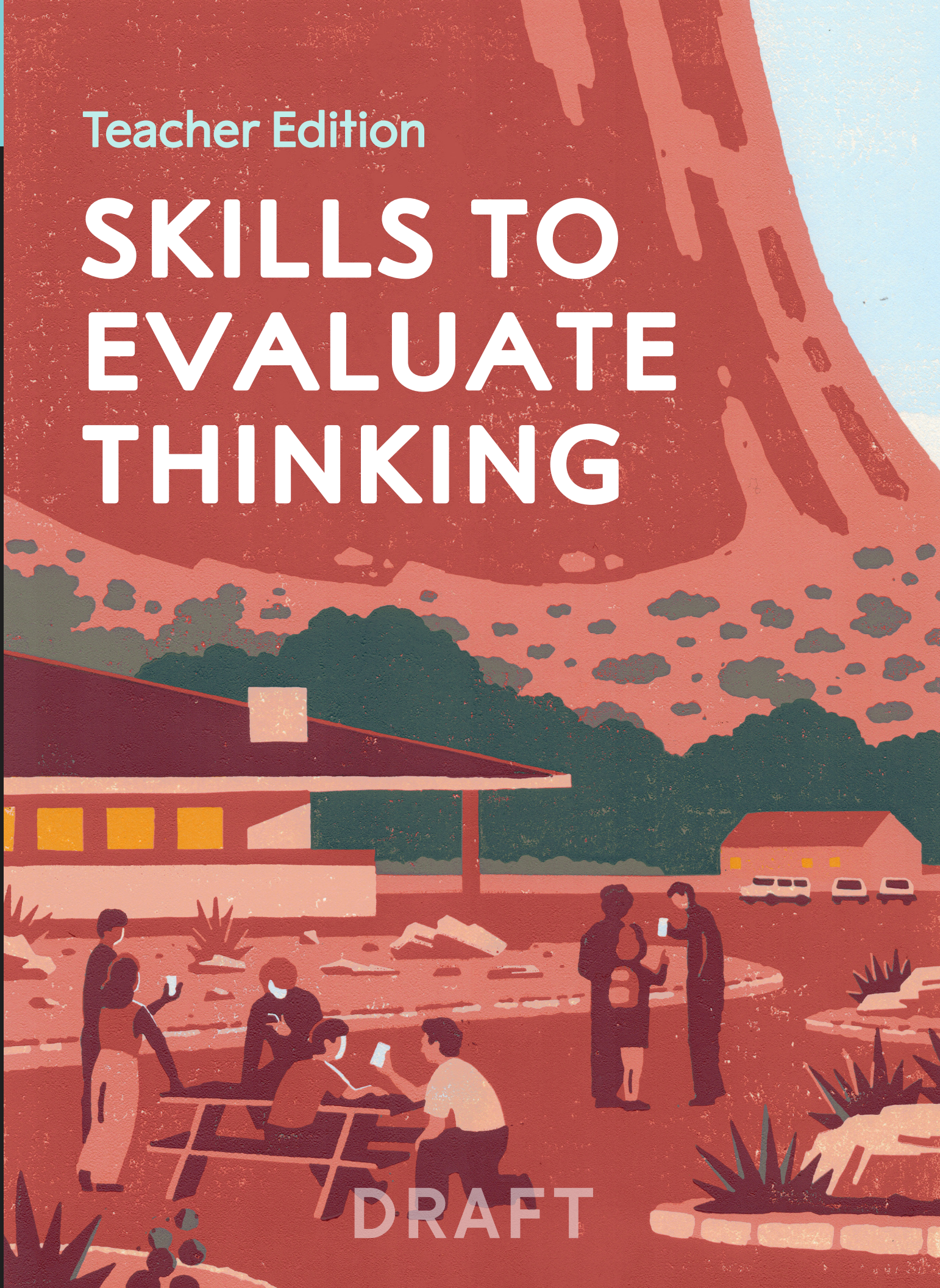
UNIT 5

v 1.0

SCIENTIFIC THINKING FOR ALL : A TOOLKIT

Teacher Edition

SKILLS TO EVALUATE THINKING



DRAFT

This book is part of the *Scientific Thinking for All: A Toolkit* curriculum that is a high school adaptation of the University of California, Berkeley, "Big Ideas" course titled Sense and Sensibility and Science https://sensibility.berkeley.edu/. It was developed by professors Saul Perlmutter, John Campbell, and Robert MacCoun and represents a collaboration among physics, philosophy, and psychology. *Scientific Thinking for All: A Toolkit* was developed by curriculum developers and researchers at The Lawrence Hall of Science, University of California. The initiative is a cooperation between Nobel Prize Outreach (NPO) and Saul Perlmutter. This work is supported by a consortium of funders including Kenneth C. Griffin, the William and Flora Hewlett Foundation, the John D. and Catherine T. MacArthur Foundation, the Gordon and Betty Moore Foundation, and The Rockefeller Foundation.

SCIENTIFIC THINKING FOR ALL TEAM

PRINCIPAL INVESTIGATOR
Saul Perlmutter

PROJECT DIRECTOR
Ben Koo

PROJECT LEAD
Janet Bellantoni

UNIT 5 AUTHORS
Kristina Duncan
Janet Bellantoni
David House
Emlen Metz
Manisha Hariani

OTHER CONTRIBUTORS
Maia Binding
Tim Hurt
Wendy Jackson
Sara Kohler
Ben Koo

FIELD TEST COORDINATOR
Kelly Grindstaff

RESEARCH
Eric Greenwald
Kelly Grindstaff
Crystal Menzies

SCIENTIFIC REVIEW
Justin V. Remais, PhD
Professor of Environmental Health Science
University of California, Berkeley

Kimberly Hernandez, MPH, CPH
Division Director of Health Services
Kern County Public Health Department, California

PRODUCTION
EDITING
Trudihope Schlomowitz

DESIGN
otherwise

TOOL ICONOGRAPHY
DOT Stockholm

COVER ILLUSTRATION
Merijn Jansen

THE LAWRENCE HALL OF SCIENCE
University of California, Berkeley
Berkeley, CA 94720-5200

DEAR TEACHER,

In a world flooded with information, we continually make choices about what information to believe, and human limitations and biases can make it easy to fool ourselves. Many people in the scientific community have worked to understand and counter these limitations, developing cognitive tools and techniques to minimize bias and avoid cognitive traps. Tools such as probabilistic reasoning, the use of multiple lines of evidence, and differentiating correlation from causation are essential to scientists' efforts to make sense of the world. For too long, these conceptual tools have been missing from much of high school education.

Scientific Thinking for All: A Toolkit is a curriculum designed to bring these ideas to students from all walks of life and cultural backgrounds. Our goal is to equip students with an everyday conceptual toolkit of some of the most powerful techniques from science. The curriculum situates the learning and practice of these techniques in real-world issue-based contexts of everyday importance that highlight the intersection of science and society. Your students will use these tools to ask questions, brainstorm ideas, interpret data, manage trade-offs, and develop solutions. The toolkit includes new and proven strategies to help students evaluate information, reflect on their thinking, and make more informed decisions. It is our hope that this science toolkit will empower your students to think more clearly about the things they care about, to provide them with strategies for addressing problems, and to help them achieve their personal goals.

As a teacher, you play a critical role in your students' lives and development. This work would not be possible without you. We invite you to work with us to help youth see the power and value of scientific thinking in their lives. Together, we can make scientific thinking more accessible, helping students to reimagine what science looks like and who gets to participate.

Sincerely,

Scientific Thinking for All Program Team

SCIENTIFIC THINKING FOR ALL
A TOOLKIT

COURSE DESCRIPTION

Scientific Thinking for All: A Toolkit is a high school curriculum designed to equip students with scientific tools and ideas for using and evaluating information. For example, conceptual scientific tools include modeling and strategies for probabilistic reasoning. Such conceptual tools can be used to interpret evidence, identify uncertainty, manage trade-offs, and develop iterative solutions. Students learn these ideas in the context of real issues at the intersection of science and society, ranging from medical treatments to land use.

The six-unit curriculum is divided into three major sections, each emphasizing different scientific tools. In Section 1, "Tools for Investigating the World," students are introduced to the nature of science as an iterative process based on observation and measurement and use modeling to represent and predict specific aspects of the world. In Section 2, "Tools for Evaluating Data," students evaluate different types of evidence for causation, discuss appropriate inferences and sources of uncertainty, and identify errors due to human bias. In Section 3, "Applying Science to Everyday Life," students use techniques that encourage effective decision-making and consider science as a lens through which to understand the world.

COURSE DRIVING QUESTION

How do scientific tools and scientific thinking help people address complex challenges?

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UNIT 5

SKILLS TO EVALUATE THINKING

UNIT SUMMARY

INTRODUCTION

In this unit, students will learn and practice skills to help them think about the information that they encounter in their lives, such as online information, social media posts, scientific investigations, and everyday situations. Students explore the role of **slow thinking** techniques as they examine issues related to the social confusion around the events of a disease outbreak. Students practice skills to help them determine whether the conclusions that are drawn are based on evidence and reasoning. Students discuss the role of different types of thinking, such as **cognitive shortcuts** and **cognitive biases**, including **confirmation bias**. They consider the impact of these types of cognitions on health decisions for individuals, scientific research, and society. Students will practice evaluating evidence with an **actively open mindset**, which can reduce errors from fast thinking and cognitive biases when evaluating information and making decisions.

UNIT DRIVING QUESTION

How can people evaluate their thinking about everyday issues, such as health and disease?

PRIMARY CONCEPTUAL TOOL

Slow Thinking

UNIT 5

SKILLS TO EVALUATE THINKING

KEY CONCEPTS & PROCESS SKILLS

SLOW THINKING

- Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
- Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.

COGNITIVE SHORTCUTS AND BIASES

- Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.
- There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.
- Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.

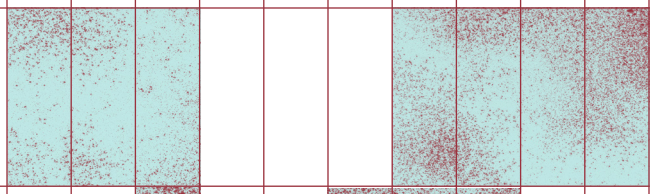
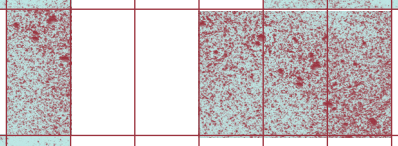
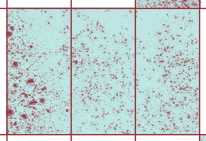
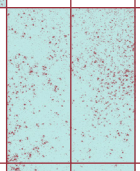
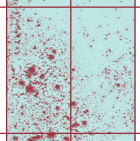
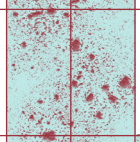
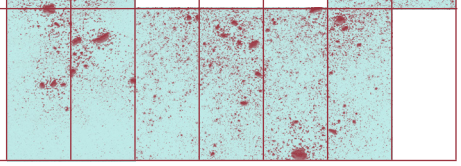
CONFIRMATION BIAS

Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.

ACTIVELY OPEN MINDSET

An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

While each activity focuses primarily on one or two of these concepts outlined in the following table, the concepts are addressed in multiple places throughout the unit. In the table, you can see where in the unit each of these Key Concepts & Process Skills is addressed.

KEY CONCEPTS & PROCESS SKILLS	ACTIVITY 1	2	3	4	5	6	7	8	9	10
Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.										
Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.										
Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.										
There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.										
Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.										
Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.										
An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.										

UNIT 5

SKILLS TO EVALUATE THINKING

UNIT OVERVIEW

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
1. Types of Cognition INVESTIGATION Students work through challenging brain-teaser questions to experience two different thinking modes. They evaluate their own metacognitive experiences by reviewing when they used fast thinking and slow thinking in the activity. The characteristics of both thinking modes are presented, and students consider how the two modes affect how people evaluate information and reach conclusions.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.	**What are two different modes of thinking?**
2. Thinking About Thinking DISCUSSION Students apply two different modes of cognition—fast thinking and slow thinking—in the context of a health scenario. First, they are introduced to a fictional scenario by reviewing imaginary headlines about a community facing a disease outbreak. They gauge their fast-thinking responses and then slow down their thinking to consider the believability of the headlines and evaluate additional text of the news stories. This sets the stage for a discussion about what students think about when they engage in fast thinking and slow thinking while consuming media.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions. • NGSS Connection: Compare, integrate, and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.	**How do people use fast thinking and slow thinking in everyday situations?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
3. Cognitive Shortcuts INVESTIGATION Students deepen their understanding of fast thinking and slow thinking by learning to recognize specific types of fast-thinking errors, called shortcuts. These include the availability, representativeness, and anchoring shortcuts. Students investigate these ideas in the context of a contemporary disease known as avian influenza, or bird flu. They examine statements about this disease and analyze them for the characteristics of cognitive shortcuts. Then, students explore some skills to slow down thinking and reduce errors due to cognitive shortcuts. These include looking for additional evidence that reveals the shortcuts by searching for credible online sources.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable. • Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions. • NGSS Connection: Compare, integrate, and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • NGSS Connection: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**How do people avoid errors from cognitive shortcuts?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
4. Looking at Evidence CARD-BASED INVESTIGATION Students explore how confirmation bias can affect people's ability to evaluate information. They do so in the context of the health issue of social media and teen mental health. Students unwittingly select evidence to support an existing belief for or against social media and then examine their own cognitive biases. Students then learn about a suite of slow-thinking skills by using an actively open mindset as a skill for reducing the influence of confirmation bias.	• There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning. • Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim. • Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind. • NGSS Connection: Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • NGSS Connection: Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.	**How do existing beliefs affect the way people seek information?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
5. Reducing Cognitive Biases INVESTIGATION Students explore four common cognitive biases they may experience in their daily lives. These include confirmation bias (introduced in Activity 4), conflict of interest, conformity bias, and emotion bias. Students then practice recognizing these cognitive biases in stories from the Southsand fever scenario. This investigation helps them reflect on how to apply an actively open mindset to cognitive biases to support evaluating information in decision-making.	• There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning. • Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim. • Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.	**How do cognitive biases shape everyday decisions?**
6. Evaluating a Scientific Claim GAME In this activity, students play a game that simulates an epidemiological investigation in the Southsand fever scenario. Students gather and analyze data about the fictional disease to determine the mode of transmission of Southsand fever. The task includes the slow, actively open-minded techniques students learned in the unit so far to investigate a series of hypotheses they develop. The activity concludes when students completely evaluate the evidence and construct a claim about how Southsand fever spreads.	• Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind. • NGSS Connection: Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • NGSS Connection: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**How can an actively open mindset help to make a scientific claim?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
7. Addressing Cognitive Bias in Science READING This activity uses historical and modern examples of disease discovery and treatment to demonstrate how scientific practices rely on slow thinking and an actively open mindset. Students read two case studies: one about the pellagra epidemic in the 1900s and the other about the recent development of the COVID–19 mRNA vaccine. Both case studies show the use of the skills learned in the activity in real-world scientific contexts. Students analyze both case studies to learn how individual and community practices help scientists reduce bias, establish reliable conclusions, and advance science.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.	**How does slow thinking improve scientific conclusions?**
8. Investigating a Pathogen CARD-BASED INVESTIGATION Students evaluate information related to identifying the pathogen causing Southsand fever. They evaluate laboratory evidence to deduce the biological cause of the Southsand fever outbreak. Students apply the metacognitive scientific skills they've been practicing throughout the unit to investigate the disease, using microscope images. Based on the information they've gathered, students develop an explanation about which pathogen causes Southsand fever and how people become infected.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind. • NGSS Connection: Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • NGSS Connection: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**How do epidemiologists use an actively open mindset?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
9. Community Health Solutions DATA ANALYSIS Students consider recommendations to help Southsand reduce the impacts of Southsand fever on the community. Students use the skills they've learned from the unit to evaluate statements from community members about the recommendations for fast thinking and cognitive bias. At the end of the activity, students decide which recommendation they think is most effective for the community.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning. • Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim. • Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief. • An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind. • NGSS Connection: Evaluate competing design solutions based on jointly developed and agreed-upon design criteria, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). • NGSS Connection: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.	**How can communities evaluate science-based recommendations?**

ACTIVITY TITLE AND SUMMARY	KEY CONCEPTS & PROCESS SKILLS	GUIDING QUESTION
10. Cognitive Skills in Communication PRESENTATION Students apply what they've learned about cognition to create Public Service Announcements (PSAs) that communicate important information about Southsand fever. They evaluate one another's PSAs for cognitive shortcuts and cognitive biases and refine their own PSAs based on peer feedback. Students reflect on how different types of cognition affect how they obtain and communicate information in their daily lives.	• Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions. • There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning. • Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim. • Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief. • NGSS Connection: Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).	**How can you apply knowledge of cognition to communicating information?**

ACTIVITY 1

Types of Cognition

INVESTIGATION

ACTIVITY 1

Types of Cognition

ACTIVITY SUMMARY

Students work through challenging brain-teaser questions to experience two different thinking modes. They evaluate their own metacognitive experiences by reviewing when they used fast thinking and slow thinking in the activity. The characteristics of both thinking modes are presented, and students consider how the two modes affect how people evaluate information and reach conclusions.

ACTIVITY TYPE
INVESTIGATION

NUMBER OF
40–50 MINUTE
CLASS PERIODS
1–2

KEY CONCEPTS & PROCESS SKILLS

1 Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.

2 Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

cognition
the set of mental processes that people use to interpret, imagine, and reason

fast thinking
quick, automatic thinking that uses shortcuts to reach conclusions

slow thinking
careful, reflective thinking that uses reasoning to reach conclusions

TEACHER BACKGROUND INFORMATION

Modes of Cognition

Cognition is a broad term for all the mental activities we use to gain knowledge and understand the world. This includes processes such as perception, attention, memory, learning, reasoning, and problem-solving. A mode of cognition is a distinct way or style of mental processing. Different cognitive approaches are better suited for different kinds of mental tasks—for example, solving an algebra problem versus writing a poem. Therefore, it is important to note that there are many modes of cognition used to solve problems or make sense of the world.

Fast Thinking and Slow Thinking

One well-known model for how we think and process information uses two distinct modes of cognition: fast thinking and slow thinking. This concept was first described by Nobel Laureate Daniel Kahneman in 2011 as a result of decades of research with collaborator Amos Tversky. It is known as the dual-system theory of the mind and proposes two interactive modes of thinking: System 1, known as fast thinking, and System 2, known as slow thinking.

Fast thinking operates automatically, quickly, and often without conscious awareness. It is essential for handling the high volume of small decisions we need to make on a daily basis, such as what to wear or what to eat. Fast thinking relies on mental shortcuts called heuristics, which are rapid methods for reaching conclusions. This process has the benefit of being highly efficient and requiring little effort, but it can sometimes lead to errors because it bypasses the use of logical reasoning.

Slow thinking is the mode that requires effort, attention, and conscious control. It is more useful for complex situations, careful analysis, thoughtful decision-making, or when the risks of making an error are high, such as solving a difficult math problem or choosing a long-term medical plan. Slow thinking works by allocating resources to specific mental activities, often involving logical reasoning and step-by-step processing. While it has the benefit of reducing errors and leading to more accurate conclusions, it is less efficient and requires significant mental effort.

Both modes of cognition interact to shape our judgments and decisions. Fast thinking's reliance on heuristics is the source of cognitive biases. Slow thinking is necessary to reduce these errors but demands more cognitive resources, so it is used less frequently. Because of this constant trade-off between speed and accuracy, fast thinking and slow thinking constantly shape our judgments and decisions. People frequently shift between the two modes—using fast thinking for one part of a decision and slow thinking for another, even when working on the same problem.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 1.1 "Comparing Fast Thinking and Slow Thinking"
- VISUAL AID 1.2, "Understanding Conceptual Tools" (OPTIONAL)

FOR EACH STUDENT

- STUDENT SHEET 1.1 "Brain Teasers"
- STUDENT SHEET 1.2 "Frayer Model" (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts and Skills" (OPTIONAL)

In the Extension, students administer the brain teasers to friends and family. If you would like students to complete this task, prepare extra copies of the teasers for students to take home.

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10 MIN)

1 Elicit students' reactions to the Introduction

- Have students read the Introduction and ask, Have you ever experienced mixed messages on how to think as described in the Introduction? Accept all responses at this time. This activity helps students explore modes of cognition through a direct experience. At this time, do not introduce students to concepts and vocabulary that will be introduced later in the activity. Therefore, keep the Introduction to the brain teasers to a minimum so students' initial approach to the questions are not influenced in advance.

- 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 unit, 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.

PROCEDURE SUPPORT (20 MIN)

2 **Students complete a set of brain teasers to experience two types of cognition.**

- Hand out Student Sheet 1.1, "Brain Teasers," and encourage students to work as fast as they can to complete the questions. It is important that students work through them quickly to encourage fast thinking. Consider using a timer (e.g., 5 minutes) to make it more likely that students will rely on fast thinking for their answers. Students should complete the questions on their own and not use the Internet to search for the answers.

- In Procedure Step 2, after students have completed the questions, review the correct answers as shown on the sample student response at the end of this activity. When students go back and review the questions slowly with a partner, encourage them to explain what they were thinking at the time. Make sure to let students know that their scores don't matter; rather, the exercise is a way to think about their cognitive processes while answering the questions.

- For those students who would be more comfortable with simpler or more challenging questions, here are two additional questions, with accompanying reasoning, that can be added to or replace some of the brain-teaser questions:

Simpler:

I slither around,
with my home on my back.
I've never been rich,
but I leave silver tracks.

What am I?

SNAKE WORM SNAIL TURTLE

The only animal that fits with all three pieces of information (slither, home on my back, and silver tracks) is the snail.

More challenging:

If no babies are allergic to cats,
and some people are allergic to cats,
does it logically follow (imagine you know nothing else) that
some people are not babies?

No, it doesn't logically follow. The tempting fast-thinking answer is yes, it follows, because the final claim is true, and all the other claims are plausible. But the correct answer is that it doesn't follow because even though it's true that some people are not babies, it is not logically implied by the two premises. It requires a third premise, namely, that babies are people.

- When students share their experiences In Procedure Step 4, ask, Which of the brain-teaser questions could someone easily make a mistake answering and why? Students should recognize possible errors from at least 1 or 2 of the questions to prepare them for the next procedure step—for example, not stopping to do the math in Question 3 or not counting the number of nurses compared to doctors in the image for Question 5.

3 Introduce the characteristics of slow thinking and fast thinking.

- When students are introduced to slow thinking and fast thinking in Procedure Step 5, it is likely that they will identify that they engaged in fast thinking for Procedure Step 1 and slow thinking for Step 2. Discuss with students how some situations and prompts can encourage fast thinking, but often cognitive errors can be reduced by slowing down one's thinking.

Sample Student Response, Procedure Step 5

For Question 5, I first used fast thinking because I just looked at the picture. For Question 3, I slowed my thinking down so I could do the math.

- In Procedure Step 7, review Table 1.1: Characteristics of Fast Thinking vs. Slow Thinking before students move on to Procedure Step 8. This table provides more specific examples of how people engage in fast thinking and slow thinking. For more support differentiating between the two cognition modes, use Visual Aid 1.1, "Comparing Fast Thinking and Slow Thinking." Review the provided examples and ask students to generate some of their own examples from daily life to formatively assess their understanding.

TEACHER'S NOTE: The description of slow thinking in Table 1.1 in the Student Book connects to conceptual tools taught in other units of the *Scientific Thinking for All: A Toolkit* curriculum. In particular, the lessons about evidence from Unit 1, "Evidence & Iteration in Science," the consideration of probability from Unit 3, "Scientific Uncertainty & Probabilistic Reasoning," and the role of alternative causes and effects from Unit 4, "Investigating Evidence for Causation."

- In Procedure Step 8, students may use any one of the brain teasers to explain how fast thinking could lead to the wrong answer for that question. Student responses should show that they are referring to the characteristics from Table 1.1.

Sample Student Response, Procedure Step 8

For Question 6, fast thinking could lead to taking the total number of weeks (10) and dividing it by 2 to get 5, but that is not the correct answer. Fast thinking can happen because the numbers 5 and 10 are simple eye-catching information and easily come to mind. However, slow thinking shows that the number is doubled every week, so the pattern does not work by just dividing by 2. Using the doubling math pattern is a characteristic of slow thinking.

- When discussing student examples in Procedure Step 9, review the main differences between the types of cognition. Point out that fast thinking is more automatic and can be done unconsciously. Conversely, slow thinking is a conscious, deliberate process that requires mental effort, allowing you to carefully break down information and check if your thinking is logical. Students should identify that fast thinking tends to be more useful for low-risk, everyday situations when

a quick decision is needed such as catching a ball, choosing a snack, or simple driving decisions. Slow thinking is more useful in higher-risk situations when accuracy is crucial and there is time for deliberation such as solving a complex math problem, making a major financial investment, or evaluating evidence in science.

- In Activity 2, students will be given a scenario related to a disease outbreak. In anticipation of this, the brain-teaser questions on Student Sheet 1.1 are related to human health. Foreshadow Activity 2 by asking students to think about how cognition relates to their own health. Ask, What are examples of health decisions that might be better to rely on fast thinking for and why? Sample answers may include low-risk decisions such as choosing a simple product or a situation in which speed is needed, such as deciding to go to the hospital in an emergency. Next ask, For which types of health decisions would you want to use slow thinking instead and why? Sample answers may include situations that are more complex, such as how to change your diet to be healthier or decisions that may have more serious consequences, such as choosing whether to take a certain medication or not.

SYNTHESIS OF IDEAS (20 MIN)

4 Discuss the advantages and disadvantages to the two modes of thinking.

- After completing the activity, give students a chance to compare and contrast the two modes of thinking. Ask, What are the advantages and disadvantages of fast thinking and slow thinking? Sample responses may include the ideas that fast thinking is a way to quickly and easily interact with our surroundings through mental shortcuts that allow us to save energy and time. It can be highly valuable for everyday situations or when speed is necessary (e.g., reacting to a threat, performing routine tasks) because it saves time and mental effort. However, slow thinking is less likely to lead to cognitive errors.

- The comparison between the two modes of thinking can be supported by reviewing the responses to Build Understanding item 1, when students complete a Venn diagram about fast thinking and slow thinking. The Venn diagram will help students acquire vocabulary as they compare and contrast the concepts of fast thinking and slow thinking. You may want to complete the Venn diagram as a class. Have small groups brainstorm what to put in each circle of the Venn diagram and then work as a class to come to a consensus on a complete and correct Venn diagram. For more information about Venn diagrams, see Appendix 1: Literacy Strategies.

5 Have students consider how our mode of thinking can affect decisions.

- Review Build Understanding item 2, which relates to when fast thinking and/or slow thinking is advantageous. There are some obvious answers to these examples, but some that might use either or both modes of thinking such as choosing what to eat or responding to a question. Emphasize that sometimes we use both modes, depending on the situation and our approach to the situation.

- Connections to Everyday Life item 4 foreshadows Activity 2 when students will look at news headlines. In that activity, students are put in an initial position to use fast thinking, so do not yet discuss the types of thinking that are generally used when we scan headlines or social media feeds.

6 Introduce slow thinking as the primary conceptual tool of the unit.

- Review the term *cognition* provided in the Introduction in the Student Book. While students learned that cognition can mean many things in various situations, the principle behind slow thinking is that decision-making benefits from taking the time to examine information deliberately. Although the process of slow thinking may look different for different situations, it is an effective conceptual tool for evaluating information. In this unit, the primary way students engage in evaluating information is to use various techniques of slow thinking, making it the primary conceptual tool of the unit.

- The Scientific Toolkit is intended to be a set of conceptual tools that can be applied to everyday life. With each new unit, students will add conceptual tools to their toolkits. Use optional Visual Aid 1.2, "Understanding Conceptual Tools" to support the multiple contexts that are used with the word *tool*, which is defined as 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, there is a digital analysis tool that is used to support decision-making. There are also many tools from the last category presented on the visual aid—Conceptual Tools—that are used to analyze group decisions. In this course, students consider conceptual tools, such as weaving facts and values, as a way of exploring the application of science to everyday life.

- As students build understanding about the importance of slow thinking in evaluating information, 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 optional Student Sheet 1.3, "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 response for optional Student Sheet 1.3, is provided at the end of 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 fast thinking and slow thinking in cognition.

7 Review the key concepts of the activity related to cognition.

- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition by reviewing the terms presented in the activity and supporting the construction of a word wall. You may want to model a sample response as a class to help scaffold student understanding. For this activity, record the terms *cognition, fast thinking,* and *slow thinking.* Provide additional examples for each term as needed. For more information on a Word Wall, see Appendix 1: Literacy Strategies.

- As an additional support for the development of new vocabulary and concepts during the activity, consider using a Frayer Model with students as shown on optional Student Sheet 1.2, "Frayer Model." Use one sheet for each of the concepts of fast thinking and slow thinking. The model(s) can be introduced in the beginning of the activity, filled out as the activity unfolds, and reviewed at the end of the activity. For more information about the Frayer Model, see Appendix 1: Literacy Strategies.
- Finish the activity by revisiting the Guiding Question, *What are two different modes of thinking?* Use the responses to this question to formatively assess students' understanding of the key concepts and process skills related to fast thinking and slow thinking. Students should be able to recognize the advantages and disadvantages of both modes of cognition and why this makes them more useful or less useful in different situations.

EXTENSION (20 MIN)

8 **Use the Extension as an opportunity for advanced learning.**

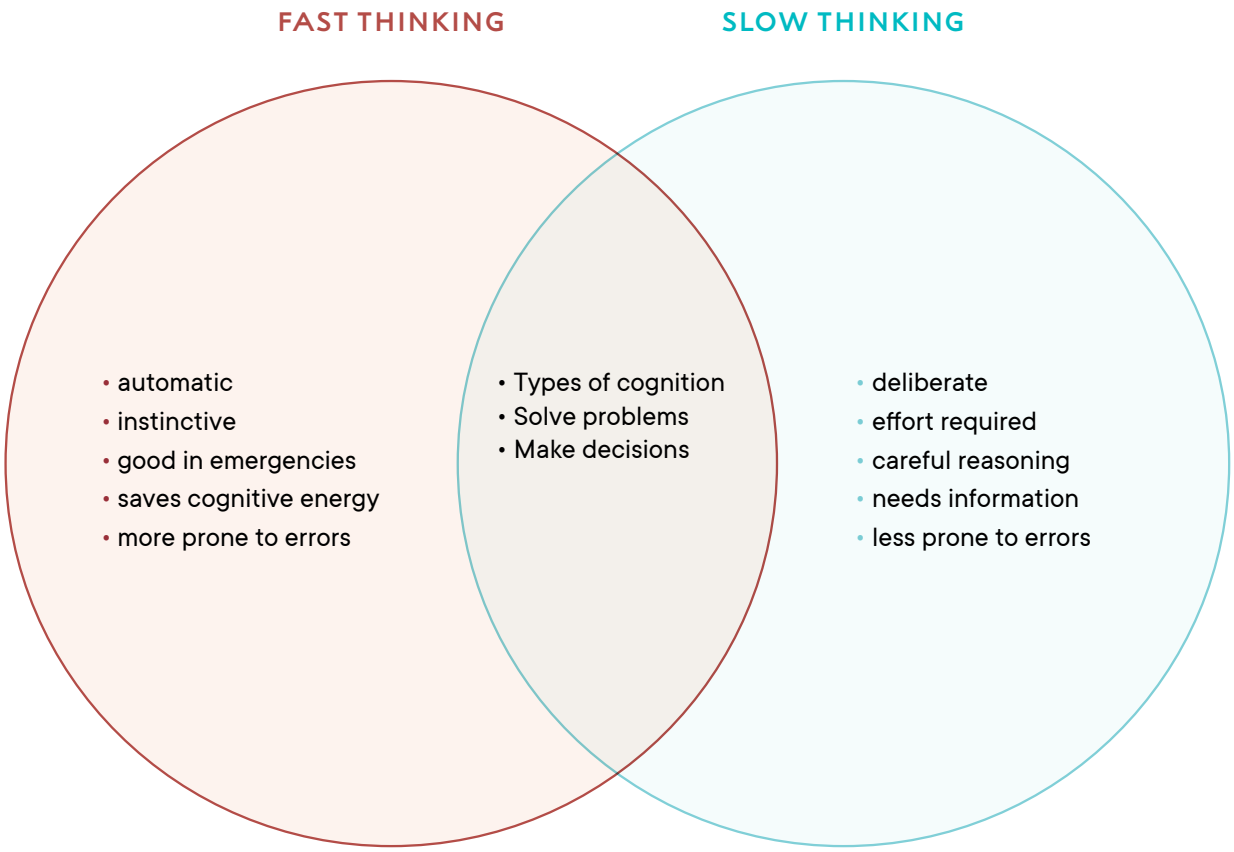
Students can have a friend or family member answer the brain-teaser questions (on Student Sheet 1.1) as a way of seeing how different people approach problem-solving. Students can make note of any differences in techniques that their friends or family use. Again, emphasize that the brain teasers are not about right or wrong answers; rather, they are about the mode of cognition used to answer them.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

The Build Understanding and Connections to Everyday Life items are intended to guide student understanding. You may decide to assign some or all of them, depending on the needs of your students. However, some of the items are recommended in particular activities for use as assessments or to review key concepts.

① **Make a Venn diagram like the one below. Fill in the areas in the circles to compare and contrast fast thinking and slow thinking. Consider the features of each mode of thinking, the advantages and disadvantages of each, and situations in which each is useful.**



② **Which would be more useful to apply in the following situations: fast thinking and/or slow thinking? Explain your reasoning.**

a **Choosing what to eat for breakfast.**
Either fast thinking if it is routine and you eat the same thing most days, or slow thinking if you are considering all the options because it's an everyday decision.

b **Responding to a fire alarm that goes off in your classroom.**
Fast thinking so you can respond quickly and get out of danger.

c **Changing your diet to improve your health.**
Slow thinking because it has long-term consequences to my health, and I need time to research a plan that might work for me.

d **Communicating to the coach what has happened when a teammate gets hurt.**
Fast thinking so your teammate gets help quickly.

e **Deciding who to vote for in the class election.**
Slow thinking so you can investigate the candidates.

f **Providing directions to a location that you are very familiar with.**
Fast thinking because you have gone there so many times.

g **Responding to a common question such as, *What's your favorite movie?***
Either fast thinking if you already know, or slow thinking if you need to think of all the movies you have watched.

③ **Imagine that an emergency responder comes upon a scene where someone has been badly hurt. Think about the knowledge, skills, and experience the emergency responder has. How would the responder's fast thinking be different from an ordinary person's fast thinking?**

A first responder has a lot more expertise to draw on when responding to an emergency and using fast thinking, such as basic medical knowledge and relevant first-aid skills. An ordinary person does not have this body of knowledge to draw on when responding with fast thinking.

CONNECTIONS TO EVERYDAY LIFE

④ **You are meeting friends downtown. The fastest way for you to get there is on your bike, but your bike lock is broken. Your only other option is to walk, which will take much longer. You have recently seen a news headline that states: *The City Experienced a 300% Increase in Bicycle Thefts Last Month!***

a What would you be most likely to do? Explain your reasoning.

I would walk. A 300% increase is a huge increase in thefts, and I'd be worried about leaving my bike anywhere.

b You later find out that the average number of stolen bikes in the city was 1 per month, but there were 4 bikes stolen in the previous month—a 300% increase. How would this information change, or not change, your behavior?

Knowing that the actual number of bicycle thefts was very low would make me less worried about leaving my bike unlocked. I would ride my bike downtown.

c Was your decision affected by fast thinking and/or slow thinking? Explain.

My first decision was based on fast thinking because I did not consider other ways to interpret the data.

⑤ **Describe a recent example when you used fast thinking but would have been better served by using slow thinking. How could slow thinking have changed the outcome?**

Responses will vary.

My friend recently came up to me and asked how I was doing, and I automatically responded, "Fine," and left. I was actually really upset about something. If I had slowed down a bit and worked through why she asked me (because she cares) and how she could help me (listen to my problem), then I would have been more likely to tell her what was bothering me. That could have made us both feel better.

Circle the one best answer.

1 **I live in your chest, and I work like a drum. I keep you moving, from your head to your thumb. What am I?**

a. LUNG

b. HEART

c. BRAIN

d. STOMACH

2 **Which job is safer: being an electrician or a delivery driver?**

a. ELECTRICIAN

b. DELIVERY DRIVER

3 **If it takes 5 lab technicians 5 minutes to prepare 5 bottles of medicine, how long would it take 100 lab technicians to prepare 100 bottles of medicine?**

a. 5 MINUTES

b. 25 MINUTES

c. 100 MINUTES

d. 500 MINUTES

4 **Arlo coughed on Bea, and Bea coughed on Kim. Arlo is sick, and Kim is not, but they don't know whether Bea is sick or not. Did a sick person cough on a healthy person?**

a. YES

b. NO

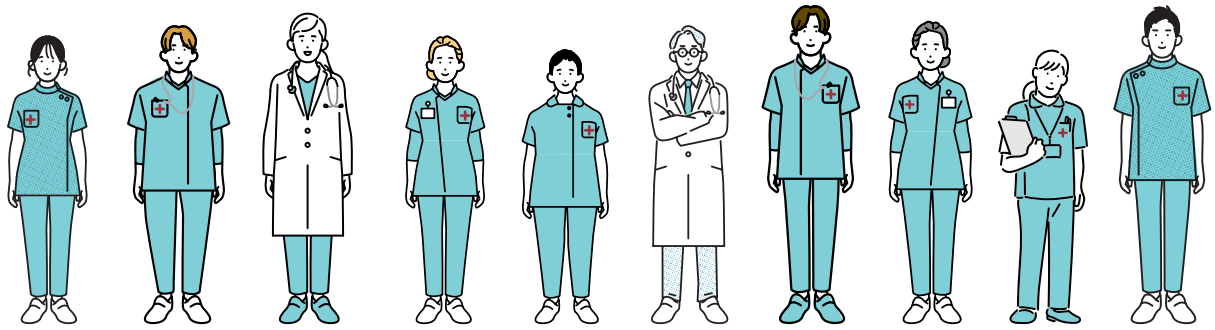
c. NOT ENOUGH INFORMATION

CONTINUED

5 **Jamie works at a health clinic. Jamie has:**

- a passion for diagnosing illness.
- a lot of confidence.
- likes to give orders.

The following sketch shows Jamie and their coworkers lined up for a photo. Is Jamie more likely to be a doctor or a nurse?



a. DOCTOR

b. NURSE

6 **A new illness is spreading through a town. Every week, the number of people with the illness doubles. The first week there was just 1 case, the second week it became 2, the third week it was 4, and so on. After 10 weeks, everyone has the illness. In what week did half of the town have the illness?**

a. WEEK 5

b. WEEK 7

c. WEEK 9

d. NOT ENOUGH INFORMATION

7 **Children with larger shoe sizes tend to have higher reading comprehension scores. What statement is the best interpretation of this?**

a. Larger feet lead to better circulation, which boosts reading ability.

b. Children who read well feel more confident and therefore select larger shoes.

c. The larger the shoe size, the more likely the child is older, and older children generally have more reading experience.

Circle the one best answer.

1 **I live in your chest, and I work like a drum. I keep you moving, from your head to your thumb. What am I?**

a. LUNG
b. HEART
c. BRAIN
d. STOMACH

2 **Which job is safer: being an electrician or a delivery driver?**

a. ELECTRICIAN
b. DELIVERY DRIVER

REASONING: There are about 3 times more deaths and injuries for drivers. But it's tempting to answer "electricians," because it's easy to imagine an electrician getting electrocuted. We rarely think about delivery drivers getting in accidents.

3 **If it takes 5 lab technicians 5 minutes to prepare 5 bottles of medicine, how long would it take 100 lab technicians to prepare 100 bottles of medicine?**

a. 5 MINUTES
b. 25 MINUTES
c. 100 MINUTES
d. 500 MINUTES

REASONING: The tempting answer is "100 minutes," through pattern matching. The correct answer is "5 minutes," since it basically takes each technician 5 minutes to prepare one bottle of medicine.

4 **Arlo coughed on Bea, and Bea coughed on Kim. Arlo is sick, and Kim is not, but they don't know whether Bea is sick or not. Did a sick person cough on a healthy person?**

a. YES
b. NO
c. NOT ENOUGH INFORMATION

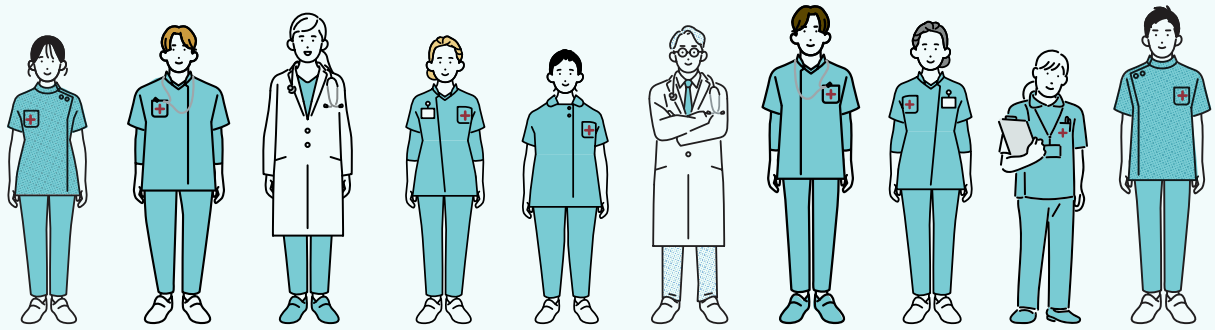
REASONING: The tempting answer is "not enough information," because you don't know if Bea is healthy or not. But the real answer is "yes," because Bea is either sick, in which case sick Bea coughed on healthy Kim, or Beal is healthy, in which case sick Arlo coughed on healthy Bea.

CONTINUED

5 Jamie works at a health clinic. Jamie has:

- a passion for diagnosing illness.
- a lot of confidence.
- likes to give orders.

The following sketch shows Jamie and their coworkers lined up for a photo. Is Jamie more likely to be a doctor or a nurse?



a. DOCTOR

b. NURSE

REASONING: Jamie is more likely to be one of the 8 nurses rather than one of the 2 doctors. Fast thinking may lead students to think that Jamie is a doctor because that description sounds more typical of a doctor than a nurse. But slow thinking reveals that Jamie is more likely to be a nurse because there are far more nurses than doctors shown.

6 A new illness is spreading through a town. Every week, the number of people with the illness doubles. The first week there was just 1 case, the second week it became 2, the third week it was 4, and so on. After 10 weeks, everyone has the illness. In what week did half of the town have the illness?

a. WEEK 5

REASONING: Tempting fast-thinking answer: "week 5", because it's half of 10. Correct slow-thinking answer: "week 9".

b. WEEK 7

c. WEEK 9

d. NOT ENOUGH INFORMATION

7 Children with larger shoe sizes tend to have higher reading comprehension scores. What statement is the best interpretation of this?

a. Larger feet lead to better circulation, which boosts reading ability.

b. Children who read well feel more confident and therefore select larger shoes.

c. The larger the shoe size, the more likely the child is older, and older children generally have more reading experience.

DEFINITION

CHARACTERISTICS

WORD

EXAMPLES

NON-EXAMPLES

DEFINITION

quick, automatic thinking that uses shortcuts to reach conclusions

CHARACTERISTICS

Relies on:

- *simple information*
- *the information that first catches one's attention*
- *information that comes easily to mind*

WORD

fast thinking

EXAMPLES

- *Getting ready for school with the same morning routine.*
- *Buying or doing something impulsively.*
- *Judging someone on their appearance.*
- *Skimming a headline.*

NON-EXAMPLES

- *Comparing the price and quality of products.*
- *Using a map to estimate travel times.*
- *Collecting and connecting clues to solve a mystery.*

SAMPLE STUDENT RESPONSE 2

DEFINITION

careful, reflective thinking that uses reasoning to reach conclusions

CHARACTERISTICS

Considers:

- *complex information*
- *math or reasoning steps*
- *the likelihood of an event*
- *alternative possible causes*

WORD

slow thinking

EXAMPLES

- *Questioning whether a viral video is actually fake.*
- *Figuring out how to beat the next level of your video game.*
- *Drafting an essay outline.*
- *Solving a complicated math problem.*

NON-EXAMPLES

- *Scrolling on your phone without remembering much of what you see.*
- *Entering a passcode on your phone without thinking.*
- *Singing along to a song while doing something else at the same time.*
- *Having a gut feeling or intuition.*

UNDERSTAND		ANALYZE
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)

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

UNDERSTAND		ANALYZE
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)
Fast Thinking	*Quick, automatic thinking that uses shortcuts to reach conclusions.* *Useful for routine situations but is more likely to lead to errors.*	*Brain teasers, skimming Southsand City news headlines, cognitive shortcuts, PSAs*
Slow Thinking	*Careful, reflective thinking that uses reasoning to reach conclusions.* *Useful for complicated or high-stakes situations and less likely to lead to errors.*	*Analyzing the brain teasers, evaluating Southsand news article, comparing evidence in the game, peer review, clinical trials, pellagra investigation, mRna vaccine, figuring out the pathogen, analyzing data for the recommendations, making PSAs*
Metacognition	*Thinking about my own thinking.*	*Reflecting on how I respond to media stories, thinking about my own use of social media, slowing down thinking, confirmation bias activity*
Cognitive Shortcuts	*Patterns of fast thinking that can lead to errors.*	*Halo effect, availability shortcut, representativeness shortcut, anchoring shortcut, social meda posts about bird flu*
Confirmation Bias	*When you look for information based on your pre-existing beliefs (biased selection).* *When you interpret information based on your pre-existing beliefs (biased interpretation).*	*Choosing evidence based on if social media is harmful to teens, stories and comments about Southsand fever from residents, cherry-picking, local poultry-farmer question*
Actively Open Mindset	*Evaluating source credibility, seeking evidence, and considering alternative ideas.*	*Considering the opposite claim about social media being harmful or not, brainstorming ways to reduce cognitive biases for Southsand City residents, staying open to alternative hypotheses for the game, scientific inquiries of pellagra and mRna vaccine, figuring out the pathogen*
Cognitive Bias	*When you make an error in thinking unconsciously and in a predictable way.*	*Confirmation bias, conflict of interest, conformity bias, emotion bias, analyzing stories and comments about Southsand fever from residents, PSAs, scientific inquiry of pellagra and mRna vaccine*

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

Choosing a recommendation for how the fictional city could reduce the risk of the Southsand fever, making a PSA for a Southsand fever recommendation.

FAST THINKING

Automatic

Effortless

Often done unconsciously

Based on mental shortcuts

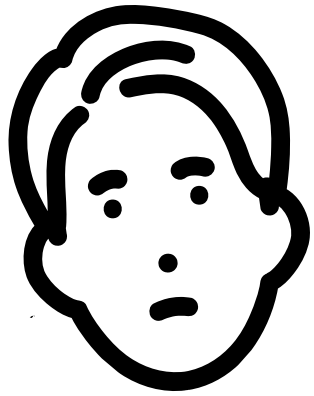
More prone to error

Examples of Fast Thinking:

Recognizing a face

Judging someone on their appearance

Skimming a headline



SLOW THINKING

Deliberate

Effortful

Careful attention used

Based on reasoning

Less prone to error

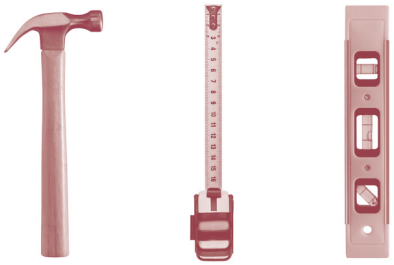
Examples of Slow Thinking:

Drafting an essay outline

Solving a complicated math problem

Learning a new dance

CONSTRUCTION TOOLS



SCIENTIFIC TOOLS

SCIENTIFIC TOOLS + TECHNOLOGY

CONCEPTUAL TOOLS

ACTIVITY 2

Thinking About Thinking

DISCUSSION

ACTIVITY 2

Thinking About Thinking

ACTIVITY SUMMARY

Students apply two different modes of cognition—fast thinking and slow thinking—in the context of a health scenario. First, they are introduced to a fictional scenario by reviewing imaginary headlines about a community facing a disease outbreak. They gauge their fast-thinking responses and then slow down their thinking to consider the believability of the headlines and evaluate additional text of the news stories and posts. This sets the stage for a discussion about what students think about when they engage in fast thinking and slow thinking while consuming media.

ACTIVITY TYPE
DISCUSSION

NUMBER OF
40–50 MINUTE
CLASS PERIODS
1–2

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.

2. Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Compare, integrate, and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. (*Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information*)

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

infectious disease
(assumed prior knowledge)
a disease that is passed from one organism to another organism

metacognition
the practice of thinking about one's own thinking

noninfectious disease
(assumed prior knowledge)
a disease that cannot be passed from one organism to another organism

organism
(assumed prior knowledge)
an individual animal, plant, or other living life-form

TEACHER BACKGROUND INFORMATION

Disease Outbreak Investigations

In epidemiology, an outbreak occurs when there are more cases of a disease than normally expected for a specific location or time period. Outbreaks can impact anywhere from small localized groups to large populations across continents depending on factors such as the disease-causing agent, its modes of transmission, the extent of exposure, and the size of the population. Outbreaks can be caused by infectious agents (pathogens) or environmental factors such as contaminated water or food.

Some outbreaks can lead to large-scale epidemics, especially if caused by an infectious disease. However, epidemics of noncommunicable diseases (e.g., heart disease, stroke, cancer, diabetes, and chronic lung disease) can occur because of other factors. When an outbreak spreads rapidly to a larger number of people within a community or region, it becomes an epidemic. If an epidemic extends across multiple countries or continents, it is classified as a pandemic.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 2.1 "Developing Communication Skills"

FOR EACH GROUP OF FOUR STUDENTS

- SET OF MEDIA STORIES CARDS (8 cards)

FOR EACH STUDENT

- STUDENT SHEET 2.1 "Responding to Media Headlines"
- STUDENT SHEET 2.2 "Analyzing Media"

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10-20 MIN)

1 **Introduce the fictional scenario for the unit.**

- Have students read the Introduction and the fictional scenario in Procedure Step 1. Let students know that they will be exploring how community members of the fictional Southsand City respond to the new disease outbreak, Southsand fever. The scenario presented in Procedure Step 1 can be shared with the class in multiple ways. Read the scenario aloud to the class or have individual students read it aloud while others follow along with the text (either as a whole class or in small groups).

- Reading the scenario aloud can better support comprehension for many students, including neurodiverse students and emerging multilingual learners who often have more highly developed listening and oral skills than reading comprehension skills. Alternatively, students can read the scenario independently.

- Consider reviewing the content about infectious diseases in the Science Review in the Student Book if appropriate for your students.

- Follow up by connecting the scenario to thinking about health decisions in students' everyday lives. Ask, What are some of the health decisions, besides infectious disease, that people have to think about? As students brainstorm ideas, make a list on the board. Examples can include choosing a snack, deciding when to sleep, or buying a personal hygiene product by seeing an ad or hearing a suggestion from a friend. Support students in sharing their knowledge for everyday health decisions while remaining sensitive to students and families with personal health challenges. Students should not be asked to consider their own personal physical or mental health decisions, as those are typically handled by guardians in conjunction with their healthcare providers.

- 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 unit, 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.

PROCEDURE SUPPORT (20-30 MIN)

2 In Part A, students read fictional headlines and evaluate their thinking.

- In Procedure Step 2, hand out Student Sheet 2.1, "Responding to Media Headlines," and encourage students to read the headlines quickly. As they complete the student sheet, ask them to imagine that they are someone living in the fictional city facing the outbreak. Emphasize that there are no right or wrong answers in this activity; the purpose of the activity is to help students think about their own thinking. As a result, student responses will vary. One sample student response to Student Sheet 2.1 is found at the end of this activity.

  TEACHER'S NOTE: Do not distribute the Media Stories cards to students until Part B, Procedure Step 9. For Procedure Step 2, students should only use the headlines printed in the Student Book, which exclude the sources and article text that is included on the cards.

- After Procedure Step 2, students work in groups to evaluate their own thinking and the believability of different media stories in this activity. You may wish to use optional Visual Aid 2.1, "Developing Communication Skills," to help guide group discussions. Visual Aid 2.1 is a tool to help students effectively participate in group or class discussions by providing sentence starters that students can use to initiate a conversation and express their ideas.

- After groups have discussed their responses to Student Sheet 2.1 in Procedure Step 3, ask a few students to share how and why they responded to a given headline—clicked for more information, reposted/shared, or ignored. Ask, How was your response influenced by fast thinking, slow thinking, or both modes of thinking? Students may share that they used fast thinking based on impulse/gut reactions to repost/share, ignore, or click for more information. While fast thinking may dominate their responses, they may also have engaged in slow thinking during or after the fast thinking if they deliberately thought about why a headline was believable or not. For example, a student might ignore the headline "Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever" because of fast thinking if they reacted to it as boring or irrelevant or because of slow thinking if they think it sounded like a fake medical claim.

- Discuss the identifying features of the headlines that are more likely or less likely to trigger someone to use fast thinking or slow thinking. Possible factors may include the use of all capital letters, exclamation points, and emotional language (e.g., "spike" or "so-called") as well as headlines conveying positive or negative news. These are all eye-catching devices to prime us for fast thinking.

3 Students assess the believability of the headlines.

- In Procedure Step 4, hand out Student Sheet 2.2, "Analyzing Media," and encourage students to slow down their thinking by looking at the tone of the headline. Again, emphasize that there are no right or wrong ratings, and the purpose of the exercise is to help students think about their own thinking. While responses will vary, students may well notice that the negative headlines tend to draw more fast thinking. One sample student response to Student Sheet 2.2 is found at the end of this activity.

- In Procedure Steps 5 and 6, students rate and discuss the believability of each headline. Students should not need more than the headline to do so. They should focus instead on how the wording or information in each headline might make it more believable or less believable. Conversely, the use of specific data (e.g., "24%") or technical terms might increase their trust and overall believability. Finally, students may realize that their background knowledge or personal experience (e.g., skepticism about lemon water as a medical treatment) naturally shapes how believable they find the information.

- In Procedure Step 7, students have an opportunity to reflect on their experiences compared to the research finding that people judge negative headlines faster than neutral ones and that negative news is more likely to be clicked on and shared.

Sample Student Responses, Procedure Step 7

a *In this activity, my student sheets show that I tended to choose "click for more information" and/or "repost/share" for negative headlines more than for positive ones. It's probably because I'm reacting to the fear in the wording or because I want my friends to see what upsets me. A neutral headline doesn't make me feel like I have to do anything right away, so I just leave it alone.*

b *In my daily life, I try to ignore negative headlines because they usually look like clickbait, but it's hard. I probably do click on negative headlines more often because they use words that make me feel like I'm missing out on something important. Neutral headlines feel more like schoolwork, so they are easy to ignore.*

- In Procedure Step 8, facilitate a class discussion about how student reactions compared to the cited research studies in Step 7. Ask, Are you more likely to click on or share negative headlines compared to neutral ones? Why? The important point for discussion is for students to reflect on their own metacognitive responses to media and assess what factors elicit their own fast thinking and/or slow thinking. For example, a student may find that content eliciting negative emotions more often leads them to click on or share content impulsively, an aspect of fast thinking.

4 In Part B, students engage in slow thinking with the media stories.

- In Procedure Step 9, provide a set of 8 Media Stories cards to each group. Inform students that they will now expand their practice of slow thinking by re-evaluating the headlines from Part A with a bit more information. In addition to the headlines, the cards include the first few lines of each article or post and the source.

- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition as they read the text. Circulate around the room and check in with students as they use the strategy to decode scientific ideas and construct meaning as they read. It may be helpful to have students read the news stories and posts aloud.

- For Procedure Steps 10 and 11, circulate and support students as they re-rate and discuss the believability of each headline based on the trustworthiness of its source and whether the article text matches what the headline is claiming.

- For Procedure Step 12, have students share their new ratings for believability and tone. Ask, Did any of your believability ratings change after more information was provided on the cards? Students should recognize that their initial ratings could have been driven by fast thinking—reacting to emotional triggers, sensational wording, or shock value. By slowing down to evaluate the source and read the actual text of the article or post, students are engaging in slow thinking. This allows them to notice when a story might be one-sided, catch claims from the headline that might not be true (such as "millions of groceries" or the lemon water "cure"), and/or realize that a headline's tone might be designed to elicit a strong emotion.

- By comparing their fast thinking and slow thinking, students should recognize that social media is often designed to exploit fast thinking through speed and emotion. Some social media headlines may elicit fear or excitement, but the story details are actually much more ordinary. This makes it even more important to consciously choose a slower, more deliberate approach before deciding what to believe or share.

- Some, but not all, of the new believability ratings for the headlines may increase or decrease, but the number is not the focus of the activity. The point of the exercise is to have students realize that the goal of slow thinking is to move beyond a first impression.

Sample Student Response, Procedure Step 12

In Part A, I used fast thinking to share the "Hospital Overwhelmed" headline because it sounded scary and urgent. But after seeing that the source was a random blog and the text didn't have any actual data, my slow thinking kicked in. I realized the headline was just trying to freak people out, so I changed my rating from 3 to 1. Because it was a negative headline, I think that helped make it seem believable at first.

5 Lead a discussion on metacognition and media consumption.

- In Procedure Step 13, inform students that they will be reflecting on their own thinking processes—a practice called metacognition—to understand how they consume media in their daily lives.

- You may wish to review the list of prompts provided in Procedure Step 13 and choose only those that might work best for your classroom based on your students' experiences and the concepts of fast thinking and slow thinking you want to bring out.

- When starting the discussion based on the questions provided in Procedure Step 13, you may want to ask students to pair-share their answers to help prepare their thoughts before the whole class discusses their responses. This allows students to practice articulating their ideas in a low-stakes setting before sharing with the group.

- The goal of this discussion is to have students reflect on their own use of fast thinking or slow thinking while consuming media. Students should understand that metacognition is a tool that allows them to pause and question their initial reactions.

SYNTHESIS OF IDEAS (10-20 MIN)

6 Discuss the relationship between fast thinking and misinformation.

- Use Build Understanding item 3 as a formative assessment to gauge how well students understand the relationship between fast thinking and slow thinking. Review student responses as a class and emphasize that one thinking mode is not inherently better than the other; they are complementary systems that we often use together. While fast thinking is essential for quick decisions, remind students that slow thinking is a vital tool for reducing errors—especially when evaluating complex or suspicious information.

- Use Connections to Everyday Life item 5 to discuss the relationship between fast thinking and misinformation in our modern media landscape. Acknowledge to students how challenging it can be to avoid spreading misinformation, as social media is specifically designed to trigger our fastest, most emotional impulses and to gain our attention. Emphasize that while it takes effort, the habit of slowing down our thinking can be a worthwhile way to ensure that we are sharing accurate information with our community.

- You may want to review the relationship between misinformation in the context of social media and in scientific inquiry. In the Student Book, *misinformation* is defined as false, inaccurate, or misleading information, and it is often spread by people who think it is true. In science, however, the term *misinformation* is defined as information that asserts or implies claims that are inconsistent with the weight of accepted scientific evidence at the time (reflecting both quality and quantity of evidence). This use of the term *misinformation* is not as nefarious in the context of science as it can be in the context of the media. Instead, it is an integral part of scientific iteration. Scientific claims that are determined to be misinformation can evolve over time as new evidence is gathered, scientific knowledge accumulates, and claims advance. Misinformation in this context is more about the dynamic nature of scientific knowledge than a focus on disinformation.

- Finish the activity by revisiting the Guiding Question, *How do people use fast thinking and slow thinking in everyday situations?* Use responses to this question to formatively assess students' understanding of the key concepts and process skills related to metacognition of fast thinking and slow thinking.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **Imagine that Southsand City resident Lumi is walking her dog along a crowded sidewalk. She sees a person coming toward her who is about to sneeze. As the person approaches to pass her, Lumi can tell that the person is not planning on covering their mouth and nose as they sneeze. Lumi is not sure how Southsand fever actually spreads, but she does not want to get the disease.**

Responses will vary. One sample response is shown below.

a If you were Lumi, what would you do?

If I were Lumi, I would definitely quickly move out of the way so I did not get exposed to the person's sneeze. I wouldn't want to get Southsand fever or anything else.

b Would your response be a result of fast thinking and/or slow thinking?

I would respond automatically, so that would be a result of fast thinking.

c How might your actions be different if you relied solely on fast thinking or solely on slow thinking?

If I used slow thinking, I would stop and think through what my chances are of getting Southsand fever in the situation, which has a lot of unknowns to think about. If I slowed down to think through it, I wouldn't move to get out of the way and would probably get sneezed on!

② **Imagine going online and reading the following post. Do you think most people would believe this post? Explain why or why not. Be sure to use ideas about cognition in your response.**

> **@Juniorrrr**
>
> PEOPLE! Green juice can cure your flu! I heard about this from my favorite influencer @DrWellnessGuru. His most recent video states that the fruits and vegetables in Green Juice activate the immune system. My friend drank a glass of green juice and felt better right away. It must work!

Student responses may vary. Two possible responses are shown below.

Yes, because many people would respond with fast thinking. They would see that the post provides evidence (friend felt better after drinking the juice), and he provides a quick solution to a common illness.

No, because if you use slow thinking, you would realize there could be an alternative explanation to the friend's improvement.

③ **A friend claims that fast thinking is not as useful as slow thinking. Do you agree or disagree? Provide an example(s) to support your reasoning.**

I don't agree with my friend because fast thinking is very efficient. If I thought about every small decision I made during a single day, everything would take forever, and I would be exhausted!

CONNECTIONS TO EVERYDAY LIFE

④ **Imagine someone sees the following photo. They conclude, "The white object in the photo is a UFO! I know that shape. It looks exactly like the flying saucers I've seen in movies and pictures." How is this an example of fast thinking?**

This is fast thinking because the friend is automatically spotting a connection between things—the object and the shape of a flying saucer from movies. They didn't stop to check if it could be a reflection or a drone. They just instantly matched it to a shape they already knew. They are also relying on a single piece of information—the object's shape—and ignoring everything else in the photo, like the fact that there is a window and reflections of other objects.

⑤ **Misinformation is false, inaccurate, or misleading information, and it is often spread by people who think it is true. The following post shows an example of misinformation. Do you think misinformation is more likely to be spread as a result of fast thinking or slow thinking? Explain your reasoning using the post as an example.**

Misinformation is more likely to be spread by fast thinking because it is much harder to spot errors compared to slow thinking. It can trigger a quick reaction. For example, in the post, a fast thinker wouldn't stop to research the name. Instead, they would just see a scary-sounding chemical and assume it's a dangerous toxin. Looking for more information about the chemical or its risks would slow down thinking and could reduce the chance the misinformation is spread.

MEDIA HEADLINE	CLICK FOR MORE INFORMATION	REPOST / SHARE	IGNORE
HOSPITAL OVERWHELMED!!! Fever Likely To Be the End of Southsand City			
24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers			
Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever			
"Neighbors Helping Neighbors" Volunteer Network Delivers Millions of Groceries to Southsand Fever Families			
So-Called "Experts" Blame Southsand Fever Surge on Both Rainfall and Drought			
Health Officials Identify Southsand Fever as Infectious and Map Cases			
"Don't Breathe on Me!" Local Man Demands Masks After Roommate Contracts Southsand Fever			
Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts			

STUDENT SHEET 2.1 | RESPONDING TO MEDIA HEADLINES | NAME SAMPLE STUDENT RESPONSE

MEDIA HEADLINE	CLICK FOR MORE INFORMATION	REPOST / SHARE	IGNORE
HOSPITAL OVERWHELMED!!! Fever Likely To Be the End of Southsand City	X		
24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers	X	X	
Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever			X
"Neighbors Helping Neighbors" Volunteer Network Delivers Millions of Groceries to Southsand Fever Families			X
So-Called "Experts" Blame Southsand Fever Surge on Both Rainfall and Drought	X		
Health Officials Identify Southsand Fever as Infectious and Map Cases			X
"Don't Breathe on Me!" Local Man Demands Masks After Roommate Contracts Southsand Fever	X		
Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts			X

MEDIA STORY	HEADLINE		HEADLINE + STORY	
	POSITIVE, NEGATIVE, OR NEUTRAL TONE?	BELIEVABILITY OF CLAIM (1 = HIGH, 3 = LOW)	BELIEVABILITY OF CLAIM (1 = HIGH, 3 = LOW)	WHAT MAKES IT MORE BELIEVABLE OR LESS BELIEVABLE?
HOSPITAL OVERWHELMED!!! Fever Likely To Be the End of Southsand City				
24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers				
Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever				
"Neighbors Helping Neighbors" Volunteer Network Delivers Millions of Groceries to Southsand Fever Families				
So-Called "Experts" Blame Southsand Fever Surge on Both Rainfall and Drought				
Health Officials Identify Southsand Fever as Infectious and Map Cases				
"Don't Breathe on Me!" Local Man Demands Masks After Roommate Contracts Southsand Fever				
Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts				

SAMPLE STUDENT RESPONSE

MEDIA STORY	HEADLINE		HEADLINE + STORY	
	POSITIVE, NEGATIVE, OR NEUTRAL TONE?	BELIEVABILITY OF CLAIM (1 = HIGH, 3 = LOW)	BELIEVABILITY OF CLAIM (1 = HIGH, 3 = LOW)	WHAT MAKES IT MORE BELIEVABLE OR LESS BELIEVABLE?
HOSPITAL OVERWHELMED!!! Fever Likely To Be the End of Southsand City	*negative*	*2*	*3*	*Source is a blog, and text says only 8% of beds are full, which is actually pretty low. This does not match what the headline says!*
24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers	*neutral*	*2*	*1*	*The bulletin explains the math (12 out of 50 is 24%) and gives a specific location. The official source makes the spike believable. The title lacked data and was less believable.*
Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever	*negative*	*3*	*2*	*Seems like it could happen, but she is an influencer, not a doctor or nurse. The science explanation doesn't make sense. The "big pharma" line makes it sound like she is selling something.*
"Neighbors Helping Neighbors" Volunteer Network Delivers Millions of Groceries to Southsand Fever Families	*positive*	*2*	*3*	*A million groceries seems like more than is possible. The source is iffy, and no volunteer numbers are given.*
So-Called "Experts" Blame Southsand Fever Surge on Both Rainfall and Drought	*negative*	*2*	*1*	*The science (rain then drought) makes sense now and is from university researchers. Conclusion seems unlikely.*
Health Officials Identify Southsand Fever as Infectious and Map Cases	*neutral*	*1*	*1*	*Source is a university, and they provide specific data (8 patients at a construction site). Also says they need more data.*
"Don't Breathe on Me!" Local Man Demands Masks After Roommate Contracts Southsand Fever	*negative*	*2*	*3*	*This is believable as a personal story but not supported as medical news. But it seems real for how one person is reacting.*
Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts	*neutral*	*1*	*1*	*Now that I see that the source is a medical journal, the medical jargon makes sense. It's credible because it explains what they don't know yet.*

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 is... 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...?

The Southsand Patriot Blog

HOSPITAL OVERWHELMED!!!

Fever Likely To Be the End of Southsand City

Inside sources report that 8% of the intensive care beds at Southsand City Hospital are filled with sick patients. Some think that a single cough from one of them could infect dozens more in the hospital. If people don't start taking preventative actions for this invisible killer, then...

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

SOUTHSAND COUNTY HEALTH DEPARTMENT BULLETIN

24% Spike in Southsand Fever Follows Wind Festival Event, Say Festival Goers

Initial interview data from a team of city health officials has shown that 12 of the 50 cases of Southsand fever occurred 4–6 days after attending Saturday's Wind Festival at the Pinwheel Pavilion. These patients had spent more than 4 hours at the outdoor "Desert Stage" concert at the festival. Officials are beginning to investigate if the food served at the festival or the windy conditions could have been responsible for...

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

@HealthGuru_Chloe
June 25

Lemon Water Proven to Kill Bacteria and Fight Off Southsand Fever

According to local influencer Health Guru Chloe, lemon water works at a cellular level to alkalize your body's pH, creating a biological environment that flushes out deep-seated toxins and destroys bacteria. Big pharma has not discovered this yet because . . .

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

COMMUNITY COUNTS NEWSLETTER

"Neighbors Helping Neighbors"

Volunteer Network Delivers Millions of Groceries to Southsand Fever Families

Community organizers have reported that grocery donations shattered their expectations and that they have had a flood of volunteers to help families with members who are sick from Southsand fever! This is so much better than the way local health officials are responding to this crisis . . .

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

THE SOUTHSAND CHRONICLE

So-Called "Experts" Blame Southsand Fever Surge on Both Rainfall and Drought

OPINION: Some disease experts at the local state university have noted that the current outbreak has occurred after a 6-week period of heavy rain and then a 10-week period of drought. They argue that this combination could create conditions where heavy rains first provide the perfect condition for the biological agent that causes infection and then drought contributes to its spread. It sounds like utter nonsense to me because...

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

State University Medical Research Report

Health Officials Identify Southsand Fever as Infectious and Map Cases

Disease researchers mapped cases of Southsand fever and identified an 8-patient cluster at a new construction site. Medical evaluations confirmed an infectious organism, ruling out noninfectious factors such as heatstroke or chemical exposure. More data is needed to determine if the outbreak is spread person-to-person or...

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

re/southsand • 2 days ago
CarlWatts

"Don't breathe on me!"

Local Man Demands Masks After Roommate Contracts Southsand Fever

My roommate came home from an ER visit last Monday after having a high temperature and trouble breathing; doctors diagnosed it as Southsand fever. I'm not going to get sick like all those people, so now I am making my roommate wear a mask, and I'm wearing one even inside our apartment. I can feel the germs in the air every time he walks by!

77 12 Share

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

MEDICAL INSIGHTS JOURNAL

Differential Diagnostic Tests Confirm Absence of Typical Infectious Disease Markers in Southsand Cohorts

This technical update comes from lab tests performed by researchers at the Southsand City Regional Hospital. Although the symptoms of Southsand fever look like a typical respiratory infection, high-precision lab tests have failed to find any traces of the viruses that cause the flu or the common cold. Researchers are now investigating other organisms that cause disease.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 2: MEDIA STORIES CARDS

ACTIVITY 3

Cognitive Shortcuts

INVESTIGATION

ACTIVITY 3

Cognitive Shortcuts

ACTIVITY SUMMARY

Students deepen their understanding of fast thinking and slow thinking by learning to recognize specific types of fast thinking errors, called shortcuts. These include the availability, representativeness, and anchoring shortcuts. Students investigate these ideas in the context of a contemporary disease known as avian influenza, or bird flu. They examine statements about this disease and analyze them for the characteristics of cognitive shortcuts. Then, students explore some skills to slow down thinking and reduce errors due to cognitive shortcuts. These include looking for additional evidence that reveals the shortcuts. This is done through looking for evidence about bird flu in credible online sources.

ACTIVITY TYPE
INVESTIGATION

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
2. Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.
3. Fast thinking is useful for straightforward or routine situations and relies on cognitive shortcuts. It is quick and automatic but can lead to flawed conclusions.

CONCEPTUAL TOOLS

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTIONS:

Compare, integrate, and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. (*Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information*)

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. (*Science and Engineering Practice: Engaging in Argument From Evidence*)

VOCABULARY DEVELOPMENT

anchoring shortcut
a cognitive shortcut where a person relies too much on an initial piece of quantitative information to make a conclusion

availability shortcut
a cognitive shortcut where a person depends on easily recalled or recent information to make a conclusion

claim
a statement that asserts something is true

cognitive shortcut
a specific pattern of fast thinking that can lead to errors when evaluating information

credible source
a source with relevant expertise that provides accurate information that is free from bias

evidence
information that can support or refute a claim

quantitative
(assumed prior knowledge)
relating to, or expressible as, a number or amount

representativeness shortcut
a cognitive shortcut where a person depends on a pre-existing idea or category to make a conclusion

TEACHER BACKGROUND INFORMATION

Heuristics

Fast thinking (System 1) depends on what are called heuristics in the field of psychology. Cognitive heuristics are common types of cognitive shortcuts that simplify judgment and decision-making processes. These strategies allow people to make quick and efficient judgements by focusing on a subset of relevant information rather than considering all the information. While heuristics often lead to accurate conclusions, they can also result in errors. There are over 200 types of heuristics. The term *heuristic* has other meanings in computer science and math that do not always align with how the term is used in psychology.

Anchoring Shortcut

The anchoring shortcut occurs when your brain latches on to the first piece of information it encounters—the anchor—and uses this information as a reference point for all subsequent judgments. For example, when you're trying to estimate an unknown value, such as the fair price of a used car, your mind starts at that initial anchor and adjusts away from it. The problem is that these adjustments are usually insufficient; even if you know the anchor is irrelevant or exaggerated, your final decision remains tethered to it. In the car example, if the initial price of the car is high and a discount is offered, this can seem like the price is a great deal, even if it is not. Other examples of situations that might involve anchoring shortcuts include salary or other negotiations, year-end sales, bulk purchase limits, and social contexts such as first impressions.

Availability Shortcut

The availability shortcut occurs when a judgment is about the likelihood of an event based on how easily information comes to mind. An example is online Information that is focused on exciting or sensational topics in an attempt to get more views from consumers. Vivid and/or scary images are also more memorable, making them more available to recall. The availability shortcut is also why people think airplane travel is more dangerous than car travel. While airplane accidents make the news and are very memorable, traffic accidents, which kill far more people, are not as well covered in the news.

Representativeness Shortcut

The representativeness shortcut occurs when judgements are based on how similar something is to an existing model or prototype. The representativeness shortcut often relies on stereotypes, which are oversimplified representations of a group that people use to make assumptions. Stereotypes can also be about behaviors, events, and objects. Although it is natural for our brains to group similar individuals/objects of a category together, stereotypes can exist when they are used to perpetuate negative ideas about different race, ethnic, cultural, gender, or class groups. As with the availability shortcut, media coverage can reinforce the representativeness shortcut. The representativeness shortcut is related to base rate neglect, where general statistical information about an occurrence (the base rate) is ignored. This neglect leads to incorrect probability judgments.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 3.1 "Scoring Guide: Engaging in Argument from Evidence (ARG)"
- ITEM-SPECIFIC SCORING GUIDE: Activity 3, Build Understanding Item 4

FOR EACH PAIR OF STUDENTS

- COMPUTER WITH INTERNET ACCESS

FOR EACH STUDENT

- STUDENT SHEET 3.1 "Evaluating Posts for Cognitive Shortcuts"
- STUDENT SHEET 3.2 "Lateral Reading" (OPTIONAL)
- STUDENT SHEET 3.3 "Writing Frame: Engaging in Argument from Evidence (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts And Skills" (OPTIONAL)
- SCORING GUIDE: Engaging in Argument from Evidence (ARG) (OPTIONAL)

Prepare online sources for Part B of the activity. Gather a variety of credible sources about avian influenza, or bird flu, for students to use. Decide if you would like students to choose from a selection of sources, or if you prefer to preselect for them. For the purposes of this activity, it is good to have some sources that are not as credible as others for students to evaluate. The following lists, divided into general categories, are some sources about bird flu. Note that since bird flu is a dynamic and emerging disease, more up-to-date information may be needed.

Credible Sources:
World Organization of Animal Health: *Avian Influenza*
Association of Microbiology: *What You Should Know About Avian Influenza A (H5N1)*
Knowable Magazine: *Everything You Need to Know about Bird Flu*
Nature (website or youtube): *Is bird flu the next pandemic? The science so far.*
Reuters: *Bird flu virus could risk pandemic worse than COVID if it mutates, France's Institut Pasteur says*

Partially Credible Sources:
Science Daily: *H5N1*
Live Science: *Bird flu could soon evolve to spread between humans. Here's how to slow its progress.*
Wikipedia: *Avian influenza*
Vox (website or YouTube): *Is it Time to Worry about Bird Flu?*

Not Credible Sources:
Quora: *What is the truth about the bird flu?*
Reddit: *Scientists warn bird flu could spark a human pandemic in 2026*

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10-20 MIN)

1 Introduce an emerging disease that will be investigated.

- Let students know that in this activity, they will be exploring a real emerging disease, known as avian influenza, or bird flu. This current infectious disease is prevalent around the world and is listed on the World Health Organization's (WHO) list of priority diseases that could cause the next global pandemic. As of 2026, the disease is limited to pockets of outbreaks similar to the Southsand fever scenario from Activity 2. At this point in the activity, do not provide more information about the bird flu, although students may have heard of it or seen media about the issue. Let students know that their investigation of bird flu in this activity will help them build skills they will later apply to the Southsand fever scenario.
- Have students read the Introduction in the Student Book, either as a class or individually, and review the term *cognitive shortcut*. Connect it to the previous activities as a type of fast thinking. Students may want to share their everyday experiences with the Halo Effect described in the Introduction.
- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition as they read the text.

PROCEDURE SUPPORT (40-60 MIN)

2 In Part A, support students as they learn about cognitive shortcuts.

- In Part A, students match the cognitive shortcuts to social media posts about a real disease. It may help to clarify that bird flu is real, but the postings are not. The postings are designed to highlight different cognitive shortcuts. As students begin, review the postings and support students as they identify the claims and record them in Table 1 on Student Sheet 3.1, "Evaluating Posts for Cognitive Shortcuts." A sample student response to Student Sheet 3.1 is found at the end of this activity.

- In Procedure Step 2, groups should discuss whether they agree or disagree with each poster, but they do not have to agree amongst themselves. Encourage them to record their own choices on their student sheets.

- To support reading comprehension for students who may need it to read the shortcut descriptions in Procedure Step 3, consider conducting a pair-share or providing a copy of the text for students to read in advance.

- When reviewing the shortcuts described in Procedure Step 3, make sure to highlight the examples provided. Discuss any other everyday examples that come up. There are many cognitive shortcuts, so some student-generated examples may not be one of the three identified in this activity.

- If it hasn't come up, point out that more than one cognitive shortcut can be involved in any given situation. For example, the stereotype of what a librarian looks like may also be something that very easily comes to mind for a student who spends a lot of time in a library, so a student might argue that the availability shortcut could also come into play.

- After reviewing some of the negative outcomes of shortcuts, ask, Do cognitive shortcuts always lead to an incorrect conclusion? Students should see that no, cognitive shortcuts, like all fast thinking, are not always bad. There are lots of situations in which just a quick answer or decision doesn't need a lot of heavy thinking or all the facts. For example, if you want to buy something at the store such as toothpaste, you don't need to use slow thinking if you already bought that brand and know it works fine. These shortcuts allow our brains to save energy by making fast, good-enough decisions without needing to analyze every single detail.

3 **In Part B, students consider how evidence plays a role in evaluating social media posts.**

- In the beginning of Part B, discuss how cognitive shortcuts impact the conclusions people make. Ask, What is a common characteristic of the claims in the posts as it relates to evidence? Students should have noticed that the claims in the posts are not based on much information. If it is helpful, review the limited amount of information or lack of consideration for information in each post. Emphasize that one of the key characteristics of cognitive shortcuts is that they tend to emerge when there is not much evidence.

- Either assign or have students choose the post they would like to investigate. You may choose to differentiate the instruction by having students investigate all three posts or have one group work together to investigate evidence for a single claim.

4 Students look for credible sources to investigate the bird flu claims.

- In Procedure Step 7, provide a list of preselected sources for students to investigate (See Advance Preparation). These should be primarily good sources that provide evidence for the claims made in the shortcuts. Include a few less credible sources for students to use in their investigation and critique. Following are some examples—for each of the criteria—of poor sources and suggestions for related actions:

  - *The author has relevant training or experience*

    An influencer who is not a registered dietitian is not qualified to advise on nutrition, someone who is a veterinarian may not have the specific background to give advice on human global pandemics. Encourage students to click on the author and check their experience and background.

  - *Listed references to other trustworthy sources*

    Science topics referenced from *People* magazine are not as reliable as those from *New England Journal of Medicine*. Encourage students to click on the references and check the date published and supporting organizations.

  - *A perspective that is balanced or neutral*

    A post that advocates for beauty products with affiliate links are generally biased and equivalent to an advertisement. Encourage students to look through the post completely to see if there is a relationship with other organizations or companies, even if they are de-emphasized.

- In Procedure Step 8, discuss with students what made the sources credible or not credible, based on the criteria provided in the Student Book. Have students share the examples they explored and what first tipped them off that there might be a credibility problem.

- Emphasize that credibility of sources should not necessarily be classified as binary—credible or not credible. The credibility of sources is better described as a continuum, as many sources may have more than one source or partially provide accurate information.

- The credible sources should provide evidence that supports and/or refutes the claims from the posts. Review what students found and how the evidence changes their thinking. For example, students may learn from their research that rapid mutation does not universally lead to a deadlier strain of disease. There are evolutionary trade-offs that most often result in strains that spread easily but are less lethal. When this evidence is applied to the post from @OutbreakOutl00k, it clearly refutes the claim.

5 Support student investigation of credible sources through lateral reading (optional).

- Lateral reading is a research technique used to evaluate a source's credibility as well as confirm the accuracy of facts. You may choose to support lateral reading with optional Student Sheet 3.2, "Lateral Reading." As students work, circulate around the room and check that students are using multiple browsers as they work.

- Remind students to focus on evaluating the credibility of the source first instead of looking for

facts from the source. The lateral reading support is used purely to examine the source and is not designed to help students evaluate the validity of a claim. A sample student response for one of the sources is found at the end of this activity.

TEACHER'S NOTE: Students may need additional clarification around the ideas of source bias and conflict of interest, which have not yet been introduced. Let them know that they will further investigate those terms later in the unit.

SYNTHESIS OF IDEAS (30 MIN)

6 **Discuss ways to reduce the negative effects of cognitive shortcuts.**

- In Procedure Step 12, have students reflect on their metacognitive experience in the activity. Discuss how their ideas did or didn't change based on the gathering of more evidence.

  Sample Student Response, Procedure Step 12

  The social media posters should slow down their thinking by gathering more evidence before making a claim. If they did that, then @BirdNerd7865 would realize that her stream is using an algorithm to post similar content. She should look up the statistics for bird flu to put it into context. @OutbreakOutl00k shouldn't assume this disease is the same as others. He could challenge his assumptions by looking at a variety of influenzas and their level of harm. @DoubterDom might get stuck on the first number he sees, which in this case was 1 in 1 million. Instead, he could find out about the history of case numbers for similar diseases that have spread through animal populations

- When students discuss how their thinking process in Part B differed from the social media posters in Part A, look for students to show understanding that the posters were using fast thinking compared to students' slow thinking during the investigation. Ask, How do you think you can reduce cognitive shortcuts in your own thinking? Students should indicate that the metacognitive skill of slowing down thinking is a good approach, but also that using credible sources to get insight supports slow thinking. The specific slow-thinking skill of using credible sources to find larger sets of evidence to evaluate a claim can counteract cognitive shortcuts.

- Another skill is to apply metacognition to social media claims to be more aware of them. This is because one of the key characteristics of cognitive shortcuts is that they can occur unconsciously. We all use cognitive shortcuts unintentionally, so being able to identify them is helpful.

- Have students recall the beginning of the activity when they could respond with "not sure" about whether or not they agreed about each social media post. Point out that this is a good strategy when confronted with a claim with scant evidence. If you are not able or willing to take the time to slow down thinking and get evidence, simply saying, "I don't have enough information to make a judgement" is a prudent response.

7 Draw a parallel from bird flu to the Southsand fever scenario.

- Draw a parallel to the real-life bird flu with the fictional Southsand fever scenario. In both situations—the emerging nature and the sensationalized coverage they have received—clear information is challenging to get. Likewise, in the Southsand fever scenario, the headlines students worked with in Activity 2 reflect cognitive shortcuts within an environment where there isn't a lot of information.

8 Review concepts generated by the Build Understanding items.

- In Build Understanding item 2, students consider whether a Language Learning Model (LLM) is considered to be a credible source. Review how an LLM will produce results that look believable and professional, but it does not check for credibility of sources when it compiles its results.
- For Build Understanding item 3, follow up with the idea that if students pay attention to others, they may see that anecdotes are very common and usually lead to "going too far" with limited information, otherwise known as a cognitive shortcut.

9 Introduce the assessment for Build Understanding item 4.

- Build Understanding item 4 is an assessment item that uses claims, evidence, and reasoning for argumentation. This first opportunity should be used to introduce your students to the Scoring Guide: Engaging in Argument from Evidence (ARG). As this is the first opportunity for students to review the Scoring Guide, you may wish to have them work in pairs or small groups to discuss and/or write their responses, using the Scoring Guide to help develop their responses. See Appendix 2: Assessment Resource at the end of the Teacher's Edition for more guidance and information on using the Scoring Guide with your students.
- Do not share the item-specific version of the Scoring Guide (Item-Specific Scoring Guide: Activity 3, Build Understanding Item 4) with students as it provides specific information on how to respond to the item prompt. Review the Item-Specific Scoring Guide to support scoring this specific item.
- Visual Aid 3.1, "Scoring Guide: Engaging in Argument from Evidence (ARG)," can be used to assess Build Understanding item 4. 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 4 response is complete and correct. A Level 3 response is almost complete and mostly correct, but possibly missing minor details or containing small errors. 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 4 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.

- For some students, you may wish to support a specific level of growth—this can be particularly helpful if students have an Individualized Educational Plan (IEP), a 504 plan, or other specific educational goals. Growth from a Level 1 to a Level 2 may indicate significant progress for a student and should be recognized as such. Additionally, assessments can be a good opportunity to have students evaluate one another's work and provide initial feedback for revisions prior to submitting their responses to you. You may wish to project a copy of the Scoring Guide for your students to review each level and clarify your expectations.

- Sample responses for Levels 1–4 are provided in the Build Understanding section. Review these responses to get an idea of what is expected for each level, alongside the Item-Specific Scoring Guide. See Appendix 2: Assessment Resource at the end of the Teacher's Edition for more guidance and information on using the Scoring Guides and assessment system with your students.

- Optional Student Sheet 3.3, "Writing Frame: Engaging in Argument from Evidence," provides additional support for students responding to Build Understanding 4. A Writing Frame can support learners, particularly emerging multilingual learners, in decoding scientific ideas, constructing meaning, sensemaking, and language acquisition. This strategy, which has been deemed effective for emerging multilingual learners, was built on and adapted from strategies for English-proficient learners. You may wish to provide students with the Writing Frame to compose their responses or simply as a reference or checklist to help them organize how they will respond. Consider posting an enlarged version of the writing frame on a classroom wall for students to refer to now and in future assessments. For more information on a Writing Frame, see Appendix 1: Literacy Strategies.

10 **Revisit Student Sheet 1.3, "Unit Concepts and Skills," and add key concepts and skills about fast thinking and slow thinking.**

- The end of this activity is a good time to revisit optional Student Sheet 1.3, "Unit Concepts and Skills," to help students formally organize the ideas introduced in the unit so far. Students can place the headings of the main ideas of metacognition and cognitive shortcuts into the organizer and add examples from their classroom experiences in Activities 2 and 3. See the end of Activity 1 in the Teacher's Edition for a sample student response.

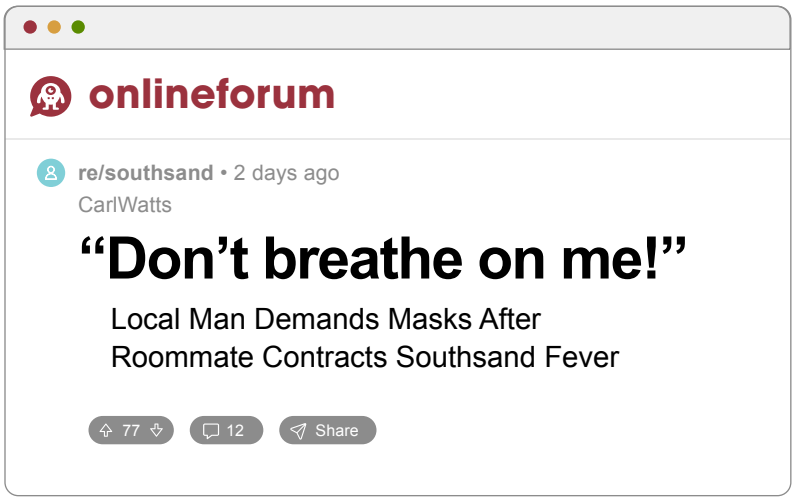
- This activity has an unusually large amount of vocabulary. Review the terms at the end of the activity and answer students' questions. Support students, particularly emerging multilingual learners, in sensemaking and language acquisition by adding unit words to the word wall. Record the seven Key Scientific terms—*anchoring shortcut, availability shortcut, claim, cognitive shortcut, credible source, evidence, and representativeness shortcut*—and provide examples as needed. For more information on a Word Wall, see Appendix 1: Literacy Strategies.

- To conclude the activity, evaluate whether your students are able to answer the Guiding Question, *How do people avoid errors from cognitive shortcuts?* Students should have learned through their experience in the activity that gathering more evidence is a key skill in combating cognitive shortcuts. Revisit and summarize the key concepts and process skills of the activity.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **Review the following headline and beginning of a fictional post from Activity 2. What type of cognitive shortcut is the person using? Explain your reasoning.**



This is an availability shortcut because he is using the most recent information about his roommate being sick to make a decision. He doesn’t stop to ask if evidence supports transmission through the air compared to other routes of transmission, such as through water or soil.

② **Large Language Models (LLMs), such as ChatGPT or Gemini, use artificial intelligence (AI) technology to answer questions by gathering information available on the Internet to construct a response to a search or a question. Most LLMs do not identify the source of the information or list the evidence used to construct the answer. Would you consider an LLM to be a credible source? Why or why not?**

Responses will vary. One sample response is shown here.

I think that LLMs can produce biased information even though it appears believable. The credibility is not based on human judgements. There aren’t any standards for LLMs to check their sources. So it just parrots the Internet, which is not a reliable source itself. I always check my AI results.

③ **Many social media posts focus on personal anecdotes, which are single stories or one-time events, usually involving one person. How could using an anecdote lead to one or more cognitive shortcuts?**

Someone providing an anecdote because it is faster and easier than having to spend the time and energy to get and analyze data. Since an anecdote relies on a single piece of information to reach a conclusion, it could include any of the shortcuts in this activity. Using data from a larger group of people provided by a credible source would lead to a more accurate conclusion.

④ **ARG Scoring Guide**

In the Southsand fever scenario, Trevor reads an article that states: *Adults are most at risk of this disease.* Trevor suspected that the claim involved a cognitive shortcut, so he went to the Southsand fever public health website to get more information. He found the following data from the local hospital, a credible source. Based on analysis of the data, which age group (children, adults, or seniors) do you think is most at risk from the disease? In your response:

- **a make a claim about which age group is most at risk.**
- **b support your claim, using at least 2 pieces of evidence from the data in Table 3.1. Use reasoning to explain how each piece of evidence supports your claim.**

TABLE 3.1
Southsand Fever Hospital Data

	CHILDREN (0-14 years)	ADULTS (15-59 years)	SENIORS (60+ years)	TOTAL
Number of cases	13	68	19	100
Number hospitalized	2	27	10	39
Number who died	1	2	4	7
Average length of hospital stay (days)	10	5	14	

Level 4 response

a *My claim is that seniors are the most at risk from Southsand fever.*

b *The data shows that the senior group had 4 deaths out of only 19 cases (about 21%), which is a much higher rate than children (1 death out of 13 cases, about 8%) and adults (2 out of 68 cases, about 3%). This strongly suggests that although fewer seniors are infected, the disease is far more serious for them once they get it. Also, seniors have the longest hospital stays at 14 days, which is a lot longer than the 5-day average for adults and a little longer than the 10-day average for children. These long hospital stays are strong evidence that Southsand fever probably causes more severe health problems for seniors. These two pieces of evidence are from a credible source (the hospital). All of this supports the idea that seniors are more at risk of dying or having serious health problems than the other groups. Even though adults have the highest total number of cases, it's seniors who are probably more at risk.*

Level 3 response

a *I think seniors are the age group most at risk from the disease.*

b *My first piece of evidence is that they are more likely to die than the other two groups if they get the disease. Four seniors died from Southsand fever, compared to only 2 adults and 1 child. Another piece of evidence is that seniors had to stay 14 days on average at the hospital. So this shows that seniors are affected the most by the disease.*

Level 2 response

a *Some children are at risk.*

b *They have to stay for 10 days on average if they are hospitalized. This is a very long time for a child, so it shows that they are in danger if they get the disease.*

Level 1 response

a *Every age group can get Southsand fever.*

b *My evidence is that every age group can die from the disease. So Southsand fever is dangerous.*

CONNECTIONS TO EVERYDAY LIFE

5. **Imagine that the very first piece of information Sam receives about a severe weather event is a social media post. The post claims the storm will be a Category 5 hurricane that will hit the town. The storm turned out to be strong, but was rated a Category 3. Sam's home had expensive damage but it wasn't structural, and he was still safe. Sam felt like he was lucky. Which cognitive shortcut could have affected his interpretation of the situation? Explain.**

   It would probably be the anchoring shortcut. It works because the first piece of information was a Category 5 hurricane, which anchored Sam's expectations. When the actual storm was rated a Category 3, he felt like he was lucky. If his expectations were that there wasn't going to be a storm, the damage from the Category 3 hurricane would not have made him feel lucky.

6. **Imagine you have a friend who complains about a stomachache. He says, "I had a stomachache a few months ago when I had the flu. I must have the same illness again." Which cognitive shortcut could have affected his interpretation of the situation? Identify the cognitive bias and explain how you would advise him.**

   This friend is using an availability shortcut because he is using his most recent experiences to guide his thinking. I would advise him to slow down, to not assume that he has the same thing, and to go see a doctor if it doesn't get better soon.

STUDENT SHEET 3.1	EVALUATING POSTS FOR COGNITIVE SHORTCUTS	NAME

PART A: TABLE 1

POST	@BirdNerd7865	@DoubterDom	@OutbreakOutl00k
Claim			
Do you agree with the reasoning?	YES NO NOT SURE	YES NO NOT SURE	YES NO NOT SURE
Cognitive Shortcut			

PART B: TABLE 2

POST	@BirdNerd7865	@DoubterDom	@OutbreakOutl00k
Possible evidence to support or refute claim			
Credible sources			
Supporting evidence			
Refuting evidence			

STUDENT SHEET 3.1	EVALUATING POSTS FOR COGNITIVE SHORTCUTS	NAME	SAMPLE STUDENT RESPONSE

PART A: TABLE 1

POST	@BirdNerd7865	@DoubterDom	@OutbreakOutl00k
Claim	*A big outbreak of bird flu must be coming*	*Bird flu is very rare, so people should not be worried about it.*	*The next outbreak of bird flu will be very deadly.*
Do you agree with the reasoning?	(YES) NO NOT SURE	YES (NO) NOT SURE	YES NO (NOT SURE)
Cognitive Shortcut	*Availability*	*Anchoring*	*Representativeness*

PART B: TABLE 2

POST	@BirdNerd7865	@DoubterDom	@OutbreakOutl00k
Possible evidence to support or refute claim	*Who is reporting the story?* *Likelihood of outbreak.*	*How the outbreak could happen.* *Who is getting sick?*	*How bird flu is spread.* *Chances of getting it.*
Credible sources	*Reuters* *World Organization of Animal Health*	*World Organization of Animal Health* *Reuters*	*World Organization of Animal Health* *Knowable Magazine*
Supporting evidence	*Because there are many types of bird flu, and there is a potential for mutation bird flu, it is a continued global health concern.*	*There have been 1,000 cases in humans since 2003, and 48% died.*	*Bird flu mostly affects wild birds and poultry. Not contagious between people. The odds of an outbreak in humans are very low.*
Refuting evidence	*Risk of bird flu pandemic is low. World is more prepared for viral pandemics.*	*People need close contact with infected birds to get it. Can't get it from properly cooked food.*	*If it mutates, it could be more likely to spread to humans. Your risk is higher if you work with poultry or farm animals.*

Find a relevant information source and record the information about it below.

Website URL _____

Name of site/title _____

Who is the author? _____

What type of website is it (.gov, .edu, .com, .org)? _____

What date was the page published/last updated? _____

Who is the intended audience? _____

Purpose of the site (to inform, entertain, persuade) _____

Does the site provide facts, opinions, or both? _____

Open a separate browser window to evaluate the site for evidence of credibility.
Look for other sources that describe the site, author, or its related institution (company, organization, or university). Use the other sources to answer the next three questions.

Is there evidence of expertise?
(Does the author have appropriate education or relevant experience? A strong reputation among peers? Do they work at a reliable organization, institution, or university? Are references acknowledged in the source? Are the references credible?)

Is there evidence of conflict of interest?
(Where does their funding come from? What other organizations do they partner with? Might these connections influence their writing?)

Is there any indication of bias?
(Is it politically neutral? Does there seem to be some kind of agenda—political, social, environmental? If there is a bias, what is it?)

Find a relevant information source and record the information about it below.

Website URL *https://www.livescience.com/health/viruses-infections-disease/bird-flu-could-soon-evolve-to-spread-between-humans-heres-how-to-slow-its-progress*

Name of site/title *Live Science: Bird flu could soon evolve to spread between humans. Here's how to slow its progress.*

Who is the author? *Ron Barrett*

What type of website is it (.gov, .edu, .com, .org)? *.com*

What date was the page published/last updated? *April 6, 2025*

Who is the intended audience? *people in the community/general public*

Purpose of the site (to inform, entertain, persuade) *inform and educate*

Does the site provide facts, opinions, or both? *facts, opinions*

Open a separate browser window to evaluate the site for evidence of credibility.

Look for other sources that describe the site, author, or its related institution (company, organization, or university). Use the other sources to answer the next three questions.

Is there evidence of expertise?

(Does the author have appropriate education or relevant experience? A strong reputation among peers? Do they work at a reliable organization, institution, or university? Are references acknowledged in the source? Are the references credible?)

He is a Professor of Anthropology who studies social issues related to infectious disease. While his research is related, his experience may not be relevant enough for medical treatment recommendations related to avian flu, though he was formerly a nurse and does seem like a credible source for general information. He does give references to other credible sources including research studies.

Is there evidence of conflict of interest?

(Where does their funding come from? What other organizations do they partner with? Might these connections influence their writing?)

Live Science is a science news website. Their policies have high standards for fact-checking scientific and medical articles. They require authors to disclose conflicts of interest.

Is there any indication of bias?

(Is it politically neutral? Does there seem to be some kind of agenda—political, social, environmental? If there is a bias, what is it?)

Live Science is a pro-science website. Their policies page states that they won't publish stories that go against accepted scientific theories (such as climate change) unless there is extremely good evidence to consider. They don't allow the use of AI to create their stories. This article is marked as an opinion piece, so it is not purely informational and contains the author's interpretations of the data and situation.

CLAIM (statement about how the disease is spreading)

My claim is:

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

The second piece of evidence is

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

Second piece of evidence: My reasoning is that

CLAIM (statement about how the disease is spreading)

My claim is:

that seniors are the age group most at risk from Southsand fever.

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

that the senior group had the highest rate of deaths. 4 of 19 (about 21%) seniors died, compared to only 1 of 13 children (about 8%) and only 2 of 68 adults (about 3%).

The second piece of evidence is

that seniors have the longest stays at the hospital. People 60 or older stay 14 days on average, compared to 5 days for adults and 10 days for children.

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

the higher rate of deaths for seniors is probably because the disease is much more serious for them if they contract it. If they get Southsand fever, seniors probably get a lot more sick and could die.

Second piece of evidence: My reasoning is that

the longer hospital stays are also probably because the disease is causing more severe health problems for seniors. All of this supports the idea that seniors are more at risk of dying or having serious health problems than the other groups.

VISUAL AID 3.1 | SCORING GUIDE: ENGAGING IN ARGUMENT FROM EVIDENCE (ARG)

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim; is relevant, accurate, and sufficient; AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

ITEM-SPECIFIC SCORING GUIDE | ACTIVITY 3, BUILD UNDERSTANDING ITEM 4

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim; is relevant, accurate, and sufficient; AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.
	The student's response includes: • a clear claim about which age group is most at risk from the fictional disease. • a thorough description of at least 2 pieces of evidence from the data table that supports their claim. • an accurate description of the strength of each piece of evidence.		

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.
	The student's response includes: • a clear claim about which age group is most at risk from the fictional disease. • a thorough description of at least 2 pieces of evidence from the data table that supports their claim. • a description of the strength of each piece of evidence that may not be accurate.		
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
	The student's response includes: • provides an unclear claim about which age group is most at risk from the fictional disease. • describes 1 piece of evidence from the data table to support their claim. • provides a description of reasoning that may be unclear or does not logically support their claim.		

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
	The student's response includes: • a clear claim about which age group is most at risk from the fictional disease. • evidence that is irrelevant to which age group is most at risk. • reasoning that does not logically support their claim.		
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

ACTIVITY 4

Looking at Evidence

CARD-BASED INVESTIGATION

ACTIVITY 4

Looking at Evidence

ACTIVITY SUMMARY

Students explore how confirmation bias can affect people's ability to evaluate information. They do so in the context of the health issue of social media and teen mental health. Students unwittingly select evidence to support an existing belief for or against social media and then examine their own cognitive biases. Students then learn about a suite of slow-thinking skills by using an actively open mindset as a skill for reducing the influence of confirmation bias.

ACTIVITY TYPE
CARD-BASED INVESTIGATION

NUMBER OF 40–50 MINUTE CLASS PERIODS
2

KEY CONCEPTS & PROCESS SKILLS

1. There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.
2. Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.
3. Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.
4. An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

CONCEPTUAL TOOLS

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTIONS:

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*)

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. (*Science and Engineering Practice: Engaging in Argument From Evidence*)

VOCABULARY DEVELOPMENT

actively open mindset
a metacognitive thinking approach in which one evaluates source credibility, seeks evidence, and considers alternative explanations

confirmation bias
the tendency for a person to seek out and interpret information in a way that supports their existing ideas

trade-off
a desirable outcome given up to gain another desirable outcome

TEACHER BACKGROUND INFORMATION

Confirmation Bias

Confirmation bias is a cognitive bias that generally occurs via two primary mechanisms: biased selection (called selective exposure in the field of psychology) and biased interpretation (called biased assimilation in the field of psychology). Biased selection and biased interpretation of information can occur simultaneously, making it challenging to consider alternative ideas or beliefs.

Biased selection is when people preferentially seek out, take in, and remember information likely to confirm their existing beliefs while neglecting to seek out, notice, or remember information that might undermine their existing beliefs. Biased selection appears in the way people seek out information online, typically by searching or following sources that agree with what they already think. Generally, people do not search for or follow sources that are likely to offer alternative perspectives or counterevidence.

Biased interpretation of information occurs when people interpret information in such a way that helps to support their existing beliefs. This is done by discounting the strength, quality, or reliability of information that might undermine their beliefs; being less critical of information that supports their beliefs; or otherwise interpreting information in such a way as to justify what they already think. Biased interpretation can boost one's confidence and attachment to one's own beliefs. It can also occur simultaneously with biased selection.

Actively Open Mindset

An actively open mindset, also known as actively open–minded thinking, is the type of thinking that involves deliberately seeking out a wide range of viewpoints, considering evidence and arguments from different perspectives, and being willing to revise beliefs in light of new information. This metacognitive approach helps reduce the effects of confirmation bias (and other cognitive biases) by promoting a more deliberate and reflective approach to thinking. This slow thinking encourages a more complete and accurate picture of an issue before making conclusions or decisions. Research indicates that actively open-minded thinking is associated with fewer errors from cognitive shortcuts, less bias, less vulnerability to misinformation, and greater acceptance of scientific consensus.

Research on the Effects of Social Media

To date, there has been limited consensus in the scientific research on the impacts of social media that shows both harmful and beneficial effects. Some notable findings are summarized in the following tables.

SOCIAL MEDIA: HARMFUL EFFECTS

RESEARCH AREA	SUMMARY
Mental Health	Some studies link social media use to increased anxiety, depression, and loneliness among teens. The constant comparison with peers and exposure to cyberbullying can exacerbate these issues.
Sleep	Excessive use of social media—especially before bedtime—can disrupt sleep patterns, leading to negative effects on overall well-being and academic performance.
Body Image	Social media posts emphasizing appearance can contribute to body dissatisfaction and eating disorders due to the pervasive culture of idealized body images.

SOCIAL MEDIA: BENEFICIAL EFFECTS

RESEARCH AREA	SUMMARY
Mental Health	Social media can provide a sense of community and support, especially for teens who may feel isolated in their offline lives. It allows them to connect with peers, share experiences, and find solidarity.
Education	Educational platforms offer access to resources, learning materials, and the ability to gain qualifications in a way that was previously inaccessible.
Media Literacy	Social media can help teens develop digital literacy skills, including content creation, online communication, and critical thinking about information.

Social Media Algorithms

Social media can exacerbate confirmation bias, largely due to the algorithms that tailor content to users' preferences. These algorithms filter users into online bubbles where similar ideas are amplified, and alternative ideas are not shown. When users engage more often with content that aligns with their existing views, the algorithms serve more of the same, reinforcing their beliefs and creating a skewed perception of reality that neglects the diversity of ideas and opinions in real life and, thus, may miss key facts. Additionally, the social aspect of these platforms encourages users to join like-minded groups and follow people with similar opinions, further isolating them from diverse perspectives.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 4.1 "Actively Open Mindset"
- VISUAL AID 2.1 "Developing Communication Skills" (OPTIONAL)

FOR EACH PAIR OF STUDENTS

- SET OF EVIDENCE FOR CLAIM *YES* CARDS (4 cards, in envelope)
- SET OF EVIDENCE FOR CLAIM *NO* CARDS (4 cards, in envelope)

FOR EACH STUDENT

- STUDENT SHEET 4.1 "Evidence About Social Media"

Prepare the 2 sets of Evidence cards and place each set into a large labeled envelope ("Evidence for Claim YES," and "Evidence for Claim NO"). Make sure the envelopes do not have any transparency so the contents are hidden from view.

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (20 MIN)

1 **Introduce the social media focus of the activity.**

- Have students read the Introduction in the Student Book. Follow up by asking, What kind of social media do you use regularly, or don't you regularly use social media? Student responses will vary depending on your student population. Focus on the reasons why students do or do not engage with the technology. It may be helpful to review students' experiences with the social media posts from Activity 3.

- Review the fictional scenario in Procedure Step 1, which is set in Southsand, and connect Trevor's anxiety about Southsand fever to frustrations that students have had with social media. Ask, Have you ever considered getting off social media for a bit? Discuss what circumstances led them to think it might be a good idea or reasons they wouldn't consider it. Use this discussion as a way to introduce the central health question in the activity: *Is social media harmful to teens' mental health?*

- Reading the scenario aloud can better support comprehension for many students, including neurodiverse students and emerging multilingual learners who often have more highly developed listening and oral skills than reading comprehension skills. Alternatively, students can read the scenario independently.

TEACHER'S NOTE: Do NOT give students any information about confirmation bias before they complete Procedure Part A.

PROCEDURE SUPPORT (30–40 MIN)

2 **Sort students into pairs and let them choose and evaluate evidence related to their chosen claim.**

- Distribute Student Sheet 4.1, "Evidence About Social Media," and let students know that they will be working on evaluating claims and evidence related to the health question: *Is social media harmful to teens' mental health?* Student responses for this student sheet will vary depending on which cards they pull. Complete responses for YES claims and NO claims (which show the cards in numerical order, for ease of reference) are shown at the end of this activity.
- In order to experience biased selection, it is important for students to initially partner with someone who is investigating the same claim. Students are not likely to experience confirmation bias if they are with a partner who has opposing thoughts about the claim.
- For Procedure Step 3, make sure the class is roughly divided between students who chose the YES claim and those who chose the NO claim. While students begin the activity with a similar-claim partner, they meet later in the activity with a pair of students who chose the opposite claim. To make those groups work evenly, there should be similar numbers on both sides of the claim.
- Be clear with students that the evidence in the envelopes is real data and not made up for the scenario.
- While it is important that students do not read the cards before the activity, you may want students to read them aloud to each other in their pairs as they draw cards from the envelope to support their reading comprehension.
- During Procedure Steps 4–7, you should find that in most cases, students will select evidence only from the envelope labeled as supporting their preferred claim. Although they can select from either envelope, allow them to do this and do not disrupt their choices.
- In Procedure Step 8, review how confident students are about their claim, using a scale from 0% (no confidence) to 100% (completely confident). While these numbers are somewhat arbitrary, they can be useful for self-reflection later in the activity when comparing the responses to the same question asked again.

3 Students are formally introduced to confirmation bias.

- At the end of Part A, review the term *confirmation bias* and ask, Which envelope did you open first and why? Generally, students initially pull from the envelope that supports their claim. Students might be surprised to realize that they were unintentionally introducing confirmation bias when they selected evidence from a particular envelope. Student responses will vary depending on their approach, but use the responses to make a tally on the board of the number of students who:
  - took all Evidence cards *only* from the envelope with evidence supporting their preferred claim.
  - took 2 Evidence cards from the supporting envelope and 1 Evidence card from the envelope with counter evidence.
  - took 1 Evidence card from the supporting envelope and 2 Evidence cards from the envelope with counter evidence.
  - took all Evidence cards *only* from the envelope with counter evidence.
- The tallies should show that the majority of students showed confirmation bias in their selection of evidence. Those students who gathered information from both envelopes experienced *less* confirmation bias. Use the totals to make the point that confirmation bias is both unnoticed and extremely common. Moreover, the stronger the existing belief, the more likely confirmation bias is used to maintain that belief.
- You may want to discuss with students that the term *cognitive bias* is related to, but not equivalent to, the more general term *bias*. Students may connect bias to the negative social bias of prejudging people, making assumptions, stereotyping, being treated unfairly, or discriminating based on social factors such as personal identity or race or ethnic or economic background.

4 Form new groups of students with opposite claims.

- In Part B, pairs have a chance to work with another pair to gain a more balanced selection and interpretation of the evidence. Encourage students to work through all the evidence with an open mind.
- To support students' discussion, you may wish to use optional Visual Aid 2.1, "Developing Communication Skills," to help guide student interactions. Visual Aid 2.1 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. For more information about Developing Communication Skills, see Appendix 1: Literacy Strategies.

5 Form new groups of students with opposite claims.

- When the term *actively open mindset* is introduced in Procedure Step 11, follow up with Visual Aid 4.1, "Actively Open Mindset." Be explicit about how the four prompts on the visual aid outline a metacognitive approach to being open to changing one's mind. Ask, How could an actively open mindset be helpful in science? Students should see that a less biased selection of evidence will lead to more reliable conclusions. For example, if participants are recruited for a health study from flyers placed in a gym, the people who sign up are likely to be healthier than the average person.

The study's results will therefore reflect the selection of healthier, more motivated people rather than the general population.

- Discuss with students how conformation bias could impact what is happening in the Southsand fever scenario. It should be obvious to students that the information in the scenario, such as the news headlines and people's actions as a result, may show significant confirmation bias from the social media posters.

- Ask, How do you think your own existing ideas or experiences with social media might have affected your choices and thinking about the evidence? Students may think their own positive or negative experiences steered them in a particular direction when selecting and evaluating claims. This activity sheds light on how our reasoning is affected by our prior experiences, beliefs, and wishes.

6 Have students reflect on the role of evidence in making claims.

- Ask, How might only looking for evidence to support your claim in this activity be a problem? Student responses should indicate that only looking for evidence that is one-sided engages in confirmation bias and is simply a way to support their existing ideas and not necessarily create a better argument for a claim. Anticipating the opposing claim by looking at various pieces of evidence strengthens their ability to support a claim. Likewise, it may convince them to adjust their claim if they may find other ideas that offer better explanations for the evidence.

- If it hasn't yet been addressed, point out that sometimes evidence is neutral in that it doesn't support or help refute a claim. In this activity, there was no neutral evidence. The evidence provided in the envelopes was either supporting or refuting. There may be different situations, however, where evidence neither supports nor helps refute a claim.

- In Procedure Step 13, discuss how students' confidence has changed from looking at all the evidence in Part B. Most students may find that their confidence has decreased as a result of looking at both sides of the evidence, or it increased after having considered all the evidence. Discuss how the role of increased evidence can change a person's claim.

- This activity encourages students to use evidence in a different way than they may have in the past. Instead of using evidence to support a position or justify a reason retroactively, the experience of the activity should encourage students to look at the evidence *first* and make a claim following that analysis. Point out that by doing so, confirmation bias is reduced. A reduction in confirmation bias means that the conclusion, or claim, is more likely to be reliable because it is built on all the available evidence.

SYNTHESIS OF IDEAS (20 MIN)

7 Have students reflect on the role of an actively open mindset during the activity.

- Reinforce the ideas that an actively open mindset is an important type of slow thinking that helps reduce errors related to confirmation bias. In Activity 5, students will be introduced to more biases, all of which can be addressed in the same way. For now, encourage students to understand that the metacognitive skill of an actively open mindset is important when selecting and evaluating information. At its core, an actively open mindset involves being intentionally open to evidence and ideas that are counter to one's own preferred ideas.

- Review the claims that students made about social media and teens' mental health. Ask, What types of prior experiences or beliefs about social media may have affected how you chose evidence for your claim in Part A? Students should recognize that, like most people, they acted on an unrecognized confirmation bias. They may note that this is a common occurrence for people. Then pose a follow-up question. Ask, How might you have approached the claims and evidence differently if you had intentionally used an actively open mindset from the beginning? Students should see that they might have had a more balanced perspective from the beginning when the evidence led to a conclusion, and not the other way around.

- Discuss how reducing confirmation bias is important to scientific investigations because confirmation bias results in limited data and less reliable conclusions.

8 Introduce the concept of trade-offs and how it applies to Build Understanding item 1.

- Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs. In Build Understanding item 1, students use trade-offs when they make a decision as to how to advise Trevor to handle his social media. 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 is used throughout the units of the *Scientific Thinking For All: A Toolkit* curriculum, especially as part of the decision-making activities in Unit 6, "Group Decision-Making."

- 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: 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.

9 Distinguish between biased selection and biased interpretation.

- Build Understanding items 2 and 3 introduce the idea of cherry-picked data (biased selection) and biased interpretation. Review the terms when discussing student responses to the items. Emphasize that confirmation bias can happen when people either select evidence that suits them, or interpret evidence in a way that they prefer, or both. Often these two types of confirmation bias happen concurrently, and both are very common.
- Use Connections to Everyday Life item 4 to help students connect to existing ideas or experiences they might have with both biased selection and biased interpretation in their everyday social media. If students are not familiar with how social media algorithms work, review how they are designed to keep people on the app by confirming what they already like or know.

10 Evaluate the key content of the activity.

To conclude the activity, evaluate whether your students are able to answer the Guiding Question, *How do existing beliefs affect the way people seek information?* Use this as a chance to revisit and summarize the key concepts and process skills of the activity. This should include the concept of biased selection and how it contributes to confirmation bias.

EXTENSION (20 MIN)

11 **Use the Extension as an opportunity for advanced learning.**

In this extension, students are encouraged to investigate a project run by Amanda Yarnell at the Harvard University Center for Health Communication. The project helps influencers promote evidence-based information on key mental health topics, using their own posting style. She showed that an increase in evidence-based posts on health topics gathered more views than previous posts by the creators on the same subjects. The project provided evidence that access to factual information is important when evaluating information for decision-making. Other resources that focus on teen mental health include those from the Greater Good Science Center at University of California, Berkeley, and Laurie Santos at Yale University, creator of The Happiness Lab, which examines the latest scientific research on factors impacting young people's well-being.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **Recall that in the scenario in Procedure Step 1, Trevor asked himself whether he should take a break from social media. Based on what you learned in this activity, how would you advise him? Support your answer with evidence from this activity and identify the trade-offs of your decision. A trade-off is a desirable outcome given up to gain another desirable outcome.**

The evidence that influenced my thinking the most was Card 3 for the YES claim. It showed the survey data from 2023 with the percentage of teens who agree with each of the statements about a negative impact of social media. I realized that I also experience a lot of those negative aspects of using social media, so I think Trevor should avoid that.

A trade-off of my decision is that if Trevor spends less time on social media, he will also not get as much interaction with friends on social media. He might not be able to interact with friends and family who live far away, or hey may miss seeing funny videos.

② **Sometimes confirmation bias results in selectively choosing information that supports a claim. This is called *cherry-picking* because the focus is on the pieces of evidence that support our existing ideas and ignoring those that don't—such as picking the most appealing cherries from a tree. Consider the following story:**

A research team did an experiment to prove that the corn grown locally in Southsand City was making people sick. After conducting the experiment, they found that 20% of their tests supported the idea that the corn could cause disease, while the other 80% did not support it. One researcher on the team decided to present only the 20% of their results that supported their claim.

a What was the data that the researcher cherry-picked?

The data that was cherry-picked was the 20% that supported the claim, and the researcher presented it as all the evidence when there was evidence that was not included.

b What are the possible consequences of this cherry-picking?

The consequences of cherry-picking are those who only look at the 20% of the data that supported the claim could assume that the data supporting the claim was 100% (and not just 20%). They may think that the experiment supported their claim when, in reality, it refuted it.

③ **Sometimes confirmation bias comes from the tendency to seek out and interpret information in a way that supports an existing idea. This leads to dismissing other interpretations that do not support the existing ideas. Consider the following story:**

A local poultry farmer reported symptoms of the Southsand fever. The week before he became ill, he was pecked in the leg by a chicken while working. Later that day, he went to a party where one of his friends was coughing. What could be a biased interpretation of this evidence if you believed that the Southsand fever was transmitted.

a from person-to-person?

He was at a party with friends, so the farmer was infected by another person at the party. It is not likely that a disease is transmitted by a bird pecking a human.

b from animal-to-person?

The chicken transmitted the infection when the farmer was pecked in the leg at the party. It isn't clear that the friend coughed anywhere near the poultry farmer.

CONNECTIONS TO EVERYDAY LIFE

④ **If a social media app is designed to keep you scrolling by showing you things similar to what you already like, how could this amplify confirmation bias? Explain the possible consequences of this amplification.**

The algorithm increases the biased selection of the information you see because it only shows you certain content that is already related to your existing ideas. This confirmation bias can end up making your attachment to your existing ideas and disbelief in opposing ideas stronger. By limiting different viewpoints, you are more likely to believe that your viewpoint is the best or only viewpoint.

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CLAIM *YES* **Social media is harmful to teens' mental health**

CLAIM *NO* **Social media is not harmful to teens' mental health.**

CLAIM ENVELOPE (YES OR NO)	CARD NUMBER	CARD TITLE	SUPPORTS / HELP REFUTE

CLAIM *YES* **Social media is harmful to teens' mental health**

CLAIM *NO* **Social media is not harmful to teens' mental health.**

CLAIM ENVELOPE (YES OR NO)	CARD NUMBER	CARD TITLE	SUPPORTS / HELP REFUTE
YES	*1*	*Teen Article*	*Supports*
YES	*2*	*Bullying Study*	*Supports*
YES	*3*	*Survey: Social Media Use*	*Supports*
YES	*4*	*Survey: Negative Feelings*	*Supports*
NO	*1*	*Personal Narrative*	*Helps Refute*
NO	*2*	*COVID-19 Study*	*Helps Refute*
NO	*3*	*Survey: Connection*	*Helps Refute*
NO	*4*	*Survey: Positive Feelings*	*Helps Refute*

CLAIM *YES* **Social media is harmful to teens' mental health**

CLAIM *NO* **Social media is not harmful to teens' mental health.**

CLAIM ENVELOPE (YES OR NO)	CARD NUMBER	CARD TITLE	SUPPORTS / HELP REFUTE
NO	*1*	*Personal Narrative*	*Supports*
NO	*2*	*COVID-19 Study*	*Supports*
NO	*3*	*Survey: Connection*	*Supports*
NO	*4*	*Survey: Positive Feelings*	*Supports*
YES	*1*	*Teen Article*	*Helps Refute*
YES	*2*	*Bullying Study*	*Helps Refute*
YES	*3*	*Survey: Social Media Use*	*Helps Refute*
YES	*4*	*Survey: Negative Feelings*	*Helps Refute*

Actively Open Mindset

A metacognitive tool

Sources

Evaluate the credibility of your source.

Evidence

Seek out evidence for and against claims.

Alternatives

Consider alternative explanations.

New Information

Consider how new information might change your thinking.

CARD 1 CLAIM: YES

Teen Article

Excerpt of a personal narrative titled *I'm an American teen lured by social media. It's ruining our lives.*

"... I began using social media in middle school. The promotion of unrealistic body standards made me question my self-esteem. I spent hours comparing myself to girls on these sites who presented themselves in a sexualized manner. It wasn't long before I was posting [inappropriate] content myself to be [more] desirable among my peers. Likes became addictive and validating. I craved them, and, because the posts were inappropriate, I needed to hide them from my parents by creating fake accounts or blocking them from certain posts. The result of this deceitful behavior was isolation and depression."

SOURCE: Roy, a San Diego teen in a 2024 opinion article written for the *San Diego Union-Tribune* newspaper.

CARD 2 CLAIM: YES

Bullying Study

Findings from a scientific analysis of 42 studies between 2010 and 2021 from various countries to compare the effects of traditional bullying (TB) and cyberbullying (CB).

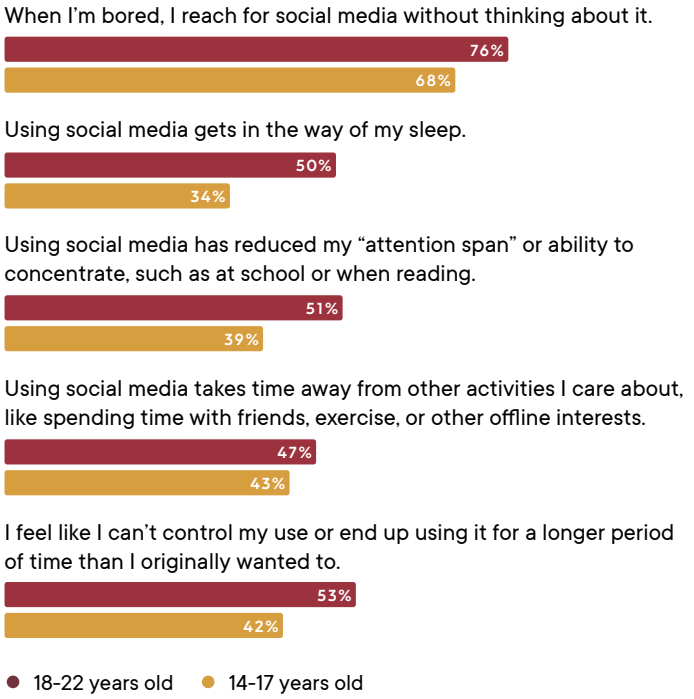
"... The prevalence of TB (traditional bullying) victims was about twice that of CB (cyberbullying) victims. About one-third of youth who [primarily] suffered TB also suffered CB. Conversely, two-thirds of youth who [primarily] suffered CB also experienced TB... Suicidal ideations, suicide attempts, and self-harm are at higher risk with CB than with TB... Victims who experienced both TB and CB had a substantial increase in both suicide-related and depression risks."

SOURCE: 2022 Peer-reviewed scientific study published in a journal called *European Child & Adolescent Psychiatry*.

CARD 3 CLAIM: YES

Survey: Social Media Use

Percent of social media users who agree with the following statements:



SOURCE: 2023 Survey conducted by Common Sense Media, a nonprofit organization that evaluates digital resources for students and parents.

CARD 4 CLAIM: YES

Survey: Negative Feelings

Percent of teens who say the following about social media:

45% feel overwhelmed by all of the drama there.

43% feel pressure to only post content that makes them look good to others.

37% feel pressure to post content that will get a lot of likes and comments.

SOURCE: 2018 Survey "Teens' Social Media Habits and Experiences" front the Pew Research Center, a nonprofit, nonpartisan research group that collects data on public opinions on social issues.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 4: EVIDENCE FOR CLAIM YES CARDS

CARD 1 CLAIM: NO

Personal Narrative

Excerpt of a personal narrative titled *How Social Media Saved My Mental Health.*

"I was seventeen when I developed agoraphobia [fear of leaving home]. Slowly my world became smaller and smaller until it consisted of just my house. I lost my friends, hobbies, and sense of self.
All I had was the internet. Without it, I would have been closed off from the world. I had no friends to chat with about current events, so the internet was how I stayed up to date with the outside world. I couldn't join a group to do my hobbies or be in a classroom to study. Fortunately, I was able to do these things through the internet. But what helped to keep me human was social media."

SOURCE: Laura Fox, in a 2021 opinion article written for *Medium*, an online publication.

CARD 2 CLAIM: NO

COVID–19 Study

Findings from a scientific study done on a sample of more than 700 children (ages 11–17) in Peru during COVID–19 lockdown in 2020.

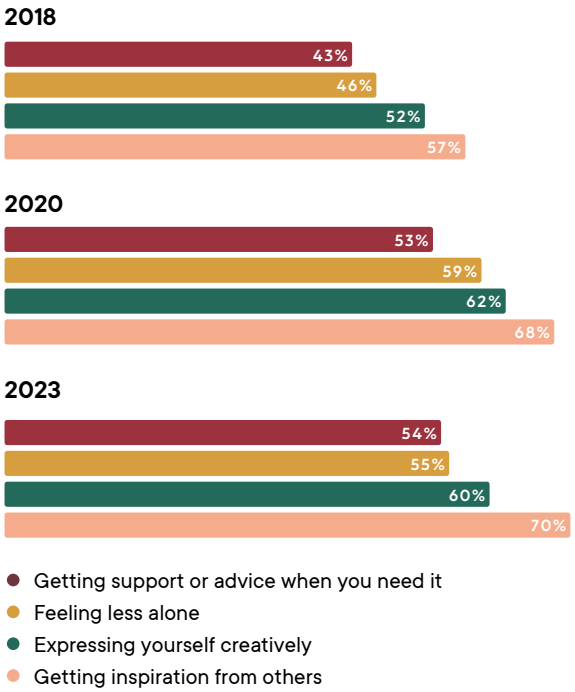
"... COVID–19 lockdowns have disrupted adolescents' in-person social networks, increasing the likelihood of loneliness. Social media can help adolescents maintain and develop peer relationships across distance... We investigated whether online experiences relate to loneliness during initial stages of lockdown. Loneliness remained constant between weeks 6 and 11 of lockdown... Greater positive online experiences related to lower loneliness, with the reverse pattern for negative online experiences. Our results suggest that positive online experiences may [help reduce] loneliness during physical isolation."

SOURCE: 2021 Peer-reviewed scientific study published in the *Journal of Research on Adolescence*.

CARD 3 CLAIM: NO

Survey: Connection

Percent of social media users age 14–22 using it for connection and creativity:



SOURCE: 2023 Survey conducted by Common Sense Media, a nonprofit organization that evaluates digital resources for students and parents.

CARD 4 CLAIM: NO

Survey: Positive Feelings

Percent of teens who say the following about social media:

81% feel more connected to their friends.

69% think it helps teens interact with a more diverse group of people.

68% feel as if they have people who will support them through tough times.

SOURCE: 2018 Survey "Teens' Social Media Habits and Experiences" front the Pew Research Center, a nonprofit, nonpartisan research group that collects data on public opinions on social issues.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 4: EVIDENCE FOR CLAIM NO CARDS

ACTIVITY 5

Reducing Cognitive Biases

INVESTIGATION

ACTIVITY 5

Reducing Cognitive Biases

ACTIVITY SUMMARY

Students explore four common cognitive biases they may experience in their daily lives. These include confirmation bias (introduced in Activity 4), conflict of interest, conformity bias, and emotion bias. Students then practice recognizing these cognitive biases in stories from the Southsand fever scenario. This investigation helps them reflect on how to apply an actively open mindset to cognitive biases to support evaluating information in decision-making.

ACTIVITY TYPE
INVESTIGATION

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

1. There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.
2. Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.
3. Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.
4. An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

cognitive bias
an unconscious and systematic error in thinking

conflict of interest
a situation in which an interest in the outcome may compromise a person's actions or conclusion

conformity bias
a tendency for a person to change their thoughts and actions to fit in with the other people around them

emotion bias
a tendency for a person to depend on their emotions to make a conclusion

TEACHER BACKGROUND INFORMATION

Cognitive Biases

Psychologists have identified over 150 different cognitive biases that arise from the attempt to speed up decision-making by simplifying information. Cognitive bias is most present in fast thinking but can also be part of slow thinking. For example, while researching an essay with slow thinking, cognitive biases can affect how you select and evaluate evidence, resulting in missed facts and possibilities. Cognitive biases can lead to

- ignoring competing explanations.
- misinterpreting details.
- mistaking random patterns and coincidence as meaningful.
- accepting misinformation in order to justify one's ideas.

Conflict of Interest

Although conflict of interest is not always considered a cognitive bias, there is some research that suggests that it may be. With conflict of interest, the existence of a competing interest for someone in a position of power creates a strong risk that their objectivity will be undermined, leading to other potential biases, unfair advantage, or a breach of trust.

Conformity Bias

Conformity bias is the tendency to change your thoughts and actions to be like others, often to fit in. This bias can take the form of informational conformity (assuming the group knows best) or behavioral conformity (choosing to act like others, often to fit in socially). This bias is thought to be caused by a subconscious desire for connection, often resulting in the mimicry of others' languages and mannerisms.

Emotion Bias

Emotion bias is actually a set of several biases that are governed by emotions. Often, someone's emotions can unconsciously steer their choices away from objective facts or rational analysis. This is because strong emotions such as anger, sadness, joy, and love can make it difficult for us to think logically about the benefits and drawbacks of the different options. For instance, loss aversion—the tendency to feel the pain of a loss more strongly than the pleasure of an equivalent gain—is a common emotion bias. For example, this cognitive bias could cause a person to hold onto poorly performing investments too long despite what objective evidence suggests. These biases are generally more spontaneous and persistent than other cognitive biases, making them particularly difficult to overcome.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 5.1 "Cognitive Biases"
- VISUAL AID 4.1 "Actively Open Mindset" (OPTIONAL)
- VISUAL AID 2.1 "Developing Communication Skills" (OPTIONAL)

FOR EACH GROUP OF FOUR STUDENTS

- SET OF SOUTHSAND FEVER STORY CARDS (7 cards)

FOR EACH STUDENT

- STUDENT SHEET 5.1 "Evaluating Cognitive Bias in Southsand Fever Stories"
- STUDENT SHEET 5.2 "Frayer Model: Cognitive Bias" (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts and Skills" (OPTIONAL)

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10 MIN)

1 **Review the concept of confirmation bias introduced in Activity 4.**

- Have students participate in a simple game to review the concept of confirmation bias introduced in Activity 4.
  - First, let students know that you have a rule in mind for a number sequence. It is their job to figure out your rule. The actual rule (which you keep to yourself) is simple: Each number in the sequence must be larger than the one before it.
  - Students try to figure out the rule by providing a set of 3 numbers and asking you if their proposed set obeys the rule. You may not give them any information about the rule, but students can guess it, and you may tell them if it is correct or incorrect.
  - Begin by providing the sequence 2, 4, 8 and ask for student guesses for the rule. Most students will try to confirm a rule they already have in their head, such as ascending even numbers, rather than guess 3 numbers that would disprove the rule they are considering. For instance, someone who believes the rule is that the sequential numbers are doubled might guess 4, 8, 16 or 10, 20, 40 instead of trying an incorrect sequence such as 8, 4, 2 to see if they were wrong. Incorrect guesses are essential in the game to illuminate the correct rule efficiently.
- When the game is over, ask, How was the experience in the game related to confirmation bias? Students should recognize that if they were only testing numbers that fit with a rule they had in mind (searching for a *yes* to their idea), they were only seeking information based on their pre-existing belief instead of asking questions that would have proved them wrong (searching for a *no*). The exercise is an example of confirmation bias in that people want to confirm the truth with similar data (pattern matching) instead of getting to the truth by proving false data (edge-case detection). Both approaches have value, but the latter is critical. In science, experiments are designed to disprove ideas. When they can't be disproven, it may lead to an incorrect hypothesis.

2 Introduce the focus of the activity on additional common cognitive biases.

- Have students read the Introduction in the Student Book. The Introduction can be shared with the class in multiple ways. Read the Introduction aloud to the class or have individual students read it aloud while others follow along with the text (either as a whole class or in small groups).
- Reading the Introduction aloud can better support comprehension for many students, including neurodiverse students and emerging multilingual learners who often have more highly developed listening and oral skills than reading comprehension skills. Alternatively, students can read the scenario independently.

PROCEDURE SUPPORT (30 MIN)

3 Support groups as they work with the cards to learn about Southsand fever stories.

- In Procedure Step 1, distribute the set of Southsand Fever Story cards to each group and have each group member read one of the cards aloud until all 7 cards have been read.
- For students who need support reading the cards, have students divide into pairs and preread them. They can describe the content of each story by using whatever modality is most comfortable, such as verbal (story) or visual (drawing). If there is time, students could find a generic picture on the Internet that matches each description.
- For students who struggle with the amount of reading on the cards, another option is to limit the cards to Cards A–D, which provide one story per cognitive bias.
- After students have learned about four various cognitive biases in Procedure Step 2, you may want to briefly discuss the term *cognitive bias*. Ask, How do you think cognitive bias is related to the common term *bias* that is used in everyday language? Students should understand that bias refers to when someone's thinking, actions, or memories are influenced, either consciously or unconsciously. Unlike the scientific use of *cognitive bias*, the familiar term *bias* is often associated with social factors such as stereotypes and prejudices that can result in inequitable treatment.
- In Procedure Step 3, hand out Student Sheet 5.1, "Evaluating Cognitive Bias in Southsand Fever Stories," to each student. Circulate and support students as they sort the cards related to the different biases. Encourage students to explain their reasoning about how different cards relate to each of the different biases.
- Some students may have strong negative experiences with bias in their lives. This might include experiences related to racism, sexism, and discrimination based on their socioeconomic status. Listen to and validate student's experiences if they are willing to share.

- After Procedure Step 3, you may want to pause the class to formatively assess that students understand the cognitive biases they've been investigating. Review student responses to Student Sheet 5.1 and clarify any questions that students have about the cognitive biases. A sample student response for Student Sheet 5.1 is found at the end of this activity.

- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition by adding additional terms for the unit to the word wall. Record the terms *cognitive bias*, *conflict of interest*, *conformity bias*, and *emotion bias* and provide an example as needed. For more information on a word wall, see Appendix 1: Literacy Strategies.

4 Students brainstorm ways to reduce cognitive bias in the Southsand fictional scenario.

- In Procedure Steps 4 and 5, support students as they discuss a few strategies to reduce the cognitive bias described in each story. Remind students that the primary way they were able to combat shortcuts earlier in the unit was to increase the amount of evidence they were considering. In the case of cognitive biases, confirming the credibility of the source of evidence is also helpful in reducing cognitive biases.

- If students need help coming up with ideas for reducing cognitive bias in the stories, you may want to model how to do this, using one of the sample student responses on Student Sheet 5.1 .

- If helpful for completing Procedure Step 6, remind students to look at the Actively Open Mindset summary in the Student Book.

Sample Student Response, Procedure Step 6

How representative are the Southsand fever stories to real-world behavior?
The stories from Southsand fever are similar to real-world stories. The stories have fictionalized people and situations, but the cognitive biases are the same as what we find everyday.

How might you apply the strategies from Step 4 in your everyday life?
Checking the credibility of the sources is a good way to reduce bias. Looking at evidence for both sides is also helpful. Most of all, using an actively open mindset is the best way to try to reduce biases. This metacognitive tool can help me identify when there is bias in a conclusion.

- When students share their experiences in Procedure Step 7, lead a discussion that helps connect the biases in the Southsand fever scenario with the real world. Students should find similarities between our everyday experiences and the stories they read, and that using an actively open mindset is an important strategy to reduce cognitive biases of all kinds.

- Conclude the discussion by asking, What experiences from this activity have you had with cognitive biases in your daily life? Responses will vary depending on student experiences. In particular, students are likely to relate to the conformity bias and recognize its similarities to peer pressure. Their responses may include experiences of giving in to what their classmates and friends want so they can fit in. When sharing experiences, students may notice that confirmation bias online can be very difficult to spot compared to other biases, unless the claim is obviously outrageous.

SYNTHESIS OF IDEAS (10 MIN)

5 Consider the role of credible sources to reduce bias.

- Although not covered directly in the activity, using credible sources are part of an actively open mindset. When discussing the ways to reduce bias, the reliability of a source may come up. Especially with short online postings, using a credible source can reduce bias.
- If appropriate for your students, review some specifics about credible sources, which were presented in Activity 3 and as shown in the following table.

MORE TRUSTWORTHY SOURCES	LESS TRUSTWORTHY SOURCES
• written by scientists or other experts who study the topic • written by journalists that frequently focus on the topic • include references and links to actual data, scientific research, or primary sources (such as interviews) • published by news or research organizations	• do not contain any data, research, primary sources, or references • provide links that go to websites that do not provide research or data • not written by experts • written by someone whose experience is not relevant to the topic • published on social media, blog sites, or by influencers

- If it hasn't come up, point out to students that the presence of bias in a source does not necessarily mean the information isn't useful. However, they should be aware of it and always keep its shortcomings in mind.

6 Connect the concept of cognitive bias to fast thinking and slow thinking.

- When students were introduced to cognitive shortcuts in Activity 3, one of the main points was that shortcuts are closely related to fast thinking. In contrast, cognitive biases can be present with either mode of thinking. Slow thinking is not immune to cognitive biases—they can occur even when someone is looking at any amount of evidence. For example, cherry-picking data examples from Activity 4 are a type of confirmation bias that can occur when there is ample evidence. Equally common is to have a bias, such as emotion bias, when there isn't enough evidence. Conclusions or claims using cognitive biases are most likely to occur when there is
  - too much information (information overload).
  - not enough information (ambiguity).
- Emphasize that cognitive biases can often lead to weak conclusions, regardless of whether fast thinking or slow thinking is used.

- Finally, remind students that more than one cognitive bias may be present in a given situation, influencing a person's judgement or opinion simultaneously. Cognitive biases can also occur at the same time as fast thinking, and these two types of cognition can lead to or exacerbate one another.

- Present an analogy for how cognitive biases are similar to cognition that has become colored or distorted. This is similar to how different kinds of sunglasses can color or distort how you see the world. Display Visual Aid 5.1, "Cognitive Biases," while describing this colored-glasses analogy.

- As with cognitive shortcuts, it's important for students to understand that cognitive biases can influence behavior without a person being aware of it. Since many conclusions are unconscious, it is extremely difficult to confirm that another person was influenced by a bias in a specific situation.

7 Review the role of an actively open mindset to reduce cognitive biases.

- Support student understanding that cognitive biases can be reduced by using an actively open mindset. This metacognitive approach helps someone be more aware of their own ideas and more open to other ideas and possibilities. Review this idea by referring to the Actively Open Mindset summary in the Student Book or by displaying Visual Aid 4.1, "Actively Open Mindset," that you introduced in Activity 4. Relate each of the following items to examples in the Southsand fever stories where the individual items could have reduced the storyteller's cognitive bias:

  Sources
  Card G: Gill's thinking is dependent on one blog that is not credible. She even says that she doesn't fact-check, so she should look for a more credible source of information.

  Evidence
  Card A: Santiago's information—that almost 30% of people who were infected had dogs as pets—is very limited. He is selecting only that information and then interpreting the evidence to confirm his beliefs. He would do better to look at more evidence, especially evidence that refutes his idea.

  Alternatives
  Card F: Trevor did not consider alternative ideas, namely, that his diagnosis may not be Southsand fever. Because he didn't consider other possibilities and waited so long to see a doctor, his illness needed more aggressive treatment.

  New information
  Card B: Jiwoo is not seeking new information because she earns money through affiliate links, whether the products work or not. Without considering other information, her reviews will not be impartial.

8 Support students' vocabulary development related to cognitive biases.

- To support the development of new vocabulary and concepts during the activity, consider using a Frayer Model with students as shown on optional Student Sheet 5.2, "Frayer Model: Cognitive Bias." For the concept of cognitive bias, the model can be introduced in the beginning of the activity, filled out as the activity unfolds, and reviewed at the end of the activity. For more information about the Frayer Model, see Appendix 1: Literacy Strategies.

9 **Build Understanding items and Connections to Everyday Life items can be used to review the main ideas of the unit.**

- In Build Understanding item 1, encourage students to do something creative, such as make a video or create a visual. This foreshadows what they will do in Activity 10 when they generate a Public Service Announcement (PSA) and present it to the class.
- In Connections to Everyday Life items 3 and 4, students connect cognitive biases to what they see online. This can be a continuation of the discussion in Activity 2 when students judged their fast-thinking responses to news headlines. Connect the idea of rage bait in item 3 and the personal video format in item 4 with the attempt of social media posters to generate a quick emotional response. Discuss how students can reduce their susceptibility to these posts by using an actively open mindset.
- To conclude the activity, evaluate whether your students are able to answer the Guiding Question, *How do cognitive biases shape everyday decisions?* Use this as a chance to revisit and summarize the key concepts and process skills of the activity as it relates to identifying cognitive biases.
- You may wish to have students revisit optional Student Sheet 1.3, "Unit Concepts and Skills," and add information about the concept of cognitive bias.

EXTENSION (20 MIN)

10 **Use the Extension as an opportunity for advanced learning.**

There are an infinite number of examples of cognitive biases that students can find from online information. Encourage students to compare social media posts they find online directly to the cards provided in the activity for verification or to investigate one of the many cognitive biases that were not addressed in the activity.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **With a partner, come up with your own everyday example for each cognitive bias presented in this activity. Choose one of the following activities to creatively communicate the bias.**

- **Write a narrative story.**
- **Draw a picture or diagram.**
- **Make a short video.**

Narrative story

Liam personally finds a certain brand of oversized, brightly colored athletic shoes unattractive and expensive. However, his most popular peers have started wearing these shoes and talk about them constantly. Despite his dislike, Liam asks his parents to buy him the shoes. He worries that if he doesn't wear them, he will be seen as uncool.

② **The presentation of information may contain cognitive bias. Does that mean you should always doubt the information it provides? Why or why not?**

No. The information itself might still be good information, but you should pay attention to the claims that are made from the information. It would also be important to find additional evidence about the claims to put the information into perspective.

CONNECTIONS TO EVERYDAY LIFE

③ **Rage bait is a type of content that is designed to get a strong reaction from the viewer. The purpose is to spread ideas (often misinformation) or to generate engagement on social media. Explain which cognitive bias(es) from this activity could influence someone's reasoning when they see rage bait.**

I think emotion bias, because rage bait is trying to make people feel strong emotions in order to influence their thinking. I also think confirmation bias could be involved because when people have really strong feelings about their existing beliefs, sometimes they get really mad or worked up about them.

④ **Many social media platforms use a format of a short video where the person posting speaks directly to the camera, which mimics having a personal conversation with the viewer. In addition, influencers often share stories about their lives, which makes their posts feel authentic and relatable.**

a What cognitive bias(es) does this kind of format promote? Explain your answer.

I think it is the emotion bias, because you feel like you know this person and they are your friend. You have an emotional connection to them, which could make you more likely to believe what they say.

b What might be some of the consequences of this cognitive bias?

It may be misleading if you trust this source of information without a lot of evidence. You might be likely to pay more attention to other information they say, while ignoring or undervaluing information that conflicts with their ideas. This reinforces and spreads what the influencer is claiming, even if it is not accurate or trustworthy information.

STUDENT SHEET 5.1 | EVALUATING COGNITIVE BIAS IN SOUTHSAND FEVER STORIES | NAME

STORY	COGNITIVE BIAS	HOW BIAS APPEARS IN THE STORY	STRATEGIES TO REDUCE THIS BIAS
CARD A **Santiago**			
CARD B **Jiwoo**			
CARD C **Mohamed**			
CARD D **Maria**			
CARD E **Georgia**			
CARD F **Trevor**			
CARD G **Gill**			

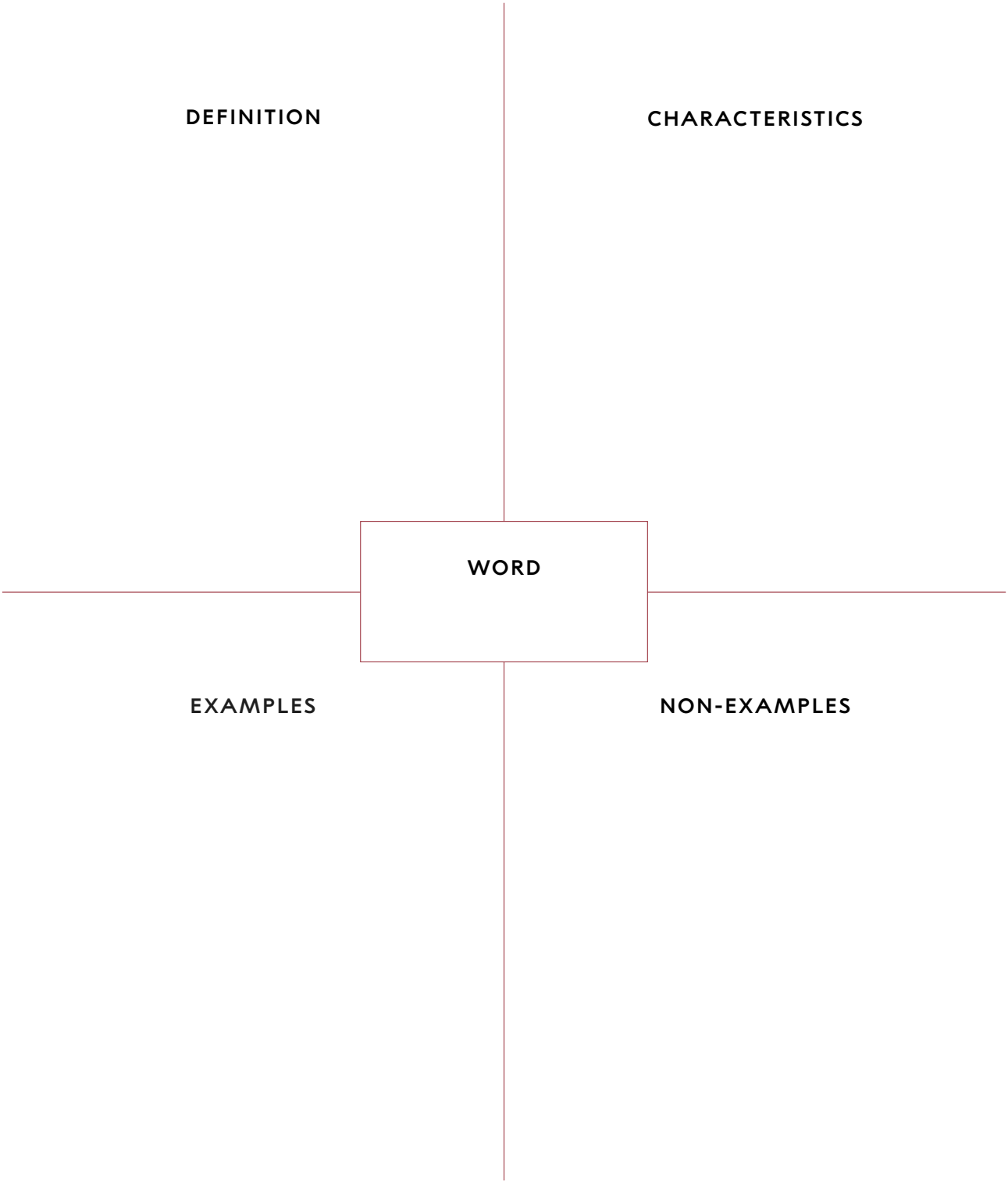
STUDENT SHEET 5.1 | EVALUATING COGNITIVE BIAS IN SOUTHSAND FEVER STORIES | NAME SAMPLE STUDENT RESPONSE

STORY	COGNITIVE BIAS	HOW BIAS APPEARS IN THE STORY	STRATEGIES TO REDUCE THIS BIAS
CARD A **Santiago**	*confirmation bias*	*He interpreted the data in a way that fit with his idea about Southsand fever.*	*Look for more information from other sources.*
CARD B **Jiwoo**	*conflict of interest*	*She gives good reviews to products because she earns money through affiliate links.*	*Check other online reviews of the products.* *Look for a review that doesn't have affiliate links.*
CARD C **Mohamed**	*conformity bias*	*He had been wearing a mask everywhere but then went to a party and didn't want to stand out, so he took off his mask.*	*Don't worry about it.* *Try to ask others why they are not wearing masks to understand their reasons.*
CARD D **Maria**	*emotion bias*	*Maria donated all her money because she felt bad for the sick patients.*	*Research other charity organizations to see if any of them would be better to donate to.*
CARD E **Georgia**	*confirmation bias*	*She only selects information from the* Southsand Chronicle *to read, because she believes they report what she knows to be true.*	*Look at other newspapers to see if they are reporting the same facts.*
CARD F **Trevor**	*emotion bias*	*He didn't want to go to the doctor because he was worried that a diagnosis of Southsand fever would ruin his planned trip.*	*Don't let your emotions keep you from evaluating the evidence you have.* *Consider other explanations for symptoms.*
CARD G **Gill**	*confirmation bias: biased selection, conformity bias*	*She only used information that came from the conspiracy blog site and matches her existing ideas.* *She believes the hoax because her relatives believe it.*	*Look for more trustworthy sources. A blog about conspiracy theories is probably cherry-picking data.* *Consider other explanations for Southsand fever and evidence for and against the idea of it being a hoax.*

STUDENT SHEET 5.2

FRAYER MODEL: COGNITIVE BIAS

NAME



DEFINITION

an unconscious and systematic error in thinking

CHARACTERISTICS

- *usually done unconsciously*
- *errors are predictable*
- *happens in both fast thinking and slow thinking*

WORD

cognitive bias

EXAMPLES

- *confirmation bias: confirming existing beliefs*
- *conflict of interest: money or loyalty make it hard to make fair decisions*
- *conformity bias: changing to fit in*
- *emotion bias: emotions overpower reasoning*

NON-EXAMPLES

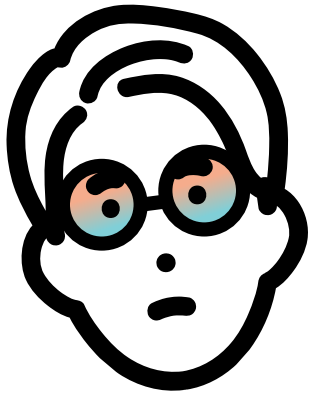
- *carefully controlled scientific experiments*
- *trying to prove yourself wrong*
- *updating your ideas when you encounter new information*

FAST THINKING

- Automatic
- Effortless
- Often done unconsciously
- Based on mental shortcuts
- More prone to error

Example of Cognitive Bias Affecting Fast Thinking:

Being overconfident in the accuracy of your judgements when making a quick decision



SLOW THINKING

- Deliberate
- Effortful
- Careful attention used
- Based on reasoning
- Less prone to error

Example of Cognitive Bias Affecting Slow Thinking:

Only gathering information that favors your existing ideas when researching a topic

Cognitive Bias

can be like wearing colored glasses that distort how you see the world.

CARD A

Santiago believes you can get Southsand fever from your pets. He knew 2 people who got Southsand fever who had dogs. Then he heard on the news that almost 30% of people who were infected have dogs as pets. "See," Santiago told his friend, "that evidence shows that having a dog increases your chances of getting Southsand fever."

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD B

Jiwoo has a lot of followers on her social media. She reviews a lot of healthcare products because it generates the largest numbers of viewers. Lately, she has been reviewing supplements that might help fight Southsand fever. While she likes some of the products, she knows that there is not much evidence showing that they cure any disease, let alone Southsand fever. It doesn't bother her though, because she earns money through affiliate links whether the products work or not.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD C

Mohamed was not concerned about the outbreak of Southsand fever. He knew some people were wearing masks, especially while at work, to protect themselves. He didn't know anyone who was sick, but he decided to wear a mask at work and when he was out with groups of people. One day, he went to a large party for a coworker, and he noticed no one was wearing a mask. He felt like he didn't fit in, so he took off his mask and put it in his pocket.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD D

Maria's mom had Southsand fever and was very ill for a long time. Maria was extremely worried and felt helpless in that situation. Several weeks later, Maria was at the store where she saw a flyer. It requested donations for the local hospital to treat patients with Southsand fever. The flyer showed pictures of cute sick kids and elderly patients. Maria felt badly for the people in the pictures and remembered her mom's experience. Maria donated all the money to the hospital that she had planned to spend at the store.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD E

Georgia reads the *Southsand Chronicle*, and only the *Southsand Chronicle*, as a news source. She believes they report what she knows to be true—that Southsand fever is already everywhere. She almost always agrees with the articles, especially since she selects the ones that appeal to her. She sees no need to read other perspectives.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD F

Trevor developed a cough a few days ago. He was worried about getting Southsand fever because he had planned a trip. He refused to go to the doctor even when he started to feel worse. He thought, *If I go to the doctor, I might have Southsand fever and that would ruin my trip.* He ignored his symptoms because he was so worried, but he continued to feel worse. Finally, his friend convinced him to go to the health clinic. He was not diagnosed with Southsand fever, but he waited so long to see the doctor that his illness needed more aggressive treatment.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

CARD G

Gill thinks that Southsand fever is a hoax because everyone in her family, including her parents, thinks so. She thinks the government made up the disease so they could inject patients with microchips when they go to the hospital. She recently found a blog called *Southsand Secrets* that describes possible government conspiracies. It argues that the absence of any clear evidence for such conspiracies must mean that the city is hiding the evidence. Gill has always felt that there was a conspiracy and that article proved it to her. She believes *Southsand Secrets*, so she doesn't fact-check any of the information from it.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 5: SOUTHSAND FEVER STORY CARDS

ACTIVITY 6

Evaluating a Scientific Claim

GAME

ACTIVITY 6

Evaluating a Scientific Claim

ACTIVITY SUMMARY

In this activity, students play a game that simulates an epidemiological investigation in the Southsand fever scenario. Students gather and analyze data about the fictional disease to determine the mode of transmission of Southsand fever. The task includes the slow, actively open-minded techniques they learned in the unit so far to investigate a series of hypotheses they develop. The activity concludes when students completely evaluate the evidence and construct a claim about how Southsand fever spreads.

ACTIVITY TYPE
GAME

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

1 Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.

2 An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTIONS:
Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. (*Science and Engineering Practice: Engaging in Argument From Evidence*)

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. (*Science and Engineering Practice: Engaging in Argument From Evidence*)

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

disease transmission
(assumed prior knowledge)
the various ways that infectious diseases can spread

epidemiologist
a scientist who studies the patterns, causes, and control of disease in groups of people

hypothesis
(assumed prior knowledge)
a possible explanation for observations, facts, or events that may be tested by further investigation

TEACHER BACKGROUND INFORMATION

Disease Outbreak Response

Potential outbreaks can be identified by surveillance systems that monitor health-related events and data from sources such as hospitals, clinics, laboratories, healthcare providers, schools, public reports, or even social media trends. A public health team will respond to an outbreak in three major stages that identify the outbreak, find the cause of the outbreak, and then manage the outbreak. The order of these steps and the work needed for each step will vary depending on the outbreak. For example, public health teams will often implement prevention and control measures (e.g., recommending hand washing) before they know the exact cause or source.

Identifying the Outbreak

In the first stage, epidemiologists will compile a list of possible illnesses and establish a public health team. Next, they will establish if an outbreak is actually occurring by comparing the current case count to historical data. They consider the speed and severity of the illness to decide if it is an outbreak. If possible, a laboratory professional will also verify the diagnoses and identify the disease-causing agent. Once an outbreak is confirmed, a detailed case definition is established to identify which individuals are to be considered affected by the outbreak. A public health team then systematically collects and records information on affected individuals including demographics, symptoms, and potential exposures. All the relevant data for each case is compiled in a table called a line list. Biostatisticians will then analyze the data to identify patterns and trends such as similarities in age, location, or activities among cases.

Finding the Cause of the Outbreak

In the second stage, investigators attempt to pinpoint the source of the outbreak. This often involves constructing epidemiological curves, which visualize the distribution of cases over time. By examining these curves, patterns emerge that can suggest the nature of the outbreak, such as a point source, common source, or propagated outbreak. Environmental investigations may also be conducted to identify potential contamination sources. The public health team will develop hypotheses based on relevant information (e.g., usual sources of the disease-causing agent, the cluster or spread of the disease, age groups affected), and a biostatistician will evaluate the hypotheses by comparing the rates of affected

and unaffected populations with the same exposure factor. If there is a strong association between a given factor and the illness, further collection of environmental data or tests looking for the disease-causing agent can be used to confirm the epidemiology data.

Managing the Outbreak

In the third stage, the public health team attempts to control the spread of disease, prevent further cases, and identify measures to improve public health preparedness for future outbreaks. This can include the collaboration of various public health professionals. Infection prevention specialists will contact or visit source areas to inspect and recommend actions to prevent spread; behavioral scientists will consider human interactions to try to decrease exposure. Health communication specialists will create messaging and reach out to the public by providing information about prevention, symptoms, community resources, and treatment, if available. In the meantime, the public health team will initiate and maintain a surveillance system for the outbreak. By continuing to collect and analyze data, they monitor if the disease is decreasing and if the control measures are working.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 6.1 "Scoring Guide: Engaging in Argument from Evidence (ARG)"
- ITEM-SPECIFIC SCORING GUIDE: Activity 6, Build Understanding Item 1
- VISUAL AID 4.1 "Actively Open Mindset"
- VISUAL AID 2.1 "Developing Communication Skills" (OPTIONAL)

FOR EACH GROUP OF FOUR STUDENTS

- SOUTHSAND CITY GAME BOARD
- SET OF INTERVIEW CARDS (12 cards)
- SET OF DATA CARDS (6 cards)
- SET OF EVENT CARDS (6 cards)
- NUMBER CUBE
- 4 GAME PIECES
- STUDENT SHEET 6.1 "Southsand Fever Hypotheses"
- STUDENT SHEET 6.2 "Evidence from Interviews: Infected People"
- STUDENT SHEET 6.3 "Evidence from Interviews: Healthy People"
- STUDENT SHEET 6.4 "Field Notes from Data Cards and Event Cards"

FOR EACH STUDENT

- STUDENT SHEET 6.5 "Comparing Infected and Healthy Individuals" (OPTIONAL)
- STUDENT SHEET 6.6 "Writing Frame: Activity 6, Build Understanding Item 1" (OPTIONAL)
- SCORING GUIDE: Engaging in Argument from Evidence (ARG) (OPTIONAL)

To prepare for the game, print the game board map (two separate pages) and the three complete sets of cards for each group. The cards can be printed double-sided to show the card type on the back or printed one-sided and labeled on the back by hand before use. The game board map can be taped or glued together. The game pieces can be sets of any four items that are distinguishable and easily available from home or the classroom such as colored beads, coins, paper clips, or old marker caps.

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (20 MIN)

1 **Discuss the role of disease transmission in an outbreak.**

- Begin by asking, How are infectious diseases spread? Accept all responses at this time. Students may suggest that infectious diseases can spread from blood or other bodily fluids, direct physical contact, through the air on dust or in droplets (from coughing, for example), touching dirty surfaces, sexual intercourse, eating or drinking contaminated food or liquids, or by bites from insects or other animals. Build upon students' experiences with disease and allow them to brainstorm from lived experiences.
- Support students in sharing their knowledge about disease and validating their points of view by eliciting students' observations, experiences, and knowledge as assets to building understanding.
- If students are not familiar with the basics of disease transmission, review the process by referring them to the Science Review at the end of the activity in the Student Book. Some students may confuse infectious disease with contagious disease. If helpful, after brainstorming modes of transmission, have students review the Science Review from Activity 1. Clarify that infectious diseases are passed from any type of organism to another, whereas a contagious disease is an infectious disease passed from person-to-person.
- Students may also be confused by the difference between the organism that causes the disease (known as a pathogen, which is formally introduced in Activity 8) and the organisms through which the infectious disease spreads (called a vector). For example, fire blight is a disease that affects apple trees and pear trees; it is infectious because it spreads from tree to tree by wind or by insects or birds that visit between trees. However, the pathogen being spread from organism to organism that causes fire blight is a bacterium. The trees, insects, and birds are vectors.
- Ask, How would discovering the way an infectious disease is transmitted help to prevent more illness? Students may share that knowing how an infectious disease is transmitted helps to develop specific ways to stop it from spreading. This could either be ways of preventing infection (e.g., wearing masks, washing hands) or ways to reduce sick individuals from making others sick (e.g., isolating individuals at an early stage or developing vaccines). Let students know that in this activity, they are going to try to figure out how people in Southsand are getting sick.

PROCEDURE SUPPORT (40-60 MIN)

2 Introduce the fictional scenario and review the procedure for Part A.

- The scenario presented in Step 1 can be shared with the class in multiple ways. Read the scenario aloud to the class or have individual students read it aloud while others follow along with the text (either as a whole class or in small groups).
- Reading the scenario aloud can better support comprehension for many students, including neurodiverse students and emerging multilingual learners who often have more highly developed listening and oral skills than reading comprehension skills. Alternatively, students can read the scenario independently.
- Let students know that by playing a game to discover the modes of transmission of Southsand fever, they will conduct an investigation similar to how epidemiologists study diseases in real life. Emphasize that the goal of the game is to figure out as a team of four how Southsand fever is spreading—not as individuals trying to win their own group's play.
- Students will need to work together effectively to conduct the investigation. To support students' discussion, you may wish to use optional Visual Aid 2.1, "Developing Communication Skills," to help guide student interactions. This visual aid (introduced in Activity 2) 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. For more information about Developing Communication Skills, see Appendix 1: Literacy Strategies.
- Students begin by discussing how they think Southsand fever could possibly be spreading in the community. Student ideas will vary, depending on their background knowledge of infectious diseases. If appropriate, have students read the Science Review to help support their ideas.

Sample Student Response, Procedure Step 2

I think the disease is spreading through the air, like a flu or cold, but it is not a flu or a cold.

- In Procedure Step 3, show Visual Aid 4.1, "Actively Open Mindset," to remind students of the metacognitive prompts for an actively open mindset. While most students will focus on slow thinking, remind them that fast thinking can also be helpful.

Sample Student Response, Procedure Step 3

Hopefully, we will not use a lot of fast thinking and instead use more slow thinking as we figure out how people are getting sick in Southsand City. We should watch out for all the cognitive shortcuts and cognitive biases we learned about in the unit. One of the big ones we need to be careful of is confirmation bias because we all have ideas formed about how people are catching Southsand fever.

- Assign students to groups and distribute one copy each of the following student sheets to each group:
  - Student Sheet 6.1, "Southsand Fever Hypotheses"
  - Student Sheet 6.2, "Evidence from Interviews: Infected People"
  - Student Sheet 6.3, "Evidence from Interviews: Healthy People"
  - Student Sheet 6.4, "Field Notes from Data Cards and Event Cards"

  Explain that each group member will be in charge of recording information on only one of the four student sheets. Point out that this is similar to the way professional epidemiologists record a lot of data in order to find patterns in the data. An especially important sheet is Student Sheet 6.1, "Southsand Fever Hypotheses," as it is a way to record the groups' most plausible hypotheses and revise them as they collect evidence during game play. Sample Student Responses to all four student sheets are found at the end of this activity. (Note that for sample student response on Student Sheet 6.1, the listed relevant game cards in the last column relate to the hypotheses that are crossed-out as well as the ones that are not.)

- As groups record their ideas on Student Sheet 6.1, encourage them to discuss evidence they have that either supports or refutes each hypothesis. They should consider at least two hypotheses before they begin the game. Be sure to mention that scientists sometimes identify several hypotheses at the start of an investigation.
- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition as they read the Science Review, Field Notes in Part A (from Student Sheet 6.4), and the card sets and game materials in Part B.

3 Students revise their hypotheses after each round of play.

- In Procedure Step 6, distribute all the materials for the game to each group: a Southsand City game board, 4 game pieces, a number cube, a set of Interview cards, a set of Data cards, and a set of Event cards. Expect that students will take 4–5 rounds of play to circumnavigate the game board and draw most of the cards.
- After each team completes one round of play, they should stop and reconsider their hypotheses based on the evidence they have collected in that round. Procedure Step 9 guides students through this slow-thinking process. Emphasize that all group members are responsible for checking that each hypothesis still fits the evidence, regardless of who records it on Student Sheet 6.1.
- The hypotheses across groups might vary. Sample student hypotheses are provided on Student Sheet 6.1 at the end of this activity. At the end of the rounds of play, ask, Would you like more evidence to help determine if your hypotheses are correct or not? Responses will undoubtedly be yes; students will want more evidence to figure out how the disease is transmitted. Reinforce this idea of adding evidence as part of using an actively open mindset.
- As they play, let students know that even though they have at least one plausible hypothesis at this point, it is important for them to stay open to new information, alternative ideas, and to evaluate new evidence fairly as they continue the game.

- As students work through the evidence, they may have difficulty deciding when they have enough evidence to rule out a certain hypothesis or deciding on a correct hypothesis when definitive evidence is lacking. To help students deal with uncertainty, you can prompt them to consider the following when comparing hypotheses:
  - how strongly each piece of evidence supports or rejects a hypothesis
  - the number of pieces of evidence and what the combination indicates

  You may want to pause the play around the middle of the game and lead a shareout about each group's leading hypothesis. This allows students to compare their ideas and hypotheses. Keep in mind that at the midpoint of the game, groups have different data, so they are likely to have different ideas as a result.

4 Support groups as they analyze epidemiological data in Procedure Part B.

- In Procedure Step 11, students use the data they collected in the game to calculate the rates of infected and healthy individuals exposed to each factor in Table 6.1. If you would like to provide a preconstructed table instead of having each student make their own in their science notebook as instructed, provide optional Student Sheet 6.5, "Comparing Infected and Healthy Individuals." A sample student response to this student sheet is shown at the end of this activity.

- If needed, support students by modeling the percentage calculation by dividing the number of *yes* responses for a given factor by the total number of individuals interviewed. For students with limited mathematical ability, you may want to provide the completed calculation, using the sample student response to Student Sheet 6.5

- Using Student Sheet 6.5, review the percentages of infected and healthy individuals exposed to each factor. To help students interpret the data, discuss how epidemiologists compare the rates of infected and healthy groups for each factor to identify the most probable cause of an illness. A higher rate of people exposed to a factor (such as being a construction worker) in the infected group makes it more likely that the factor is related to causing the disease, while similar rates in both groups (such as eating locally grown corn) make it less likely that the factor is related. If there are similar chances of either becoming infected or remaining healthy, that factor is probably not causing the disease.

- Let students know that the type of analysis they completed in Procedure Step 12 is similar to how epidemiologists look for patterns in data, albeit with much more data and computer assistance.

5 Have a class discussion about how groups arrived at a final hypothesis.

- In Procedure Step 13, ask each group to share their final hypothesis(es) with the rest of the class. Ask, Can the class reach an agreement on a single explanation for transmission? Facilitate a discussion so groups can compare their ideas and try to reach a consensus. The sample size of the data is very limited, and making a strong conclusion is challenging. However, the following pieces of evidence may help clarify a claim they can make based on their final hypothesis:

- Many more people who worked outside became infected than those who have other types of jobs.
- Attending the kite festival is likely to be related to getting the disease because the difference in the number of people who attended the festival is higher than the number who attended and remained healthy.
- It is questionable if having a dog is likely to be related to causing the disease because the number of people who have dogs and became infected was higher than those who don't have dogs and became infected, but not by a large amount.
- Eating locally grown corn does not appear to be significant because there is the same percentage between infected and healthy individuals.

- In Procedure Step 14, hold a class discussion about how students did and did not engage in aspects of using an openly active mindset during the activity. Students may have experienced times in the game when they were aware that they jumped to a conclusion or used a cognitive shortcut or when they had confirmation bias.

Sample Student Response, Procedure Step 14

I tried not to use fast thinking during the activity, but the first card we drew made me jump to a conclusion. The first card made me think that the disease was foodborne. It was an availability shortcut because it was the first card we read. It was also one that supported what I thought was going on about Southsand fever before we started the game, so it also led to confirmation bias. After we paused the game, I slowed down my thinking, and that helped reduce cognitive shortcuts and cognitive biases.

SYNTHESIS OF IDEAS (20-30 MIN)

6 **Build Understanding item 1 can be assessed using Scoring Guide: Engaging in Argument from Evidence (ARG).**

- Remind students of the Engaging in Argument from Evidence (ARG) Scoring Guide. You may wish to project Visual Aid 6.1, "Scoring Guide: Engaging in Argument from Evidence (ARG)," for your students to review each level and clarify your expectations..
- Do not share the item-specific version of the Scoring Guide (Item-Specific Scoring Guide: Activity 6, Build Understanding Item 1) with students as it provides specific information on how to respond to the item prompt.
- Remind students that you expect to see them demonstrate growth in their understanding and explanation of engaging in argument from evidence and that they may want to review their responses to the assessment in Activity 3 (Build Understanding item 4). You may also want to let students know that they will have one more opportunity in the unit to be assessed (Activity 9, Build Understanding item 1).

- Sample responses for Levels 1–4 are provided in the Build Understanding section that follows. Review these responses to get an idea of what is expected for each level alongside the Item-Specific Scoring Guide. See Appendix 2: Assessment Resource at the end of the Teacher's Guide for more guidance and information on using the Scoring Guides and assessment system with your students.

- Depending on your students, you may want to have them provide feedback on one another's work for revision prior to turning in their work to you for scoring. Alternatively, consider having students turn in a rough draft to you for feedback and revision.

- The formal assessment opportunity can be completed by a variety of alternative options other than a written argument, including a presentation; creation of a graphic, poster, or video; or through a debate format. Consider whether any changes to the scoring guide or prompt will be necessary for students to complete an alternative assessment format.

7 Use Build Understanding item 2 to review the metacognitive aspects of the activity.

- Evaluate if your students can identify the essential ideas of the activity by reviewing their answers to Build Understanding item 2 as a class. Then ask, In what ways did slow thinking—such as using complex information, using math, considering the likelihood of an event, and considering alternate causes—help you to reach a final conclusion for your disease investigation? Students should realize that using:
  - percentages calculated from the data collected in the game helped to come up with the most likely factor related to causing the disease.
  - different kinds of evidence (data and observations from Interview cards, Data cards, and Event cards) increased the reliability of their conclusion by preventing it from being based on a single piece of information.
  - reasoning helped them to evaluate each piece of evidence as supporting or refuting different hypotheses and to combine evidence to reach a conclusion.

- Ask, In what ways did using an actively open mindset during your investigation help to prevent confirmation bias? Hopefully, students tried to use an actively open mindset during the game play to help them stay open to many different hypotheses and not to favor just one. In particular, this activity focused on the acquisition or need for new information when the evidence on hand is not enough to prove or disprove a hypothesis. Students should explain that an actively open mindset helped them prevent confirmation bias by encouraging them to:
  - stay open to many different hypotheses, rather than favoring a single one.
  - consider evidence for and against each hypothesis fairly and impartially.
  - be open to new information, even when that evidence directly refuted their current leading hypothesis.

  All of this should help students recognize that an actively open mindset motivates someone to follow the data wherever it leads, instead of just searching for information that confirms their existing beliefs.

- Finally, discuss with students what the epidemiologists would do after figuring out how Southsand fever is transmitted. Students should see that the next step would be to inform the public. This foreshadows Activity 10 when they will construct a Public Service Announcement (PSA) to do just that.
- Finish the activity by revisiting the Guiding Question, *How can an actively open mindset help to make a scientific claim?* Use responses to this question to formatively assess students' understanding of key concepts and process skills related to the purpose of using slow-thinking techniques and an actively open mindset.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① ARG Scoring Guide

How do you think Southsand fever is being transmitted? Develop an argument supported by evidence from your disease investigation. In your response:

- **a make a clear claim about how Southsand fever is or is not being transmitted.**
- **b support your claim, using at least 3 pieces of evidence gathered in the activity. Use reasoning to explain how each piece of evidence supports your claim.**
- **c describe and explain at least 1 piece of evidence against your claim or that supports an alternate claim. Use reasoning to explain why you still support your claim as the most likely.**

Student responses may vary but should include that the disease is spreading by breathing in dust particles that carry the disease instead of being spread from person to person.

Level 4 response

- **a** *My claim is that Southsand fever is being transmitted by breathing in dry soil particles in the air that contain the disease.*
- **b** *First, the interview data showed that the factor that made the biggest difference between the infected and healthy groups was being a construction or agricultural worker—82% (9 of 11) of people who got infected worked in one of those types of jobs, compared to only 36% of healthy people. Second, a survey found that 75% of patients with Southsand fever regularly work outdoors. Both of these strongly support the idea that working outside and near soil could be where people got infected because the numbers come from all the individuals interviewed, not just a few of them. Third, a couple of specific events also support my claim. For example, Lumi Hernandez and her dog both got sick after breathing in dust while on a hike. Similarly, a scientist became sick after digging up soil without wearing a mask. These are anecdotes, so they are weaker evidence than the interview information. But all together, it suggests that people are breathing in soil to get the disease, especially in dusty places such as construction sites.*
- **c** *An alternate claim is that the disease is spreading from person to person instead. The fact that most respiratory diseases are contagious supports this idea. However, other evidence does not support this claim. For instance, almost no healthcare workers have gotten sick with the disease over the last couple of months, even though they have treated a lot of very sick people. Likewise, the doctor got sick in the field while alone, so I still believe that it's most likely that the disease is spreading by breathing in soil particles.*

Level 3 response

a *I think it's being transmitted by people breathing in dust with the disease.*

b *My first piece of evidence is that Lumi and her dog got Southsand fever after going on a hike in dry soil and breathing in dust. Her dad never got sick later, even after she came home. This means that the disease is probably not spreading from person to person (is not contagious), and she got it from the dust. Second, a scientist was alone without wearing a mask and got sick when he was digging up soil samples. I think these are good pieces of evidence because both are firsthand accounts of what happened. My third piece of evidence is that most people who got Southsand fever were construction workers. All of this supports the idea that the disease could be spreading by breathing in the dust with the disease.*

c *One piece of evidence against my claim is that Chloe, a doctor in a hospital, caught Southsand fever. Since she works in a clean hospital and wears a mask, you wouldn't expect her to get sick from dust. However, she still could have been exposed to dust outside of work, just like Lumi was when she went on her hike.*

Level 2 response

a *The disease is spreading because of the soil.*

b *The scientist got sick when he was digging, showing that soil was the cause. Also, there was a dust storm at the end of the kite festival, and lots of people got infected after that.*

c *However, the number of dogs getting infected by the disease has been increasing. Because of this, we can't be sure if the soil or pets is spreading the disease.*

Level 1 response

a *A disease can be tracked by interviewing patients and using data from lab tests.*

b *Most of the people in Southsand City work in construction or agriculture.*

c *However, only some of them eat corn from local farms, which could have had the disease.*

② **Identify at least two cognitive thinking skills that were helpful in conducting your investigation. Explain why each was helpful.**

I used math as a slow-thinking technique to calculate the exposure rates and determine which factor was the most likely cause. An actively open mindset was important for my final hypothesis because it kept me from just picking a favorite idea at the start. I tried to look at the evidence for and against every hypothesis fairly. This meant that I was willing to accept new information, even if it went against my current hypothesis.

③ **What is the difference between simply agreeing with evidence that supports your hypothesis and maintaining an actively open mindset?**

Keeping an actively open mindset is different from just agreeing with evidence because you don't just check if the evidence works. You make sure it actually supports your hypothesis, and you purposefully try to find evidence that might prove it wrong. It's about honestly considering other hypotheses to see if they make more sense than your own and being willing to change how sure you are about your idea as you find new facts.

CONNECTIONS TO EVERYDAY LIFE

④ **Imagine you were diagnosed with a medical illness. Why would it be important for you that the scientists studying that illness use slow thinking and an actively open mindset?**

It would be important for scientists to study that illness using slow thinking to make sure their research is accurate and using an actively open mindset to reduce cognitive bias. For example, if scientists were biased toward a certain treatment, they might not be open to testing other ones that could be more effective, or they might not try to study any side effects that could be there. This could result in a delay in getting the most safe and effective drug for patients.

⑤ **Describe a situation in your everyday life when using an actively open mindset could help you make a better decision.**

Right now, I am deciding on whether I want to apply to college or not. I think it is important to find out new information about what college would be like, where I might be able to get admitted, and if I can afford it. I have to be open to ideas other than the ideas of my counselors and parents and look for evidence for and against a decision. It will take some slow thinking!

STUDENT SHEET 6.1

SOUTHSAND FEVER HYPOTHESES

NAME

HYPOTHESIS 1	RELEVANT GAME CARD(S)

HYPOTHESIS 2	RELEVANT GAME CARD(S)

HYPOTHESIS 3	RELEVANT GAME CARD(S)

HYPOTHESIS 4	RELEVANT GAME CARD(S)

CONTINUED

HYPOTHESIS 5	RELEVANT GAME CARD(S)

HYPOTHESIS 6	RELEVANT GAME CARD(S)

HYPOTHESIS 7	RELEVANT GAME CARD(S)

HYPOTHESIS 8	RELEVANT GAME CARD(S)

SOUTHSAND FEVER HYPOTHESES

NAME SAMPLE STUDENT RESPONSE

HYPOTHESIS 1	RELEVANT GAME CARD(S)
~~*The food at the kite festival could be causing the disease.*~~ *The corn at the kite festival could be causing the disease.*	*Event 5 (supporting)* *Event 6 (refuting)* *Data 6 (refuting)*

HYPOTHESIS 2	RELEVANT GAME CARD(S)
~~*People are getting sick at the hospital.*~~	*Interview 1 (supporting)* *Interview 1 (refuting)* *Interview 12 (refuting)* *Data 5 (refuting)*

HYPOTHESIS 3	RELEVANT GAME CARD(S)
~~*It is spreading from person-to-person like at the kite festival .*~~ *The disease is spreading from person-to-person.*	*Data 6 (supporting)* *Data 5 (refuting)* *Event 2 (refuting)* *Event 4 (refuting)*

HYPOTHESIS 4	RELEVANT GAME CARD(S)
~~*The disease is spread by dogs.*~~ *Dogs can be infected by the disease but can't spread it to people.*	*Data 4 (supporting)* *Event 1 (supporting)* *Interview 8 (supporting)* *Event 3 (refuting)* *Data 1 (refuting)*

CONTINUED

HYPOTHESIS 5	RELEVANT GAME CARD(S)
~~*The disease could be caused by working in construction.*~~ ~~*The disease could be from breathing in dust outside.*~~	*Event 1 (supporting)* *Event 2 (supporting)* *Data 2 (supporting)* *Interview 1 (refuting)*

HYPOTHESIS 6	RELEVANT GAME CARD(S)
~~*The disease is being spread by chickens.*~~	*Interview 7 (refuting)* *Event 6 (refuting)* *Data 1 (refuting)*

HYPOTHESIS 7	RELEVANT GAME CARD(S)
~~*The disease is being spread to humans by rodents.*~~	*Interview 1 (supporting)* *Event 3 (refuting)* *Data 1 (refuting)*

HYPOTHESIS 8	RELEVANT GAME CARD(S)
~~*The disease is being spread by cats.*~~	*Event 3 (refuting)* *Data 6 (refuting)*

INFECTED INDIVIDUALS

INTERVIEW CARD NUMBER: NAME	ATE LOCALLY GROWN CORN? YES / NO	CONSTRUCTION OR AGRICULTURE JOB? YES / NO	ATTENDED KITE FESTIVAL? YES / NO	HAVE DOG(S)? YES / NO	NOTES
TOTAL YES RESPONSES					

INFECTED INDIVIDUALS

INTERVIEW CARD NUMBER: NAME	ATE LOCALLY GROWN CORN? YES / NO	CONSTRUCTION OR AGRICULTURE JOB? YES / NO	ATTENDED KITE FESTIVAL? YES / NO	HAVE DOG(S)? YES / NO	NOTES
1: Chloe Bennet	*no*	*no*	*no*	*no*	*works at hospital, has a cat, wears a mask*
2: Mr. Torres	*no*	*yes*	*yes*	*no*	*died, worked at same site as the Youngs*
2: Mrs. Torres	*no*	*yes*	*yes*	*no*	*owns and works on a cattle ranch*
3: Devin Patel	*no*	*yes*	*yes*	*yes*	*works at same site as the Youngs*
4: Isabella Young	*yes*	*yes*	*no*	*no*	
4: William Young	*yes*	*yes*	*no*	*no*	*died*
5: Michael Lee	*yes*	*yes*	*yes*	*yes*	
6: Sophia	*yes*	*yes*	*yes*	*no*	
6: Daniel	*yes*	*yes*	*yes*	*no*	
7: Mr. Moore	*no*	*yes*	*yes*	*no*	
8: Lumi	*yes*	*no*	*no*	*yes*	*works at a cafe, dog is infected*
TOTAL YES RESPONSES	*6*	*9*	*7*	*3*	

HEALTHY (UNINFECTED) INDIVIDUALS

INTERVIEW CARD NUMBER: NAME	ATE LOCALLY GROWN CORN? YES / NO	CONSTRUCTION OR AGRICULTURE JOB? YES / NO	ATTENDED KITE FESTIVAL? YES / NO	HAVE DOG(S)? YES / NO	NOTES
TOTAL YES RESPONSES					

HEALTHY (UNINFECTED) INDIVIDUALS

INTERVIEW CARD NUMBER: NAME	ATE LOCALLY GROWN CORN? YES / NO	CONSTRUCTION OR AGRICULTURE JOB? YES / NO	ATTENDED KITE FESTIVAL? YES / NO	HAVE DOG(S)? YES / NO	NOTES
1: Ethan Rodriguez	*yes*	*no*	*no*	*no*	*works at hospital, has a cat, wears a mask*
7: Mrs. Moore	*no*	*yes*	*no*	*no*	*was bitten by a rat a week ago*
8: Mr. Hernandez	*yes*	*yes*	*no*	*yes*	*dog is infected*
9: David	*yes*	*no*	*no*	*no*	*works at grocery store, 2 cats*
9: Kelsey	*yes*	*no*	*no*	*no*	*teacher, 2 cats*
10: Mr. Brown	*no*	*no*	*yes*	*no*	*died, worked at same site as the Youngs*
10: Mrs. Brown	*no*	*no*	*yes*	*no*	
10: Ava Brown	*no*	*no*	*no*	*no*	
11: Zoey Williams	*no*	*yes*	*yes*	*yes*	*has 3 dogs*
12: Mrs. Walker	*yes*	*no*	*yes*	*yes*	*works at hospital, 2 dogs*
12: Lucas	*yes*	*yes*	*yes*	*yes*	*works in cornfield, 2 dogs*
TOTAL YES RESPONSES	*6*	*4*	*5*	*4*	

FIELD NOTES FROM DATA CARDS AND EVENT CARDS

NAME

EVIDENCE CARD (TYPE AND NUMBER)	SUMMARY

EVIDENCE CARD (TYPE AND NUMBER)	SUMMARY
Event 1	*Lumi and her dog both breathed in dust while hiking. Her dog got sick 4 days later, and Lumi got sick 5 days later.*
Event 2	*A scientist was digging up dirt alone. Afterward, he got sick from the disease, but the doctors and nurses that treated him later never got sick.*
Event 3	*A vet never gets the disease from any dogs or cats even though he got bitten and scratched and never wore a mask. Five researchers who handled infected rats without wearing masks never got the disease.*
Event 4	*A doctor pricks himself with a scalpel that has the blood of a sick person on it, but he does not get sick.*
Event 5	*There is a big dust storm at the end of the kite festival. A public health worker finds that the corn at the kite festival was stored in a warm, humid silo, so it could have been contaminated.*
Event 6	*Food-safety inspectors don't find any contamination of chicken or corn from farms that provided food for the kite festival. No chickens on the farms show symptoms of the disease.*
Data 1	*Chickens cannot be infected with Southsand fever. A test shows that rodents, cats, and dogs can't spread the disease to each other.*
Data 2	*75% of patients with Southsand fever work outdoors, 20% work indoors, and 5% work in both locations.*
Data 3	*Southsand fever cases started in July after a heavy rain earlier in the year and then a drought. Cases started occurring during the dry summer months.*
Data 4	*Cases of Southsand fever in dogs have increased over the past 8 weeks.*
Data 5	*Out of 85 people who worked at the hospital without wearing masks, only 1 person got the disease.*
Data 6	*Southsand fever is a respiratory illness. Most respiratory diseases are contagious and not caused by eating contaminated food.*

COMPARING INFECTED AND HEALTHY INDIVIDUALS

FACTOR	INFECTED INDIVIDUALS (%)	HEALTHY INDIVIDUALS (%)
ate locally grown corn		
works outside		
attended the kite festival		
has dog(s)		

COMPARING INFECTED AND HEALTHY INDIVIDUALS

FACTOR	INFECTED INDIVIDUALS (%)	HEALTHY INDIVIDUALS (%)
ate locally grown corn	*6/11 = 0.55 x 100%* ***= 55%***	*6/11 = 0.55 x 100%* ***= 55%***
works outside	*9/11 = 0.82 x 100%* ***= 82%***	*4/11= 0.36 x 100%* ***= 36%***
attended the kite festival	*7/11 = 0.64 x 100%* ***= 64%***	*5/11= 0.36 x 100%* ***= 45%***
has dog(s)	*3/11 = 0.27 x 100%* ***= 27%***	*4/11= 0.36 x 100%* ***= 36%***

CLAIM (statement about how the disease is spreading)

My claim is:

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

The second piece of evidence that supports my claim is

The third piece of evidence that supports my claim is

CONTINUED

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

Second piece of evidence: My reasoning is that

Third piece of evidence: My reasoning is that

Lastly, evidence against my claim or that supports an alternate claim is

However, I still support my claim as the most likely because

CLAIM (statement about how the disease is spreading)

My claim is:

that Southsand fever is spreading when people breath in soil particles in the air with the disease pathogen.

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

that most people who got sick (82%) were construction or agricultural workers, while very few people who stayed healthy had those same types of jobs (36%).

The second piece of evidence that supports my claim is

that the scientist was alone without a mask and got sick after digging up soil. Also, although he died later, none of the people without masks at the hospital who treated him got sick.

The third piece of evidence that supports my claim is

that Lumi and her dog got Southsand fever after going on a hike in dry soil and breathing in dust. Also, her father, Mr. Hernandez, did not get sick afterward, even though she must have been around him.

CONTINUED

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

that Southsand fever is spreading when people breath in soil particles in the air with the disease pathogen.

Second piece of evidence: My reasoning is that

the scientist getting infected after digging alone is good evidence that also supports my claim. He could have easily breathed in the soil with the pathogen while he was digging. And he could not have gotten sick from person-to-person transmission because no one else was around him at the time.

Third piece of evidence: My reasoning is that

Lumi's hike also fits my claim because she definitely inhaled dust and got sick a few days later, which matches how long it took for the scientist to show symptoms of Southsand fever. Also, because Lumi's dad never got sick and they live together, it is more evidence that the disease is probably not spreading from person-to-person.

Lastly, evidence against my claim or that supports an alternate claim is

that both Lumi and her dog got sick with the disease after their hike. Based on this, an alternate claim is that she got sick from her dog having the disease instead of breathing in the dust.

However, I still support my claim as the most likely because

as far as we know, the scientist was alone and away from both people and dogs before getting Southsand fever. Also, there was not a big difference between people who got sick who had dogs (27%) and those who stayed healthy and had dogs (36%). This is pretty good evidence that having a dog probably does not cause someone to get sick.

VISUAL AID 6.1 | SCORING GUIDE: ENGAGING IN ARGUMENT FROM EVIDENCE (ARG)

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim; is relevant, accurate, and sufficient; AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

ITEM-SPECIFIC SCORING GUIDE | ACTIVITY 6, BUILD UNDERSTANDING ITEM 1

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim, is relevant, accurate, and sufficient, AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.

The student's response includes:

- a clear claim about how the fictional disease is being transmitted, specifying either how it spreads or how it does not spread.
- at least 3 pieces of evidence from the activity that includes at least 1 quantitative comparison of infected versus healthy groups.
- an accurate description of the strength of each piece of evidence.
- a thorough description of at least 1 piece of evidence that contradicts their claim or supports a different transmission method.

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.
	The student's response includes: • a claim about how the fictional disease is being transmitted, specifying either how it spreads or how it does not spread. • a description of at least 3 pieces of evidence from the activity, but may not include a quantitative comparison of infected versus healthy groups. • at least 1 piece of evidence that contradicts their claim or supports a different transmission method. • a description of the strength of each piece of evidence that may not be accurate.		
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
	The student's response includes: • an unclear claim about how the fictional disease is being transmitted. • 1 or 2 pieces of evidence from the activity to support their claim. • at least 1 piece of evidence that contradicts their claim or supports a different transmission method.		

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
	The student's response includes: • a claim that is unrelated to how the fictional disease is transmitted. • evidence that is irrelevant to transmission of the disease. • no evidence that contradicts their claim or that supports a different transmission method.		
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

INTERVIEW 1

HOUSEHOLD

Chloe Bennet: INFECTED
Ethan Rodriguez: HEALTHY

- Ethan ate locally grown corn recently, but Chloe has not had any for a very long time.
- Ethan works as a nurse, and Chloe is a doctor at the hospital. Both always wear masks at work.
- Did not attend the kite festival.
- No dog but they have a cat.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 2

HOUSEHOLD

Mrs. Torres: INFECTED
Mr. Torres: INFECTED, died of Southsand fever

- Neither had eaten any locally grown corn recently.
- Mr. Torres works at the same construction site as William and Isabella Young. Mrs. Torres owns and works on a cattle ranch.
- Both attended the kite festival.
- No dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 3

HOUSEHOLD

Devin Patel: INFECTED

- He had not eaten locally grown corn recently.
- He works at the same construction site as William and Isabella Young.
- He attended the kite festival.
- Has a dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 4

HOUSEHOLD

Isabella Young: INFECTED
William Young: INFECTED, died of Southsand fever

- Both ate locally grown corn recently.
- William is a construction worker. Isabella is a site inspector at the same construction project.
- Neither attended the kite festival.
- No dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 5

HOUSEHOLD

Michael Lee: INFECTED

- Ate locally grown corn.
- Works for a construction company that digs wells.
- He attended the kite festival.
- Has a dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 6

HOUSEHOLD

Sophia: INFECTED
Daniel: INFECTED

- Both ate locally grown corn.
- Both are farmers who recently bought land for a new corn farm.
- Both attended the kite festival.
- No dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 7

HOUSEHOLD

Mr. Moore: INFECTED
Mrs. Moore: HEALTHY

- Neither ate any locally grown corn.
- They both work on a chicken farm. Mrs. Moore was bitten by a rat on the farm a week ago.
- Mr. Moore attended the kite festival alone.
- No dog.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 8

HOUSEHOLD

Mr. Hernandez: HEALTHY
Lumi: INFECTED

- Both ate locally grown corn.
- Mr. Hernandez works in construction downtown. Lumi works at a cafe.
- Neither attended the kite festival.
- The family has a dog that is infected.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: INTERVIEW CARDS

INTERVIEW 9

HOUSEHOLD

David: HEALTHY
Kelsey: HEALTHY

- Both ate locally grown corn.
- David works at a grocery store, and Kelsey is a teacher.
- They did not attend the kite festival.
- No dog but they have 2 cats.

INTERVIEW 10

HOUSEHOLD

Mr. Brown: HEALTHY
Mrs. Brown: HEALTHY
Ava Brown: HEALTHY

- All three had not eaten any locally grown corn for months.
- None of them work in construction or agriculture.
- Parents attended the kite festival, but Ava did not.
- No dog.

INTERVIEW 11

HOUSEHOLD

Zoey Williams: HEALTHY

- Did not eat locally grown corn.
- Works at the cattle ranch for Mrs. Torres.
- Attended the kite festival.
- Has 3 dogs.

INTERVIEW 12

HOUSEHOLD

Mrs. Walker: HEALTHY
Lucas: HEALTHY

- Both ate locally grown corn at the kite festival.
- Mrs. Walker works in the emergency department of the hospital. Lucas is a cornfield worker.
- Both attended the kite festival.
- They have 2 dogs.

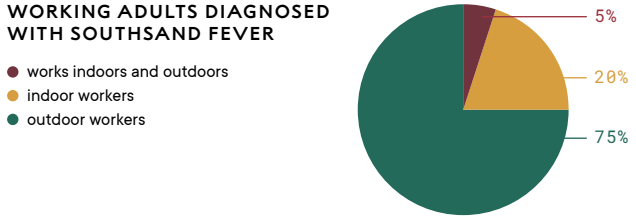
DATA 1

A team of scientists confirms that chickens do not carry the disease.

The team also ran experiments to see if sick rats, sick cats, and sick dogs can pass the illness to healthy animals of the same kind. Even though they touched each other and breathed the same air, the healthy rats, cats, and dogs did not catch the disease. Scientists conclude that Southsand fever does not transmit between animals.

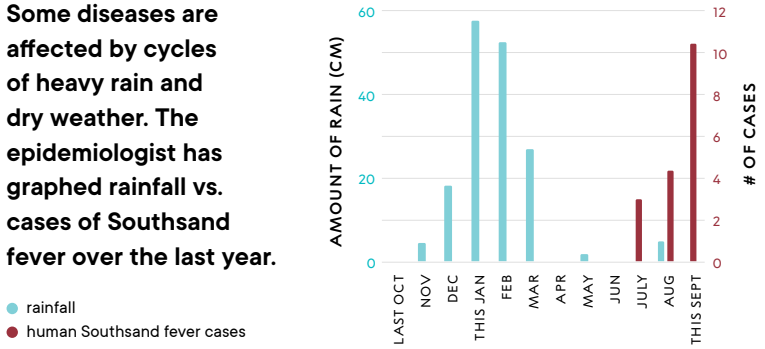
DATA 2

Data from the hospital showing the percentage of adult patients with Southsand fever who primarily work indoors, outdoors, or in both types of locations.



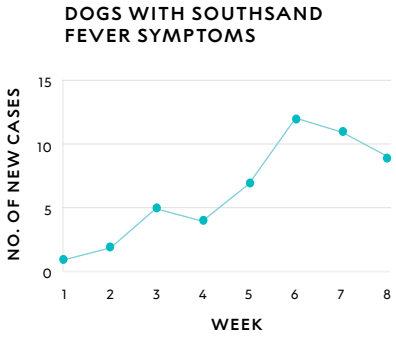
DATA 3

Some diseases are affected by cycles of heavy rain and dry weather. The epidemiologist has graphed rainfall vs. cases of Southsand fever over the last year.



DATA 4

Scientists have tracked new cases of Southsand fever in dogs over the past 8 weeks.



DATA 5

Since the first sign of the disease, 219 people from the community have been treated at the hospital. Some of the patients had severe symptoms and could not stop coughing. Despite this, almost no members of the hospital staff have gotten Southsand fever. Of the 85 medical workers who don't regularly wear masks, only 1 has contracted the disease.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: DATA CARDS

DATA 6

A majority of respiratory illnesses are contagious. Many of them, such as the common cold, influenza, and COVID-19, are caused by viruses and spread easily from person to person through respiratory droplets or contact with contaminated surfaces. In contrast, respiratory diseases caused by eating contaminated food are very rare.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: DATA CARDS

EVENT 1

Lumi Hernandez thinks that her dog got her sick. She often goes hiking with her dog in the hills. After a recent drought, the trails have been really dry. She and her dog go for a walk and breathe in a lot of dust while walking. Her dog had symptoms of Southsand fever 4 days later, and Lumi had symptoms 5 days later.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS

EVENT 2

A scientist is digging soil samples alone and without wearing a mask. He is infected with Southsand fever 5 days later and dies. None of his family, friends, or doctors got sick afterward.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS

EVENT 3

A local veterinarian has treated 10 infected dogs and 5 infected cats over the last month, and he never wore a mask. He is bitten by one of the dogs and scratched by one of the cats, but he never contracts Southsand fever.

A university research lab conducted recent studies of rodents that were sick with Southsand fever. Five research employees failed to wear masks while handling infected rodents, and the employees never contracted the disease.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS

EVENT 4

A doctor accidentally pricks himself with a scalpel that was contaminated with the blood of someone who died from Southsand fever. However, the doctor does not get sick with the disease.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS

EVENT 5

A huge dust storm caused the kite festival to end in the late afternoon.

Afterward, a public health worker discovers that locally grown corn served at the festival had been stored in a warm, humid silo. These are good conditions for certain diseases to grow in food.

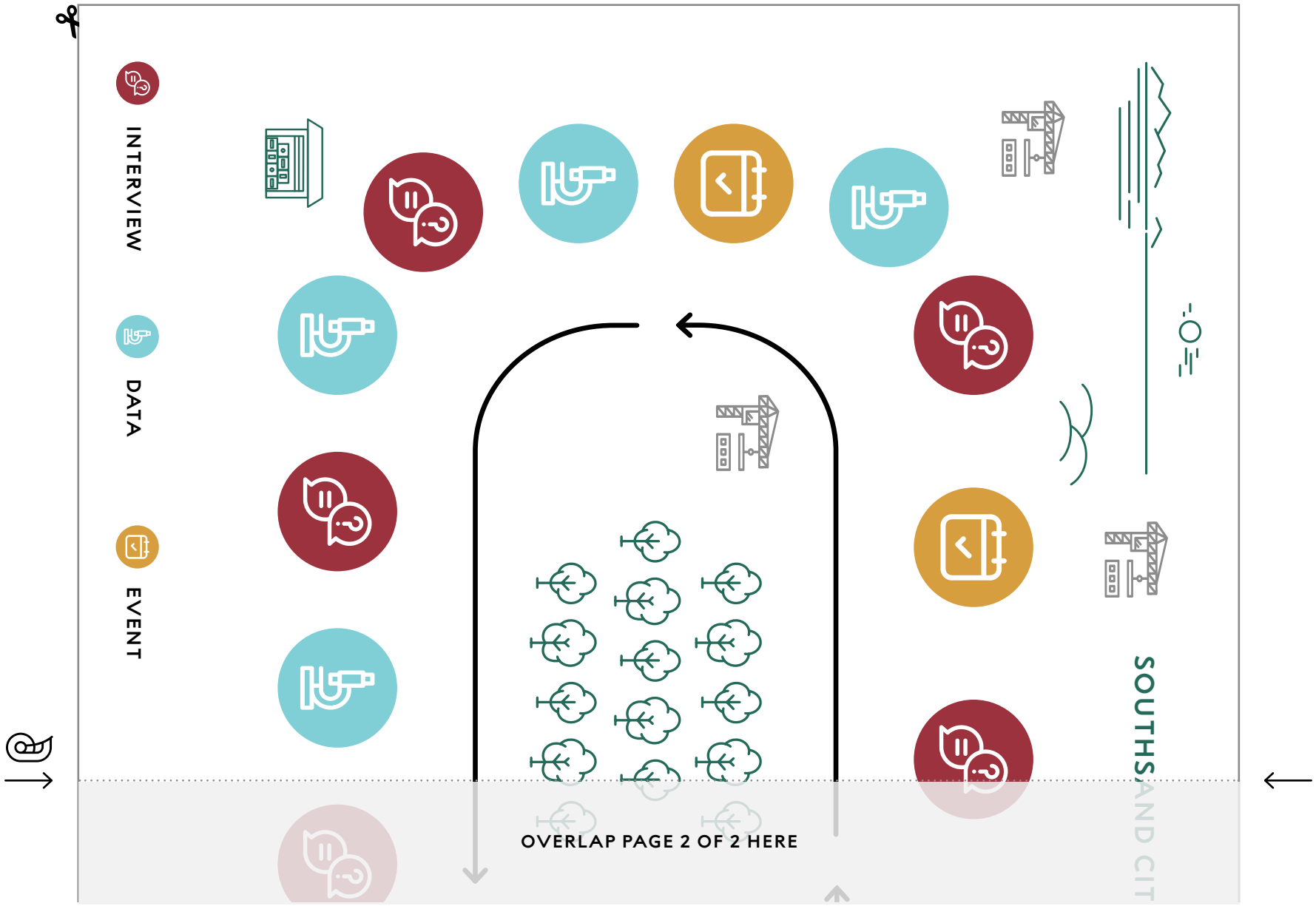
SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS

EVENT 6

Food-safety inspectors did not find any signs of contamination in the chicken or in the corn sourced from the local farms that provided the food at the kite festival.

Also, no chickens from any local farms showed symptoms of the disease.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 6: EVENT CARDS


INTERVIEW
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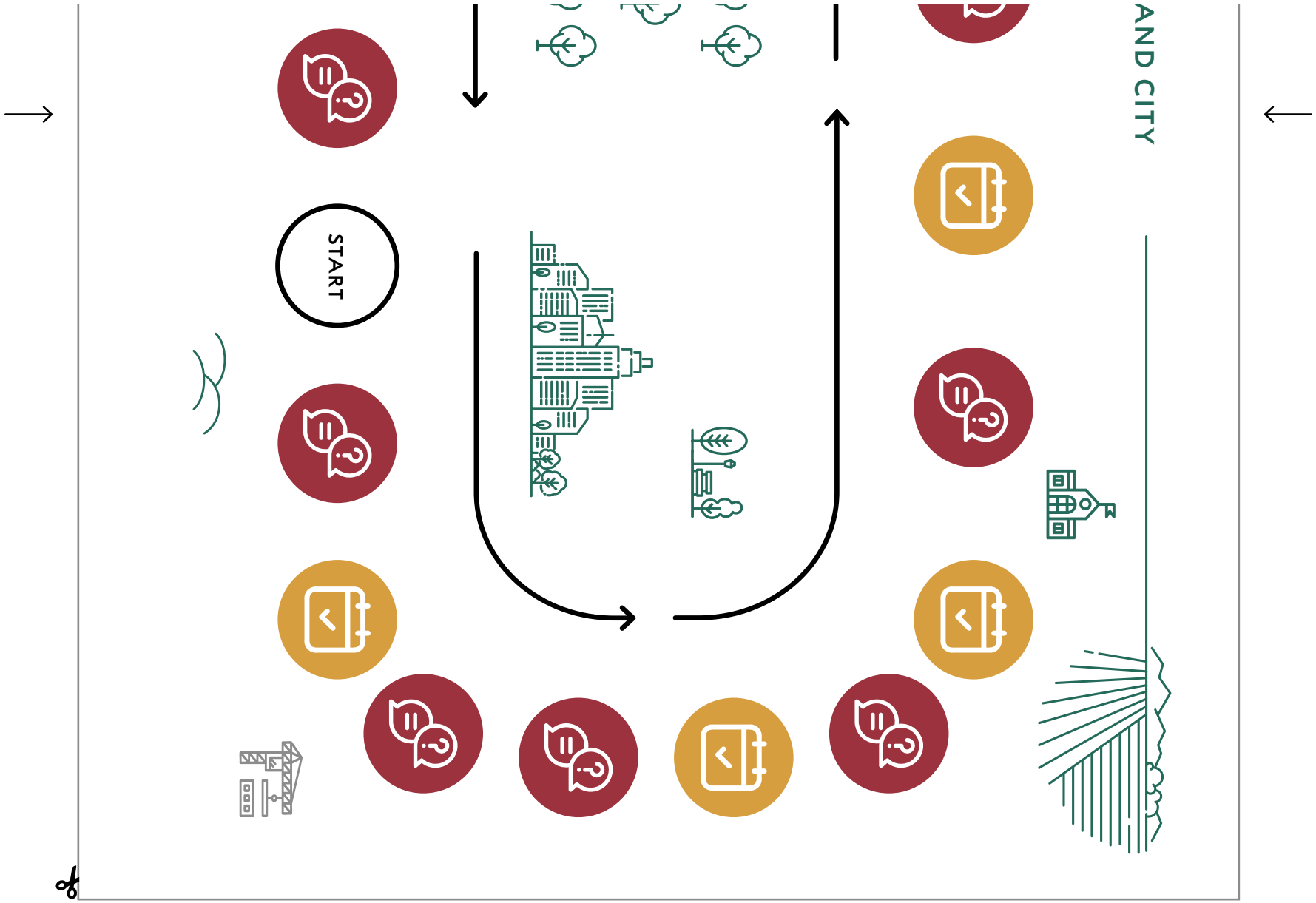
START
AND CITY

ACTIVITY 7

Addressing Cognitive Bias in Science

READING

ACTIVITY 7

Addressing Cognitive Bias in Science

ACTIVITY SUMMARY

This activity uses historical and modern examples of disease discovery and treatment to demonstrate how scientific practices rely on slow thinking and an actively open mindset. Students read two case studies: one about the pellagra epidemic in the 1900s and the other about the recent development of the COVID-19 mRNA vaccine. Both case studies show the use of the skills learned in the activity in real-world scientific contexts. Students analyze both case studies to learn how individual and community practices help scientists reduce bias, establish reliable conclusions, and advance science.

ACTIVITY TYPE
READING

NUMBER OF
40–50 MINUTE
CLASS PERIODS
1–2

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
2. Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.
3. An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

clinical trial
a carefully controlled experiment to test a medicine's safety and effectiveness

peer review
a process in which a scientist's research is critically evaluated and judged by other independent experts

TEACHER BACKGROUND INFORMATION

Protein Synthesis

Protein synthesis is the process by which cells build the proteins they need to function, grow, and repair themselves. In eukaryotic cells, it begins in the nucleus, which contains all the genetic instructions to make every protein in the body in the form of DNA. The first step in the process is transcription in which the master instructions in a gene's DNA are copied into a mobile molecule called messenger RNA (mRNA). A simple analogy is to imagine DNA as a permanent reference book in a library and mRNA as a photocopy that can be taken home. The mRNA then travels out to a ribosome in the cytoplasm for the second step, called translation. During translation, the ribosome reads the mRNA's code in sets of three bases called codons. Specialized molecules called transfer RNA (tRNA) deliver specific amino acids to the ribosome based on the mRNA's instructions. These amino acids are linked together into a long chain called a polypeptide, which then folds into a functional protein.

The mRNA vaccine technology uses the body's own natural processes for making proteins. Proteins are one of the three macronutrients in food that provide energy. Proteins are used primarily for building tissues, such as muscle and bone. They also make up hormones and important components of chemical reactions that help different parts of the body communicate and function.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 7.1 "Read, Think, and Take Note Guidelines"

FOR EACH GROUP OF FOUR STUDENTS

- STUDENT SHEET 7.1 "DART: Examples of Scientific Practices" (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts and Skills" (OPTIONAL)

FOR EACH STUDENT

- 3–5 STICKY NOTES

Consider if you would like to show a video for the first part of the reading in addition to the written content. If so, here are two credible options.

- SEPUP at The Lawrence Hall of Science
  Pellagra Video
- Extra History channel (YouTube)
  Pellagra: A Medical Mystery

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10-20 MIN)

1 **Review unit concepts related to scientific investigation by using a word sort.**

- Depending on your student population, you may want to conduct a word sort before starting the activity to make sure students have an understanding of the major themes they will need to complete this activity. This quick formative assessment presents one or more sets of words. In each list, one word is not related to the others, and another word encompasses the remaining words. The following two word sorts can be used to support a review of basic causation ideas. For more information on a word sort, see Appendix 1: Literacy Strategies.

- Have students copy the lists of words that follow. Instruct them to look for a relationship among the words within each list. Then, ask them to cross out the word or phrase that does not belong in each list and highlight the word or phrase that includes the others on the list. Have students write a sentence to show how the highlighted word or phrase is related to all the other words or phrases in the list. Note that there may be more than one correct answer to a single word sort.

LIST 1

scientific investigation
fast thinking
slow thinking
evidence
actively open mindset

LIST 2

scientific investigation
confirmation bias
availability shortcut
alternative explanation
new evidence

Sample Student Response

LIST 1

scientific investigation
~~fast thinking~~
slow thinking
evidence
actively open mindset

In scientific investigations, the researchers should use slow thinking to gather and analyze the evidence with an actively open mindset.

LIST 2

scientific investigation
confirmation bias
~~availability shortcut~~
alternative explanation
new evidence

In a scientific investigation, the researchers should avoid confirmation bias by gathering new evidence to examine alternative explanations.

- Let students know that in this activity, they will read about how the scientific process uses slow thinking by investigating two disease outbreaks—one from 100 years ago and one that is more recent. In both cases, the outbreaks led to pandemics, and the principles of an actively open mindset from scientists helped find a cure in each case. Remind students to be on the lookout for these aspects of scientific practice in the case studies they will read.

PROCEDURE SUPPORT (20-30 MIN)

2 Review the Read, Think, and Take Note Guidelines to support students' reading comprehension.

- Review the Read, Think, and Take Note Guidelines to support students in completing the reading. The Read, Think, and Take Note strategy provides an opportunity for students to record their thoughts, reactions, and questions on sticky notes as they read. The notes serve to make concrete the thoughts arising in their minds and then serve as prompts to generate conversation or write explanations. You can use Visual Aid 7.1, "Read, Think, and Take Note Guidelines," to review this literacy strategy. If your students are unfamiliar with the strategy, it can be helpful to demonstrate with a short passage of simple text, such as the Introduction to the activity. For more information about the Read, Think, and Take Note strategy, see Appendix 1: Literacy Strategies.

- In particular, ask students to place a sticky note in locations where they see cognitive biases and cognitive shortcuts. This will help them prepare to answer Build Understanding item 1.

3 Support student's synthesis of information as they complete the reading.

- To help synthesize the information in the reading, you may have students work in pairs to complete optional Student Sheet 7.1, "DART: Examples of Scientific Practices." For more information on a Directed Activity Related to Text (DART), see Appendix 1: Literacy Strategies. Students can complete this student sheet as an individual, in pairs, or as a class. A sample student response to Student Sheet 7.1 can be found at the end of this activity.

- Decide how you would like students to complete the reading. The reading is divided into two case studies. Depending on the time you have available and the reading abilities of your students, consider supporting students with one or more of the following options:

  - Have students take turns reading with a partner. Students can alternate reading one paragraph at a time.

  - Have pairs divide the case studies: have one student read the first case study and the other student read the second case study. Partners can then summarize the main points of their case study for each other and share the thoughts and questions they recorded on their sticky notes.

  - Chunk the case studies into smaller sections by stopping the class at intervals to review the main points and notes they recorded in each section. This can give you an opportunity to clarify students' questions and discuss the main ideas as they read.

  - Provide copies of the reading so students can record their thoughts and questions directly onto the pages.

- Review the terms introduced in this activity and answer students' questions. Support students, particularly emerging multilingual learners, in sensemaking and language acquisition by adding words from this activity to the word wall. Record the terms *clinical trial* and *peer review* and provide examples as needed. For more information on a Word Wall, see Appendix 1: Literacy Strategies.

SYNTHESIS OF IDEAS (10-20 MIN)

4 Highlight essential ideas about scientific processes from the reading.

- Ask students to share their responses to Build Understanding items 1–3. Point out that scientific practices incorporate a very structured way to go about using slow thinking and an actively open mindset. This forces scientists to consider evidence, reasoning, reducing bias, and alternative ideas as part of their work process to understand the natural world.
- Discuss some of the improvements of the scientific process from the time of the pellagra investigation to the mRNA vaccine trials. For example, Goldberger did not use blind experiments or placebos in his experiments. The procedures for reducing bias were not required at that time. However, the process of peer review was in place, albeit less formal, because other scientists later verified his work.
- Ask, How do scientists use slow thinking and an actively open mindset in ways that are similar to and different from how slow thinking and an actively open mindset are used in everyday situations? Students should respond in a way that shows they can see the similarities that both require a reduction of bias and consideration of evidence before making a judgement. Differences include how much more evidence and analysis is involved in a scientific experiment compared to a social media post.
- To conclude the activity, evaluate whether your students are able to answer the Guiding Question, *How does slow thinking improve scientific conclusions?* Use this as a chance to revisit and summarize the key concepts and process skills of the activity that relate to scientific processes such as experimental design and peer review.

5 Summarize the key concepts and process skills of the unit.

- You may wish to revisit optional Student Sheet 1.3, "Unit Concepts and Skills," to help students formally organize the ideas introduced in the unit so far. Students can place the headings of the main ideas—confirmation bias and an actively open mindset—into the organizer and add examples from their classroom experiences in Activities 5–7. See the end of Activity 1 in the Teacher's Edition for a sample student response.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **Give an example of a scientific practice from the reading that shows the following approaches, using an actively open mindset.**

a Seek out evidence for and against a claim.

Goldberger's experiments with changing the diet of those with pellagra are an example of seeking evidence for and against a claim. If improving their nutrition did not help the health of those with pellagra, that would be evidence against the nutrition hypothesis. If those with pellagra's symptoms got better with improved nutrition, that would be evidence against the germ hypothesis.

b Consider alternative explanations.

Goldberger considered alternative explanations for pellagra, such as the germ hypothesis, the toxin hypothesis, and the missing-nutrient hypothesis.

c Be open to others' ideas.

Peer review is a scientific practice that helps scientists be open to others' ideas because they have to allow other scientists to critique their work. Sometimes, this requires scientists to rethink their conclusions or conduct additional experiments to check their results.

d Evaluate the need for more evidence.

Evaluating their experimental designs can help scientists decide if they need more evidence, such as a larger-scale clinical trial.

② **Give an example from the case study about the pellagra epidemic that illustrates**

a a cognitive shortcut.

Responses will vary. One sample response is shown below.

One cognitive shortcut was the assumption that pellagra was caused by a microbe that made people sick. This was a representativeness shortcut because this idea was a result of pellagra's similarities to well-known contagious illnesses such as typhus and cholera.

a slow thinking.

Responses will vary. One sample response is shown below.

Goldberger slowed down his thinking by considering other ways people could get pellagra. He took a lot of observations and data and then developed a hypothesis that fit with all the evidence he had.

③ **Explain how the scientific practices described in the reading require scientists to apply slow thinking rather than relying on cognitive shortcuts.**

Carefully designed experiments, thorough data collection and analysis, and having scientists evaluate and critique one another's work are all elements of slow thinking. All of these reduce the chances of error and increase the accuracy of claims made by scientists.

CONNECTIONS TO EVERYDAY LIFE

④ **Imagine that when you finish a big project for school, you ask a friend to read it over before you turn it in.**

a **How is this process similar to and different from what scientists do in a peer review?**

It is similar to a peer review because you are trying to get another perspective on your work. A friend might offer information you didn't know at the time of writing.

b **How might your friend's objective feedback help you avoid a cognitive bias in your own work?**

This might help me avoid bias in my own work because the other person reading it might notice things that I did not because their existing ideas and experiences are different from mine.

⑤ **You see an article that states: *A new study showed that a newly developed vaccine for tuberculosis (TB) prevents over 50% of TB infections.* You decide to look up the study to see if you trust the results. What would you look for in the study?**

I would check and see if the vaccine was developed using a clinical trial and whether the results of the study were peer reviewed.

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STUDENT SHEET 7.1	DART: EXAMPLES OF SCIENTIFIC PRACTICES	NAME

CASE STUDY	SCIENTIFIC PRACTICE	RELATIONSHIP TO ACTIVELY OPEN MINDSET

CASE STUDY	SCIENTIFIC PRACTICE	RELATIONSHIP TO ACTIVELY OPEN MINDSET
pellagra	*Goldberger investigated hypotheses other than just the popular idea.*	*Consider alternative possibilities, reduced cognitive shortcuts.*
pellagra	*Goldberger reviewed evidence both for and against all the ideas.*	*Willingness to look at evidence that does not support their own ideas.*
mRNA vaccine	*Random assignment: The COVID–19 trial assigned people randomly.*	*This made sure that what is being tested is the only difference between groups, reducing cognitive bias.*
mRNA vaccine	*Blind assignment: COVID–19 doctors and participants did not know who received the vaccine and who did not.*	*This prevented researchers and participants from letting unconscious cognitive biases affect the data.*
mRNA vaccine	*Peer review: Other scientists examined the data and methods for the COVID–19 trial to make sure the results were valid.*	*This checks the results and forces researchers to be open to other people's ideas.*

Read, Think, and Take Note Guidelines

Stop at least three times during each section of the reading to mark on a sticky note your thoughts or questions about the reading.

As you read, use a sticky note from time to time to:

- explain a thought or reaction to something you read.
- note something in the reading that is confusing or unfamiliar.
- list a word from the reading that you do not know.
- describe a connection to something you've learned or read previously.
- make a statement about the reading.
- pose a question about the reading.
- draw a diagram or picture of an idea or connection.

After writing a thought or question on a sticky note, place it next to the word, phrase, sentence, diagram, drawing, or paragraph in the reading that prompted your note.

After reading, discuss with your partner the thoughts and questions you had while reading.

ACTIVITY 8

Investigating a Pathogen

CARD-BASED INVESTIGATION

ACTIVITY 8

Investigating a Pathogen

ACTIVITY SUMMARY

Students evaluate information related to identifying the pathogen causing Southsand fever. They evaluate laboratory evidence to deduce the biological cause of the Southsand fever outbreak. Students apply the metacognitive scientific skills they've been practicing throughout the unit to investigate the disease, using microscope images. Based on the information they've gathered, students develop an explanation about which pathogen causes Southsand fever and how people become infected.

ACTIVITY TYPE
CARD-BASED INVESTIGATION

NUMBER OF 40–50 MINUTE CLASS PERIODS
1-2

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
2. Common scientific practices are designed to support slow thinking, which makes scientific conclusions more reliable.
3. An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTIONS:

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)*

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. *(Science and Engineering Practice: Engaging in Argument From Evidence)*

CONCEPTUAL TOOLS

VOCABULARY DEVELOPMENT

cell culture
(assumed prior knowledge)
the process of growing cells under controlled conditions outside of their natural environment

eukaryotes
(assumed prior knowledge)
organisms whose cells contain a nucleus

microbe
(assumed prior knowledge)
a microscopic cellular organism or a virus

pathogen
an organism or biological agent that causes infectious disease

prokaryotes
(assumed prior knowledge)
cells that do not have a nucleus, and their DNA is located in the cytoplasm of the cell

protist
(assumed prior knowledge)
an organism made up of a single cell or many cells with a nucleus and that is not an animal, plant, or fungus

protozoa
(assumed prior knowledge)
types of protists that are unicellular eukaryotes

spore
(assumed prior knowledge)
a reproductive cell that can develop into a new individual without fusing with another reproductive cell

TEACHER BACKGROUND INFORMATION

Koch's Postulates

The first infectious disease organism that was identified by microscope, *Mycobacterium tuberculosis*, is credited to German scientist Robert Koch in 1882. Koch won a Nobel prize for his work, which became the foundation of studying infectious diseases. Through his research, he came up with the following four postulates (guiding principles) that experiments would need to confirm in order to show that a pathogen causes a disease. Koch's four postulates are:

- The microorganism must be found in abundance in all organisms suffering from the disease but should not be found in healthy organisms.
- The microorganism must be isolated from a diseased organism and grown in pure culture.
- The cultured microorganism should cause disease when introduced into a healthy organism.
- The microorganism must be re-isolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.

Subsequent research has shown that the first postulate is not true in all cases. For example, some diseases can cause someone to carry an infectious pathogen, while they do not develop the disease themselves.

Valley Fever

Valley fever is caused by a fungal pathogen, *Coccidioides immitis*, that lives in soil and dust in certain areas. When disturbed, the fungal spores can become airborne and inhaled, leading to disease (coccidioidomycosis) in some people and other animals. *Coccidioides* most commonly infects rodents, dogs, and humans but can sometimes infect cats and livestock. Valley fever primarily affects the lungs and can cause flu-like symptoms such as cough, fever, chest pain, fatigue, and shortness of breath. In severe cases, the infection can spread from the lungs to other parts of the body—including the skin, bones, and central nervous system—leading to more serious complications, such as meningitis or, rarely, death. Valley fever is often misdiagnosed as pneumonia or lung cancer due to the appearance of spherule masses in lung X-rays. The populations most at risk for the disease include people of African or Filipino descent; people with frequent contact to outdoor dusty/windy conditions; and people with compromised immune systems, including those over age 60 and pregnant people.

Valley fever is prevalent in arid and semi-arid regions, particularly in the Southwestern United States—including Arizona, California, Nevada, New Mexico, Texas, and Utah—as well as parts of Mexico, Central America, and South America. The majority of identified cases occur in Arizona and California. However, climate change has influenced how this pathogen and many other fungi grow and spread around the world. Some scientists think that *Coccidioides* will be found as far north as the Canadian border by 2100.

Modern diagnosis of Valley fever can be accomplished through antibody blood test, skin test, cell culture, and microscope analysis. The blood test is the most accurate and is less invasive than some of the other diagnostics. Treatment typically involves antifungal medications such as fluconazole or itraconazole, especially for severe or disseminated cases where the disease spreads throughout the body. People suffering severe forms of the disease may need hospitalization and prolonged treatment (months or years). In many cases, patients cannot be cured of the disease and will need treatment for the rest of their lives.

Researchers are actively studying Valley fever to better understand its epidemiology, improve diagnostic methods, and develop effective treatments and vaccines. Studies are focusing on identifying genetic factors that contribute to susceptibility, understanding the environmental conditions that facilitate the spread of the fungus, and exploring potential new antifungal therapies and preventive measures. A vaccine for dogs is currently in development, which could pave the way for a human vaccine.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 8.1 "Pathogen Taken From the Soil"
- VISUAL AID 8.2 "Southsand Fever Infection Cycle"

FOR EACH GROUP OF FOUR STUDENTS

- SET OF PATHOGEN TYPE CARDS (4 cards)

If you have the time and equipment, consider having students complete a microscope investigation before this activity to enhance the biology content of the activity. Find sample organisms that correspond to the general types of pathogens that students will see in the activity (i.e., bacteria, prokaryotes, and fungi). You can use prepared slides or live samples. Common sources for live samples to look at under the microscope include pond water for protozoa, yogurt for bacteria, and baker's yeast for fungi. Viruses are not able to be seen with the light microscopes that are common in most classrooms, but you can provide a variety of electron-microscope images for students to examine instead.

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10 MIN)

1 Review the findings from the epidemiology investigation game in Activity 6.

- Let students know that they are going to continue the investigation into Southsand fever. Ask, What are the key findings from the epidemiology investigation from Activity 6? Student responses may vary, but important information should include that most people who became ill from the disease were exposed to areas with soil (e.g., outdoor workers) and that based on multiple cases, the disease is not contagious (spread from person to person).
- Have students read the Introduction in the Student Book. Review the term *pathogen* with students. If appropriate, you may want to have students review ideas related to prokaryotic and eukaryotic cells in the Science Review at the end of the activity.

TEACHER'S NOTE: Please do not provide any information about Valley fever, the illness that Southsand fever is modeled after, until after the completion of this activity.

- If you decided to run the optional laboratory microscope investigation (see Advance Preparation), do so before students begin the Procedure.
- Let students know that they will be looking at evidence and images related to microbes to try to figure out the Southsand fever pathogen. Inform them that most specimens in the images are dyed or colorized by computer to reveal features and are not actually the color presented.

PROCEDURE SUPPORT (30 MIN)

2 Students examine information about different pathogens.

- As a class or in their groups, have students read the fictional scenario in Procedure Step 1. Remind students to use an actively open mindset when approaching the evidence in the activity.

- Use the diagram in the Introduction to review the relative and absolute sizes of the pathogens students will be investigating. Students may need additional support converting between units of nanometers (nm), micrometers (μm), millimeters (mm), and centimeters (cm).

- In Procedure Step 2, hand out a set of Pathogen Type cards to each group of four students and have students read the cards. Clarify any questions about the information on the cards. If you have students who may require more support analyzing the information about the pathogens, consider assigning these students to the virus or bacteria pathogens, which are simpler pathogens with less information to synthesize.

3 Have a class discussion about the different types of pathogens and which ones are unlikely to be the Southsand fever pathogen.

- When reviewing student responses to Procedure Step 4, ask, Do you have enough information to make a claim, or would you like additional information? Student responses will vary, with some feeling that they can identify the pathogen and others not as sure.

Sample Student Response, Procedure Step 4

I think the type of pathogen is likely to be a protozoa. Viruses can't be the pathogen because they are not made of cells, and the pathogen found in the patient sample is made of cells. Bacteria can't be the pathogen because they are very small. The Southsand fever pathogen is much larger than bacteria and has cells with a nucleus. Protozoa is within the right size range, and the images look similar to the Southsand fever pathogen.

- In Procedure Step 5, have each group share their ideas and evidence about which pathogens are likely to be the Southsand fever pathogen. Discuss the importance of first approaching the question using a process of elimination. Students should be able to eliminate viruses and bacteria. That leaves protozoa and fungi as possibilities. Students should notice that the images look similar to protozoa and not similar to fungi. This should lead students to believe, at this point, that it is a protozoan.

4 Students get additional evidence and adjust their claims about the pathogen.

- In Procedure Step 8, students gain more evidence through the fictional scenario. This information should lead students to think more about their conclusions from Procedure Step 4. The growth in the petri dish looks like mold, and the microscope image does not look like protozoa. The only image on the Pathogen Type cards that is similar to the microscope slide is the bottom image on the Fungi card (Card 4). Students should see that this evidence contradicts their initial conclusion that the pathogen is protozoa.

- In Procedure Step 9 when students revisit their predictions, they should be able to narrow down the possibilities to fungus as the pathogen. This is a good time to discuss the quantity and quality of the evidence provided.

Sample Student Response, Procedure Step 9

The evidence doesn't support the claim that the pathogen is protozoa. Under the microscope slide, it doesn't look like protozoa. It looks more like fungi. Also, it is found in dry soil.

- Ask, What are some possible alternative explanations for what you saw in Procedure Step 10? Student responses could vary, but here are three of the most likely:
  - The organism growing on the petri dish is not *Coccidioides* but is some other protozoa.
  - The organism growing on the petri dish is caused by something that has contaminated the sample, because it looks like mold.
  - The organism growing on the petri dish is mold because that's what's causing Southsand fever.
- Use Visual Aid 8.1, "Pathogen Taken From the Soil," to confirm that the pathogen looks like a picture of the pathogen isolated from a soil sample. These two matching images should confirm for students that the pathogen is fungi.
- In Procedure Step 11, have groups share their claims about what type of pathogen causes Southsand fever and how people become infected. Ask students what their strongest evidence is that supports their claims and if there is any evidence that counters their ideas.

Sample Student Response, Procedure Step 11

The pathogen type is fungi because it is too large to be viruses or bacteria. It has a nucleus, and it looks like the petri-dish mold from the scenario and also the yeast. Infection most likely occurs in Southsand by breathing in dry particles of fungi from the soil, especially at construction sites. We learned this in Activity 6. Inside the body, the pathogen looks more like a yeast in the lungs of people. Outside the body, the pathogen looks like a mold in the petri dish when it is cultured. In the soil, it looks like a fungus.

- Use Visual Aid 8.2, "Southsand Fever Infection Cycle," to review the important information about the Southsand fever disease so all groups get on the same page about the disease pathogen and how it infects people. Southsand fever is caused by fungi that live in the soil. When the fungal particles get disturbed, they enter the air by wind and can then be inhaled by humans and other animals. Once in the lungs, the infection takes hold, causing respiratory symptoms. Since the respiratory symptoms are not caused by viruses or bacteria, they can't be treated with antiviral or antibiotic medications.
- If appropriate for your students, introduce and explore dimorphic fungus. Dimorphic fungi change their structure based on the temperature. In cold soils, they grow as mold with spores. In the warm human body, they transform into large, round, yeast-like structures (spherules) to reproduce and evade the immune system.
- In Procedure Step 12, ask students to look for problems in the thinking (and behavior!) of the scientist in the fictional scenario. Students should see the fast thinking and/or confirmation bias of the scientist who used one piece of information *(the petri dish looks like it has mold in it)* to confirm what he believed. Use the opportunity to discuss how cognitive shortcuts and cognitive biases can affect how evidence is used to draw conclusions.

Sample Student Response, Procedure Step 12

There was fast thinking when the scientist assumed the petri dish was contaminated, and he put it aside. It was fast thinking because he used the availability shortcut to jump to the conclusion that it was like something else he had experienced. He slowed down his thinking after he got sick from it! The fact that he was careless with the petri dishes showed confirmation bias because he had decided the pathogen was not in the dish. One way he dealt with it was to have an actively open mindset and look for the new evidence that related to his experience and be open to new ideas about the pathogen.

SYNTHESIS OF IDEAS (10-20 MIN)

5 **Use the Build Understanding items to consider the metacognitive approaches used in scientific investigation.**

- In Build Understanding item 2 and Connections to Everyday Life item 3, students should easily be able to identify the confirmation bias and aspects of an actively open mindset in the scenario on the part of the researcher. Encourage students to also think about their own metacognition during the investigation. Ask, What caused you to change your mind about the pathogen? Students should point out that new information and considering the evidence for and against the previous claim made them open to alternative explanations. These are central ideas of an actively open mindset.

- A critical takeaway for students in this activity is to see that while an actively open mindset can apply to everyday experiences, as explored earlier in this unit, the approach is also central to achieving reliable results in a scientific investigation.

6 **Reveal that the fictional Southsand fever disease is based on a real disease called Valley fever.**

- After students have confirmed what the pathogen is, reveal that Southsand fever is modeled after Valley fever, also known as coccidioidomycosis, and is caused by a fungus called *Coccidioides*. It follows an infection cycle like the one shown in Visual Aid 8.2.

- Share with students that the pathogen investigation in this activity loosely follows the historical investigation of the *Coccidioides* fungus, which occurred during the late 1800s and early 1900s. *Coccidioides* was initially misclassified as a protozoa, culture samples were thought to be contaminated, and there was confirmation bias and authority bias present in the early investigations. The true nature of the disease was determined through careful studies, using experiments on guinea pigs and rabbits to transmit the disease to healthy animals by injecting the animals with tissue samples from infected patients. A breakthrough in the study of the disease came from a mishap in the lab when a medical student got sick after breathing in dust from an old sample petri dish.

Finally, the disease transmission was connected to the soil after the fungal pathogen was isolated from the soil that was under the living quarters of a group of farm workers who came down with the disease.

- Be clear that while the case study used throughout the unit is inspired by Valley fever research and data, it was modified to fit the Southsand fever disease scenario. Make sure students understand that Southsand fever is NOT a real disease, even though it is modeled after one.
- Conclude the activity by revisiting the Guiding Question, *How do epidemiologists use an actively open mindset?* Use this as a chance to revisit and summarize the key concepts and process skills of the activity, especially those related to evidence for and against an idea.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **What is the pathogen of Southsand fever? Use the evidence from this activity to make a claim about the pathogen type and how it appears inside the body and in the soil. Include your reasoning.**

The pathogen is fungi because it is too large to be viruses or bacteria. It has a nucleus, and it looks like the petri-dish mold from the scenario. It also matches the yeast image, which is evidence that it is fungi. The last piece of evidence was that we confirmed that the pathogen from the body looks like the pathogen isolated from a soil sample. We know the pathogen is in the soil from Activity 6. Outside of the body, it looks like the mold in the petri dish. Inside the lungs, it looks more like protozoa but is actually a yeast.

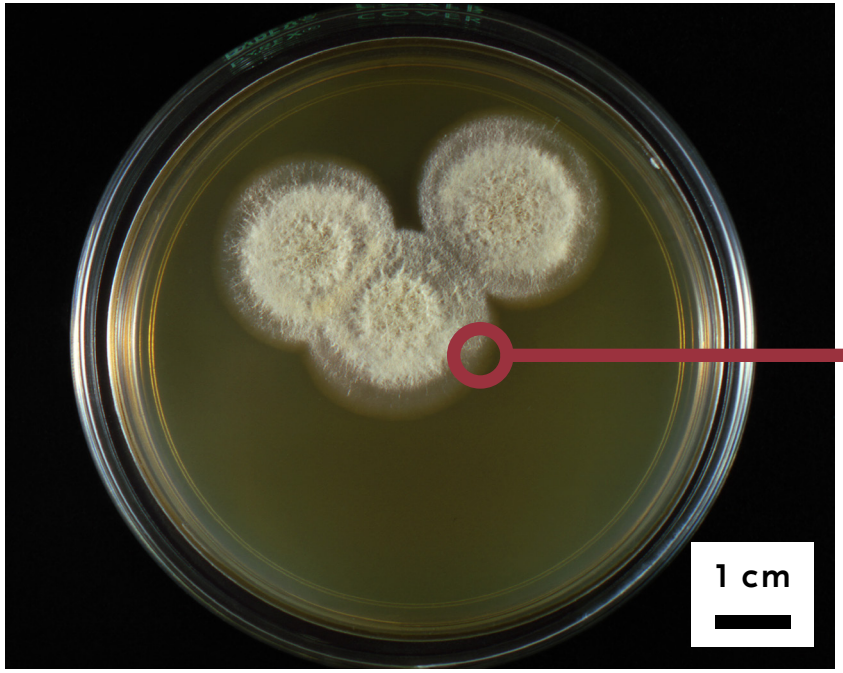
② **How did confirmation bias appear in the investigation to identify the pathogen?**

There was confirmation bias when the researcher decided to ignore the mold growing on the petri plates as a contaminant instead of considering the alternative possibility that the mold was the actual pathogen.

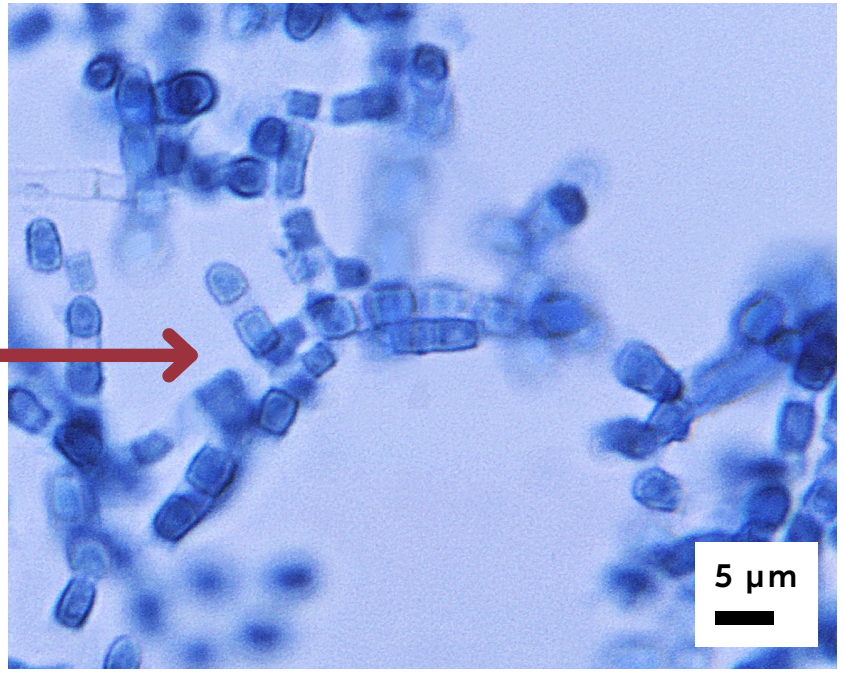
CONNECTIONS TO EVERYDAY LIFE

③ **What were the most important aspects of an actively open mindset you used to identify the pathogen in this activity? Explain.**

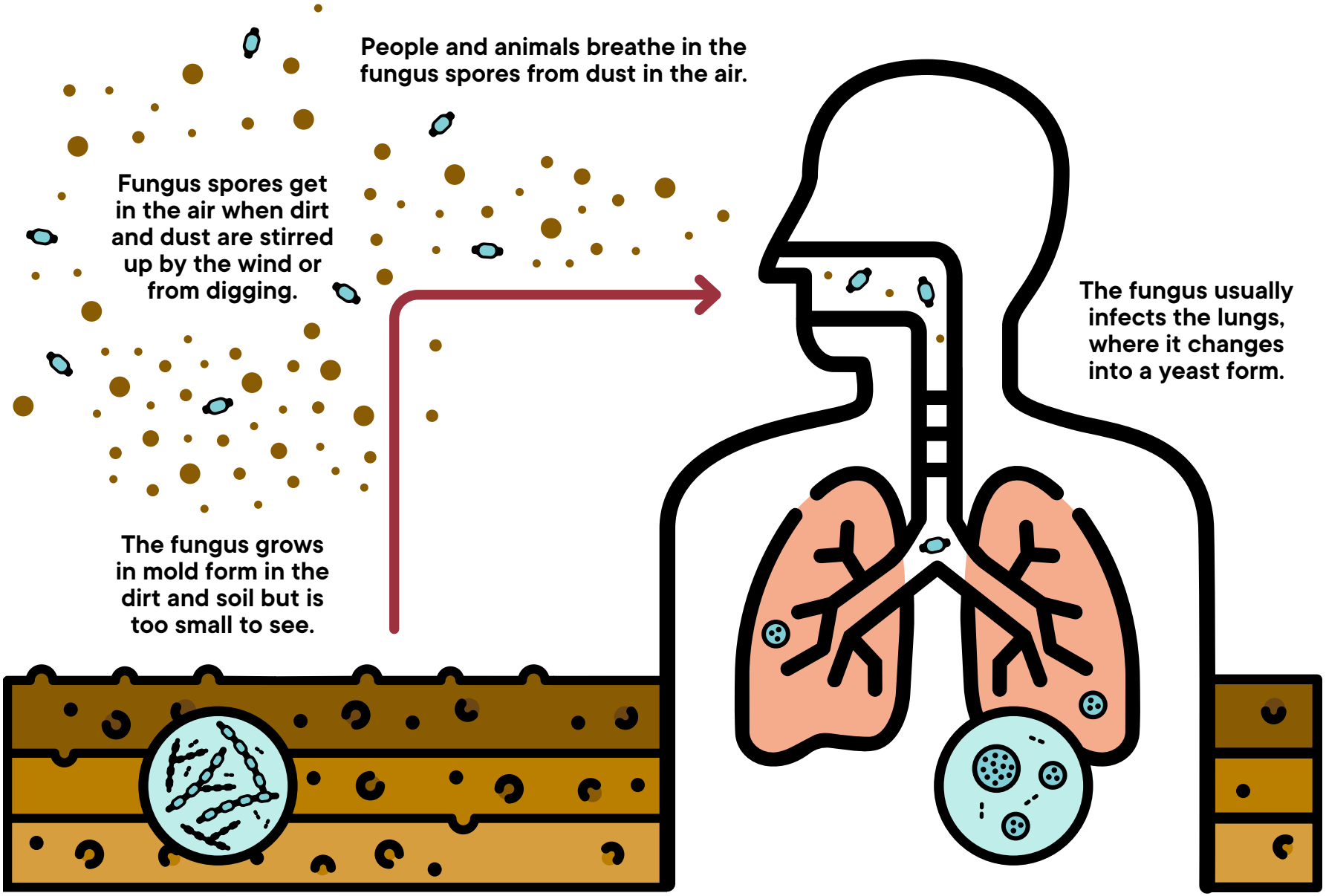
The most important was considering possible alternative explanations for the mold by considering that the mold in the petri dishes was not a mistake. Also important was knowing that there was a need for new evidence.



The pathogen taken from soil and grown in a petri dish.



Microscope image of the organism from the same petri dish.

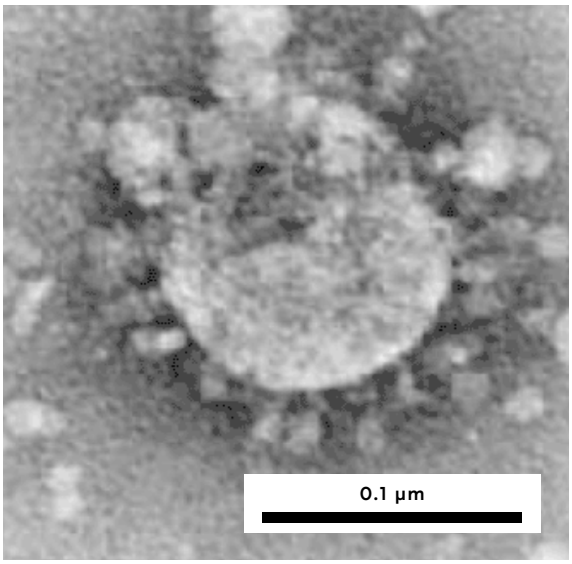

People and animals breathe in the fungus spores from dust in the air.
Fungus spores get in the air when dirt and dust are stirred up by the wind or from digging.
The fungus usually infects the lungs, where it changes into a yeast form.
The fungus grows in mold form in the dirt and soil but is too small to see.

CARD 1

PATHOGEN TYPE: VIRUSES

- Genetic material inside a protein shell
- Not a cell itself (so no cell membrane, cytoplasm, or nucleus)
- Needs to infect a host cell to reproduce
- Size: 20 nanometers–400 nanometers

EXAMPLE DISEASES WITH THIS PATHOGEN:
influenza (flu), COVID-19, bird flu, rotavirus, Ebola, HIV/AIDS



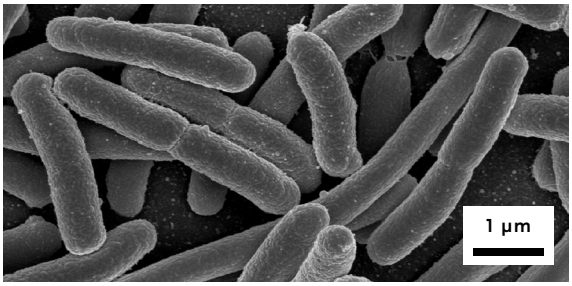
Electron microscope image of SARS-CoV, the virus that causes COVID-19.

CARD 2

PATHOGEN TYPE: BACTERIA

- Single-celled organism without a nucleus
- Bacteria thrive in moist conditions including soil, water, and food and inside other organisms
- Some can survive in extreme environments—such as very dry, cold, hot, or salty environments
- Size: length: ~1 —10 micrometers
  width: 0.2 —1 micrometers

EXAMPLE DISEASES WITH THIS PATHOGEN:
tuberculosis (TB), bronchitis, sepsis infection



TOP Groups of *Escherichia coli* cells growing on a petri dish in the lab. Each small cluster of cells can contain millions of bacterial cells.

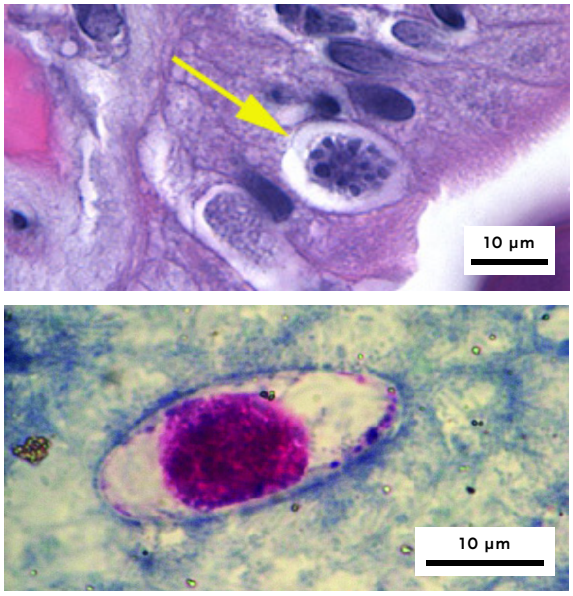
BOTTOM Electron microscope image of *Escherichia coli* bacteria.

CARD 3

PATHOGEN TYPE: PROTOZOA

- A single-celled organisms with a nucleus
- Almost all need moist environments to survive—such as water, moist soil, or inside another organism
- Some can change their form depending on the environment
- Can reproduce in multiple ways, including by a spore-like form
- Size: ~5—1,000 micrometers

EXAMPLE DISEASES WITH THIS PATHOGEN:
malaria, toxoplasmosis



TOP Microscope image of Cystoisospora belli, a type of *Coccidian* protozoa, in animal intestines. The yellow arrow points to a spore containing many protozoan cells.

BOTTOM A microscope image of an individual cell of *Cystoisospora belli* in a different form.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT • UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 8: PATHOGEN TYPE CARDS

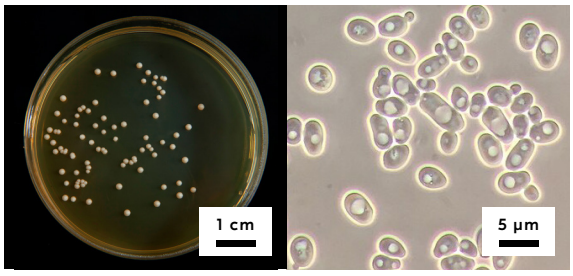
CARD 4

PATHOGEN TYPE: FUNGI

- A single-celled or multicellular organism with a nucleus
- Most live in dead matter or soil, but some can be pathogens inside organisms
- Some change form between yeast (single-celled) and mold (multicellular), depending on conditions
- Can reproduce in multiple ways, including by spores
- Size range: single-celled: ~5–40 micrometers
  multicellular: up to several meters

EXAMPLE DISEASES WITH THIS PATHOGEN:
ringworm, cryptococcosis

YEAST FORM



MOLD FORM

TOP *Saccharomyces cerevisiae* yeast grown on a petri dish (left) and viewed under a microscope (right).

BOTTOM *Aspergillus fumigatus* mold grown on a petri dish (left) and viewed under a microscope (right).

SCIENTIFIC THINKING FOR ALL: A TOOLKIT • UNIT 5: SKILLS TO EVALUATE THINKING, ACTIVITY 8: PATHOGEN TYPE CARDS

ACTIVITY 9

Community Health Solutions

DATA ANALYSIS

ACTIVITY 9

Community Health Solutions

ACTIVITY SUMMARY

Students consider recommendations to help Southsand reduce the impacts of Southsand fever on the community. Students use the skills they've learned from the unit to evaluate comments from community members about the recommendations for fast thinking and cognitive bias. At the end of the activity, students decide which recommendation they think is most effective for the community.

ACTIVITY TYPE
DATA ANALYSIS

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
2. There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.
3. Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.
4. Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.
5. An actively open mindset helps reduce errors from cognitive biases and cognitive shortcuts by deliberately seeking out new ideas and information that could change one's mind.

CONCEPTUAL TOOLS

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTIONS:
Evaluate competing design solutions based on jointly developed and agreed-upon design criteria, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations.) (*Science and Engineering Practice: Engaging in Argument From Evidence*)

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. (*Science and Engineering Practice: Engaging in Argument From Evidence*)

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 9.1 "Recommendations for Reducing Risks from Southsand Fever"
- VISUAL AID 9.2 "List of Cognitive Shortcuts and Cognitive Biases"
- VISUAL AID 9.3 "Scoring Guide: Engaging in Argument from Evidence (ARG)
- ITEM-SPECIFIC SCORING GUIDE: Activity 9, Build Understanding Item 1

FOR EACH GROUP OF FOUR STUDENTS

- SET OF COMMUNITY MEMBER COMMENT CARDS (4 cards)
- SET OF HEALTH DEPARTMENT EVIDENCE CARDS (8 cards)

FOR EACH STUDENT

- STUDENT SHEET 9.1 "Evaluating Community Member Comments"
- STUDENT SHEET 9.2 "Writing Frame: Engaging in Argument from Evidence" (OPTIONAL)
- SCORING GUIDE: Engaging in Argument from Evidence (ARG) (OPTIONAL)

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10 MIN)

1 **Review key points about Southsand fever from previous activities in the unit.**

- Have students read the Introduction in the Student Book and review the map presented. Ask pairs to first discuss and then share with the class what they observe about the locations of fungal diseases around the world. Student responses may indicate that fungal diseases are more common around the world than they realized because almost every continent has some sort of widespread fungal disease caused by environmental disturbances.
- Remind students that Southsand fever is a fictional disease based on a real fungal disease called Valley fever that affects people mostly living in parts of the Southwestern United States. Although Southsand fever is fictional, it highlights a continuing problem that more communities around the world are experiencing as fungal diseases continue to expand their ranges. The recommendations presented in this activity are realistic recommendations for the model disease, Valley fever. The data provided on the Health Department Evidence cards is based on Valley fever but modified for the fictional Southsand fever.
- Make sure students understand that they will apply what they've learned in the unit to evaluate proposed recommendations for reducing risks from Southsand fever and community members' comments about those recommendations.
- Before students begin, review the facts of the Southsand fever disease as a class. Collectively make a list of key points about the disease. The following can guide your class review:

  How does Southsand fever spread?
  - breathe in fungal pathogen that lives in the soil
  - not infectious (doesn't spread from person to person)

  What are the environmental risk factors that might increase exposure risk?
  - dry and dusty soil
  - gusty winds that disturb the soil
  - hot, dry weather
  - activities that disrupt the soil: digging for construction, farming, research, landscaping projects, driving on dirt roads, hiking, etc.

Who is most at risk?
- people who are outside a lot
- older people

PROCEDURE SUPPORT (40-50 MIN)

2 **Support students as they analyze community members' comments and evidence about Southsand fever recommendations.**

- Read the fictional scenario and recommendations in Procedure Steps 1 and 2 as a class. Clarify any questions students have at this point.
- In Procedure Step 3, hand out one set of Community Member Comment cards to each group and have each group member work with one of the cards. The comments on the cards represent fictional community members and their reactions to the recommendations for reducing Southsand fever.
- For groups with students that require additional support with argument and evidence analysis, consider assigning Community Member Comment cards by Erykah or Jimena, which have more straightforward claims and evidence.
- In Procedure Step 4, hand out Student Sheet 9.1, "Evaluating Community Member Comments," to each student and have them complete columns 2 and 3 of the table. A sample student response for this student sheet is found at the end of this activity.
- Students may need support identifying the main claim for their comment. They may also need support looking for potential cognitive shortcuts and cognitive biases in the comment. Use Visual Aid 9.2, "List of Cognitive Shortcuts and Cognitive Biases," to review the features of the cognitive shortcuts and cognitive biases that students have learned about throughout the unit.
- Before groups move on to Procedure Step 5, consider having a class discussion related to the cognitive shortcuts and cognitive biases they found in their community members' comments. Ask, Should the presence of a cognitive shortcut or cognitive bias automatically mean that the argument the community member made should not be considered? Most students will empathize with community members and advocate for considering their views. Follow up with a more important question. Ask, If a community member did not agree with the recommendation, does that mean that the recommendation is not a good solution? Student responses may be mixed. Bring up the following points if no one mentions them:
  - Some arguments for or against the recommendations may be biased because they were written by community members who wanted to protect their interests. This doesn't necessarily mean that the points being made are not valid.
  - Cognitive biases shouldn't rule out a solution, but it's important to be aware of them so you can think carefully about which solutions might be best for the community.

3 **Students use evidence about Southsand fever to evaluate community members' claims.**

- In Procedure Steps 5 and 6, distribute a set of Health Department Evidence cards to each group and support group members as they analyze the data. While students look for evidence both for and against the claims made by community members, remind students that there may be more than one piece of evidence that relates to the recommendation.

4 **Group members share their analysis of community member comments.**

- In Procedure Step 7, individual students choose a community member's comment and considers whether they agree or disagree with the claim. In Step 8, you may want to assign a community member to each group to make sure all community members are represented. It is not necessary for students to agree with their group members on their positions.
- In Procedure Step 9, groups discuss the most effective solution to reduce the number and severity of Southsand fever cases and the priority for funding.

5 **Facilitate a class discussion about the recommendations by using a Walking Debate.**

- In Procedure Step 10, groups switch focus from community member comments back to the recommendations. As needed, revisit the scenario from Procedure Step 1 and review the city leaders' goals: *They've set aside some special funding and would like to emphasize recommendations that reduce the number and severity of Southsand fever cases in the community.*
- Use the literacy strategy of a Walking Debate to encourage students to discuss their opinions for the funding priority for Southsand City. See Appendix 1: Literacy Strategies at the end of the Teacher's Edition for more guidance and information on using the Walking Debate with your students.

SYNTHESIS OF IDEAS (20 MIN)

6 **Build Understanding item 1 can be used as an assessment opportunity.**

- Remind students of the Engaging in Argument from Evidence Scoring Guide. You may wish to project Visual Aid 9.3 "Scoring Guide: Engaging in Argument from Evidence (ARG)," for your students to review each level and clarify your expectations.
- Do not share the item-specific version of the Scoring Guide (Item-Specific Scoring Guide: Activity 9, Build Understanding Item 1) with students as it provides specific information on how to respond to the item prompt.
- Remind students that you expect to see them demonstrate growth in their development of evidence-based arguments, and they may want to review their responses to the previous

assessment in Activity 3 (Build Understanding item 4), and/or Activity 6 (Build Understanding item 1). Note that this is the last opportunity in the unit to formally assess students using the Engaging in Argument from Evidence (ARG) Scoring Guide.

- Sample responses for Levels 1–4 are provided in the Build Understanding section that follows. Review these responses to get an idea of what is expected for each level alongside the item-specific Scoring Guide. See Appendix 2, Assessment Resource, at the end of the Teacher's Edition for more guidance and information on using the Scoring Guides and assessment system with your students.

- Depending on your students, you may want to have them provide feedback on one another's work for revision prior to turning in the work to you for scoring. Alternatively, consider having students turn in a rough draft to you for feedback and revision.

- The formal assessment opportunity can be completed by a variety of alternative options other than a written argument, including a presentation, the creation of a graphic, a poster or video, or through a debate format. Consider whether any changes to the scoring guide or prompt will be necessary for students to complete an alternative assessment format.

7 Review Build Understanding item 2 as a follow-up to the assessment in Build Understanding item 1.

- Build Understanding item 2 gives students an opportunity to reflect on their own thinking as they construct their arguments. Students may be hesitant to discuss their own cognitive shortcuts or cognitive biases with other students at first. They may need help identifying what types of ideas or experiences they have that might lead them to be influenced by cognitive biases. Potential scaffolding questions to help students as they work include:
  - Do you know anyone who is a medical worker, a construction worker, or other outdoor worker?
  - Have you ever been sick with a fungal illness or sick enough to require a hospital stay?
  - How might these things influence how you think about Southsand's problem and possible solutions?
  - Do your experiences make you focus on certain details in the recommendations more than others?
  - Do your experiences affect what you see as advantages or disadvantages of the recommendations?

- For students who need support organizing and writing their responses, you may wish to provide optional Student Sheet 9.2, "Writing Frame: Engaging in Argument from Evidence," to compose their responses. Students could also use Student Sheet 9.2 only as a reference or as a checklist as they write their responses. A sample student response for this student sheet is shown at the end of this activity. For more information on a Writing Frame, see Appendix 1: Literacy Strategies.

- Use Connections to Everyday Life item 3 to help students apply their understanding of cognitive shortcuts and cognitive biases to persuasive content they come across online.
- Conclude the activity by revisiting the Guiding Question, *How can communities evaluate science-based recommendations?* This activity was the first time students could apply the concepts to a larger community decision-making scenario. You might ask students to reflect on which slow-thinking techniques or aspects of an actively open mindset were the most effective at helping them evaluate the science-based recommendations.

EXTENSION (20 MIN)

8 **Use the Extension as an opportunity for advanced learning.**

- The extension gives students an opportunity to research a disease issue that is impacting their community. Information, public service announcements, and outbreak status can be found at the local public health department. Encourage students to use the skills they have learned in the unit to look at the data.
- Alternatively, students could investigate a wellness or safety problem in their school or community. Example topics could include school transportation and parking, school nutrition and exercise programs, or support for mental health.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① ARG Scoring Guide

Which recommendation do you think is the highest funding priority for helping Southsand City reduce risks from Southsand fever? Develop an argument supported by evidence from the Health Department Evidence cards and the Community Member Comment cards. In your response:

a make a claim about which recommendation best reduces the risk from Southsand fever.

b support your claim, using at least 3 pieces of evidence from the activity, and use reasoning to explain how each piece of evidence supports your claim

c describe and explain at least 1 piece of evidence against your claim or that supports an alternate claim. Use reasoning to explain why you still support your claim as the strongest.

Level 4 response

a *My claim is that a public health campaign is the best way for the city to reduce the risk of Southsand fever for residents. It would teach residents how to lower their chance of exposure to the disease and when to get medical help.*

b *My first piece of evidence is that treating Southsand fever too late can lead to more serious health problems. Delays in diagnosing the disease led to a 20% increase in severe cases such as long-term lung damage. This strongly supports my recommendation because better awareness about the disease could prevent this by helping people spot symptoms and seek treatment a lot earlier. Second, a study from nearby counties showed that these types of public campaigns can work. In counties that taught citizens about the flu, a larger percentage of residents knew the symptoms and exposure risks compared to residents in counties that did nothing. Residents were also more likely to say they would seek medical help if they had symptoms. This data comes from scientific studies of many people, so it is strong evidence that a similar public health campaign could work for Southsand fever. My third piece of evidence is that 75% of adults with Southsand fever were outdoor workers. Since the proposed campaign focuses on outdoor exposure risks, it will directly reach the largest and highest-risk group. This is strong evidence that the campaign is a good idea, because educating these workers on how to avoid the fungus could prevent the most new infections.*

c *One piece of evidence against my claim is that a study showed no difference in the percentage of people who said they would likely wear a mask. However, I'm still supporting this recommendation because even if people don't wear masks to prevent the fever, the campaign teaches them to recognize the symptoms. I think this could help make sure people get to the doctor quickly, which saves lives regardless of whether they wear a mask or not.*

Level 3 response

a *My claim is that public education is the best recommendation for Southsand fever.*

b *The first piece of evidence is that most people who got the disease work outdoors, and a public education campaign would inform people of how they get exposed to the disease. This could help prevent people from getting sick with Southsand fever if they know how to avoid it. My second piece of evidence is a study of nearby counties. It found that when people learned about a disease, they were more aware of the symptoms and said they would be more willing to seek medical help if they became ill. The third piece of evidence is that late diagnoses led to more severe medical issues and even death. This is all good evidence. A public campaign would educate residents on how to recognize the symptoms and seek medical help sooner.*

c *An alternate recommendation is that they could use a new blood test to improve patient outcomes. Data showed that the new diagnostic blood test to quickly and accurately diagnose Southsand fever decreased the chance of long-term care and deaths from Southsand fever. However, I don't believe this will work as well as the public education campaign to reduce the risk of Southsand fever because it would not reach as many people.*

Level 2 response

a *I think that people in Southsand City should learn more about the disease.*

b *My evidence is that a study in nearby counties showed that education about the symptoms and risks of a disease can encourage people to visit their doctor if they get sick. This indicates that people were more willing to follow health guidelines after learning about a disease. Another piece of evidence is that 75% of people who got the fever were outdoor workers. Educating these workers could help prevent a lot of infections.*

c *However, educating citizens does not always work. The same study in one of the counties showed no difference in the number of people who said they would likely wear a mask. So education about the disease might not actually change how people behave or make them safer.*

Level 1 response

a *My claim is that Southsand City should build more hospitals to treat the disease.*

b *The fungus causing the disease is found in the soil, and it could be treated more effectively if there were more hospitals. Also, there probably aren't enough medical professionals available. More hospitals and doctors could help lower people's risk of getting the disease.*

c *However, some of the other recommendations might work as well.*

② **Consider your response to Build Understanding item 1 and then describe**

a any of your own cognitive biases or cognitive shortcuts that may have affected your thinking.

My dad is a teacher, so I tend to think that educating people is always a good solution because that is what he taught me. I suppose this could have led me to an availability bias that favored the recommendation that educates people about the symptoms and risk factors.

b at least one trade-off for the solution you have chosen.

One trade-off is that it was the most expensive of the recommendations, and the cost of the recommendation means that the city would not be able to implement more than one solution to address Southsand fever.

CONNECTIONS TO EVERYDAY LIFE

③ **Provide an everyday example of how online comments that include cognitive biases, cognitive shortcuts, and limited evidence can still be persuasive to a reader.**

One example of this is online reviews. They can be persuasive even though they are biased because there are so many of them. Also, some of the biases such as conflict of interest are not apparent when you read the reviews.

COMMUNITY MEMBER	CLAIM	COGNITIVE SHORTCUTS AND/OR COGNITIVE BIAS	EVIDENCE SUPPORTING THEIR IDEAS	EVIDENCE REFUTING THEIR IDEAS
Erykah: Public Education				
Circle one: AGREE DISAGREE		NOTES:		
Gerald: Diagnostic Testing				
Circle one: AGREE DISAGREE		NOTES:		

CONTINUED

COMMUNITY MEMBER	CLAIM	COGNITIVE SHORTCUTS AND/OR COGNITIVE BIAS	EVIDENCE SUPPORTING THEIR IDEAS	EVIDENCE REFUTING THEIR IDEAS
Jimena: Soil Stabilization				
Circle one: AGREE DISAGREE		NOTES:		
Marshall: Protective Gear				
Circle one: AGREE DISAGREE		NOTES:		

COMMUNITY MEMBER	CLAIM	COGNITIVE SHORTCUTS AND/OR COGNITIVE BIAS	EVIDENCE SUPPORTING THEIR IDEAS	EVIDENCE REFUTING THEIR IDEAS
Erykah: Public Education	*People need to be educated on the facts about Southsand fever.*	*anchoring shortcut*	*Evidence Card 6: Public health campaign for flu increased people's awareness of symptoms and risks, made them more likely to ask for medical advice.* *Evidence Card 8: Patients who get prompt medical diagnosis and treatment experience less severe Southsand fever disease.*	*none*
Circle one: (AGREE) DISAGREE	NOTES: *I agree because awareness leads to early treatment and lessens the chance of severe disease.*			
Gerald: Diagnostic Testing	*The blood test is not reliable, so we shouldn't use it.*	*confirmation bias*	*Evidence Card 4: The blood test is not very accurate within the first 2 weeks of infection.*	*Evidence Card 4: The blood test is very accurate beyond 2 weeks of infection.* *Evidence Card 5: Blood test led to increase in patients with full recovery, decrease in patients needing long-term care, and small decrease in patient deaths.* *Evidence Card 8: Delays in diagnosis lead to poor patient outcomes.*
Circle one: AGREE (DISAGREE)	NOTES: *Data refutes his claim.*			

CONTINUED

COMMUNITY MEMBER	CLAIM	COGNITIVE SHORTCUTS AND/OR COGNITIVE BIAS	EVIDENCE SUPPORTING THEIR IDEAS	EVIDENCE REFUTING THEIR IDEAS
Jimena: Soil Stabilization	*We should wet the soil to avoid having more workers become ill with Southsand fever.*	*availability shortcut*	*Evidence Card 1: Higher % of workers who dig in soil have Southsand fever symptoms.*	*Evidence Card 1: Higher % of workers exposed to a dust cloud had Southsand fever symptoms.* *Evidence Card 1: Higher % of workers who wet the soil had fewer Southsand fever symptoms.*
Circle one: AGREE DISAGREE	NOTES: *She made a cognitive shortcut, but the data backs it up.*			
Marshall: Protective Gear	*Installing HEPA filters will be more effective than having people wear masks.*	*conflict of interest* *conformity bias*	*Evidence Card 2: HEPA filters reduce fungus in the air inside buildings.* *Evidence Card 6: Public health campaign, but did not make people more likely to wear a mask, even when they knew the risks.*	*Evidence Card 3: 75% of working adults with Southsand fever were outdoor workers.* *Evidence Card 7: Most types of mask materials are effective at filtering fungal particles compared with no masks.*
Circle one: AGREE DISAGREE	NOTES: *While I think that masks are not cool, I can't agree because people are getting sick from something outdoors, not from being indoors.*			

CLAIM (statement about how the disease is spreading)

My claim is:

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

The second piece of evidence that supports my claim is

The third piece of evidence that supports my claim is

CONTINUED

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

Second piece of evidence: My reasoning is that

Third piece of evidence: My reasoning is that

Lastly, evidence against my claim or that supports an alternate claim is

However, I still support my claim as the most likely because

CLAIM (statement about how the disease is spreading)

My claim is:

that a public health campaign is the best way for the city to reduce the risk of Southsand fever for residents.

EVIDENCE (data and observations related to the claim)

The first piece of evidence that supports my claim is

that 75% of adults with Southsand fever are outdoor workers.

The second piece of evidence that supports my claim is

that delays in diagnosing Southsand fever led to a 20% increase in severe cases, such as long-term lung damage or death.

The third piece of evidence that supports my claim is

that a study from nearby counties showed that when counties used public health campaigns, more residents recognized symptoms and were willing to see a doctor compared to counties that did nothing.

CONTINUED

REASONING (how or why each piece of evidence supports the claim)

First piece of evidence: My reasoning is that

if the public health campaign specifically focuses on outdoor exposure risks, it will reach the largest and most vulnerable group. Educating these workers on how to avoid the fungus could prevent the most new infections.

Second piece of evidence: My reasoning is that

education could help people recognize the symptoms earlier. A public health campaign could encourage residents to seek treatment before the disease causes serious health problems, such as long-term lung damage.

Third piece of evidence: My reasoning is that

because people in the study were more likely to say they would seek medical help after being educated, a similar public health campaign could work in Southsand City. Education would increase the rate of residents getting diagnosed and treated correctly. This could help prevent more serious cases.

Lastly, evidence against my claim or that supports an alternate claim is

that the study in a nearby county showed no difference in the amount of people who said they would likely wear a mask. This means the campaign didn't really have an impact in helping people avoid getting sick.

However, I still support my claim as the most likely because

the campaign could do more than just encourage mask-wearing. It could teach residents how to avoid exposure through safer digging habits and how to recognize symptoms early. By getting patients to the doctor faster, the campaign could save lives even if a lot of people choose not to wear masks.

SOUTHSAND HEALTH DEPARTMENT

Recommendations for Reducing Risks from Southsand Fever

DIAGNOSTIC TESTING

Funding for medical providers to use a newly developed diagnostic blood test to quickly and accurately diagnose Southsand fever. This helps prevent unnecessary treatments and prolonged illness that could lead to long-term care or death.

PUBLIC EDUCATION

A public health campaign to educate community members about the symptoms of Southsand fever and the outdoor exposures that put people at risk of contracting Southsand fever. The campaign will encourage residents to contact their doctor if they believe they have been exposed to the fungus or notice symptoms.

PROTECTIVE GEAR

Grants for companies and community organizations to buy and use devices that can successfully filter particles such as pollen, dust, and airborne microbes out of the air. This includes:

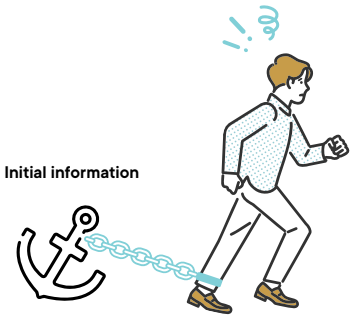
- protective gear (such as masks) to reduce breathing in the fungal pathogen when outdoors.
- high efficiency particulate air (HEPA) filters to reduce the number of fungal pathogens in indoor spaces.

SOIL STABILIZATION

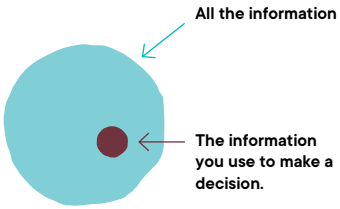
Grants for companies and community organizations to reduce activities that disturb soil or produce dust, including money to:

- support soil wetting (for individual community members) to reduce the amount of airborne dust and particles.
- fund soil-stabilization projects such as planting ground-cover plants to retain soil and prevent airborne dust.
- buy advanced soil-wetting equipment and large-scale soil dust covers for companies.

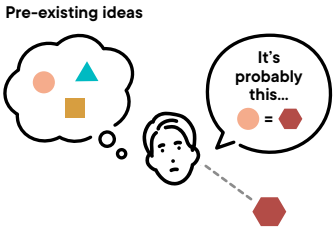
COGNITIVE SHORTCUTS



Anchoring Shortcut



Availability Shortcut



Representativeness Shortcut

COGNITIVE BIASES

Confirmation Bias

Conflict of Interest

Conformity Bias

Emotion Bias

VISUAL AID 9.3 | SCORING GUIDE: ENGAGING IN ARGUMENT FROM EVIDENCE (ARG)

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim; is relevant, accurate, and sufficient; AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.

LEVEL	GENERAL DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

ITEM-SPECIFIC SCORING GUIDE | ACTIVITY 9, BUILD UNDERSTANDING ITEM 1

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are developing effective evidence-based arguments.

WHAT TO LOOK FOR:

- Response includes a clear and relevant claim.
- Response includes sufficient evidence, including multiple lines of evidence when appropriate.
- Reasoning is logical, sufficient, and connects the evidence to the claim.

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 4 **Complete and correct**	The student's claim is clear and relevant.	The student's evidence supports the claim; is relevant, accurate, and sufficient; AND the student evaluates the strength of the evidence in supporting the claim.	The student's reasoning is appropriate, logically connected to the claim, and sufficient.

The student's response includes:

- a clear claim about which of the four recommendations would be the most effective at reducing the risk of the fictional disease.
- at least 3 pieces of evidence from the Evidence cards in the activity, including the use of quantitative evidence.
- an accurate description of the strength of each piece of evidence and how it supports their claim about disease transmission.
- a thorough description of at least 1 piece of evidence that supports a different recommendation method.

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 3 **Almost there**	The student's claim is relevant BUT incomplete.	The student's evidence is relevant, accurate, and sufficient.	The student's reasoning is appropriate and logically connected to the claim BUT is not sufficient.
	The student's response includes: • a claim about which of the four recommendations would be the most effective at reducing the risk of the fictional disease. • at least 3 pieces of evidence from the Evidence cards in the activity. • at least 1 piece of evidence that contradicts their claim or supports a different recommendation. • a description of the strength of each piece of evidence that may not be accurate.		
Level 2 **On the way**	The student's claim seems relevant BUT is unclear.	The student's evidence is relevant BUT is incomplete and/or contains inaccuracies.	The student's reasoning is incomplete or not logically connected to the claim.
	The student's response includes: • an unclear claim about which of the four recommendations would be the most effective at reducing the risk of the fictional disease. • 1 or 2 pieces of evidence from the activity to support their claim. • at least 1 piece of evidence that contradicts their claim or supports a different recommendation.		

LEVEL	ITEM-SPECIFIC DESCRIPTION		
	CLAIM	EVIDENCE	REASONING
Level 1 **Getting started**	The student's claim is irrelevant.	The student's evidence is irrelevant or does not support the claim.	The student's reasoning does not logically support the claim and does not connect the claim to the evidence.
	The student's response includes: • a claim that is unrelated to any of the four recommendations. • a description of evidence that is irrelevant to their claim. • no evidence that contradicts their claim or that supports a different recommendation.		
Level 0 **Missing or off task**	The student provided no claim.	The student provided no evidence.	The student provided no reasoning.
X	The student had no opportunity to respond.		

Jimena

CONSTRUCTION WORKER

I got sick, and I think it was from contaminated soil at my job site. This is because everyone I know who got Southsand fever works with me in construction. We specialize in soil removal for construction, so we are exposed to airborne dirt particles all day long. I'm going to wet the soil before we start the next job. We might have to dig in mud, but at least we'll all be safer.

Marshall

INDUSTRY ALLIANCE FOR CLEAN AIR BUSINESSES

My friends don't believe in masks, so they won't wear them. I won't wear one either, especially around my friends. It doesn't matter if masks stop the spread of respiratory viruses or fungal particles because they aren't cool. It is a better idea to install HEPA filters in all the city buildings. Filters are much better than masks because they significantly lower fungus spores in the air and limit people's exposure to pollen, pollution, and other microbes. This will be a great investment for Southsand City!

Gerald

COMMUNITY TOWN CLERK

This blood test is so new, I don't think that we should trust it. I just knew it wasn't a reliable test, so I wasn't surprised when I heard of a doctor who refused to use it. When I searched online for "Southsand fever after testing negative," I found several stories about people who got the test, and it was wrong. It just doesn't make sense to use an unreliable test.

Erykah

DIRECTOR OF SOUTHSAND HEALTH CENTER

Increasing education about Southsand fever is the easiest way to make sure everyone can get their facts straight about the disease. We did a survey that found 90% of people thought Southsand fever was caused by a flu virus. That was before epidemiologists figured out it was a fungus, so it's probably a much lower number now, but there are still a lot of people who don't know it isn't a virus!

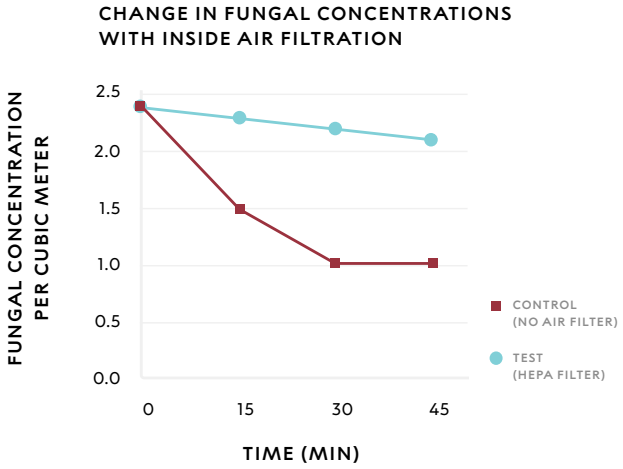
EVIDENCE CARD 1

A local university professor conducted a survey to determine if different types of outdoor work activities were associated with Southsand fever symptoms. She surveyed construction workers working on a large-scale solar panel installation project. She compared the work activities of 325 workers without Southsand fever symptoms to 89 workers with Southsand fever symptoms. Some workers participated in more than one work activity.

TYPE OF WORK ACTIVITY	WITHOUT SOUTHSAND FEVER SYMPTOMS (325 WORKERS)	WITH SOUTHSAND FEVER SYMPTOMS (89 WORKERS)
active digging	16%	27%
wetting soil before active digging	62%	31%
working in a trench	22%	46%
exposed to dust cloud	29%	81%

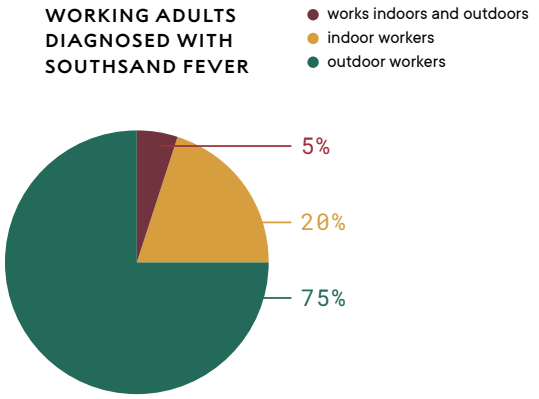
EVIDENCE CARD 2

A research group at the local university recently conducted a test of a new HEPA filter product. This test showed that using the HEPA filter inside a closed home for 45 minutes resulted in a 58% reduction of indoor fungus particles compared to a 12.5% reduction from no filter and with natural ventilation. The HEPA filter gave an over 4.5 times bigger reduction for fungal particles.



EVIDENCE CARD 3

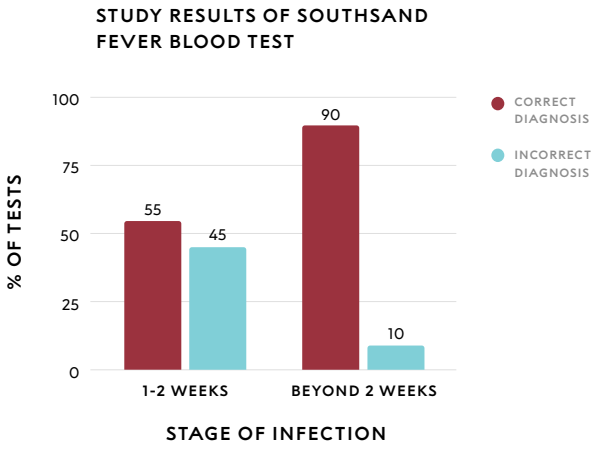
The Southsand Health Department investigations found that of working adults with Southsand fever, 75% were outdoor workers, 20% were indoor workers, and 5% worked equal time indoors and outdoors.



EVIDENCE CARD 4

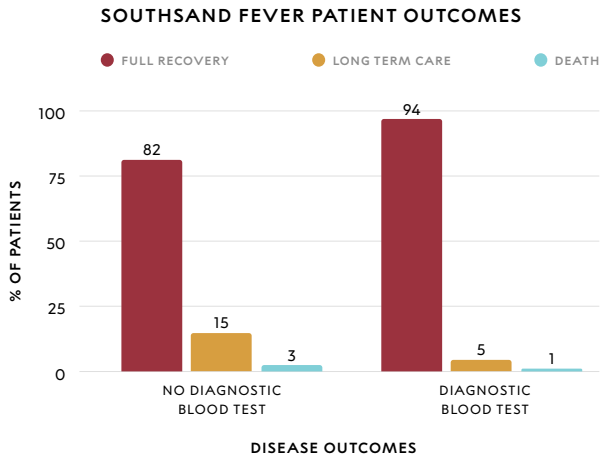
Researchers at the local university developed the new diagnostic blood test and conducted a study to determine its effectiveness. The study looked at over 1,000 participants and found that the test

- gave a correct diagnosis 55% of the time when patients were within 2 weeks of the start of infection.
- gave a correct diagnosis 90% of the time when patients were beyond 2 weeks from the start of infection.



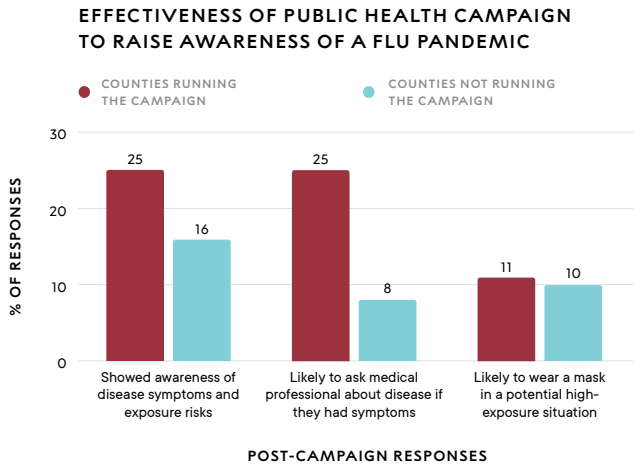
EVIDENCE CARD 5

According to the data from the Southsand Health Department, the new blood test started being used at various health-care locations in the area. The following graph shows the data on 2,027 patient outcomes. The diagnostic blood test increased the number of patients who fully recovered. It also decreased deaths and the number of people who needed long-term care.



EVIDENCE CARD 6

The following survey results are from a public health campaign a few years ago to raise awareness of a flu epidemic. The study, conducted by the Southsand Community Health Center and the local university, collected data on people's awareness of the symptoms and exposure risks of the disease and some actions they might take as a result.



EVIDENCE CARD 7

The local university made a model to show the effectiveness of materials used in common types of protective masks against various airborne particles. They tested the materials and compared them to the natural filtration through our nose and throat during breathing.

FILTERING EFFICIENCY OF MASK MATERIALS*

PARTICLE TYPE	UNMASKED BREATHING	COTTON CLOTH	N95 MATERIAL
pollen	40%	96%	99%
fungal spores	25%	95%	99%
wildfire smoke	1%	35%	90%
viral particles	5%	60%	96%

*Materials modeled in ideal conditions without consideration of mask fit.

EVIDENCE CARD 8

Analysis of patient outcomes from Southsand Hospital showed that delays in diagnosis of Southsand fever led to a 20% increase in severe Southsand fever disease. This included severe lung symptoms, long-term lung damage, and hospitalization. Patients who got prompt medical testing and care were less likely to experience severe Southsand fever symptoms.

ACTIVITY 10

Cognitive Skills in Communication

PRESENTATION

ACTIVITY 10

Cognitive Skills in Communication

ACTIVITY SUMMARY

Students apply what they've learned about cognition to create Public Service Announcements (PSAs) that communicate important information about Southsand fever. They evaluate one another's PSAs for cognitive shortcuts and cognitive biases and refine their own PSAs based on peer feedback. Students reflect on how different types of cognition affect how they obtain and communicate information in their daily lives.

ACTIVITY TYPE
PRESENTATION

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

1. Slow thinking relies on careful reasoning and is useful for complex or higher-stakes situations. Slow thinking takes time and effort but is less prone to cognitive error when evaluating information and reaching conclusions.
2. There are many cognitive biases that shape the way people make conclusions, including confirmation bias, conflict of interest, conformity bias, and emotion bias. Recognizing these biases can lead to improved reasoning.
3. Cognitive shortcuts and cognitive biases can lead to cognitive errors that affect how one chooses and reasons about evidence related to a claim.
4. Confirmation bias is a common bias that leads to faulty reasoning. It is a result of the unintentional misuse of evidence to support an existing belief.

CONCEPTUAL TOOLS

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically). (*Science and Engineering Practice: Obtaining, Evaluating, and Communicating Information*)

VOCABULARY DEVELOPMENT

public service announcement (PSA)
(assumed prior knowledge)
an educational message created to raise awareness and change people's attitudes or behaviors

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- VISUAL AID 9.1 "Recommendations for Reducing Risks from Southsand Fever"
- VISUAL AID 9.2 "List of Cognitive Shortcuts and Cognitive Biases"

FOR EACH STUDENT

- PSA SUPPLIES (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts And Skills" (OPTIONAL)

Consider in what form you would like your students to prepare their PSAs. Some options include paper, video, audio recording, meme, large poster, or digital drawing. Prepare any templates or materials you would like students to use.

Prepare a few examples of PSAs to share with your students in the Getting Started section. Choose PSAs that are appropriate and applicable to your student population. The following are some suggested resources for successful PSAs:

- The Ad Council: *Browse Campaigns*
- National Foundation for Infectious Disease: Public Service Announcements
- CDC Tips from Former Smokers: *Campaign Resources: Tips From Former Smokers*
- Seize the Awkward: *Seize the Awkward*

TEACHING NOTES

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

Strategies for the **equitable inclusion of diverse students** are highlighted in light blue.

GETTING STARTED (10 MIN)

1 **The class discusses what makes a successful public service announcement (PSA).**

- Have students read the Introduction in the Student Book. Let them know that they will be making PSAs. Review the features of an unbiased PSA from the Introduction:
  - a clear way to take action
  - use a relatable messenger
  - memorable and seen often enough
- Share the PSA examples you have prepared (See Advance Preparation). Have the class briefly analyze each example for the features listed above.
- For the PSA examples, have students identify any cognitive biases, cognitive shortcuts, or evidence used and discuss their effectiveness. You may also want to share a few historical examples that were not as successful, as a contrast, since pairs will be creating biased PSAs and then working to improve them into unbiased PSAs. Most of these unsuccessful examples included extreme scare tactics that caught attention and/or engaged in fast thinking, but they were not effective.

PROCEDURE SUPPORT (40-60 MIN)

2 **Support students as they create biased PSAs.**

- Review Procedure Steps 1–2 as a class. Clarify any questions that students have about the task. Review Southsand City Health Department's recommendations by displaying Visual Aid 9.1, "Recommendations for Reducing Risks from Southsand Fever," which was originally introduced in Activity 9. (The recommendations can also be found in Activity 9, Procedure Step 1 in the Student Book.)

- If you have additional requirements that students must include in their PSAs, be sure to let them know before they begin. You might consider assigning recommendations to each pair or group in order to make sure there is a variety in the whole class.
- For students who need more support creating a visual product, you may want them to create a PSA by using whatever modality is most comfortable, such as verbal (story), scrapbook (photos), or audio (recording).
- In Procedure Step 3, students create biased PSAs that take advantage of cognitive shortcuts and cognitive biases. At this point, let students know that they will eventually revise their PSAs to be unbiased. It might be helpful to review ways to recognize the different cognitive shortcuts and cognitive biases introduced in Activities 3 and 5. Help students think of ways they could include these shortcuts and biases in their PSAs, such as:
  - focusing on extreme emotions.
  - highlighting worst-case scenarios or magical solutions.
  - sensationalizing the content.
  - referring to readily available ideas.
  - repeating a phrase several times.
- Display Visual Aid 9.2, "List of Cognitive Shortcuts and Biases," again to remind students of the biases and shortcuts they can include in their biased PSAs.
- If time and inclination allow, you may want to have students incorporate other cognitive shortcuts and cognitive biases not included in this instructional unit. Make sure these are identified by student creators for others who may not be familiar with those shortcuts and/or biases.
- In Procedure Step 4, have pairs trade their biased PSAs with another pair's biased PSA. Support students as they review each other's PSAs. Remind them to use the skills from the unit to look for misuse of evidence, cognitive shortcuts, cognitive biases, and/or fast thinking.
- After Procedure Step 4, have a class discussion about the biased PSAs. Ask students to share what types of cognitive shortcuts and cognitive biases they found to be the most impactful. Have students share how these features might affect a reader's thinking. Students might respond that features such as focusing on worst-case scenarios might make readers fearful and more likely to act.
- In Procedure Step 5, it may be helpful to offer some general strategies that students could use to improve the biased PSAs to make them less biased and misleading. Some ideas might include:
  - not focusing on negative emotions or worst-case scenarios.
  - making sure there are actual facts in the PSA.
  - not using sensational language or things such as ALL CAPS, bold type, and/or exclamation points.

3 Students give feedback on each other's biased PSAs.

- As each pair works through Procedure Steps 6–7, support them as they review another pair's PSA, provide feedback to make that PSA less misleading and reduce cognitive bias, and listen to the other pair's suggestions for improving their PSA. Remind students that they should make sure their PSAs are still engaging and interesting. Also remind students to think about the features of unbiased PSAs from the beginning of the activity. Their PSAs should give readers a way to take action, be relatable, and be memorable.

SYNTHESIS OF IDEAS (40 MIN)

4 Students present their PSAs to their classmates

- In Procedure Step 8, students present their unbiased PSAs to the class. They can explain the changes they made to their biased PSAs and then show their original PSAs for the class to see how both PSAs compare. Students should be able to identify how they reduced the cognitive biases and cognitive shortcuts when making their revisions.

- Another option for presenting the PSAs, especially for diverse student populations that may struggle with a traditional presentation, is to conduct a Gallery Walk in the classroom where all PSAs are on display, and students walk around and view them. Alternatively, you could create a digital display space for the PSAs where students can provide feedback.

- Student presentations will vary depending on the recommendation chosen, the cognitive shortcuts and cognitive biases included, the medium used, and students' creativity. The following shows a sample of possible student responses.

RECOMMENDATION	BIASED PSA	UNBIASED PSA
Soil Stabilization	**Wet It or Regret It** Don't let your backyard become a community health hazard!!! **All your smart neighbors** are wetting the dirt before it becomes a HOTBED of Southsand fever. Wet soil traps the Southsand fever spores before they can ever reach your lungs. **Don't get left behind!** Start flooding your yard!	**Stop the Dust, Stop the Disease** Digging up dirt can release Southsand fever spores hidden in the soil. Always wet down the soil thoroughly before and during any digging projects, big or small. Don't let the dust fly in your breathing spaces. Keep fungal spores in the ground and out of your lungs! #StoptheDust
Protective Gear	**Masks Are Cool** Do you want to get sick with Southsand fever like all those people in the headlines? **Don't be caught without wearing an N95 mask!** They are SOOOO TRENDING right now. I have been selling top-quality masks for years, and 100 happy customers can't be wrong. This is the easiest way to protect your lungs so you can keep doing the things you love. #MaskUp	**Your Lungs Deserve Clean Air** Windy day or working in the dirt? Invisible Southsand fever spores travel on dust. Don't take the risk. Wear a fitted N95 mask when outdoors in dusty conditions to filter out harmful fungi before you breathe it in. Indoors, a HEPA filter will keep your indoor air clean and safe. Protect yourself to stay in the game.
Diagnostic Testing	**You Don't Have the Flu!!!** There were **1,000 new cases** of Southsand fever that have been **diagnosed incorrectly** this year, and you shouldn't be one of them! The new diagnostic blood test can result in cutting the number of cases in half by giving you correct results so you can get early treatment. When you go to the doctor, you want them to confirm what you already know—you have Southsand fever!!! Start with the right diagnosis from a GENUINE diagnostic blood test. **Get the clarity on your symptoms that you deserve!**	**Correct Diagnosis Matters** Health workers: Southsand fever mimics the flu or pneumonia, causing treatment delays. If a patient in our area has persistent respiratory symptoms, consider a fungus in addition to familiar pathogens. Don't guess at a diagnosis—order the specific Southsand fever diagnostic blood test immediately. Early diagnosis ensures correct treatment.
Public Education	**Don't Be Stupid About Symptoms** The symptoms of Southsand fever are a NIGHTMARE!!! You should be frightened about what happens if you get Southsand fever! Knowing the symptoms will make you even MORE SCARED. If you are really tired and your cough won't quit, you might have Southsand fever. It's time to ask your doctor about Southsand fever. Don't lose another week to the unknown.	**Southsand Fever: Know the Signs** If you live in a dusty region and have been near dirt lately, be aware of the symptoms of Southsand fever: • a cough that won't quit. • a fever for more than one day. • extreme fatigue. Don't ignore persistent symptoms. Know the signs and ask your doctor about Southsand fever today. #CheckYourCough

5 Compare and contrast students' two PSAs.

- In Procedure Step 9, have pairs discuss the experience of creating a biased PSA and an unbiased PSA. Ask, What was challenging about creating each type of PSA? Students might say that it was hard to create an interesting PSA without incorporating some of the features such as appeals to emotion and sensational language.

- This discussion (from Procedure Step 9) should lead to the central idea of the activity. Use the questions provided in the Student Book as a guide for the discussion.

  Sample Student Response, Procedure Step 9

  I see cognitive shortcuts and cognitive biases all the time online. Now that I can identify them, it seems obvious that people use them to grab attention and create certain reactions. I really notice the emotion bias in my feed. I am not sure if it is unfair. On one hand, it seems to get attention; on the other hand, I don't think it works over the long term. These shortcuts and biases might catch attention initially, but they are not persuasive in changing action. It would be easy to make a rule against using them, but that would never work. I think more awareness and education is a good idea.

6 Generalize the experience in the activity to everyday media communications.

- Relate the strategies discussed in students' PSAs to advertisements in general. Review Connections to Everyday Life item 4, which relates to how product advertising often takes advantage of cognitive shortcuts and cognitive bias in potential customers. Ask students to reflect on how the ideas in this activity affect how they look at product advertisements.

- Relate the ideas of biased advertisements and promotions to the conclusion from Activity 3 when students investigated the effectiveness of fast thinking in news headlines.

7 Summarize the key concepts and process skills of the unit.

- You may wish to revisit optional Student Sheet 1.3, "Unit Concepts and Skills," to help students formally organize the ideas introduced in the unit. Students can place the headings of any remaining main ideas from the unit into the organizer and add examples from their classroom experiences in Activities 8–10. See the end of Activity 1 in the Teacher's Edition for a sample student response.

- Finish the activity by revisiting the Guiding Question, *How can you apply knowledge of cognition to communicating information?* Use responses to this question to formatively assess students' understanding of the key concepts and process skills related to how cognitive biases appear in our everyday communications.

- Revisit the Unit Driving Question, *How can people evaluate their thinking about everyday issues, such as health and disease?* Over the course of the unit, students have been introduced to practical skills to help them think about the different types of information they encounter in their lives. They've learned about the concepts of cognition and different types of cognition, such as fast thinking, slow thinking, and cognitive bias. They have begun practicing using an actively open mindset to reduce the effects of bias, and they have seen how slow thinking and an actively open mindset can improve the scientific process.

- Ask students to reflect on the application of the unit content to their everyday lives. Ask, How can using the skills you learned in this instructional unit help you make better judgments and decisions about your life? Accept all responses and let students know that while awareness is the first step, they'll have to continue to practice slow-thinking techniques and an actively open mindset more and more often as they evaluate information related to more complex challenges as adults.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

1. **In this activity, you compared a cognitively biased PSA to an unbiased PSA. Describe a situation in which you would want to receive information that is more like**

   a **the biased PSA.**

   I would be okay with more biased information when it is related to something that doesn't have big consequences, like choosing what activity to do with my friends this weekend, or maybe even when considering which product to buy.

   b **the unbiased PSA.**

   I want to receive unbiased information from my doctor when I need to make a decision about my health, or unbiased product reviews when I need to make an important purchase.

2. **Think about the media (news articles, posts, videos, images, music) you consume every day. How have your experiences with this instructional unit changed your thinking about how to process that media information?**

   I will probably use both fast thinking and slow thinking when I respond to different media. I will try to use more slow thinking. I tend to get upset at posts, so being able to know when there is a cognitive bias could probably calm me down. It will help to use an actively open mindset to identify when cognitive shortcuts and cognitive biases are in play.

3. **Southsand fever is based on a real-life disease called Valley fever. Scientists began investigating Valley fever in the late 1800s. One set of researchers, Emmett Rixford and Thomas Caspar Gilchrist, isolated the organism causing the disease and thought it looked like a type of protozoa called *Coccidia*. They sometimes found mold growing on their petri dishes and dismissed this mold as a contaminant instead of a pathogen. Rixford and Gilchrist's ideas matched the thinking of earlier doctors studying the disease. Explain how fast thinking and/or confirmation bias may have played a role in their conclusions.**

   They could have relied on the availability shortcut to make a conclusion about the type of pathogen at the beginning of their investigation. If they had looked at the work of the earlier doctors, this may have been what came to mind most easily. This developed into confirmation bias when they decided to ignore the mold growing on the petri dishes as a contaminant, instead of considering the alternative possibility that the mold was the actual pathogen.

CONNECTIONS TO EVERYDAY LIFE

④ **Product advertising often relies on messaging that appeals to people through cognitive shortcuts and cognitive biases. Imagine a popular skincare brand that markets one of their products as environmentally friendly.**

a **How could the product advertisements take advantage of cognitive shortcuts or cognitive biases in people who value environmental protection?**

The ads may take advantage of confirmation bias by emphasizing how few resources the product uses or ways that it can be recycled. They might use an eco-friendly image or slogan. This could lead someone to buy the product not because it's a good product, but because they think it is good for the environment.

b **How could skills from this unit help you evaluate claims in the advertisement?**

I'd want to check my thinking and see how my existing beliefs have influenced my reaction to the product. I'd also want to look for evidence for and against any claims made about the effectiveness of the product or its environmental impact.

APPENDIX 1

LITERACY STRATEGIES

Teaching ***Scientific Thinking for All: A Toolkit*** provides constant opportunities for students to improve their English language skills. For example, students are expected to read informational text and procedures, write clearly to respond to assessment items, and use oral language skills during discussions. Research-based support strategies are embedded throughout the activities to help students process new content, develop analytical skills, connect concepts, become more proficient readers, and express their knowledge.

The literacy strategies offered in the curriculum depend on the instructional needs of the activity in which they are embedded. Because a full explanation of each research-based strategy is not practical to provide in the Teaching Notes of the Teacher Edition, a more detailed description for each goal is described below.

Eliciting Prior Knowledge

Anticipation Guide
Concept Map

Processing Information

Frayer Model
Venn Diagram
Word Sort

Reading Comprehension

Directed Activity Related to Text (DART)
Read, Think, and Take Note
Word Wall

Oral Discussion and Debate

Developing Communication Skills
Walking Debate

Writing Support

Science Notebook
Writing Frame

ANTICIPATION GUIDE

What It Is

An Anticipation Guide is a pre-reading exercise to help students activate their background knowledge about a topic and generate curiosity about the material they will learn. Students answer a set of prompts before reading; after reading, students discuss how their predictions compare with the information in the reading.

Why Use It?

The value of an Anticipation Guide is in the discussion that occurs before and after the reading. Before reading, students discuss their predictions and the reasons for them. During this discussion, the teacher gleans information about the depth of students' existing knowledge and their misconceptions about a topic. The post-reading discussion on how students' answers have changed allows teachers to formatively assess what students gained from the reading.

How To Use It

Students begin by individually responding to a series of statements related to the text they will read. They state whether they agree or disagree with a statement by marking it with a + (agree) or a – (disagree). The statements give students a sense of the key ideas in the reading and elicit their current ideas about and knowledge of the material. Students then discuss their predictions as a class. After completing the reading and participating in another discussion, students revisit the statements and record whether they now agree or disagree with each one. Their final task is to cite information from the reading to explain how the text either supported or changed their initial ideas.

Where It Is

The Anticipation Guide Student Sheet can be found in the Teacher Edition for the activities in which it is used. Sample student responses are also located in the Teacher Edition.

CONCEPT MAP

What It Is

A concept map is a visual representation of the relationship between ideas and concepts. Concept maps ask students to make and describe relationships between main ideas and subtopics and among the subtopics themselves.

Why Use It?

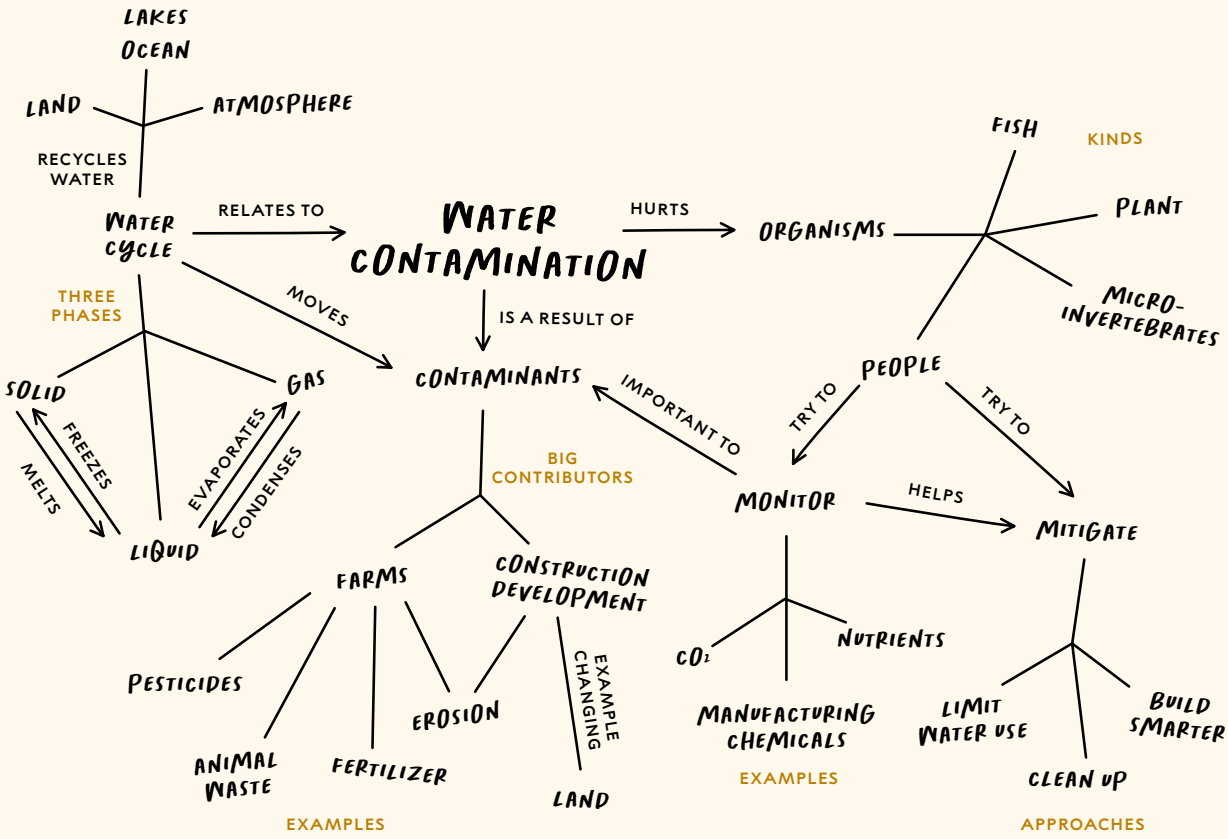
Concept maps demonstrate students' understanding of the connections between topics in a spatial manner. They also allow students to expand their knowledge related to a topic.

How To Use It

The main concept is written in the center of a page (or on the board), and students place subtopics around it, connecting lines between each subtopic and the main concept. On or near each line they've drawn, students add a brief description of the relationship between the two words.

The following example is from a prompt in a unit in which students are asked to draw a concept map about water contamination.

Initially, students may find it helpful to have a list of words that must be included in the map or an incomplete concept map to fill in. Later, students might brainstorm words that should be included and make a list before beginning their concept maps. It may also be helpful to write each subtopic on an index card or sticky note so students can physically manipulate them and lay out the map.



If your students are unfamiliar with concept maps, model the process by using a familiar central idea, such as school. Write "school" on the board and with the class, brainstorm subtopics to place around it (i.e., What are words and ideas associated with school?). Off to the side, organize these subtopics in a hierarchy, listing the more general ideas first and the more specific ones toward the bottom. Arrange the ideas spatially on the map, with the more general ideas closer to the central topic and the more specific ideas radiating out from the general ideas. Link the general ideas to the central concept with specific ideas, words, or short sentences defining the connection between the concepts. Then add links explaining the connection between the general and more specific ideas.

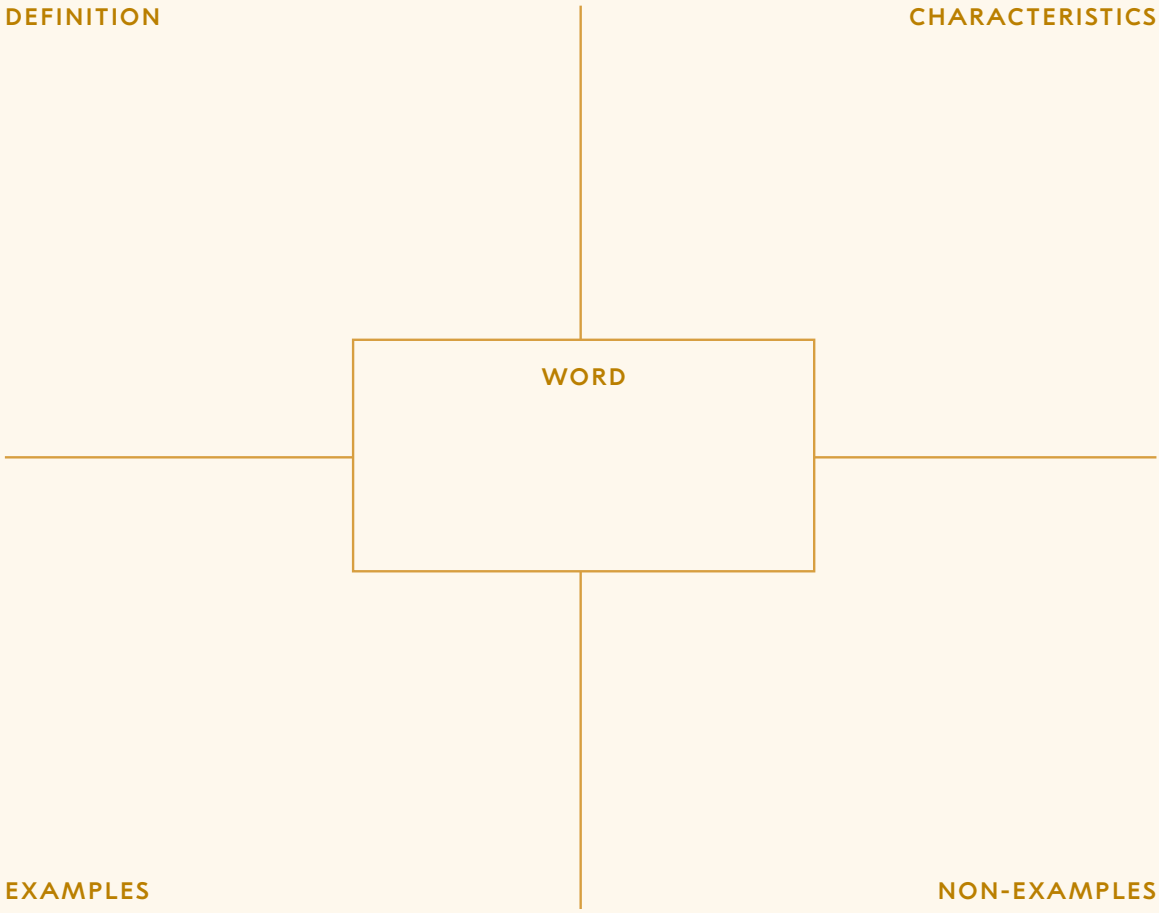
Where It Is

Concept maps are most often part of the Teaching Notes in the Teacher Edition; they may also be Build Understanding items in the Student Book. Instructions for constructing a concept map can be found in the Teacher Edition.

FRAYER MODEL

What It Is

The Frayer Model is a graphic organizer used in direct instruction of discipline-specific vocabulary. In a Frayer Model, students define a word and examine its characteristics and then offer examples and non-examples to build a deep conceptual understanding of the word.



Why Use It?

The Frayer Model offers support as students examine the conceptual meaning of discipline-specific vocabulary. The Frayer Model supports the conceptual development of terms and concepts as they are introduced. Students can return to the Frayer Model as they continue to use the word throughout a course of learning to revise the model, based on their deepening understanding of the word.

Where It Is

Frayer Models can be found in the Teaching Steps in the Teacher Edition and as Build Understanding items in the Student Book.

VENN DIAGRAM

What It Is

A Venn diagram is a strategy for comparing the relationship between two ideas or concepts in a simple visual format. Students visually map the characteristics that are unique to a set of ideas or concepts and the characteristics that are shared.

Why Use It?

By placing words on a page in relation to each other and then explaining their placement, students show that they understand the meaning of each word and the relationship between them. A Venn diagram can be used as a focus for a discussion or for a writing assignment that asks students to compare and contrast ideas. It can also be used as a formative assessment that probes students' understanding of a set of concepts. The simplicity and flexibility of setting up a Venn diagram makes it easily adaptable to many classroom situations.

How To Use It

A Venn diagram involves drawing two to four overlapping circles, each labeled according to the subject being compared. In the outer part of each circle, students write the information that is unique to the subject of the circle. In the overlapping spaces, they write the elements common to all subjects. Students may complete Venn diagrams as a class, in groups, or individually.

Where It Is

Venn diagrams can be found in the Teaching Steps in the Teacher Edition and as Build Understanding items in the Student Book.

WORD SORT

What It Is

A word sort is a categorization activity that helps students synthesize science concepts and vocabulary. Students classify words and phrases into categories based on the relationship between them.

Why Use It?

Word sorts encourage students to accurately draw on what they've learned and to use logic to determine how different words and phrases are related. Teachers can use students' explanations as a formative assessment of how well they understand the overall concepts.

How To Use It

Students are first asked to look for a relationship among a list of four or five words or phrases related to a topic and to cross out the one word or phrase that does not belong. Next, they are asked to circle or highlight any word or phrase that includes all the other words. (There may be more than one correct answer to a single word sort.) Finally, students must explain how the circled word or phrase is related to all the other words or phrases in the list.

Where It Is

Word sorts can appear in the Teaching Steps in the Teacher Edition or as Build Understanding items in the Student Book.

DIRECTED ACTIVITY RELATED TO TEXT (DART)

What It Is

A Directed Activity Related to Text (DART) supports reading comprehension and critical thinking by having students interact with and manipulate the information they are reading. Examples of DARTs are matching and labeling exercises, sequencing, grouping, predicting, and completing a diagram or table. DARTs that require higher-order processing include extracting information and placing it in tables and flowcharts.

How To Use It

A DART must be prepared before students begin so that it can be tailored to a particular text. Students usually complete the DART after they finish the reading. To help students further engage with the content, they may discuss the DART in groups before completing it or complete it as a group.

Where It Is

DARTs are usually found as Build Understanding items or as Student Sheets in the Teacher Edition for the activity in which they are used.

READ, THINK, AND TAKE NOTE

What It Is

Read, Think, and Take Note is a strategy that helps students externalize their thinking by recording their thoughts, reactions, or questions on sticky notes as they read. The notes serve to make concrete the thoughts arising in students' minds and then serve as prompts to generate conversation or write explanations.

Why Use It?

Asking students to record thoughts on sticky notes as they read helps with literacy development by providing a structure for students to record the thinking process. Students may later return to that record to clarify misconceptions or to add depth to their thoughts. The notes also provide a way for the teacher to see how students think as they read, enabling the teacher to select appropriate supports. For example, a student who is unsure of the meaning of a word benefits from the teacher's suggestion to look up the definition. Or, if a student has noted how a reading reminds them of an event from their own life, the teacher can note how making those connections helps with comprehension.

How To Use It

Teachers can explain to students that as they follow this strategy, they are learning some ways that proficient readers think while reading. After reviewing the Read, Think, and Take Note Guidelines in the Student Book, teachers can then model the strategy, using a section of text from the Student Book. There are many ways to respond to text, and each student will create a unique set of comments. Teachers should emphasize that everyone is learning and has questions and that they should all be respectful of one another's ideas. One option is to conduct small-group discussions or a class discussion during which students can clarify any points of confusion, and the teacher can see how students are interpreting the reading.

Where It Is

The Read, Think, and Take Note Guidelines can be found in the Student Book and the Teacher Edition.

WORD WALL

What It Is

A word wall is a collection of words displayed in a classroom for students to use during reading and other classroom activities.

Why Use It?

Word walls are interactive tools that can help students build vocabulary, support reading, and make connections between ideas. The prominently displayed words provide a visual point of reference when students are reading, writing, and discussing their ideas.

How To Use It

Consider the instructional goals of the activity or unit and select vocabulary terms that are important for the topic. Display the words prominently on a wall, bulletin board, or other surface. The words should be visible at all times during class and can be organized alphabetically or grouped, based on the topic.

Where It Is

Suggestions for when to use or add terms to a word wall can be found in the Teacher Edition for the activities in which it is used.

DEVELOPING COMMUNICATION SKILLS

What It Is

The Developing Communication Skills Visual Aid is a tool to help students effectively participate in class discussions. It promotes positive classroom discourse by suggesting how students might appropriately express disagreement, seek clarification, or build on one another's ideas.

How To Use It

Suggestions are presented in the form of sentence starters that students can use to initiate a conversation and express their ideas. Teachers can gradually incorporate this strategy into group work by introducing one sentence starter at a time to elicit students' ideas.

Where It Is

The Developing Communication Skills Visual Aid can be found in the Teacher Edition for the activities in which it is used.

DEVELOPING COMMUNICATION SKILLS

COMMUNICATION	SENTENCE STARTERS
to better understand	One point that was not clear to me was . . . Are you saying that . . . ? Can you please clarify . . . ?
to share an idea	Another idea is to . . . 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 it is . . . I'm still not convinced that . . .
to challenge	How did you reach the conclusion that . . . ? Why do you think that . . . ? How does it explain . . . ?
to look for feedback	What would help me improve is . . . 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 . . . ?
to discuss information presented in text and graphics	I'm not sure I completely understand this, but I think it may mean . . . I know something about this from . . . A question I have about this is . . . If we look at the graphic, it shows . . .

WALKING DEBATE

What It Is

A Walking Debate allows students to practice oral argumentation. The teacher designates specific locations around the classroom that represent differing perspectives on an issue. Students stand in the location that best represents their opinion regarding the issue. In turns, students argue for the merits of their perspectives and support their arguments with evidence. As they hear others' arguments and evidence, students can opt to change their opinions and physically move to the area of the room that best represents what they now believe.

Why Use It?

Walking Debates require students to physically engage in oral discourse in the classroom. By committing to a position, both literally and figuratively, Walking Debates support oral discourse that uses claims, evidence, and reasoning. Students' engagement in scientific argumentation is motivated by seeing the distribution of perspectives among their classmates. Research also suggests that the inclusion of movement in the activity provides sensory input to the brain that enhances learning.

How To Use It

Begin by identifying the question or issue to be debated and designate different parts of the classroom as representing certain points of view. For example, for the question *Which vehicle do you think is safer, Vehicle 1 or Vehicle 2?*, one corner of the room could be designated as Vehicle 1 and a different corner designated as Vehicle 2.

Students walk to the corner that best represents their point of view and then talk within that group to come up with a convincing argument to bring people from the other area(s) to their own area. It is helpful to have students keep a record of the evidence they will consider for the Walking Debate, especially when they are new to the strategy. Teachers might also have students work in pairs to generate the evidence.

Each group makes its presentation, and students from the other group(s) may ask questions. When all groups have presented, students who change their minds move to the area that represents their final position.

Where It Is

Walking Debates are usually identified in the Procedure steps in the Student Book. The corresponding Teacher Edition provides instructions on how to run the specific debate.

SCIENCE NOTEBOOK

What It Is

The science notebook is an informal place for students to record their ideas and develop new constructs that aid in their sensemaking. In their notebooks, students bring together their ideas as they make sense of the unit issue and key concepts.

Why Use It?

A science notebook allows students to authentically engage in the practices of science. It supports students' efforts to process ideas, ask questions, keep track of data during investigations, and build their scientific-observation skills and writing skills. Students can also use the science notebook to keep complete records of their data and investigations.

How To Use It

When introducing science notebooks, introduce guidelines for how to keep good records and model how students should record information. Include the purpose, background, hypothesis, experimental design, data, and conclusion for an investigation.

Where It Is

The Student Book regularly prompts students to use their science notebooks, particularly during Procedures.

WRITING FRAME

What It Is

A Writing Frame creates an outline to guide student composition. It can be geared to a particular type of explanatory writing, such as arguments that depend on evidence. Through prompts that students briefly respond to in writing, the Writing Frame leads students to develop headings, sentences, and main content points.

Why Use It?

Writing Frames are an excellent strategy to help students develop and organize their ideas prior to writing extended analysis-item responses or completing a writing assignment. Writing Frames also support assessment of student work.

How To Use It

Teachers first provide direct instruction on the appropriate type of Writing Frame and the components it includes. When introducing the Writing Frame, teachers instruct students on the components essential to the structure of the essay, including an opening sentence that states the decision or conclusion each student has come to, evidence that supports the decision or conclusion, and a discussion of the trade-offs associated with their conclusion.

Where It Is

The Writing Frame Student Sheet can be found in the Teacher Edition for the activities in which it is used. Sample student responses are also located in the Teacher Edition.

APPENDIX 2

ASSESSMENT RESOURCE

The assessments provided in ***Scientific Thinking for All: A Toolkit*** are designed to be used as formative and summative assessment of students' progress. Assessments support classroom instruction while ensuring that students are provided with adequate opportunities to demonstrate their developing understanding of the content and receive feedback to further this learning process. Teachers can use this research-based approach for interpreting students' work to monitor and facilitate their progress. The assessment approach for the course shifts the assessment of knowledge from **what students know to how they are able to apply what they know**. As such, students engage in the key concepts and process skills of the course as they analyze evidence and make decisions related to everyday issues.

Assessment tasks are embedded in the curriculum and are an integral part of the learning activities. Teachers can use these assessments to inform future instruction, with the aim of helping to enhance students' learning. This is done through the use of purposefully designed assessment variables, assessment items, and Scoring Guides, as shown in the following diagram and description of each component.

ASSESSMENT VARIABLES concepts and practices		ASSESSMENT ITEMS		SCORING GUIDES general and item-specific rubrics
Analyzing and Interpreting Data (AID) Decision-Making (DM) Developing and Using Models (MOD) Engaging in Argument from Evidence (ARG) Evidence & Trade-Offs (E&T)	→	embedded in activities for each variable	→	describe competency levels for each variable

ASSESSMENT VARIABLES

The assessment variables listed in the second column of the following table are the key areas across which students are expected to progress throughout a unit or sequence of units. Each unit focuses on one of these variables as shown here.

UNIT	ASSESSMENT VARIABLE	DESCRIPTION
1 **Evidence & Iteration in Science**	Evidence and Trade-Offs (E&T)	This Scoring Guide is used when students are making a choice or developing an argument about a socioscientific issue where arguments may include judgments based on nonscientific factors.
2 **Scientific Modeling**	Developing and Using Models (MOD)	This Scoring Guide is used when students develop their own models or use established models to describe relationships and/or make predictions about scientific phenomena.
3 **Scientific Uncertainty and Probabilistic Reasonings**	Analyzing and Interpreting Data (AID)	This Scoring Guide is used when students analyze and interpret data that they have collected or that has been provided to them.
4 **Investigating Evidence for Causation**	Analyzing and Interpreting Data (AID)	This Scoring Guide is used when students analyze and interpret data that they have collected or that has been provided to them.
5 **Skills to Evaluate Thinking**	Engaging in Argument from Evidence (ARG)	This Scoring Guide is used when students are developing arguments about alternative explanations of scientific phenomena.
6 **Group Decision-Making**	Decision-Making (DM)	This Scoring Guide is used when students are making a decision by integrating evidence, facts, and values.

Within each unit, the focus should be on progress, and each student's goal should be to improve with each subsequent assessment in a unit. Across the units, the variables build on one another as the curriculum progresses. Over time, the progression of variables supports students' increasing sophistication in using the conceptual thinking tools of the curriculum for decision-making in their everyday lives. For example, in Unit 1, students are assessed on their ability to use evidence to make a decision and identify simple trade-offs based on that decision. By Unit 5, students' understanding of how evidence is used in claims has increased, and they are expected to articulate their decision using more complex claims, evidence, and reasoning.

ASSESSMENT ITEMS

Assessment items are questions, tasks, or prompts related to the assessment variables that are designed to gather evidence about students' progress. Assessment items may take the form of a procedural step, a Build Understanding or Connections to Everyday Life prompt that asks students to communicate about a new idea, analyze data from an experiment, model concepts and relationships, transfer their understanding to a novel context, or make predictions. For example, in Unit 6, students make a recommendation for a fictional community's energy generation system. After their group collectively comes up with a recommendation, each student is assessed on their individual response to a Build Understanding item that prompts students to describe in detail how they used facts and values to make a decision.

SCORING GUIDES

Scientific Thinking for All: A Toolkit Scoring Guides directly correspond with each assessment variable and are used to interpret students' responses. Scoring Guides allow teachers and students to monitor students' growth and encourage their progression from novice to expert on each variable. The general Scoring Guides are formatted as holistic scoring guides. Additionally, all items designated as assessments within the curriculum also have detailed Item-Specific Scoring Guides with criteria specific to each assessment item. These Item-Specific Scoring Guides can be found in the Teacher Edition for the activity in which a summative assessment appears.

Students' responses are categorized into the following scoring levels:

Level 4	**Complete and correct**
Level 3	**Almost there**
Level 2	**On the way**
Level 1	**Getting started**
Level 0	**Missing or off task**

To achieve a particular scoring level, a student's response must fulfill all the requirements of that level. A Level 4 response indicates that the student has mastered the practice or concept. The Teacher Edition includes Level 1–4 student exemplar responses in the Teaching Steps or sample responses for each designated assessment item.

Note that while the Scoring Guides involve assigning numerical values to student work from 0 to 4, these scores are not equivalent to a grading system. Rather, scores on assessment items are indicative of the level of performance demonstrated by the student on a specific task, evaluated through a clearly defined lens. They are meant to reflect levels of performance on individual tasks, whereas a grading system inevitably reflects the goals and desired outcomes of a district, school, and/or teacher.

USING A SCORING GUIDE

Initially, it is not reasonable to expect students to perform at Levels 3 and 4. The targets for a scoring level may vary over the course of a unit and a school year. Likewise, it is not always useful to use students' work to set the standards for each scoring level. For example, the best student response should not automatically be given a score of 4. The important thing is that both teacher and student understand what each various scoring level represents and that it can identify growth over multiple uses of the Scoring Guide. For most students, achieving consistent improvement of one level or more in an assessment variable over the course of a unit is an indicator of academic progress.

Before using a Scoring Guide, teachers must make sure that the criteria for each scoring level are clear to themselves and their students and that everyone understands the distinctions between levels. While the Item-Specific Scoring Guide is provided only for teacher use, as it can reveal an appropriate response, students should be provided the general Scoring Guide in advance of an assessment item. They should be encouraged to refer to the Scoring Guide as they develop their responses. This helps them develop the ability to evaluate their own work and take on more ownership of their learning.

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