

The Mining Process

Level: Grades 3–5 Facilitator Guide

LESSON DETAILS

Objective: Students will investigate the monetary and environmental costs of mining by mimicking the mining process and assessing ore samples.

Standards NVACSS and NGSS

- **5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **DCI:** Natural Resources; Human Impacts on Earth Systems; Developing Possible Solutions
- **SEP:** Analyzing and Interpreting Data; Constructing Explanations and Designing Solutions
- CCC: Cause and Effect

Career Readiness

- 1.2.3: Demonstrate criticalthinking and problem-solving skills by analyzing and resolving problems that arise in completing assigned tasks
- 1.2.8: Demonstrate time, task, and resource management skills by organizing and implementing a productive plan of work

Materials

- copies of handouts
- ore samples or images of samples
- chocolate chip cookies (see Preparation)
- flat toothpicks
- round toothpicks
- paper clips
- graph paper
- colored pencils (optional)
- Cookie Mining Money (optional)

Lesson Summary

Students begin by observing ore samples that contain gold and share their thoughts on the images. Students then conduct a hands-on activity in which they "mine" the chocolate chips from a cookie to mimic the mining process. A class discussion will help students consider a number of factors that affect a mine's profits, including environmental costs. Students will then assess a map of a mineral resource to apply what they have learned about the costs of mining. The lesson concludes with students choosing a mineral sample to write about in terms of its worth.





Preparation

For **Explore**, students need to be able to choose from cookies with different "concentrations" of chocolate chips. Purchase brands that have varying amounts of chocolate chips, or, if possible, make cookies to fit these parameters. Consider the hardness of each cookie, as this affects the difficult of extracting the chocolate chips. Each student should have a cookie to mine, though it is recommended they work in a group to discuss their mining plans before and as they work. **SAFETY NOTE**: Be aware of food allergies your students may have.

Engage

- 1. Provide samples of an ore to students and allow them to make observations without much prompting.
 - **a.** Use samples in which it is easy to distinguish the rock from the mineral that would be extracted from it.
 - **b.** It is likely that the samples will have very little of the mineral of interest. Show images of gold-containing ore samples and allow for discussion without prompting:
 - Gold in quartz, Olinghouse Mine
 - Gold, Goldfield Nevada (called a Bonanza Ore because of the high amount of mineral)
 - Gold Vein, Goldfield Nevada (also a Bonanza Ore sample)
 - Sleeper Rhyolite Gold Ore
- **2.** If students start to discuss their favorite picture or the sample they would like to have, prompt them for details.
 - **a.** If they do not discuss this, prompt them and have a few students share their ideas.
 - **b.** Have other students indicate whether they agree with what their classmates are saying. If any students disagree, call on them to have them explain why.





Explore

- 1. Each miner starts with \$20 of Cookie Mining Money, a Cookie Mining Costs and Earnings Report, and a sheet of grid/graph paper. Discuss the following costs and profits for students to consider as they make purchasing decisions in steps 2 and 4:
 - a. Let students know that mining costs will be \$1 per minute.
 - **b.** If the mining tools break, they are no longer usable and a new tool must be purchased.
 - **c.** Sale of the "mineral" (chocolate chips) earns \$2.00 per chip (broken chips can be combined to make 1 whole chip).
- Each miner must buy his/her own "mining property" cookie. Allow students to observe three types of mining properties that have varying amounts of "mineral" in them to choose which they will purchase. Have them record their choice and its cost in the first table of the "Cookie Mining Costs and Earnings Report". Optionally, have them use a red pen/pencil to record this, to mimic accounting books.
 - a. (low concentration) \$3.00
 - **b.** (moderate concentration) \$5.00
- **3.** After the mining property has been purchased, the miner should place it on the grid paper and use a pencil to trace the outline of the mining property.
- 4. Each miner must buy his/her own "mining equipment". More than one piece of equipment may be purchased. You may want to allow students to test out equipment on a practice mining property. Have them record the equipment they purchase before and during mining in the second table of the "Cookie Mining Costs and Earnings Report". Optionally, have them use a red pen/pencil to record this, to mimic accounting books. Mining equipment for sale is:
 - a. Flat toothpick \$2.00
 - **b.** Round toothpick \$4.00
 - **c.** Paper clip. \$7.00
- 5. Rules:
 - **a.** No miner can use their fingers to hold the cookie. The only things that can touch the cookie are the mining tools and the paper the cookie is sitting on.





- **b.** Miners should be allowed a maximum of five minutes to mine their chocolate chip cookie. Miners that finish mining before the five minutes are up should only be charged for the time spent mining.
- **c.** A miner can purchase as many mining tools as the miner desires and the tools can be of different types.
- **d.** The paper clip can be bent to reshape it as many times as the miner wants to change its shape, with no additional cost.
- **6.** Students should discuss or write observations of how their mining property compares to before mining began.
 - **a.** They should compare the overall size to the outline they drew in step 3.
 - **b.** They should also assess damage to the mining property.
- 7. Have students count the chocolate chips they extracted- whole chips and pieces that are combined to make a whole chip. Have them record this number and their earnings in the third table of the "Cookie Mining Costs and Earnings Report". Optionally, have them use a green pen/pencil to record this, to mimic accounting books.
- 8. Have students calculate and share how much money they end with. As needed, check their calculations to make sure that those who lost more than they earned have a negative value.
 - **a.** Have a couple students with the most money share what they think made them most successful at locating or extracting mineral.
 - **b.** Have a couple students with lower amounts of money share what they think they would change if they were to mine a new property.

Explain

- 1. Have a class discussion on the Cookie Mining activity and what they learned about the costs (both monetary and environmental) of mining. Prompt student ideas but be sure to discuss:
 - the amount (ratio of mineral versus rock) and the concentration (distribution of the mineral throughout the rock) of the mineral within the ore,
 - the type of ore and how hard it is,
 - the cost of machinery to extract the mineral from the ore, and
 - the presence of rock waste after mining is completed.





- Discuss mining reclamation (reference and/or show images from "What is Mine Reclamation? Benefits, Purpose, and Process"). Show a few more images of before and after mine reclamation (Pennsylvania, Kentucky) to discuss that the process does not rebuild the land exactly how it was before mining.
 - **a.** Tell students they have an option to revisit their mining property to do reclamation, but it will cost them \$4.
 - **b.** Discuss their decisions to do reclamation on their mining property and the use of rock waste (cookie crumbs) to do this.
- **3.** Have students revisit their observations from **Engage** to assess which sample they would most like to "dig" in to extract the mineral.

Elaborate

- 1. Give students the handout with the map of a mineral resource found underground.
 - **a.** Tell them that the green line represents the land surface.
 - **b.** As needed, review the word "concentration" in terms of the amount of mineral located in different areas.
 - c. Give students a minute or two to make observations of the map before discussing it.
- 2. Have students work in groups to develop a plan for extracting as much mineral as they can, while taking into consideration the costs (both monetary and environmental) that they learned about in **Explore** and **Explain**.
 - a. Have students rank each of the four deposits in the order in which they would choose to mine them (1: the deposit they would most like to mine --> 4: the deposit they would least like to mine).
 - **b.** Have them shade in boxes on the grid that they think would be affected by mining each deposit.
 - **c.** What factors did they consider as they ranked the mineral deposits? (slope/steepness, safety, depth of the deposit, concentration of the deposit, proximity to another deposit, or others that they cannot see, such as what organisms live on the land or where water resources might be located)
 - d. Discuss with students if there are any deposits they would not mine at all and why.





Evaluate

- **1.** Show the images from Engage again.
- 2. Have students write about which sample would be most profitable. They should:
 - **a.** Include questions that they have about the deposit that might affect their choice (i.e., factors they cannot determine from the images, such as depth of the deposit and other environmental factors), and
 - **b.** use evidence from this lesson (especially using their completed handouts) to support their choice.





HANDOUTS

SAMPLE	DESCRIPTION





Cookie Mining Costs and Earnings Report

An investor has given you \$20 to start a mine!

Costs: Mining Property

Mining Property	Check which property you purchased	Cost for Mining Property
Low Concentration		
Moderate Concentration		
High Concentration		

Costs: Mining Equipment

Equipment Type	Cost per Item	Number Used	Total Cost per item
Flat Toothpick	\$2		
Round Toothpick	\$4		
Paper Clip	\$7		
Total Equipment Cos			

Add up your total costs and record that here: \$_____

Mineral Extracted	Number of Pieces	Earning Per Piece	Total Earned
Chocolate Chips		\$1	\$

What is your profit? To find this, subtract:

Earnings: \$_____

Costs \$_____

= \$_____













