbes.* *Water will be treated with chlorine.*	*Will there be enough water for the 2 years?* *Will the water be tested for other factors?* *Is the water from Lake Timtim clean?*
AFTER DATA CARDS 1–8	*Yes, keep using water from Mizu River.*	*Tap water looks and smells fine.* *Bacterial and pH tests of water show no change.* *City saved $500,000.*	*Who is deciding that the water looks and smells fine?* *Exactly how is this being determined?*
AFTER DATA CARDS 9–16	*Yes, keep using water from Mizu River.*	*No other tests indicate any change in water quality.* *Water meets national treatment standards.* *Conducting more water quality tests for cloudiness than required by law.*	*What else could be making people sick?* *Why is the water cloudy?*

	MY DECISION	EVIDENCE SUPPORTING MY DECISION	QUESTIONS I HAVE
INITIAL PROPOSAL	*Yes, use water from Mizu River for 2 years.*	*Saves money.* *Water is clear and has no odor.* *The pH is in the right range.* *Low level of microbes.* *Water will be treated with chlorine.*	*Will there be enough water for the 2 years?* *Will the water be tested for other factors?* *Is the water from Lake Timtim clean?*
AFTER DATA CARDS 1–8	*No, stop using water from Mizu River.*	*Some residents have cloudy tap water.* *Some residents worried about water quality.*	*What is making the tap water cloudy?* *What other water quality tests could be conducted?* *Who is deciding?*
AFTER DATA CARDS 9–16	*No, stop using water from Mizu River.*	*Thousands of people have stomach upset and diarrhea.* *Stool sample of a sick patient contains Cryptosporidium, a parasite that causes diarrhea.*	*Why wasn't the water tested more often?* *Why weren't other water quality tests done?* *What would prove if there is a parasite in the water?*

	IS THE DATA RELEVANT?		DOES IT PROVIDE EVIDENCE THAT SUPPORTS OR REFUTES USING WATER FROM MIZU RIVER?	
DATA	YES	NO	SUPPORTS	REFUTES
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

	IS THE DATA RELEVANT?		DOES IT PROVIDE EVIDENCE THAT SUPPORTS OR REFUTES USING WATER FROM MIZU RIVER?	
DATA	YES	NO	SUPPORTS	REFUTES
1	x		x	
2	x		x	
3	x		x	
4		x	-	-
5	x			x
6	x			x
7		x	-	-
8	x		x	
9	x		x	
10	x			x
11	x		x	
12	x			x
13	x			x
14	x			x
15		x	-	-
16	x			x

THERE IS A LOT OF DISCUSSION ABOUT THE ISSUE OF

MY DECISION IS THAT

MY DECISION IS BASED ON THE FOLLOWING EVIDENCE:

FIRST,

SECOND,

THIRD,

THE TRADE-OFF(S)

PEOPLE WHO DISAGREE WITH MY DECISION MIGHT SAY THAT

THERE IS A LOT OF DISCUSSION ABOUT THE ISSUE OF

whether to get water from the Mizu River.

MY DECISION IS THAT

the town should not get water from the river.

MY DECISION IS BASED ON THE FOLLOWING EVIDENCE:

FIRST,

many residents are worried and have complained about their water.

SECOND,

some people have become sick from Cryptosporidium, which can be found in water.

THIRD,

Cryptosporidium cannot be detected by most water quality tests.

THE TRADE-OFF(S)

is that it will cost the city more money.

PEOPLE WHO DISAGREE WITH MY DECISION MIGHT SAY THAT

the Cryptosporidium could have been a result of contaminated food or another source.

UNDERSTAND		ANALYZE
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)

WHAT DECISION(S) WERE MADE OR ACTION(S) TAKEN?

UNDERSTAND		ANALYZE
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)
Multiple lines of evidence	*Scientific explanations are supported by multiple lines of relevant, accurate, and reliable evidence*	*Skipton's water source* *use of Lake Timtim*
Data from human senses + scientific tools and technology	*Evidence can be the result of data from human senses + scientific tools and technology*	*Odor and appearance of water samples, pH data, turbidity data*
Validation	*Evidence from different sources can be used to validate each other*	*pH data from multiple methods* *different water quality indicators*
Scientific advancement	*Scientific knowledge develops over time due to new evidence, better experimental methods, collaboration, + trial and error*	*Evidence of water on planet Mars, development of microscope and relationship to understanding role of microbes in infectious disease*
Iteration	*Scientific ideas and processes are continuously re-evaluated and revised*	*Julius Lucks, water quality design challenge*
Science a human endeavor	*Science is done by people*	*Pastor McCathern, LeeAnne Walters, Africa Flores, Julian Lucks, Marilou Sison-Mangus*
Scientific optimism	*People keep working to solve problems using science*	*Dr. Daniel Fernandez and team, Hugo Streeter, Dr. Peter Weiss-Penzias, Dr. Sara Baguskas, Steve Jenkins and Xeros team*

WHAT DECISION(S) WERE MADE OR ACTION(S) TAKEN?

Whether to move Skipton's water supply, whether to get water from Lake Timtim, how to design a water-treatment device, how to address local water quality and availability.

COMMUNICATION	SENTENCE STARTERS
to better understand	One point that was not clear to me was... What if we tried... I have an idea. We could try...
to disagree	I see your point, but what about...? Another way of looking at this is... I'm still not convinced that...
to challenge	How do you reach the conclusion that...? What makes you think that...? How does it explain...?
to look for feedback	What would help me improve... Does it make sense, what I said about...?
to provide positive feedback	One strength of your idea is... Your idea is good because...
to provide constructive feedback	The argument would be stronger if... Another way to do it would be... What if you said it like this...?

MAKE SURE YOUR RESPONSE:

- uses relevant evidence, concepts, and process skills to compare multiple options in order to make a choice.
- takes a position supported by evidence and describes what is given up (traded off) for the chosen option.

LEVEL	DESCRIPTION
Level 4 **Complete and correct**	The student provides a clear and relevant choice with appropriate and sufficient evidence, including BOTH of the following: • a thorough description of the trade-offs of the decision • reasons why an alternative choice was rejected (if applicable)
Level 3 **Almost there**	The student provides a clear and relevant choice with appropriate and sufficient evidence, BUT one or both of the following are insufficient: • the description of the trade-offs • reasons why an alternate choice was rejected (if applicable)
Level 2 **On the way**	The student provides a clear and relevant choice, BUT the evidence is incomplete.
Level 1 **Getting started**	The student provides a clear and relevant choice BUT provides reasons that are subjective or inaccurate.
Level 0	The student's response is missing, illegible, or irrelevant.
X	The student had no opportunity to respond.

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are making a choice or developing an argument about a socioscientific issue when arguments may include judgments based on nonscientific factors.

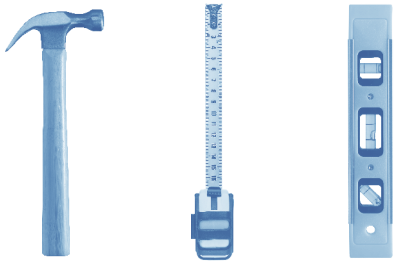
WHAT TO LOOK FOR:

- Response uses relevant evidence, concepts, and process skills to compare multiple options in order to make a choice.
- Response takes a position supported by evidence and describes what is given up (traded off) for the chosen option.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 4 **Complete and correct**	The student provides a clear and relevant choice with appropriate and sufficient evidence, including BOTH of the following: • a thorough description of the trade-offs of the decision • reasons why an alternative choice was rejected (if applicable)	**The student's response includes:** • a clear description of whether they agree or disagree with the town's choice. • a clear, thorough description of at least three pieces of evidence that are relevant to and support their position. • a clear, thorough description of at least one appropriate trade-off.
Level 3 **Almost there**	The student provides a clear and relevant choice with appropriate and sufficient evidence, BUT one or both of the following are insufficient: • the description of the trade-offs • reasons why an alternate choice was rejected (if applicable)	**The student's response includes:** • a clear description of whether they agree or disagree with the town's choice. • at least three pieces of evidence that are relevant to and support their position. • at least one appropriate trade-off. • descriptions of evidence and trade-offs may be unclear or insufficient.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 2 **On the way**	The student provides a clear and relevant choice, BUT the evidence is incomplete.	**The student's response includes:** • a clear description of whether they agree or disagree with the town's choice. • at least one piece of evidence that is relevant to their decision. **And may include:** • at least one trade-off **However, evidence is less than three pieces and/or trade-off is missing or unclear.**
Level 1 **Getting started**	The student provides a clear and relevant choice BUT provides reasons that are subjective or inaccurate.	**The student's response includes:** • a clear description of whether they agree or disagree with the town's choice. **However, evidence is subjective, inaccurate, or irrelevant and/or trade-off is missing or unclear.**
Level 0	The student's response is missing, illegible, or irrelevant.	
X	The student had no opportunity to respond.	

CONSTRUCTION TOOLS



SCIENTIFIC TOOLS

SCIENTIFIC TOOLS + TECHNOLOGY

CONCEPTUAL TOOLS