

## COOKIE MINING

Grade level: 7-12

Time Required: 1.5 hr

Cost: \$1.00

Subject Areas: Earth and space, Engineering, Algebra, Economics, Measurement

### SUMMARY

Students act as mining engineers and simulate ore mining production by using chocolate chip cookies. They focus on the cost-benefit analysis of the chocolate ore production throughout the simulation, which helps them understand the cost of production. As students “mine” with tools such as paperclips and toothpicks, they keep records of their costs—land (cookie), equipment used, cookie size before and after production, and time spent. While the goal is to make as much profit as possible, other costs and goals are taken into consideration—as in real-world mining engineering. For example, mining engineers also consider the resulting amount of destruction to the lithosphere when deciding the best method to obtain ore. Thus, a line item for land reclamation cost is included from the beginning. A provided worksheet serves as a profit and loss statement.

### ENGINEERING CONNECTION

A wide range of costs and goals need to be considered when planning engineering projects. Engineers focus on benefiting society while balancing the exploration and exploitation economic factors involved in their designs. The primary method of gaining insights while considering these two design aspects is through cost-benefit analysis (CBA). For example, using sonar to locate below-ground fossil fuel deposits or applying R&D funds to determine the best circuit board design both generate huge “exploration” costs. Similarly, extracting fossil fuels such as coal or oil, or mass-producing circuit boards both require huge exploitation costs. In all engineering fields, considerations like these and more are taken into account for every production project. Mining is a good example of this type of evaluation because it typically entails substantial environmental concerns related to the geological processes as well as economic factors in the exploration vs. exploitation CBA.

### INTRODUCTION

Mining involves removing a metal or other commodity from the ore, a volume of rock that is already elevated in the concentration of that metal or commodity compared to other rocks. In order for that rock to be classified as ore, it must be possible to extract the metal and to make a profit. That means the classification of a rock as ore depends on a lot of factors such as the expenses involved in the method of extracting the metal, the concentration of the metal in the rock, the expense involved with separating the metal from the ore, and so on. This activity models the varying concentrations of the metal (chocolate chips) and methods of extraction (choice of student) plus charges for environmental disturbances.

### OBJECTIVE

Using a variety of chocolate chip cookies to represent the ore, and toothpicks to represent the mining technique, students will model the mining process including environmental considerations and economics.

## LEARNING OBJECTIVES

After this activity, students should be able to:

- Explain what is meant by the “cost of production.”
- Complete a profit and loss statement.

## MATERIALS LIST

Each student needs:

- 1 sheet graph paper
- 1 chocolate chip cookie
- pencil
- at least 2 mining tools; choose from paperclip, round toothpick, flat toothpick
- Cookie Mining Worksheet

To share with the entire class:

- Play money (or use a credit system)
- paperclips
- round toothpicks
- flat toothpicks
- Cookie Mining Reference Sheet, either write its information on the classroom board or make copies as a handout
- clock or watch, for timing students’ mining work
- (optional) calculators

## INSTRUCTIONS

1. First, you will create a corporation to run your cookie mining operation. You will decide the mining style of your corporation and use that information to select your cookie and the proper tools for the mining operation. All information regarding your mining venture will be recorded on your Cookie Mining Worksheet.
2. Next, you will purchase your cookie (mining property) and rent your mining tools. Each cookie contains minable ingredients (ore), such as chocolate chips and nuts. Mining tools include items such as toothpicks and paper clips.
3. Before the mining operation can begin, you will need to determine the original size and topography of your cookie using a sheet of graph paper.
4. You will then mine your cookie for its ore using only the rented tools. The mining operation will be timed in order to determine its cost.

5. After removing the ore from your cookie using the tools, you will perform a reclamation operation on your cookie so that it matches its original size and topography as closely as possible. The reclamation operation will be timed in order to determine its cost. Upon completion, an "EPA inspector" will evaluate the reclamation and assess fines for any deviations from the cookie's original state. For every square that contains debris outside your original land purchase (not including squares containing water), you must pay reclamation costs.
6. Finally, you will use the information on your Cookie Mining Worksheet to determine the costs of your mining operation, the costs of any fines and the income you received for the ore. By combining these figures, you will determine whether or not your corporation made a profit or a loss.

## PROCEDURE

1. Be sure to make accurate drawings of the original cookie. Trace the outline of the intact cookie on the graph paper and then eyeball the cookie from the side in order to draw the original topography. After mining is completed, the "EPA Inspector" will use both of these drawings in order to assess fines. This is similar to mapping the mineral deposit by the geologist before and during mining. You can have the students take photos.
2. Choose the proper tools for your mining operation. You can choose any two tools out of a choice of three. Tools are rented, not purchased. Damaged or broken tools must be replaced at double the initial cost. You can even have the students modify their tools and add additional tools! Miners are constantly redesigning their tools!
3. Make good decisions concerning the removal of ore from your cookie as this is your only source of income. You will sell the ore at a set market price. The chips represent the actual ore.
4. Select cookie and tools. You can only purchase one cookie. You can use different kinds of cookies and have the students choose their cookie. You can even use cookies with chips and raisins to simulate multi-ores (copper and gold). Make sure that your students are not allergic to chocolate or nuts!!!!
5. Record the type of cookie and its cost on the Cookie Mining Worksheet.
6. Determine which mining tools your corporation would like to use for the mining activity. You may only rent two of the three available tools: a flat toothpick, a round toothpick, or an unfolded paper clip. They have different rental prices. Broken tools are replaced at double the rental price.
7. Calculate and record the cost of the tools on the Cookie Mining Worksheet.
8. Determine cookie size and topography. Trace an accurate outline of your cookie on a piece of graph paper. Determine the size (area) of the cookie by counting the graph

paper squares within the outline. Count partial squares as a full square. Geologists and mining engineers are constantly mapping and remapping their deposit!

9. Record the area of your cookie on the Cookie Mining Worksheet.
10. Look at the cookie from the side and carefully draw an accurate representation of its topography. Be sure to capture the natural peaks and valleys in the cookie.
11. Mine cookie. Start timing with the stopwatch as you begin to mine the desired ores from your cookie.
12. Excavate the ore using only the rented tools. You may not use your fingers! Be careful not to break or damage the tools.
13. Collect as much of the ore as you think is best. Whole chips are most desirable, but pieces of chips may be combined to form complete chips. In mining, the ore is transported to another facility for further processing.
14. Reclaim mined cookie. Initiate reclamation of your cookie after mining is complete. The stopwatch should still be running.
15. Use only your mining tools to perform reclamation. You may not use your fingers! Try to reclaim your cookie so that it matches its original size and topography. The difficulty in reclaiming your cookie is very similar to real life miners reclaiming their mine sites.
16. Stop timing when reclamation of your cookie is complete. Record the length of time for mining and reclamation operations on the Cookie Mining Worksheet.
17. Calculate the operational (mining and reclamation) cost on the Cookie Mining Worksheet. You can add taxes to your sheets.
18. Ask the “EPA Inspector” to check your cookie reclamation. Your teacher or another student may act as the inspector. Ideally, the cookie should match its original space and topography. Fines are given for discrepancies from the original shape and topography.
19. Record any fines on the Cookie Mining Worksheet.
20. Calculate profit or loss. Determine how many chips you removed. Small pieces of chips may be combined to form a complete chip.
21. Calculate and record the value of the ore collected.
22. Calculate a final profit or loss for your mining venture.

**STARTUP COSTS: BEFORE MINING TIMING STARTS...**

**Land Cost**

1 cookie = \$1,200

Land area = squares on graph paper (partial squares = 1 full square)

**Tools Cost (choose at least 2)**

1 paperclip = \$500

1 round toothpick = \$300

1 flat toothpick = \$100

**AFTER MINING TIMING ENDS...****Revenue from Sale of Chocolate Ore**

Chips that fall off of the graph paper = “lost”

Whole, clean chip = \$3000 each

“Dirty” chip = chips that have cookie remains on them = \$2000 each

Partial chip (must be combined to form amount of ore in one chip) = \$2000 each

**Labor Cost (Time)**

Ongoing mining operation = \$50 per minute

**Land Reclamation Cost**

Original land (cookie) = \$30 per square

Additional land (circles) made during reclamation = \$30 per square

**OTHER FACTORS**

Part way through the exercise the instructor can inflict challenges to the mine, such as a flood that moves the waste rock pile, a nearby wildfire, or COVID-19 case and the mine has to set up an emergency health care center. These unplanned for situations impact the cost of mining but are difficult to plan for. Add costs to the sheet to cover these events.

**OTHER VARIATIONS**

Add streams or rivers to the diagram and charge fines for polluting the water. Add different types of cookies that have more than one “commodity” and select which cookie you would like to mine (e.g. with chocolate chips, with colored chips, with peanut butter chips, with or without nuts, etc.).

**Cookie Mining Worksheet**  
Profit & Loss Statement

**Mining Expenses**

Land Cost & Area

Cost of cookie = \$1,200 \_\_\_\_\_

Initial size of cookie (in squares x \$100) = \$ \_\_\_\_\_

Mining Equipment Costs

Paperclip \_\_\_\_\_ x \$500 = \$ \_\_\_\_\_

Round toothpick \_\_\_\_\_ x \$300 = \$ \_\_\_\_\_

Flat toothpick \_\_\_\_\_ x \$100 = \$ \_\_\_\_\_

Total mining equipment costs = \$ \_\_\_\_\_

Labor Cost (Time)

Minutes spent mining \_\_\_\_\_ x \$50 = \$ \_\_\_\_\_

**Unexpected costs**

Landslide = \$ \_\_\_\_\_ COVID-19 expenses = \$ \_\_\_\_\_ Other = \$ \_\_\_\_\_

**Subtotal: Cost of Mining Operations**

Cost of land/cookie + mining equipment costs + labor/time cost + Unexpected = \$ \_\_\_\_\_

**Reclamation Cost (land impacted by mining)**

Final area taken up by cookie = \_\_\_\_\_ squares x \$30 = \$ \_\_\_\_\_

Minutes spent reclaiming \_\_\_\_\_ x \$10 = \$ \_\_\_\_\_

Total reclamation = area + labor = \_\_\_\_\_

**Mining Revenue (from sale of chocolate ore)**

Number of whole chips removed = \_\_\_\_\_ x \$3000 = \$ \_\_\_\_\_

Number of "dirty" chips removed = \_\_\_\_\_ x \$2000 = \$ \_\_\_\_\_

Number of grouped partial chips\* removed = \_\_\_\_\_ x \$2000 = \$ \_\_\_\_\_

\* To sell partial chips, amass the partial chips into groupings that contain at least the amount of chocolate as an intact whole chip.

**Subtotal: Total Mining Revenue**

Income from whole chips + dirty chips + grouped partial chips = \$ \_\_\_\_\_

**PROFIT (Net Revenue)**

Mining revenue – cost of mining operations – reclamation cost = \$ \_\_\_\_\_

## EVALUATION

What about the mining equipment? Which tools, or combination of tools were the most effective? Did certain tools break?

When the student tried to reclaim the cookie, what happened? Was it difficult to return this cookie back to the same exact size that it was before mining the chips?

Are the environmental costs of *mining* the only environmental costs? What other environmental costs might occur *after* the ore has been mined? Why are environmental regulations important?

What do you think are some of the costs associated with mining commodities?

Do you think this activity realistically simulated *modern* mining? Explain why or why not. Using specific examples from the activity and your own knowledge.

## VOCABULARY/DEFINITIONS

*cost-benefit analysis*: A systematic approach for calculating and comparing benefits and costs of a project. Abbreviated as CBA.

*expense*: The cost to pay for something, such as material goods, services, equipment or labor.

*lithosphere*: The crust and upper mantle of the Earth.

*ore*: A type of rock that contains sufficient minerals of a desirable element that can be extracted from the rock. Ores are extracted from the Earth through mining, and then refined to obtain valuable elements.

*reclamation*: To restore what once was, such as to restore land that has been mined to a natural or usable state.

*revenue*: The amount of money (or income) that a business makes from the sale of goods and services before expenses and cost of production are subtracted.

*surface mining*: The mass removal of the soil and rock surface of an area of land to some depth in order to extract ore, minerals and/or resources. Sometimes called strip mining.

*underground mining*: Sub-surface extraction of ore, minerals and/or resources from below the Earth's surface with minimal damage to the overlying rock and soil.