INQUIRING SCIENTISTS, INQUIRING READERS IN MIDDLE SCHOOL

Using Nonfiction to Promote Science Literacy

GRADES 6–8

Shiverdecker & Fries-Gaither

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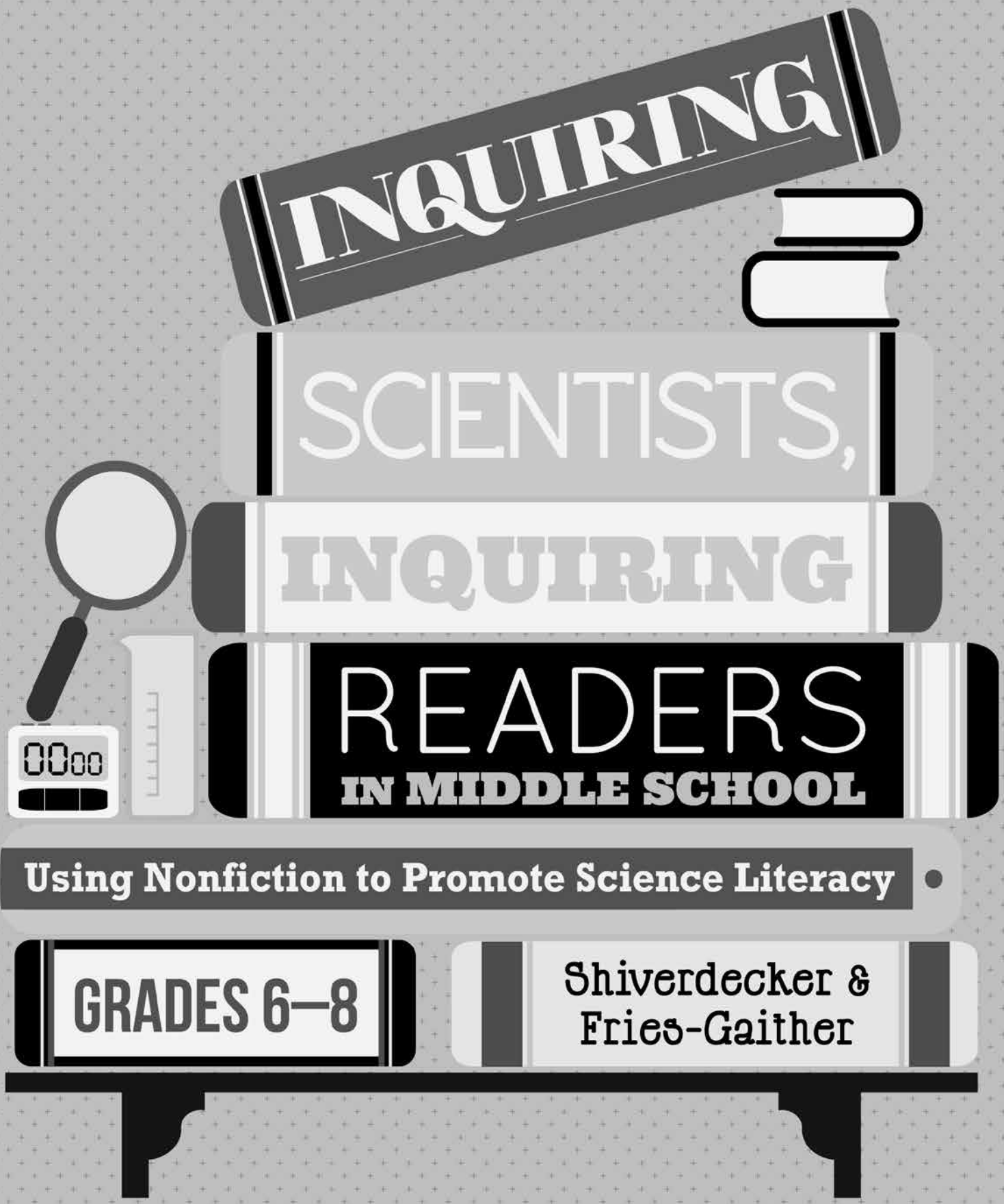
National Science Teachers Association



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Terry Shiverdecker
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NSTApress
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Arlington, Virginia

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Jessica Fries-Gaither is the lower school science specialist at the Columbus School for Girls in Columbus, Ohio, where she teaches science to grades 1–5. Prior to working at the Columbus School for Girls, she was an education resource specialist in the School of Teaching and Learning, College of Education and Human Ecology, at The Ohio State University. She served as the project director for two National Science Foundation–funded projects that supported elementary teachers in integrating science and literacy instruction. Jessica earned bachelor's degrees in the biological sciences and anthropology from the University of Notre Dame. She received her MEd from the University of Notre Dame's Alliance for Catholic Education program. She has taught middle school math and science in Memphis, Tennessee, and she has taught a variety of grade levels, ranging from eighth-grade science to fourth-grade self-contained, in Anchorage, Alaska.

Chapter 12
Landfill Recovery

OVERVIEW

In this chapter, students gather evidence by completing hands-on activities and reading texts to answer the question, *How can we reduce the volume of landfill waste?* Students learn about the volume of waste that ends up in landfills every year, investigate the feasibility of landfill mining, engage in a landfill mining simulation, and design a product made entirely of reused plastics. Students also construct an argument about the pros and cons of landfill mining using evidence they collect from a variety for sources.

This unit assumes that students know and can demonstrate that some of Earth's natural resources are limited and that recycling extends the life of nonrenewable natural resources. Additionally, this unit contributes to attainment of *Next Generation Science Standards* performance expectation ESS3-3: "Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment" (NGSS Lead States 2013).

OBJECTIVES

- Recognize that interventions can slow or stop the negative impact of human activities on the environment.
- Identify strategies for reusing natural resources.
- Investigate ways to reduce municipal solid waste.
- Draw conclusions that are based on evidence from multiple sources.
- Engage in a scientific argument.

STANDARDS ALIGNMENT

Next Generation Science Standards (NGSS Lead States 2013)

ESS3.C: HUMAN IMPACTS ON EARTH SYSTEMS

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3 and MS-ESS3-4)

Common Core State Standards, English Language Arts (NGAC and CCSSO 2010)

GRADES 6–12 LITERACY IN HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS

- CCSS.ELA-LITERACY.WHST.6-8.1: Write arguments focused on discipline-specific content.
- CCSS.ELA-LITERACY.WHST.6-8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- CCSS.ELA-LITERACY.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.

TIME FRAME

- Seven to eight 45-minute class periods

SCIENTIFIC BACKGROUND INFORMATION

Humans have been using Earth's resources for millennia. From early humans' use of flint for tools to our present-day use of technologically advanced materials, humans have recognized that using Earth's resources enhances our survival and quality of life. As humans advanced to form civilizations and use agricultural practices, the use of natural resources increased. It increased again when humans learned how to extract natural resources from the ground. When we humans learned how to manipulate, alter, and produce marketable products, our use of natural resources increased to extraordinary levels. As we began to use natural resources at increased rates, we also increased the amount of waste produced. Production and disposal of marketable items generates significant amounts of waste, and all of that waste has to go somewhere. In modern history, humans have moved waste from the view of the public eye to landfills, where it is buried and never to be seen again.

In 2013, Americans generated 254.1 million tons of trash (National Geographic 2016). That's well over 508 billion pounds of trash! Between 1960 and 2000, the amount of trash generated each year increased from 88.1 million tons to 243.5 million tons. Since 2000, the rate of increase has leveled off for the most part. But, overall, it is still creeping upward. See Table 12.3 (p. 245) to discover what humans are throwing away.

Recycling has helped reduce the amount of trash that makes its way into landfills, and recycling has increased over the years. In 1960, people recycled 6.4% of their trash; in 2013, people recycled 34.3% of their trash (EPA 2016). Increasing the rate of recycling is a necessary, but insufficient step toward reducing the amount of trash and nonrenewable natural resources that ends up in landfills. Although recycling has helped reduce the amount of trash going into landfills, the Environmental Protection Agency has stated that reducing the amount of trash generated and reusing items rather than disposing of them are the most effective ways to reduce solid waste (EPA 2015).

Mining landfills to recover valuable natural resources is an option that has been gaining traction in recent years. Some of the benefits of landfill mining, beyond the recovery of natural resources, include extending landfill capacity, lowering landfill operating costs, producing energy by incinerating materials that cannot be recovered, reducing landfill closure costs, retrofitting liners to repair leaks and tears, removing hazardous wastes, and generating income from recovered materials (EPA 1997). Drawbacks include managing hazardous materials, release of landfill gases and odors, subsidence or landfill collapse, and increased wear on excavation equipment (EPA 1997).

Several examples of successful landfill mining in the United States and abroad suggest that landfill mining may be part of the solution to our dwindling natural resources. The anticipated recovery rates of some resources, according to available information, is 85–95% for soil, 70–90% for ferrous metals, and 50–75% for plastics. The purity of the recovered materials ranges from 90% to 95% for soil, from 80% to 95% for ferrous metals, and from 70% to 90% for plastics (Environmental Alternatives 2016). A Belgian waste management company presently mining a landfill near Brussels expects to reclaim 45% of the materials; the rest of the materials will be converted to electricity (Vijayaraghavan 2011).

Landfill mining is not without drawbacks, however. Technology to mine landfills efficiently and safely has not yet been developed. Using current technology requires multiple steps to excavate, separate, and clean the resources. An important economic and environmental consideration is that recovering some of the materials consumes more energy than would be used to make new materials. Additionally, the cost to recycle the reclaimed materials costs much more than the market value of the resources. For example, in 2009 it cost $4,000 to recycling 1 ton of plastic bags, but the resulting product had a value of only $32 (Clean Air Council 2016).

Each of these options, recycling, reducing waste, reusing items, and landfill mining, offer some hope for extending the life of natural resources. Alone, none of the options is sufficient to address the problem of diminishing natural resources. But in combination, the various options could make a meaningful difference.

MISCONCEPTIONS

Misconceptions about the availability of natural resources are based on fundamental misunderstandings about core Earth science principles. Most notably, some people think that humans depend on Earth for resources and that the activities of humans significantly alter Earth. Several of these misconceptions that are most closely related to this unit appear in Table 12.1 (p. 240).

TABLE 12.1. COMMON MISCONCEPTIONS ABOUT NATURAL RESOURCES AND THE IMPACT OF HUMAN ACTIVITIES

Common Misconception	Scientifically Accurate Concept
Earth's resources are not finite. There is an endless supply of water, petroleum, and mineral resources. All we have to do is explore to find them.	Earth's resources are finite, and we have a very good idea about where we can find and harvest existing resources. Earth scientists also know approximately how abundant or lacking various Earth materials are.
• "Man-made" materials do not come from mineral resources. • Few products we use everyday have anything to do with taking rocks and minerals from the ground.	All raw materials come from Earth. Products that are "man-made" (or human-made) are the result of processing raw materials through manufacturing. The plastics we use come from crude oil; all metals originate in ores mined from Earth; building materials, such as bricks, granite counter tops, and plasterboard, come from Earth materials.
Earth and its systems are too big to be affected by human actions.	Earth is a very large system, but scientists have accumulated overwhelming evidence that human activities alter Earth in irreparable ways. Earth's resources are limited and, in some cases, dwindling rapidly. Resources such as safe, potable water are difficult to access in some parts of the world. Human population now exceeds 7 billion people. As the population continues to grow, the strain on resources such as potable water will increase. Humans can and do affect Earth systems.
Technological fixes will save us from ruining our planetary environment.	Technology and science have limitations. It is true that technology and science can reverse or remedy some of the environmental damage that humans have caused. However, so far no one has developed technology to solve all of our environmental problems. It is unlikely that our current scientific knowledge and technology will ever generate more of the nonrenewable resources we take from Earth. Moreover, these advancements cannot solve current problems such as nuclear waste spills or toxic contamination such as that found at some Superfund sites.
Earth is both an endless supply of resources and a limitless sink for the waste products of our society.	We used to believe the adage that "the solution to pollution is dilution." We now know that such thinking not only is wrong but also threatens the health of Earth and the organisms that live on it. Even small concentrations or low doses of some toxic compounds can render soil or water unsafe for decades to come.

Source: The Math and Science Partnership Network 2016.

NONFICTION TEXTS

Heroes of the Environment: True Stories of People Who Are Helping to Protect Our Planet by Harriet Rohmer (San Francisco, CA: Chronicle Books, 2009); Flesch-Kincaid reading level 7.4, published Lexile level 1070L.

The stories of 12 people who are taking inspiring actions to protect the planet are shared in this engaging book. The stories range from removing industrial pollution from a river to protecting sea turtles and whales. The individuals portrayed are just as diverse as their actions.

One Plastic Bag: Isatou Ceesay and the Recycling Women of the Gambia by Miranda Paul (Minneapolis, MN: Millbrook Press, 2015); Flesch-Kincaid reading level 2.9, published Lexile level 480L.

This children's picture book carries a powerful message about the waste we generate, the impact it has, and the ways we might reduce it.

MATERIALS

For the Landfill Mixture

Note that you can substitute other materials. Choose materials according to the separation techniques needed. If working with salt or coffee grounds, be careful of items getting wet.

- Dry pasta
- Iron filings (see safety data sheet information in Appendix 4)
- Shredded paper
- Crayon shavings (made with a pencil sharpener)
- Mini-marshmallows
- Sand

For the Rest of the Investigation

- Magnets covered with plastic wrap
- Balloons (nonlatex)
- Tub or large bowl of water
- Pans or bowls for separating with water
- Beakers, cups, or bowls for the separated materials

- Heat source and container for melting (1 per group or 1 for the class, if done as a demonstration)
- Crayon mold
- String
- Bucket or gallon milk jug with an opening cut in the top that is large enough to add weight
- Masses, washers, sand, or water for testing
- Sufficient quantity of plastic grocery bags, empty water bottles, and K-cups (if you choose to use them) for the design challenge
- General supplies, such as scissors, tape, and glue
- Goggles (sanitized, indirectly vented chemical splash)
- Nonlatex gloves
- Aprons

SUPPORTING DOCUMENTS

- "Turning Waste Into Good Business and Good Jobs" graphic organizer
- "One Year of Solid Waste" cards
- "Municipal Solid Waste" cut outs
- "Landfill Mining: Brilliant Idea or Wishful Thinking?" essay and graphic organizer
- "Based on the Evidence … " graphic organizer
- "Recovering Resources" planning and data sheet
- "Strength Test Data Sheet"
- "Recommendation to Style Barons" graphic organizer
- "Individual Recommendation to Style Barons" graphic organizer

SAFETY CONSIDERATIONS

- Have students wear goggles, gloves, and aprons during all phases of the investigation, including during setup and cleanup.
- Review safety procedures for dealing with heated materials, and supervise students carefully as they conduct the investigations.
- Review safety information in safety data sheets for chemicals (e.g., iron filings and plaster of paris) with students (see Appendix 4).
- Remind students to use caution in working with iron filings; they can be sharp and puncture skin.
- Tell students not to breathe in the dust from these filings.

- Make sure students have appropriate procedures for cleanup and disposal of iron filings.
- Remind students to use caution when heating or working with hot liquids or solids, which can seriously burn skin.
- Remind students to use caution with heating devices such as Bunsen burners and hot plates. Tell them not to touch the heating device until after it has cooled down.
- Use only GFI protected electrical outlets when working with hot plates or other electrical heating devices.
- Remind students to immediately wipe up any spilled water off the floor to prevent slip and fall hazards.
- Remind students not to eat any food used in lab investigations.
- Have students wash their hands with soap and water after completing the investigation.

LEARNING-CYCLE INQUIRY

Engage

In the Engage phase, students are introduced to the idea of reusing materials that are headed for a landfill. Students independently read "Turning Waste Into Good Business and Good Jobs," which is a chapter from *Heroes of the Environment*. As students read the chapter, they will discover that discarded items can be valuable and present opportunities for reuse.

Advance preparation: Make one copy of "Turning Waste Into Good Business and Good Jobs" for each student. Make one copy of the "One Year of Solid Waste" cards per group of three to four students. Cut the cards apart, and shuffle them before distributing a set to each group.

After preparations are made, begin the Engage phase. The steps are as follows:

1. Ask students to share something they do or something they know of that helps the planet. Then, introduce the book *Heroes of the Environment*. Describe the types of things the heroes of the book are doing to help keep the planet healthy.
2. Distribute a copy of "Turning Waste Into Good Business and Good Jobs" (Chapter 3 of *Heroes of the Environment*) and the accompanying graphic organizer. Tell students that they are now going to read about Omar Freilla from the Bronx in New York. As they read, students should be looking for the message of Omar's story. After they have finished reading, they should write what they think the message of Omar's story is in the appropriate space on the graphic organizer. Students should then add evidence that supports their thinking about the message of Omar's story.
3. After students have finished the reading, ask them to turn and talk to a neighbor about what they think Omar's message is. Then, ask several students to share what

they took away from the story. Make sure that the class has identified Omar's message: If something has a use, it is not waste.

4. Have students work in small groups to explore the amount of solid waste generated in the United States in one year.
    a. Begin by providing each group of students with one set of the "One Year of Solid Waste" cards.
    b. Ask students to work together to match the statistic card with the correct item.
    c. After 5–10 minutes, ask each group to share its results. As groups share, ask them to explain why they matched them up as they did.
    d. After all groups have shared, ask each group to review its initial matches and make changes that reflect the group's current thinking.
    e. When students are finished, reveal the correct matches shown in Table 12.2. Reinforce that these statistics represent one year of solid waste.

TABLE 12.2. ONE YEAR OF SOLID WASTE CARDS

Amount of trash generated by Americans in 2013	254 million tons of trash
Pounds of trash disposal per person	4.6 pounds
Percentage of trash from residences	65%
Percentage of trash buried in landfills	55%
Percentage of trash from schools and commercial locations	35%
Percentage of trash recycled	33%
Percentage of trash incinerated	12.5%
Number of solid-waste industry employees	368,000
Number of vehicles used to move trash to landfills	148,000
Number of communities with curbside recycling	8,660
Number of landfills	1,754
Number of recycled-materials sorting centers	545
Number of incinerators	87
Solid-waste industry annual revenue	$47 billion

Source: National Geographic 2016.

5. Engage students in a discussion about what they think they would find if they dug deep into a landfill. Students are likely to offer unspecific responses such as garbage,

trash, rotten stuff, and so on. Those answers are acceptable at this point. List the students' responses where all students can see them.

6. Students will now find out what is in landfills. Specifically, they will learn what percentage of municipal solid waste is paper, glass, metals, and so forth. For this activity, students will work in their groups.
    a. Give each group a copy of the "Municipal Solid Waste" page and a pair of scissors.
    b. Instruct students to cut categories at the bottom of the page apart and rank them, from highest to lowest, according to which ones they think make up the most or least amount of waste in a landfill.
    c. After students have ranked the categories of waste, they should match them to the appropriate section of the pie chart on the basis of their ranking.
    d. Ask groups to share where they placed each category on the pie chart and explain their reasoning.
    e. Compare and discuss groups' placements of the cards on the pie chart. After the discussion, ask groups to make any changes they want. This time, they should tape the cards in place.
    f. Reveal the correct percentages, using the information in Table 12.3.
7. Finish by introducing the question, *How can we reduce the volume of landfill waste?*

Assess this phase: Assessment of this phase is formative. Students are likely to reveal misconceptions about solid waste as they complete the "One Year of Solid Waste" and "Municipal Solid Waste" matching activities.

TABLE 12.3. MUNICIPAL SOLID WASTE

Category	Percent
Paper	27.0
Food	14.6
Yard trimmings	13.5
Plastics	12.8
Metals	9.1
Rubber, leather, and textiles	9.0
Wood	6.2
Glass	4.5
Other	3.3

Source: EPA 2016.

Explore

In this phase, students will continue working in groups to investigate the feasibility of mining landfills as a means to recover some discarded resources. They will also participate in a simulation in which they recover and test a nonrenewable resource.

PART I: MINING LANDFILLS

1. Provide each student with a copy of "Landfill Mining: Brilliant Idea or Wishful Thinking?" Instruct students to independently read the essay and complete the graphic organizer before returning to their groups.
2. After students return to their groups, distribute the "Based on the Evidence …" graphic organizer. Instruct students to discuss which company they think Style Barons should hire. Remind them that their decision must be based on evidence. Circulate around the room, asking guiding questions such as the following:

    - What evidence leads you to think Style Barons should choose this company?
    - How could you compare the materials available through traditional mining with materials recovered through landfill mining?
    - What additional evidence would help you make your decision?

PART II: COMPARING MATERIALS

Advance preparation: Collect old crayons for shaving. Remove the paper wrapping from the crayons, then use a manual pencil sharpener to make the shavings. Save some crayons to use when demonstrating how to melt the crayons and pour them into the mold. Combine the materials to make the landfill mixture. Bag and label the mixture. Make plaster of paris crayon molds.

After preparations are made, begin Part II of the Explore phase. The steps are as follows:

Separation

1. Before beginning, gather up separation tools and general materials. Put them in a central location where groups can easily access them during the separation activity.
2. Set the activity up with the following scenario:

    > *Each company has sent us some materials to test. Earth Materials R Us sent a pure sample of one of the materials they have available. Reclaiming the Past sent us a sample of items mined from their landfill. These items have gone through a washing process, so they are safe for us to handle. We have to sort the materials to recover what Style Barons needs. After we recover the materials, we must make a sample similar to the one Earth Materials R Us sent. I am expecting a mold from them to arrive any day.*

3. Give each group a bag of the landfill mixture. Provide each student with a copy of the "Recovering Resources" planning and data sheet.
4. You are playing the role of the lab manager. As groups work on designing and carrying out their separation process, circulate around the room to check on their designs and ask guiding questions.

5. After students have separated their materials, they will take turns melting the materials (crayon shavings) and pouring them into their molds.

Testing

1. Before you begin testing, reveal that the molds have arrived. Show the students the molds and demonstrate how they will be used.
    a. Show the students how to melt the crayons. Set up a single melting station that can be closely monitored. The crayons melt easily in a microwave, a candy melting pot, or in glass beakers that are in a hot-water bath. (An electric skillet works great for a hot-water bath.) It is helpful to melt the crayons in a container with a pour spout (e.g., a beaker or measuring cup). Doing so makes it much easier for students to accurately pour the melted crayons into the mold. While the crayons are melting, lubricate the mold by rubbing a drop of dishwashing detergent inside.
    b. Model how to handle the beaker with the melted crayons and how to pour the melted crayons into the mold. The melted crayons will rapidly start to harden again, so students should bring their molds to the melting station when they are ready to make their crayons. Once the melted crayons have been poured into the molds, groups can move them to a safe place for setting. Although they will set quickly, let the molds continue to set overnight so they are completely cooled before testing.
    c. Demonstrate how to remove the crayons from the molds by flipping the mold over. The crayon should fall out.
2. It is now time to test the strength of a pure crayon (the pure sample from Earth Materials R Us) and the one made from the reclaimed crayons. To contain the excitement and monitor testing, groups should test their crayons one at a time.
    a. Before beginning, separate two desks or tables by enough space so that the crayons span the opening with each end of the crayons securely on the desks. Give each student or group a "Strength Test Data Sheet."
    b. Mass the crayon to be tested.
    c. Slide the crayon to be tested through the handle of the loading device.
    d. Position the crayon so that it spans the gap in the desks.
    e. Slowly add mass (e.g., sand or marbles) to the loading device. Stop adding mass when the crayon breaks.
    f. Measure the amount of mass the crayon held before breaking.
3. Have students complete their data sheets and draw conclusions about which material is the better choice for Style Barons.

Assess this phase: The Explore phase for this learning-cycle inquiry can be formatively assessed. As students gather evidence from "Landfill Mining: Brilliant Idea or Wishful Thinking?" and from separating and testing the recovered materials (crayon shavings), they should be processing their thinking about the volume of waste that ends up in landfills and the possibility of solutions such as reducing waste and reclaiming resources found in landfills. Monitor their progress by listening carefully to their discussions as they work and by asking probing questions.

Explain

In this phase, students will use the data collected in the Explore phase to construct a scientific argument in response to the prompt, *Which company do you recommend that Style Barons use?*

1. Provide each student with a "Recommendation to Style Barons" graphic organizer.
2. Instruct students to work with their groups to review and list their evidence on the "Recommendation to Style Barons" sheet.
3. As groups work, walk around the room to ask guiding questions and provide assistance when needed.
4. When groups have finished their discussions, give each student an "Individual Recommendation to Style Barons" sheet. Tell students to work independently to construct an argument that supports their recommendation of either Earth Materials R Us or Reclaiming the Past.
5. Circulate around the room as students work independently, providing assistance and support when needed.

Assess this phase: In the Explain phase, each student's "Individual Recommendation to Style Barons" serves as a summative assessment.

Expand

In this phase, students will design a product that is made entirely of recycled plastics.

Advance preparation: Collect plastic shopping bags, water bottles, and K-cups for students to use in their design challenge. Be aware that used coffee grounds, tea leaves, etc. will still be in the K-cups.

After preparations are made, begin the Expand phase. The steps are as follows:

1. Project the infographic "Sneaky Plastic Waste We're all Producing" shown in Figure 12.1. Discuss the volume of plastics going into landfills from just these three products. Talk about personal and observed use of these plastics.

FIGURE 12.1. SNEAKY PLASTIC WASTE WE'RE ALL PRODUCING

One trillion are used worldwide

Less than 5% end up recycled

Takes 20–1,000 years to degrade completely

In 2013, Keurig cups would wrap around the equator 10.5 times

100% of this #7 plastic contains synthetic estrogen

Made of a type of plastic that doesn't recycle in most areas

In the US, 30 billion are consumed

80% do not get recycled

Wastes more than $1 billion in plastic

2. Read aloud *One Plastic Bag*. This is a children's book that is below grade level, but it is an inspiring story of how plastic shopping bags are being repurposed.
3. Discuss the benefits of keeping materials out of landfills and reusing them or repurposing them into other products.
4. Challenge students to design a product that could be made out of plastic shopping bags, water bottles, or K-cups. Students can use one material or any combination of these materials. Allow students to work independently, in pairs, or in small groups as they respond to the design challenge. Provide general supplies such as scissors, tape, and glue so students can construct, test, and modify their designs.
5. Finish the unit by asking students to reflect on what they have learned and answer the question, *How can we reduce the volume of landfill waste?* Students may record their answers as a bulleted list or in paragraph form.

Assess this phase: This phase uses both formative and summative assessment. As students work on the design challenge, ask them if their design is practical, who might be interested in the product, and how many of the recyclable items they are working with would be kept out of the landfill if they were to make 10, 100, or 1,000 of their designs. Use the final response to the question, *How can we reduce the volume of landfill waste?*, as a summative assessment.

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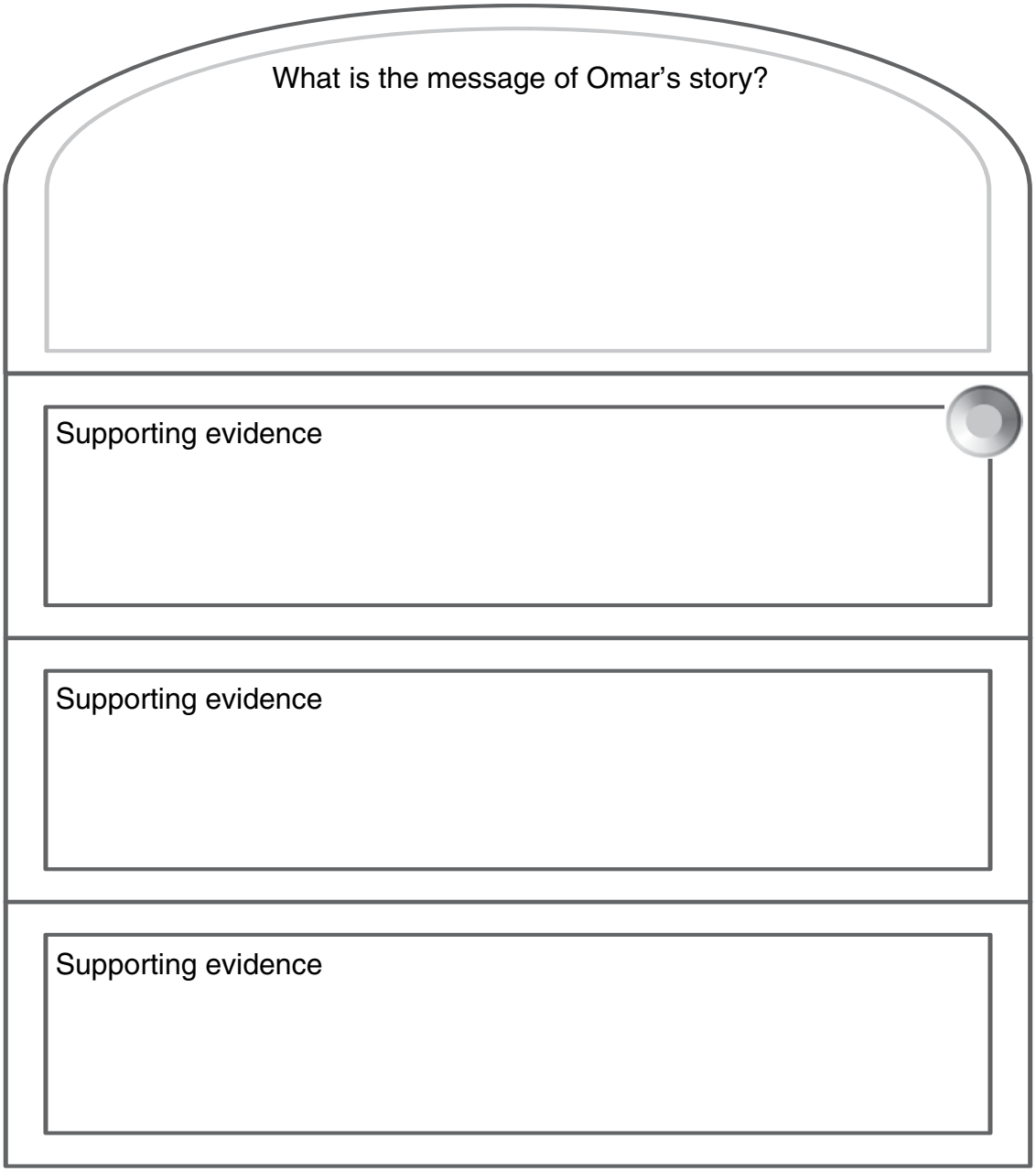
Name_____ Date_____

Turning Waste Into Good Business and Good Jobs



Name_____ Date_____

One Year of Solid Waste

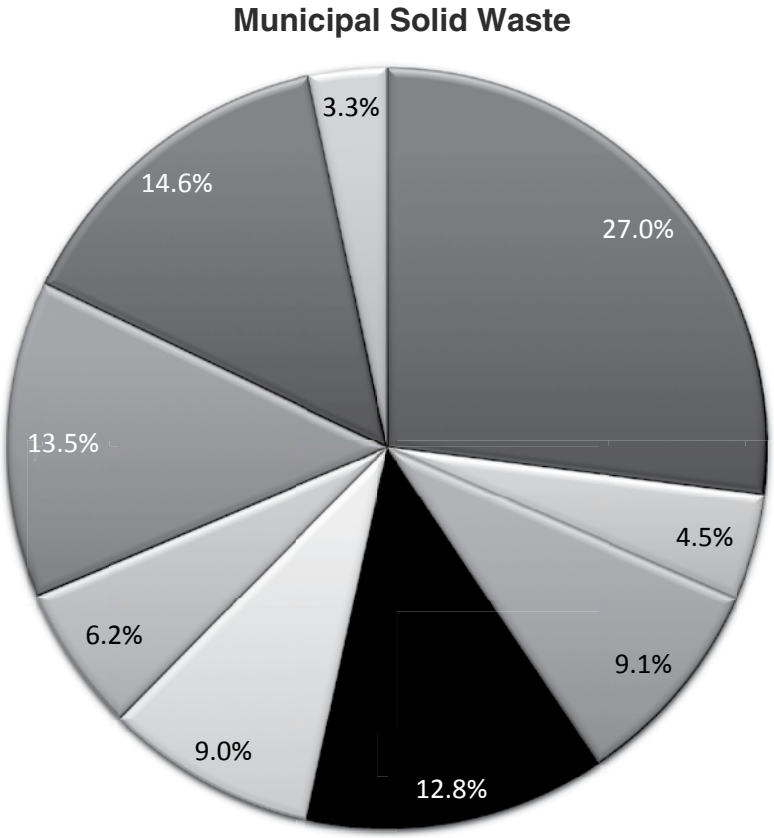
Cut out the cards below and provide one set to each group of students.

Amount of trash generated by Americans in 2013	254 million tons of trash
Pounds of trash disposal per person	4.6 pounds
Percentage of trash from residences	65%
Percentage of trash buried in landfills	55%
Percentage of trash from schools and commercial locations	35%
Percentage of trash recycled	33%
Percentage of trash incinerated	12.5%
Number of solid-waste industry employees	368,000
Number of vehicles used to move trash to landfills	148,000
Number of communities with curbside recycling	8,660
Number of landfills	1,754
Number of recycled-materials sorting centers	545
Number of incinerators	87
Solid-waste industry annual revenue	$47 billion

Name_____ Date_____

Municipal Solid Waste

Cut the categories that appear at the bottom apart. Discuss each category with your team. Rank the categories from most to least amount of waste in landfills. According to your ranking, match the category cards with the percentage of municipal waste that makes sense to you. The category you think accounts for the greatest amount of solid waste in a landfill should be placed in the 27.0% section of the pie chart, and the category with the least goes in the 3.3% section.



Paper	Glass	Metals
Plastics	Rubber, leather, and textiles	Wood
Yard trimmings	Food	Other

Name_____ Date_____

Landfill Mining: Brilliant Idea or Wishful Thinking?

Style Barons is an environmentally friendly company that is about to start making a new line of fashion accessories. The accessories are made of colorful plastics and precious metals. They range from belts to backpacks to bags. The accessories are made of plastic and decorated with thin strands of gold, silver, and platinum. The decorations make interesting designs that are sure to attract attention! Style Barons is going for a look and feel that seem expensive, but it wants its products to still be sold at a reasonable price.

Style Barons must decide where it is going to buy the raw materials needed for the items. Earth Materials R Us is a company that mines raw materials from Earth. Reclaiming the Past is a company that mines landfills. Style Barons needs to think about the environmental and economic impacts of the company it chooses. Of course, Style Barons also wants to make some money when it sells the accessories!

EARTH MATERIALS R US

The upside of mining raw materials is that the new materials may be have a higher quality and have fewer impurities, and Earth Materials R Us knows where to mine. They also have an idea about how much of each raw material is available. The down side of mining raw materials is habitat destruction, hazardous waste that can pollute air and water, and dangerous working conditions.

RECLAIMING THE PAST

The up side of mining landfills is that the unwanted waste material can be used for electricity, the landfill will last longer, and many types of recyclable materials can be recovered. Reclaiming the Past has recovered precious metals and plastics, but it cannot say for sure where it will find them in a landfill. The company also doesn't know how much of each material it will find. The downsides to mining landfills include uncovering hazardous materials, releasing landfill gases and odors, and damaging the landfill.

Style Barons has several teams of scientists researching the options. The scientists have already collected some information. The next step is to look at the information and begin forming an evidence-based argument for mining raw materials or mining landfills to recover recyclables.

Name_____ Date_____

Landfill Mining: Brilliant Idea or Wishful Thinking? (*continued*)

In the graphic organizer below, list the pros and cons of each of the companies Style Barons is researching below.

Earth Materials R Us	Pros
	Cons
Reclaiming the Past	Pros
	Cons

VOCABULARY

Word	What I think it means	Connection to essay
	Definition	
Word	What I think it means	Connection to essay
	Definition	
Word	What I think it means	Connection to essay
	Definition	

Questions I have

Name_____ Date_____

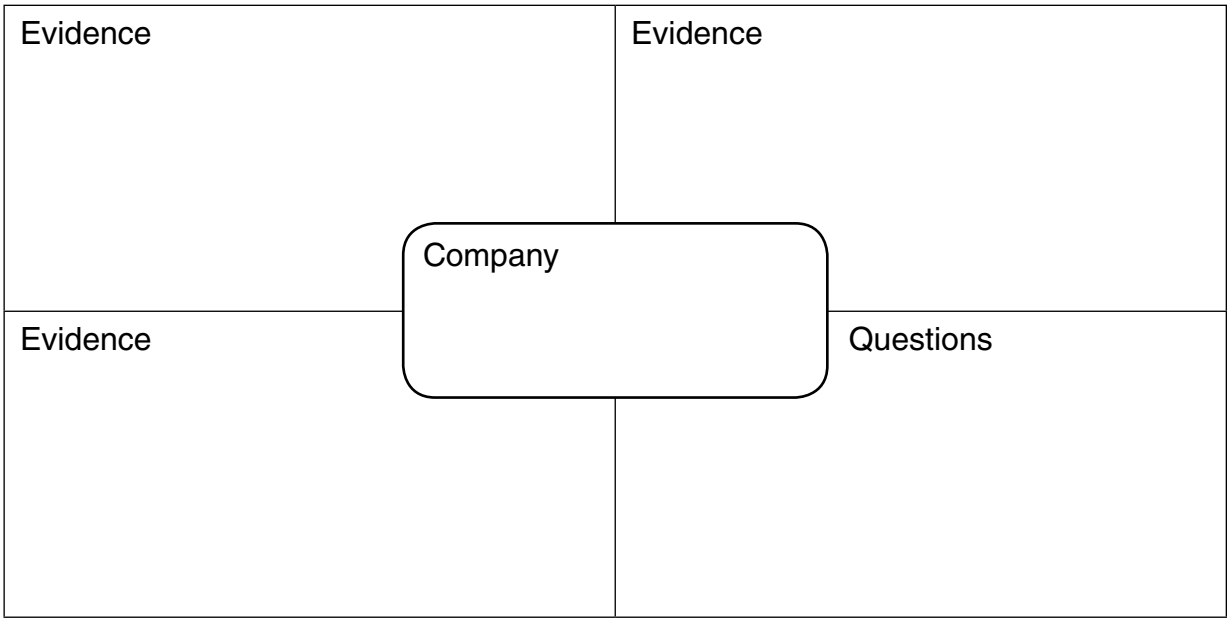
Based on the Evidence ...

Style Barons has several teams of scientists researching the options. The scientists have already collected some information. The next step is to look at the information and begin forming an evidence-based argument for mining raw materials or mining landfills to recover recyclables. Table 1 shows some of the environmental and economic impacts for both options. Review and discuss this information with your group before considering which company to select.

TABLE 1. ENVIRONMENTAL AND ECONOMIC IMPACTS

Impact Type	Regular Mining (Earth Materials R Us)	Landfill Mining (Reclaiming the Past)
Environmental	• Habitat loss • Hazardous byproducts • Soil contamination • Water pollution	• Recovers recyclables • Reduces landfill area • Exposes hazardous materials • Releases landfill gases and odors
Economic	• May provide a variety of jobs such as geological engineers, mining technicians, equipment operators • Provides raw materials for industry	• Landfill lasts longer • Produces electricity • Landfills earn money selling recovered recyclables

According to the evidence you have from "Landfill Mining: Brilliant Idea or Wishful Thinking?" and Table 1, which company do you currently think Style Barons should select?



Name_____ Date_____

Recovering Resources

The following memo arrived this morning:

SB Style Barons

TO: Earth and Environmental Scientists Research Group
FROM: Harper Baron, Style Barons Director of Research and Development
SUBJECT: Sample Materials

The purpose of this memo is to let you know that we are ready to test materials from Earth Materials R Us and Reclaiming the Past.

Earth Materials R Us has provided us with a pure sample of one of the materials we need. Reclaiming the Past has provided us with a sample of items mined from its landfill. These items have gone through a washing process, so they are safe for handling and testing. Develop a process for sorting the materials from the landfill. Sorting is the only way we can recover what we need. After the materials are recovered, perform a test to compare the two samples.

Please complete the testing within the next couple of days. We are eager to start production on the new accessories line.

ITEMS SHIPPED: Pure sample from Earth Materials R Us and landfill sample from Reclaiming the Past

In response to this memo, you must do the following:

1. Work with your team to design a process for separating the landfill sample to recover the needed material. The material is a waxy substance that can be easily melted and molded. The substance will be added to the plastic that will be used for Style Barons' new line of accessories. This material will make the plastic stronger.
2. Things to consider when designing the process include the
    a. properties of the materials in the mixture,
    b. available separating equipment,
    c. purity of the sample, and
    d. quantity of the sample.
3. Write your separation plan and share it with the lab manager. The separation plan must include
    a. a separation equipment list,

Name_____ Date_____

Recovering Resources (*continued*)

b. a step-by-step procedure for separating the materials,

c. a data collection strategy to record the amount of each material recovered, and

d. an explanation of how recovered materials that are not needed will be used.

4. After obtaining the lab manager's approval, proceed with the separation of the materials. You need 30 g of the material for testing.
5. Share the results of your separation with the lab manager.
6. Obtain the sample production and testing protocol from the lab manager. For the best results, follow the protocol exactly as directed.
7. Prepare a report for Harper Baron that explains the procedure and the results.

Name_____ Date_____

Strength Test Data Sheet

Harper Baron is eagerly awaiting the test results. Conduct the tests as directed by the lab manager. Record all data below.

Criteria	Pure Sample From Earth Materials R Us	Reclaimed Sample From Reclaiming the Past
Mass of sample		
Test mass held		
Ratio of test mass held to mass of sample (divide the mass held by the mass of the sample)		

How do the ratios of the sample and the reclaimed sample compare?

Based on this test only, which sample should Style Barons add to the plastic to make it stronger?

Based on everything you have learned about the sample from testing and about the environmental and economic effects of traditional and landfill mining, what other factors should Style Barons consider?

Name_____ Date_____

Recommendation to Style Barons

1. Working with your group, review the evidence you have gathered. Record the evidence in the table below.
2. Discuss the pros and cons of each company's mining processes and the quality of the materials that they can provide.
3. Talk about which company Style Barons should use. Write down notes during the discussion. This information could be helpful to you later.
4. Use the evidence you have gathered and meaningful information from the group discussion to make a recommendation to Style Barons.

Considerations	Earth Materials R Us	Reclaiming the Past
Environmental impact	Pros	Pros
	Cons	Cons
Economic impact	Pros	Pros
	Cons	Cons
Quality of materials	Pros	Pros
	Cons	Cons

Name_____ Date_____

Individual Recommendation to Style Barons

Using all of the evidence you have gathered and discussed with your group, make a claim about which company Style Barons should use. Present your evidence, and share your reasoning.

Claim: Which company do you recommend?

Evidence

Evidence

Evidence

Reasoning (connect the evidence to the claim)

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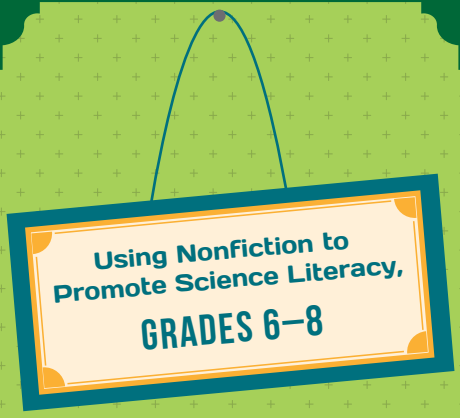
INQUIRING SCIENTISTS, INQUIRING READERS IN MIDDLE SCHOOL



Inquiring Scientists, Inquiring Readers in Middle School provides the guidance and information you need to tackle the challenge of integrating literacy into your science lessons. As authors Terry Shiverdecker and Jessica Fries-Gaither explain in the introduction, "Embedding nonfiction text and literacy activities into inquiry-based science honors the best practices of both disciplines." Research-based and classroom-tested, this book's lessons help you support student learning and maximize your time. Several unique features make this book a valuable resource:

- **Lessons integrate all aspects of literacy**—reading, writing, speaking, listening, and viewing. The texts are relevant nonfiction, including trade books, newspaper and magazine articles, online material, infographics, and even videos.
- **A learning-cycle framework** helps students deepen their understanding with data collection and analysis before reading about a concept.
- **Ten investigations support current standards** and encompass life, physical, and Earth and space sciences. Units range from "Chemistry, Toys, and Accidental Inventions" to "Thermal Energy: An Ice Cube's Kryptonite!"
- **The book is teacher-friendly**. Each unit comes with scientific background, a list of common misconceptions, an annotated text list, safety considerations, differentiation strategies, reproducible student pages, and assessments.

This middle school resource is a follow-up to the authors' award-winning *Inquiring Scientists, Inquiring Readers* for grades 3–5, which one reviewer called "very thorough, and any science teacher's dream to read." You're likely to find the middle school edition a worthy successor for meeting your classroom needs.

Grades 6–8

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