

### **ACTIVITY 1**

# Cause-and-Effect Claims

**INVESTIGATION** 

#### **ACTIVITY 1**

## Cause-and-Effect Claims

#### **ACTIVITY SUMMARY**

Students are introduced to the concept of causal reasoning through a fictional high school (Salas High School) that seeks to improve student well-being. They examine statements from members of the fictional school community to identify cause-andeffect relationships of problems and solutions. Students complete a preliminary evaluation of four strategies proposed by the fictional school to improve well-being.

ACTIVITY TYPE **INVESTIGATION** 

NUMBER OF 40-50 MINUTE CLASS PERIODS

#### **KEY CONCEPTS & PROCESS SKILLS**

- Causal reasoning can be used to identify the cause of an effect and to analyze the effectiveness of potential solutions.
- Incorrect conclusions about causation can happen when the result is due to an alternative explanation, such as chance or a confound. Careful study design and analysis can reduce the likelihood of the occurrence of alternative explanations.
- Confidence in a cause-and-effect relationship should depend on the quality, variety, and consistency of the evidence supporting it.

CONCEPTUAL TOOLS



#### **VOCABULARY DEVELOPMENT**

#### causal reasoning

the use of observations and logic to identify cause-and-effect relationships

#### causation

when a change in one factor leads to a change in another

#### cause

a factor that produces a change in another factor (the effect)

#### dependent variable

#### (assumed prior knowledge)

the variable in an experiment that is measured after the independent variable has been manipulated to see if it changes as a result of the manipulation

#### effect

a factor that is changed by another factor (the cause)

#### independent variable

#### (assumed prior knowledge)

the variable in an experiment that is manipulated (typically using a treatment) to test its effect on the dependent variable

#### variable

#### (assumed prior knowledge)

a feature, factor, or result that can change or vary

#### well-being

a combination of a person's mental, physical, emotional, and social health, both short-term and long-term

#### TEACHER BACKGROUND INFORMATION

#### **Causal Reasoning**

Investigating and describing cause-and-effect relationships can inform decisions and enable predictions about future events by providing insight into the factors that drive outcomes. Causal reasoning is used not only in science but also in policy and in individual, group, and societal decision-making. It is crucial to understand which actions will bring about which effects when making decisions that will further our goals.

#### Well-Being

According to well-being researchers, part of a working definition for the term well-being (as stated in the journal Affective Science) is "...how positive an individual feels generally and about life overall..." There are many aspects to someone's well-being, including how they feel and function, both personally and socially, based on their physical health, emotions, behaviors, thoughts, and relationships. Well-being is more than just momentary pleasure or being in a good mood—it includes life satisfaction, contentment, sense of purpose, and social connection.

Attending to one's well-being goes beyond physical and mental health to incorporate social and emotional factors. The World Health Organization (WHO) defines well-being as "...a positive state experienced by individuals and societies. Similar to health, it is a resource for daily life and is determined by social, economic, and environmental conditions. Well-being encompasses quality of life and the ability of people and societies to contribute to the world with a sense of meaning and purpose."

Although many variables that affect a person's well-being are beyond their control or require long-term planning and work to influence them, there are also a number of strategies and actions that people can use in their lives to improve their well-being in the short term and, thus, in the long term overall. Many of these strategies have been studied in detail by researchers and promoted by organizations such as the <u>Greater Good In Action</u> project from the <u>Greater Good Science Center</u> at the University of California, Berkeley, and the <u>Happiness Lab Podcast</u> by Dr. Laurie Santos at Yale University. These organizations work with academics and the public to promote everyday strategies that scientific research suggests have a positive effect on well-being.

#### MATERIALS & ADVANCE PREPARATION

#### FOR THE TEACHER

- VISUAL AID 1.1
   "Understanding
   Conceptual Tools"
   (OPTIONAL)
- VISUAL AID 1.2,
   "Developing
   Communication Skills"
   (OPTIONAL)
- VISUAL AID 1.3
   "Proposed Well-Being Strategies for Salas High School"

#### FOR EACH STUDENT

- STUDENT SHEET 1.1"Evaluating Salas High School Forum Posts"
- STUDENT SHEET 1.2
   "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 lime.

#### **GETTING STARTED (10 MIN)**

#### 1 Access students' prior knowledge about well-being.

- While many students will likely be familiar with the basic concept of cause and effect—where one variable (the cause) leads to another variable (the effect)—this unit is designed to deepen their understanding of the complexity of determining cause-and-effect relationships. Students will explore these concepts through the complicated issue of well-being, which is the focus of this introductory activity.
- Begin the activity by asking, What do you think the term well-being means? Have students briefly share their own understanding of the term based on their own lived experiences and prior knowledge. Ask, What kinds of things do you think affect a person's well-being? Compile a list of student suggestions that can be revisited later. Students may respond with ideas about being healthy or sick, amount of stress, time with friends, etc.
- Have students read the Introduction to Activity 1 in the Student Book, either as a class or individually. Connect students' prior knowledge and ideas about well-being to the information provided. Students may have personal experience with and prior knowledge of issues related to well-being. 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/or when they write reflections in their science notebooks.
- Revisit the student list of things that affect well-being. Encourage students to think about various aspects of well-being including mental, physical, emotional, and social health. Students may have the misconception that well-being is limited to how happy or healthy they feel at the moment. Emphasize that well-being is more than just positive emotions. It also includes your overall life satisfaction, a range of emotions and thoughts, your day-to-day behaviors, and the feeling that you are valued. Some psychologists think of it as both being happy in your life and being happy with your life—this is referred to as subjective well-being.

TEACHER'S NOTE: Although mental health challenges can impact well-being, this unit will focus primarily on positive aspects of well-being such as happiness, life satisfaction, and belonging. If necessary, explain to students that the scope of the unit does not include addressing mental-health challenges directly. Support students in sharing their knowledge while remaining sensitive to students with personal experiences related to well-being and mental-health issues. This unit focuses on short-term strategies, as well as actions and methods, that students may be able to easily and effectively implement in their own lives to improve their well-being. It is beyond the scope of this unit to address more long-term and complex variables such as economic conditions, underlying physical and/or mental-health challenges, etc.

#### 2 Introduce causal reasoning as the primary conceptual tool of the unit.

- Explain to students that this unit will focus on the methods scientists use to study cause and effect and how understanding these methods can be useful in students' everyday lives.
- Review the term causal reasoning provided in the Introduction in the Student Book. Emphasize
  that understanding how one event causes another can help explain why things happen, guide decisions, and help make predictions. In this unit, students primarily engage in causal reasoning by
  evaluating evidence and assessing the likelihood of cause-and-effect relationships.
- 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 well-being, causal reasoning, causation, cause, and effect. Provide additional examples for each term as needed. For more information on a Word Wall, see Appendix 1: Literacy Strategies.
- 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. Depending on your student population, use optional Visual Aid 1.1, "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. There are also many tools from the last category presented on the visual aid—conceptual thinking approaches that are used to evaluate cause-and-effect relationships. In this unit, students consider conceptual tools, such as indicators of causation, as a way of exploring the application of science to everyday life.
- As students build understanding about the importance of causal reasoning, 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 1.2, "Unit Concepts and Skills," to help students organize their learning. This course organizer is designed to help students reflect on their understanding of each 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 completed sample unit organizer is provided in the Teacher Edition 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 complete a row in the organizer about the main idea of causal reasoning and add an example from their classroom experiences. The Salas High School scenario provided in this activity is an example of when students had an opportunity to analyze evidence related to cause and effect to help inform a decision. As students engage in future activities, they can return to the organizer to add new examples of each concept they learn.

#### PROCEDURE SUPPORT (20 MIN)

#### 3 Present the fictional scenario of Salas High School found in Procedure Step 1.

- 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 this unit's scenario about Salas High School is designed to help them understand the concept of causal reasoning, which is the primary conceptual tool of the unit. In the activity, students begin to evaluate cause-and-effect relationships to support their choice of a well-being strategy. Point out that the strategies and skills explored in this unit can also be applied to managing their own well-being.

#### 4 Students brainstorm well-being strategies.

- In Procedure Step 2, students' brainstorming sets the stage for later discussions in the unit about gathering evidence to support or refute causation. Brainstorming is intended to engage students in thinking about the real and relevant challenge of improving well-being, which they will pursue throughout the unit. If students are unclear about what is meant by strategies to improve well-being, consider providing examples such as the school sponsoring a well-being workshop, creating games to improve student connection, creating a relaxation space, promoting physical activity, starting a mindfulness program, or improving school nutrition.
- While groups work, walk around the classroom and ask students to share their thoughts on what types of information about the strategies might help them choose one for Salas High School.
   Encourage students to think about cause-and-effect relationships and how this relates to the

eventual selection of activities by the Salas High School Well-Being Task Force. Before adopting a strategy, students should recognize that it would be beneficial to look at evidence to see if an individual strategy will have an effect on well-being.

• To support students' discussion, you may wish to use optional Visual Aid 1.2, "Developing Communication Skills," to help guide student interactions. Visual Aid 1.2 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.

#### 5 Students identify possible cause-and-effect relationships.

- Hand out Student Sheet 1.1, "Evaluating Salas High School Forum Posts." Let students know that
  they will be working in groups to review well-being problems and proposed solutions from fictional
  students at Salas High School for cause and effect.
- If students need support distinguishing between cause and effect or problem and solution, you may want to review the first social media post as a class and model how to fill out the first row on Student Sheet 1.1.
- In Procedure Step 4, if students are unfamiliar with the concept of scientific variables, remind them to refer to the Science Review at the end of the Student Book activity. This summary reviews basic concepts about independent and dependent variables and how they are related to cause and effect. If appropriate for your students, add the terms variable, independent variable, and dependent variable to the word wall.

#### 6 Students share their analyses of the cause-and-effect claims.

- After students have completed Student Sheet 1.1, ask a few groups to share which social media
  posts they thought were most likely and least likely to be effective. For each post, have them share
  their answers for Procedure Steps 4 and 5:
- the possible cause and possible effect for the problem.
- the possible cause and possible effect of the proposed solution.
- ideas that support their choices for the posts that are the most effective and least effective.
- the kind of additional evidence they would want to gather.

After the first group shares their ideas, ask if other groups agree or disagree and why, so students can consider a range of answers. Sample responses for why a proposed solution was chosen as most effective or least effective might include: confidence or skepticism about how it works, whether it is supported by established science, whether it has been tested with evidence, how commonly the solution addresses the problem, or other possible reasons for the results mentioned in the social media post.

#### Sample Student Response, Procedure Step 4

a Problem:

Possible Cause X: trouble paying attention, not doing well on tests Possible Effect Y: unhappiness

**b** Proposed Solution:

Possible Cause X: adding solid quartz crystals to school water Possible Effect Y: more energy, focus, and happiness

#### Sample Student Response, Procedure Step 5

I think the crystal in the water would be the least effective.

- a I don't think quartz crystals in water would do anything to your mood. I can't think of any evidence out there that says it would work at all. Quartz resonating in water sounds wacky. Plus, the person was exercising too, so that was what probably actually caused the change in mood.
- **b** I would want to see if there are studies that show that quartz crystals really affect mood. Also, It was just one person and one day after trying it. I'd want to see if it actually works for more people and more times.
- After students complete Procedure Step 6, review the four proposed well-being strategies with the class. You may wish to display optional Visual Aid 1.3, "Proposed Well-Being Strategies for Salas High School," to review them. This visual aid can also be used in later activities to remind students of the four well-being strategies being considered. Have students share which strategies they think are the most promising. There is no need for the class to come to consensus as these strategies will be revisited throughout the unit, and students will have opportunities to learn more about them and about the evidence that supports their effects on well-being. Encourage students to consider what evidence might help convince them of the strategy (or strategies) that would be the most effective.

#### SYNTHESIS OF IDEAS (15 MIN)

#### 7 Facilitate a discussion about why causal reasoning can be useful.

- Evaluate if your students are able to identify the essential ideas of the activity. Start a brief discussion by asking, Why is studying cause and effect for a problem and its potential solutions useful? Students may respond with ideas about how causal reasoning can support finding solutions. Emphasize the role of causal reasoning in identifying effective strategies and the following specific ideas:
- If you understand what is really causing the problem, you can come up with a solution that is more likely to work.

- If you study the effects of a possible solution, you can figure out how well it solves the problem.
- By studying cause and effect, you can find the best solution and make sure it doesn't cause new problems.
- Remind students that while trying to investigate a well-being strategy that works for the school, they can also evaluate how well some of these strategies might work to improve their own well-being. A prompt that asks students to apply what they have learned to their own life is provided in Connections to Everyday Life item 3. For emerging multilingual learners, students could describe this orally, through pictures and diagrams, through poetry, or with music. For example, you could use the prompt to ask students to come up with a creative way to express their approach to well-being before they describe evidence they have for its effectiveness.

TEACHER'S NOTE: 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.

• To conclude the activity, evaluate whether your students are able to answer the Guiding Question, Why is it important to identify possible cause-and-effect relationships? Use this as a chance to revisit and summarize the key concepts and process skills of the activity.

#### **EXTENSION (30 MIN)**

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

Students can learn about a variety of well-being strategies and investigate one or two of them by going to UC Berkeley's <u>Greater Good In Action</u> project or take short quizzes on well-being at the <u>Greater Good Magazine</u>'s <u>Keys To Well-Being</u> page. Alternatively, you may want to share the website for students to learn more about Dr. Laurie Santos' <u>The Science of Well-Being for Teens</u> course through Yale University. For extra well-being resources to support students, you can also explore the Greater Good in Education website for educators.

## SAMPLE STUDENT RESPONSES

#### **BUILD UNDERSTANDING**

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

- 1 Choose one of the well-being strategies that your group brainstormed in Procedure Step 2. Use causal reasoning to:
  - a identify a well-being problem that you think this strategy addresses. Describe the possible cause(s) of that problem.
    - One well-being problem is that students feel tired and have trouble focusing in class. A possible cause of this is that students don't eat healthy meals and snacks, so they don't get the nutrients their bodies and brains need to work well.
  - b evaluate how likely it is that the strategy would help to solve the problem. Explain your reasoning, using your own background knowledge, and describe what evidence you would want to gather to be more sure that the strategy would work.
    - I think it's pretty likely that improving the school lunches to offer more nutritious options would help. Eating healthier with fruits, vegetables, and protein can help you stay focused. For example, if students eat candy, they might feel more tired a couple of hours later. To be sure the strategy would work, I'd want to see studies that show how eating healthier improves students' focus and energy levels. I'd also want to look at other schools where they improved school lunches to see if their students performed better in class or felt happier.

#### CONNECTIONS TO EVERYDAY LIFE

- Which of the following are examples of possible cause-and-effect relationships? For each, use your background knowledge to explain your answer.
  - a The sound of a fire engine siren and cars pulling to the side of the road.

This is an example of cause and effect. People recognize the siren (cause) as a signal of an emergency, and this causes them to move their cars (effect) and allow the fire engine to pass.

**b** Doing my laundry on Thursday and spilling food on my shirt the next day.

This is not an example of cause and effect because it is more of a coincidence. It's not the fact that you did laundry that caused you to spill something a day later, but probably clumsiness or something else.

c A cat sitting on a windowsill, and a bird flying past the window outside.

This is not an example of cause and effect. A cat sitting on a windowsill would have no effect on whether a bird starts flying outside-unless the bird saw it (cause) and that made it start flying (effect).

d Someone swallowing acetaminophen, and the pain in their sprained wrist going away a short time later.

Yes, this is an example of cause and effect. Acetaminophen is a medicine that is known to reduce pain (effect) from things like headaches when it is taken (cause).

3 What do you do in your own life that helps your well-being? Describe any evidence you have that it works.

There are lots of things in my life that help with my well-being, but I think two of the most important ones are having a dog and having a best friend I can talk to when I'm stressed or upset. I know that having a dog helps my well-being because I always feel happier and more relaxed after I take him for a walk. If I'm upset, it helps me feel better to sit with him and pet him. I know that having a best friend I can talk to helps when I'm stressed or upset because after I talk to her, I always feel much better even if I haven't fixed the problem. I feel more calm and able to come up with solutions after I talk things over with my friend.

Avery struggles to fall asleep at night and thinks their mattress is the problem. They go out and buy a new mattress, but they haven't considered whether staying awake and on their phone could be the cause instead. Explain how this situation shows the importance of investigating cause and effect.

It's important to investigate cause and effect because you need to be sure you're fixing the right thing to actually solve the problem. If using their phone is the actual cause of the problem, then Avery will spend a lot of money but not solve the problem. The real cause might be staying awake and on their phone.

#### **REFERENCES**

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POSTED BY	PROBLEM		PROPOSED SOLUTION	
	POSSIBLE CAUSE (X)	POSSIBLE EFFECT (Y)	POSSIBLE CAUSE (X)	POSSIBLE EFFECT (Y)
@whizza457				
@artLion22				
@newGirl\$haz				
@buddys2010				
@MrHendrick_ SuperTeacher				
@2goBerock				

POSTED BY	PROBLEM		PROPOSED SOLUTION	
	POSSIBLE CAUSE (X)	POSSIBLE EFFECT (Y)	POSSIBLE CAUSE (X)	POSSIBLE EFFECT (Y)
@whizza457	sugar	bad for minds and bodies, increases anxiety	ban sugar from food at school	less anxious
@artLion22	stress from school	less happy	wearing yellow and green	happier and less stressed
@newGirl\$haz	stuck indoors	bad mood	school flower garden	feel better, less grumpy
@buddys2010	students are lonely	not happy	spending time with a dog	feel less lonely, happier
@MrHendrick_ SuperTeacher	trouble paying attention, not doing well on tests	unhappy	add solid quartz crystals to school water	more energy, focus, and happiness
@2goBerock	not enough sleep	tired and cranky	change school start time, more sleep	better mood and health

UNDERSTAND		ANALYZE	
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)	

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

NAME

UNDERSTAND		ANALYZE	
CONCEPT	DESCRIPTION	UNIT EXAMPLE(S)	
Causal Reasoning	using logic and observations to figure out if one thing causes another and to help evaluate problems and solutions	<ul> <li>social media posts on well-being</li> <li>everyday situation cartoons</li> <li>comparing evidence about the well-being data for four well-being strategies</li> </ul>	
Alternative Explanations	another possible reason for why you got a certain result or why something happened	<ul> <li>music affects mood in the lab instead of exercise</li> <li>social media posts on well-being</li> <li>well-being correlation scatter plots</li> <li>sleep and studying Build Understanding item</li> </ul>	
Indicators of Causation	evidence that supports if one thing actually causes another thing, like an association, correct timing, and a likely mechanism	<ul> <li>image of the cat and spilled paint</li> <li>using questions to explore the social media posts on well-being</li> <li>using questions to compare evidence about the four well-being strategies</li> </ul>	
Correlation	two things changing together in a pattern does not mean one causes the other	sharks and ice-cream sales correlation     comparing scatter plots on the four     well-being strategies	
Causal Reasoning	a cause-and-effect relationship depends on the quality of the evidence supporting it	<ul> <li>choosing a strategy for Salas High</li> <li>comparing research evidence about the effectiveness of the four well-being strategies</li> </ul>	
Randomized Controlled Trials	the most reliable method for identifying cause-and-effect relationships	<ul> <li>designing a better Dapple game study to support causation</li> <li>class experiment on a well-being strategy</li> </ul>	

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

Choosing a well-being strategy for Salas High School, evaluating scientific research, identifying ways to improve personal well-being, examining health-related ads and claims.

#### **CONSTRUCTION TOOLS**



#### **SCIENTIFIC TOOLS**



#### SCIENTIFIC TOOLS + TECHNOLOGY



#### **CONCEPTUAL TOOLS**



#### 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?	



## **Gratitude Writing**

A way for students to express gratitude through writing such as keeping a journal, writing a letter to someone, sharing thank-you notes, or another form of written expression.



## **Pet Therapy**

A way for students to interact with animals such as helping at an animal shelter, visiting with a therapy animal, or providing time to spend with a dog at school.



## **Quality Sleep**

A way to help students get more and better sleep such as starting school later, teaching about healthy sleep habits, or some other way of helping students get better rest.



## **Green Spaces**

A way for students to spend more time in natural places such as tending a school garden, regular visits to a park, adding more plants around campus, or another way to bring nature into their routine.