

Unit 2

PROBLEM SOLVING

The problems we perceive in the world, including many of those we experience firsthand, exist because certain conditions cause them to happen directly or enable them to occur indirectly. Sometimes those conditions result from other conditions or even long chains of interacting circumstances.

Although not every problem is preventable or solvable, understanding the root causes of a problem is essential for developing effective, long-term solutions. In this unit, students will learn to assess problems and differentiate between symptoms and root causes. They will learn about the importance of understanding the true nature of a problem, the risk of unintended consequences when designing solutions, and why some past attempts at problem solving have failed. Through the activities in this unit, students will practice critical thinking, the scientific method, and deductive reasoning skills.



Grade level

6-12

Subjects

- Social Studies • Biology • General science • Language Arts
- History • Government

Skills

- Research • Observation • Description • Analysis • Interviewing and note taking
- Critical-thinking • Reflection • Deductive reasoning

Essential Questions

- How do symptoms differ from root causes?
- Why is it important to understand the root causes of problems?
- How does our understanding of root causes help us to create effective solutions?
- What is meant by unintended consequences, and what can be done to avoid them?

Learning Objectives

Students will be able to:

- Define symptom, problem, root cause, unintended consequence, solution
- Use deductive reasoning to differentiate between symptoms and root causes
- Apply a process of critical inquiry to problems they encounter in order to identify root causes
- Apply the scientific method to form and test hypotheses about problems and solutions

Common Core Standards Addressed

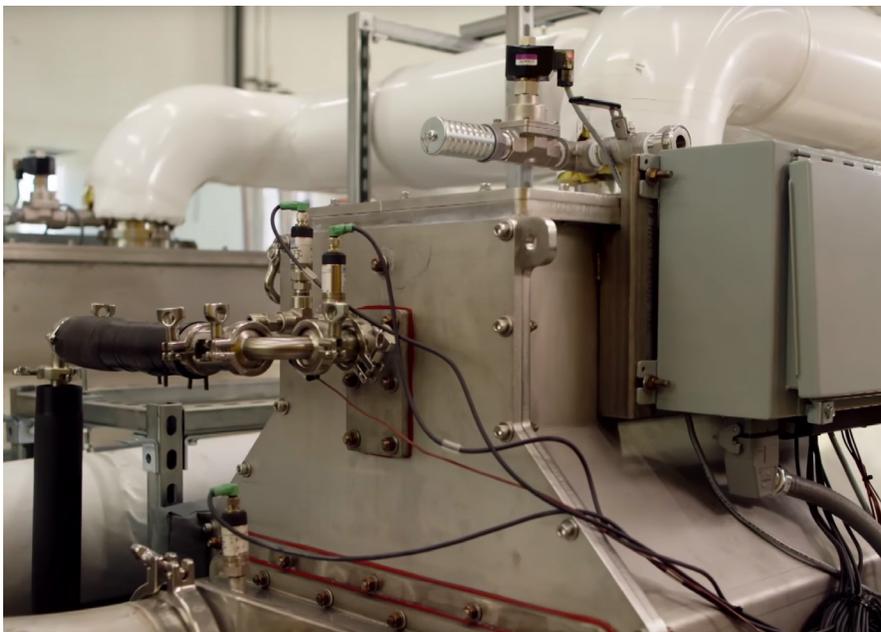
- Reading Standards for Informational Text: Grades 6-12
 - » Key Ideas and Details
 - Citing textual evidence
 - Determining a central idea
 - Analyzing in detail
 - » Craft and Structure
 - Determine an author's point of view
 - » Integration of Knowledge and Ideas
 - Integrate information presented in different media formats
 - Trace and evaluate arguments and specific claims
- Writing Standards: Grades 6-12
 - » Text Types and Purposes
 - Writing arguments with to support claims with specific evidence
 - Write informative/explanatory texts
 - » Production and Distribution of Writing
 - Produce clear and coherent writing
 - Use technology, including the internet, to produce and publish writing

- Speaking and Listening Standards: Grades 6-12
 - » Comprehension and Collaboration
 - Engage effectively in a range of collaborative discussions
 - Interpret information presented in diverse formats
 - » Presentation of Knowledge and Ideas
 - Present claims and findings
- Reading Standards for Literacy in History/Social Studies, Science and Technical Subjects: Grades 6-12
 - » Key Ideas and Details
 - Cite specific textual evidence
 - Determine central ideas
 - Identify Key Steps
 - » Integration of Knowledge and Ideas
 - Integrate visual information with other information
 - Distinguish between fact, opinion and reasoned judgment

Supplemental Resources

[Steps of the Scientific Method](#)

[Writing a News Article](#)



ACTIVITY 2.1. LINKING PRIOR KNOWLEDGE

Students will study the example of allergies to familiarize themselves with the differences between symptoms and root causes. They will investigate how different approaches to treatment address different facets of the problem.

Time: 40 minutes

Materials: Internet access; online access to or printed copies of Allergies: Symptoms vs. Root Causes worksheet (Resource 2.1 in Appendix 2); paper/pen or computer for completing assignment.

- A. Have students locate information about allergies** on the web. You may choose to allow them to search on their own, or direct them to a common resource, such as www.webmd.com/allergies.
- B. As students are reading through the materials they find online**, have them complete the Allergies: Symptoms vs. Root Causes worksheet [see Resource 2.1 in Appendix 2].



ACTIVITY 2.2. DISTINGUISHING SYMPTOMS FROM ROOT CAUSES

Students will practice recognizing and distinguishing symptoms from root causes for common household problems. They will also learn about how symptoms can be problems in themselves, leading to other undesirable circumstances. This activity takes students through a process based on the scientific method.

Time: 40 minutes

Materials: Internet access; online access to or printed copies of Assessing Problems for Effective Solutions (Resource 2.2 in Appendix 2); paper/pen for completing assignment.

- A. As a class, brainstorm some common solvable problems** that students or their parents might experience. Examples include: ants in the house, wilting plants in the yard, a dead car battery, poor grades, no lights when flipping the switch, leaky faucet, etc.
- B. Choose one problem to go over as a class**, and work together to answer the questions on the Assessing Problems for Effective Solutions worksheet (Resource 2.2 in Appendix 2).
- C. Have students work on their own or in pairs to assess** another problem using the questions on the Assessing Problems for Effective Solutions worksheet (Resource 2.2 in Appendix 2), writing out their answers on a separate sheet of paper to turn in at the end of class.
- D. Invite students to share their findings with the rest of the class.** All groups should turn in a completed problem assessment sheet to demonstrate their comprehension of the process.

ACTIVITY 2.3. ANTICIPATING UNINTENDED CONSEQUENCES

Students will learn about unintended consequences—both positive and negative. They will appreciate the potential dangers of addressing problems without fully understanding both the root causes and the possible ripple effects of a solution itself.

Time: 90 minutes

*Materials: Internet access, computer, large monitor or projector; online access to or printed copies of *Introducing Unintended Consequences* (Resource 2.3 in Appendix 2) and *Real Life Unintended Consequences* (Resource 2.4 in Appendix 2); internet access and pen/paper or computer for completing short report.*

Introduce the concept of unintended consequences by having students view a short video about what happened when wolves were reintroduced to Yellowstone National Park in 1995. Both the video and the explanation of the phenomenon in Yellowstone can be found at: <http://www.yellowstonepark.com/wolf-reintroduction-changes-ecosystem/>

- A. Define the Law of Unintended Consequences** and explain the three categories of unintended consequences using the information provided on the *Introducing Unintended Consequences* handout (Resource 2.3 in Appendix 2).
- B. Have students read and assess the scenarios outlined** in the *Real Life Unintended Consequences* worksheet (Resource 2.4 in Appendix 2).
- C. Assign a short report on a subject or event** that exemplifies an unintended consequence. An Internet search for “unintended consequence,” “perverse incentive,” or “accidental discovery” will yield numerous options from which students can choose.



ACTIVITY 2.4: UNDERSTANDING FUNDAMENTALS AND CAUSAL RELATIONSHIPS

Students will link their understanding of problem solving thus far to ideas presented in the *Billions in Change* film. This activity will draw on the list of problems created in Unit 1 and is intended to stimulate students' understanding of causal models, the perpetuating cycles that define many issues, and the effectiveness of some interventions over others at helping to alleviate global problems. The exercise may challenge existing beliefs and assumptions about the causes of social and environmental problems.

Time: 120 minutes (can be done over 2-3 days)

Materials: Original board with problems written on sticky notes; blank sticky notes (3-in x 3-in); butcher paper. A Smartboard can be used if available.

- A. Reintroduce the list of sticky-note problems** created by the class during the Building Background Knowledge activity from Unit 1.
- B. Prompt students to recall the three fundamental issues** (clean water, renewable energy, and preventative healthcare) highlighted in the *Billions in Change* film.
- C. As a class, cluster the sticky notes** under the headings Water, Energy, and Health, based on whether the problem stems from a deficit in one of those areas. If a problem exists because of an overlap between two areas, have students choose which they think is the stronger cause. For problems that seem outside the three areas, they may create an Other category.
- D. Allow students to work in groups and assign each group 4-5 problems** from the board. (It's easiest if the problems assigned to a given group stem from the same category). You may provide the actual sticky notes so that the groups can arrange the problems in different configurations, or they can write the problems on new sticky notes. Each group should have a sheet of butcher paper on which to work.
- E. Instruct each group to discuss and then agree** upon how their 4-5 problems relate to one another and stem from the overarching category of water, energy, or health. That is, which problems seem to be causing other problems, which are consequences of problems, which are consequences of solutions (e.g., unintended consequences), and which are unrelated? Is there a root cause?

- F. Have each group create a path diagram** (or sequencing graphic organizer) to illustrate the causal relationships among their 4-5 problems. They should arrange their sticky notes in a fashion that allows them to use hand-drawn arrows to show those relationships. For example, contaminated water → poor health → inability to work → poverty → hunger → poor health. Or, lack of electricity → inability to study at night → poorly educated → inability to find good work → poverty → crime. The diagrams need not be linear. They may intersect with one another, they may look like branched trees, or they involve self-reinforcing circles.
- G. Instruct each group to consider solution interventions at different points** within their path diagrams, and to evaluate whether or not those would be effective and why.
- H. Have each group decide on the best possible strategy** for solving the problems in their model. Have them consider the following questions:
1. Does one intervention need to happen first in order for the others to be effective?
 2. Do certain interventions need to happen simultaneously?
 3. What types of unintended consequences should be anticipated based on the solutions chosen?
 4. What resources would be needed to solve these problems?
 5. How much time will be required?
 6. Who needs to be involved in these solutions? The government? Businesses? Ordinary citizens?
- I. Invite groups to present their models** to the rest of the class, highlighting the relationships they found among their problems, describing the interventions they chose, and what they believe would be the most effective strategy for eliminating the largest number of problems in their model. Students may choose to present using poster boards, PowerPoint, Prezi, or another creative format.

ACTIVITY 2.5. INVESTIGATIVE REPORTING

Students will interview a parent or other adult about a problem they encountered at home or work, and their experience solving that problem. Students will ask questions and follow-up questions, take notes, and write up the interview as though they are a reporter writing a news article. Students not yet



familiar with journalistic style may benefit from one or more of the lessons in the Writing a News Article unit offered by [abcteach](https://www.abcteach.com/).

Time: 90 minutes (outside of class)

Materials: Online access to or printed copies of the Problem Solving Interview Guide (Resource 2.5 in Appendix 2) and Elements of a News Article (Resource 2.6 in Appendix 2); paper/pen or audio recorder for taking interview notes; paper/pen or computer for writing final assignment.

Instruct students to interview a parent or other adult about a problem they once faced at home or work. Provide students with the *Problem Solving Interview Guide* (Resource 2.5 in Appendix 2), which they may use to craft their questions. Students should take detailed notes, but may also choose to record the interview if given permission by their interviewee. Inform students that they will be writing up their interview in the form of a news report.

- A. **Assign students the task of filling out** the Elements of a News Article table (Resource 2.6 in Appendix 2) based on the information gathered in their interviews.
- B. **Have students write up their interviews** in the form of a news article, making sure to include the 5 W's (who, what, when, where, why) and including the important elements and structure of a news report.

APPENDIX 2: RESOURCE 2.1

Allergies: Symptoms vs. Root Causes

Instructions: Complete the assignment below using an online resource with information about allergies, such as WebMD (www.webmd.com/allergies), the American Academy of Allergy, Asthma & Immunology (www.aaaai.org), or The Allergy and Asthma Foundation of America (www.aafa.org)

1. List 7 common symptoms of allergies.
2. List 7 common allergens.
3. Explain why allergies exist, choosing one common allergic reaction to exemplify how the body responds to the presence of an allergen.
4. Name three common allergy treatments and explain whether those treatments address the root causes of the allergy or only work to reduce symptoms. Describe how the body responds to each treatment and the degree to which the treatment is effective.
5. Describe the process used to identify the root causes of allergy symptoms, how treatments are created and tested, and the effectiveness of certain types of treatments compared to others.

APPENDIX 2: RESOURCE 2.2

Assessing Problems for Effective Solutions

Instructions: Answer the following questions to assess the nature of a problem, distinguish between symptoms and root causes, and to evaluate the effectiveness of a given solution.

1. What is the apparent problem?
2. Could this problem be a symptom or result of an underlying issue or root cause? If so, what might be the underlying issue?
3. Is that underlying issue also a symptom or result of an even deeper underlying issue? If so, what's that deeper underlying issue? Continue to ask this question until you think you've identified the root cause.
4. How would you go about testing whether you've found the root cause?
5. What might be an effective way to address the root cause?
6. How would you know whether or not your solution was effective?
7. If the original problem is not solved effectively and the symptoms continue, what other problems might you eventually face?
8. What are some ways you might try to deal with those problems? Describe what you would do. How you would feel? List or discuss any other consequences that might result.
9. Based on your answers above, propose a project using the scientific method to test a solution to your problem. Your proposal should cover the following elements:
 - a. Clear statement of the problem
 - b. Hypothesis related to the cause of the problem, or about how to solve the problem
 - c. Method or experiment used for testing the hypothesis, including materials and procedure
 - d. Data to be collected and how data will be collected
 - e. Results and how they will be analyzed
 - f. Conclusions drawn based on results and analyses

APPENDIX 2: RESOURCE 2.3

Introducing Unintended Consequences

The Law of Unintended Consequences holds that most actions—whether done by people, businesses, or governments—have unanticipated effects or outcomes. Some of those outcomes have a beneficial impact. Sometimes they are neither beneficial nor detrimental. And sometimes the result is quite negative, even catastrophic. On the positive end of the spectrum, a solution to one problem can end up also solving one or more other problems. On the other hand, the possibility exists where the solution to one problem creates new problems, or even makes the original problem worse.

Social scientists recognize three main categories of unintended consequences:

- **Unexpected benefit** - A positive, beneficial, or good outcome that results from an action, such as was seen in the video about the wolves.
- **Unexpected drawback** - A detrimental, or adverse outcome that occurs alongside the desired effect of an action. A typical example is experiencing side effects from a pharmaceutical product.
- **Perverse result** - An outcome that works in the opposite direction of the desired effect, and which makes the original problem worse.

In the field of Economics, unintended consequences are associated with:

- **Externalities** - consequences of a production or industrial activity that are not reflected in the cost of the goods or services produced. An example of a negative externality is air pollution caused by a factory. An example of a positive externality is when bees kept for producing honey end up also pollinating nearby crops.
- **Opportunity costs** - The benefit or value of something that is given up when something else is chosen. For example, when choosing between two things, like going for a walk in the park vs. staying home and reading a book, the opportunity cost of making one choice is the benefit you would have gained from the alternative.

APPENDIX 2: RESOURCE 2.4

Real-Life Unintended Consequences

Instructions: For each synopsis below, (1) circle the original action, (2) draw a rectangle around the unintended consequence of the action, and (3) write the name of the type of unintended consequence described (e.g., unexpected benefit, unexpected drawback, perverse result).

1. When Germany was divided into East and West Germany after World War II, a 1,400 km-long “no man’s land” was created along the border to separate the two countries. For 45 years, until Germany’s reunification in 1990, that uninhabited border area became a haven for some 600 threatened species of plant and animal. Today it houses a highly diverse national park and is part of the European Green Belt, which stretches 12,500 km along the East-West border of the former Iron Curtain.
2. Kudzu, a rapidly growing leafy vine native to Asia, was introduced to the United States in the late 19th century to control soil erosion. A government-funded program in the early 1900s helped to distribute 85 million kudzu seedlings, and by 1946 farmers planted some 3,000,000 acres of kudzu. Although kudzu was useful for controlling erosion, it soon became apparent that few things were useful for controlling kudzu. Because of its hardiness and rapid growth, kudzu is tough to manage. It tends to outcompete native plants and trees, reducing biodiversity and resulting in losses of \$100-\$150 million in forest productivity per year. Kudzu has also been known to damage power lines, the costs of which are upwards of \$1.5 million per year. Today, kudzu infestation affects most of the Southeastern US.
3. The United States and other wealthy nations “have aid programs that import food to developing countries at very low or no cost. The result in some places has been the complete collapse of agricultural economies and local markets, because no farmer can compete against free. These programs, which were meant to help the poor, have ended up driving even more people into poverty.”^a

4. In the summer of 1927, a Scottish biologist named Alexander Fleming was researching the properties of the staphylococci bacteria. Before leaving for a month-long vacation with his family, he stacked the cultures he was studying on a bench in his rather untidy laboratory. When he returned, he noticed that one culture had become contaminated with a fungus, which had killed the staphylococci bacteria immediately surrounding it. Fleming grew the fungus in a pure culture and found that it produced a substance, which he called “mold juice,” that killed a number of disease-causing bacteria. He identified the fungus as being from the genus *Penicillium*. Thus, he named the “mold juice” it released penicillin. Fleming’s accidental discovery marked the beginning of modern-day antibiotics.

5. The practice of wildfire suppression in the United States began in the late 1800s for the purpose of preventing uncontrolled and devastating fires. The belief was that all wildfires were detrimental and should be suppressed at all times. It wasn’t until the 1960s that it became widely recognized that wildfires are a very natural and necessary part of forest ecosystems. Fire serves to clear tall undergrowth, increase grasslands for large animals, and stimulate the germination of certain types of plant and tree seeds, including the giant sequoia. The policy of fire suppression, most notably, meant that forest understories grew denser so that when wildfires occurred, they burned hotter, longer, over larger areas, were more difficult to contain, and resulted in more damage and devastation. Today fire is seen as an essential part of forest life cycles, and the US Forest and National Park Services have adopted policies that allow wildfires to burn naturally within contained areas.

6. The use of antibiotics to treat bacterial diseases has saved millions of lives over the past 75 years. However, the misuse and overuse of certain antibiotics, combined with bacteria’s ability to quickly mutate, has resulted in the emergence of antibiotic-resistant bacteria, or “superbugs.” Superbugs are immune to most common antibiotics, which means they can continue to spread within an infected person’s body. The US Centers for Disease Control and Prevention report that drug-resistant bacteria infect more than 2 million people and kill at least 23,000 in the United States alone each year.

7. Daylight Saving Time was originally conceived to help people make better use of daylight in the evening hours. The thought was that with the sun staying out later, people would also save electricity by staying outside later, thus delaying the turning on of lights and the running of small appliances. Studies now show that daylight saving time is producing the opposite effect. Energy consumption at home has increased because more and more people have air conditioners. Because the sun stays up later in the day, people are running their air conditioners for longer periods of time after they get home from work.

8. When French colonialists ruled In Hanoi, Vietnam, sewer rats were a big problem. In an attempt to control them, the colonialists offered a cash incentive to anyone who killed a rat and presented its tail as proof. Seeing this as a revenue opportunity, some residents of Hanoi began farming rats in order to get paid by the colonial government. Others began catching rats, cutting off their tails, and then releasing them back into the sewers so they could breed and make more rats. The result was an ever increasing rat population, most of which were running around without tails!

9. Chlorofluorocarbons (CFCs) became popular during the mid-20th century as a standard refrigerant. CFCs were less expensive, less explosive, and less toxic alternative than the existing refrigerants in air conditioners and refrigerators. However, in the 1970s CFCs were found to be destroying Earth's stratospheric ozone layer, meant to protect the planet from the sun's harmful ultraviolet rays. In 1978 the United States banned the use of CFCs in new appliances and products, and through the global treaty known as the Montreal Protocol, most other countries have banned CFCs as well. Today the ozone hole is slowly recovering, and some believe it will close by mid-century.

10. Aspirin is known as a common painkiller, but in recent years physicians have been increasingly prescribing aspirin to people regardless of whether they have pain. As it turns out, one of aspirin's active ingredients is a type of blood thinner that prevents blood clots, which has been shown to be beneficial to health, including preventing heart attacks and reducing the severity of some strokes.

11. Roughly 100 African elephants are killed every day for their tusks as part of the multibillion-dollar illegal global market for ivory. And just as poachers target elephants with the largest tusks, those same elephants are also the ones that father the most calves, because they are preferred by females and can fight off other suitors. When those individuals, and their large tusks, are removed from the population, the genes for large tusks can no longer be passed on to the next generation. As a result, scientists are now observing larger percentages of elephants with small tusks or no tusks at all. Unless the ivory trade is eventually halted, the African elephant may evolve into a tuskless species.

^a Bhargava, M. Opinion: Fellow Billionaires: Let's Listen to the Poor. (May 2, 2016). Retrieved from https://www.philanthropy.com/article/Opinion-Fellow-Billionaires-/236287?cid=cdfd_home.



APPENDIX 2: RESOURCE 2.5

Problem Solving Interview Guide

Instructions: Interview a parent or other adult about his or her experience with attempting to solve a problem at home or at work. The problem may have to do with pests in the house or yard, a broken appliance or device, car trouble, a ruined recipe, computer bug, etc. Use the following questions to guide your interview and take detailed notes about the answers you're given. Feel free to add your own questions as well. You will write up your interview in the style of a newspaper article, so be sure to also capture some word-for-word quotes.

1. (Introduce yourself and your project. You can use this wording or make up your own.) I'm doing a class assignment on problem solving and I'd like to interview you about an experience you had solving a problem, either at home or at work. I'd be especially interested in hearing about a situation where you had to try a couple of different ways to address the problem before you actually found something that worked. (Assuming they agree to the interview, proceed with asking them the following questions. Feel free to add questions if you need clarification about something.)
2. (Name) What is your full name?
3. (Age) How old are you?
4. (Location) Where do you live?
5. (Occupation) Where do you work? What is your title?
6. (Nature of the problem) What type of problem did you encounter at home or work that was difficult to solve?
7. (Initial attempt to solve the problem) How did you initially attempt to address the problem? Did that solve it? If not, why not?
8. (Differentiate between symptom and root problem) In what ways was the original problem a symptom of a deeper problem?
9. (Root cause identified) How did you finally figure out the root cause of the problem?
10. (If the problem was solved...) What was the final solution that worked? Why did it work? Were there any unintended consequences? (If the problem wasn't solved...) Given that you haven't solved the problem yet, how are you managing the problem in the meantime? What do you think is the root cause? Why is this so difficult to solve?

APPENDIX 2: RESOURCE 2.6

Elements of a News Article

Instructions: Use the following table as a guide for writing your article. Write out the actual wording for your article in the space provided, or use bullets to capture the elements you intend to include.

News Report Element	Definition/Purpose	Elements in Your Article
1. HEADLINE	<ul style="list-style-type: none"> • Article title • Grabs reader’s attention • Sums up main idea of story 	
1a. SUBHEAD (optional)	<ul style="list-style-type: none"> • Explains the headline 	
2. BYLINE	<ul style="list-style-type: none"> • Writer’s name • Indicates who authored the article 	
3. PLACELINE or LOCATION	<ul style="list-style-type: none"> • City where story takes place • State or Country can be included if the City is not well known • Written in ALL CAPS or bold 	
4. LEAD PARAGRAPH	<ul style="list-style-type: none"> • Opening paragraph of article • Includes most important information about story • May only be one sentence • Answers most of the 5W’s 	
5. SUPPORTING PARAGRAPHS	<ul style="list-style-type: none"> • Explains the details of the story • Most important details first • Provides background of story • Connects with past or recent news, if applicable 	
5a. QUOTES	<ul style="list-style-type: none"> • Actual quotes from person “at the scene” • Can be included throughout article to break up supporting paragraphs • Add accuracy • Connects reader with story 	