The Mining Process

Level: Middle School
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate the process of mining to understand factors that affect the success and profitability of a mining operation by modeling the process from extraction to reclamation of the land after mining is complete.

Standards

NVACSS and NGSS

- **MS-ESS3-3:** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **MS-ESS3-4:** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- **DCI:** Natural Resources; Human Impacts on Earth Systems; Developing Possible Solutions
- **SEP:** Constructing Explanations and Designing Solutions; Engaging in Argument from Evidence
- **CCC:** Cause and Effect

Career Readiness

- **1.2.3:** Demonstrate critical-thinking 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

- wild bird seed (commercial mix)
- shallow pans or trays
- paper plates or bowls
- small beads (~2mm; blue, gold and silver)
- medium beads (~4-6mm, white)
- copies of handouts

Lesson Summary

Students begin by analyzing data on the amount of rock removed from a mine compared to the amount of mineral resource extracted. They will then complete a hands-on model to demonstrate the mining process and how scarce mineral resources can be, as well as potential effects of mining on the environment. Students then read about changes in mining practices and policy that help reduce the negative environmental impacts of mining. They then analyze data (graphs and maps) on the mining history of Nevada. The lesson concludes with students researching uses for rock waste produced by mines as a way to reduce the environmental impacts of mining.

Preparation

- For **Explore**, set up a model mining site for each student group. Pour approximately 1-1/2 pounds of birdseed into each pan. In each model add 2 gold beads, 4 silver beads, 8 blue beads, which can be mixed into the birdseed. Then, shape the birdseed into a "landscape" with a hill at one end of the pan, a low spot near the foot of the hill that represents a lake, with the rest of the area being flat. Gently push 3 white beads into the flat area of the pan, being sure to cover up any divots you may have made.

- You may want to use "**Mining and Mining Impacts**" as a reference for the stages of mining for yourself or for your students. If students will be reading this content, it is recommended that it is broken up to match parts of the lesson: For **Explore**, use sections "Exploration" and "Extraction". For **Explain**, use sections "Concentration" through "Environmental and Societal Concerns".

Engage

1. Show students data on the amount of rock removed from mines compared with the amount of mineral resources extracted:

   a. Allow students to make observations of a **graph of rock waste to ore ratios** and share their thoughts on why there are different ratios for different minerals.

   b. Then show the **first figure in this article** that shows similar data but scaled to 1 kg of mineral compared to total material and ore removed from a mine.

   c. If needed, show students an image that depicts the **relative amounts of rock**, **ore, concentrate, and mineral** as the process of mining and refining progresses.

   d. You might also show **Figure 3 from this article** to look specifically at data on gold extraction.

2. Discuss the data:

   ▸ *Describe the trend(s) you notice.*

   ▸ *What factors might explain why more rock is removed than mineral collected?*

   ▸ *What do you think happens (and/or should happen) to the rock that is removed from a mine?*

Explore

1. Divide students into groups. Assign each group a number or have the students decide on a name for their mining “company”.

2. Describe the setup of the “mining sites” that you have set up. Tell students that the birdseed represents rock, and there are beads buried within it that are valuable minerals. Also tell them that the low area represents a pond that is a water source for a nearby town. Do not tell them where the white beads have beads have been placed or that they are strategically located only in the flat area.

3. Tell students what each component represents and the relative amounts they will earn for extracting each:

    a. Gold beads = Gold = $5.00 each

    b. Silver beads = Silver = $4.00 each

    c. Blue beads = Copper = $3.00 each

    d. Birdseed = Rock (Waste) = $0.00

    e. White beads = Reclamation incentive = -$2.00 each (Rebates that will be deducted from the cost of reclamation. In the mining world, these might represent the refund of a portion of a reclamation bond as a result of concurrent reclamation or a cost reduction for some type of environmental mitigation service performed by the company.)

4. Have one student from each group assume one of the following roles:

    - **Miner(s):** Search for beads (resources) in the birdseed. There can be more than one of these if there are more than 4 students in a group.

    - **Recorder:** Completes the spreadsheet with values for beads found.

    - **Environmental Monitor:** Assign a $1-3 "fine" to cover costs for "environmental damage" (see “Birdseed Mining Costs and Earnings Report” for categories of damage to look for).

    - **Accountant:** Calculates totals and profits using the spreadsheet.

5. Students search through the seed mixture and remove the beads they find to a bowl or plate. A second bowl or plate should be used for rock waste that is produced. Allow 5 minutes for the mining activity (less for larger groups with more miners).

    a. You may want to act as an additional “monitor” and circulate through the groups to ensure students are following mining laws and recording accurate data.

   b. Giving students a shorter time for mining may cause them to risk environmental damages in order to locate resources in time, which could lead to a productive discussion.

6. Have groups count the number of each colored bead and record them in the proper spaces on the "Birdseed Mining Spreadsheet".

   a. Any environmental damage fine is subtracted from the earnings.

   b. Then reclamation costs are subtracted from the initial profit. It is possible that their reclamation costs are negative if they found enough incentive beads to cancel out reclamation costs.

   c. The Grand Total is the profit (+) or loss (-) made of the mining company.

7. List the group numbers or company names on the board and compare the results.

   a. Let students know how many total beads were in the birdseed mix and show them the maximum amount that could be made if all beads were found, and no environmental damage fines were incurred.

   b. Discuss with students that this model did not include many of the costs associated with mining, such as wages for employees, mining equipment, and management of environmental effects.

   c. Discuss techniques that students used to search through the birdseed how students could change their mining technique to reduce costs if they were to mine again.

Explain

1. Have students read about mining waste and how old mining practices led to the development of policies regarding environmental effects of mining and mine reclamation. You may want to have some students complete each reading (listed in order of difficulty), or have students complete the first reading, and you can add in details from the second:

   - **How Past Mining Practices Led to Today's Permitting Rules in Nevada**
   - **Nevada Mines**

Elaborate

1. Have students use the **Nevada Mining and Land Withdrawal History Experience** to explore and explain data on the history of how land areas in Nevada are being withdrawn from prospective mining claims and the reason why these lands are being conserved.

   a. Tell students to consider that this map shows only what information was able to be obtained and so may not reflect all mining that has occurred over time.

b. Be sure they note that the key for the maps on this website change over time, with new factors being added, such as populations, mining claim density, and major highways.

2. Provide students with the questions on the corresponding handout or use the questions to have a class discussion on Land Withdrawal. You may want to focus on Inactive Mines within the data, especially if students do not choose this as a "trend" to describe as they go through the website.

   a. Scroll down until you reach the section titled "Nevada Historic Production Values". Study the key, then describe at least two trends or interesting points on the graph. Use the light grey scroll bar above the graph to zoom in on the data.

   b. Return to the top of the website. On the left of the screen, click "Pre 1850 M" under "Minerals" to access a map of mining sites in Nevada. Scroll down in the text to read the key for the map. Click through each time period and note specific trends in mining over time.

   c. How do the maps correlate with the "Nevada Historic Production Values"? What is the benefit of having both visuals to describe mining over time in Nevada?

Evaluate

1. Have students research proposed methods for using and/or minimizing the environmental impact of waste rock from mines. You may want to guide students by brainstorming suggestions for topics to research. You can also provide the following resources to get students started (resources d and e are technical readings that can provide a challenge for advanced students):

   a. **Mining Waste** (This overview can help students better understand mining waste and possible topics to research.)

   b. **12 uses of mine waste rock and tailings** (This article can also be used to generate ideas for research.)

   c. **Evaluating the rehabilitation of an old mine waste rock pile**

   d. **Strategic Evaluation of Mineralized Waste Rocks as Future Resource** (Have students read the first three paragraphs of the Introduction, the last two paragraphs of section 1.2, then sections 1.3-1.4.)

   e. **Evaluation of Mine Waste Rocks for Use as Materials for Road Construction** (Have students read the first paragraph of the Introduction, Table 1, then the Results and Discussions sections. The challenge with this reading is that students need to focus on the overall use of rock waste for road construction and what the materials need to be able to withstand to be considered. Specifics about rock types and test results should be glossed over.)

2. Have students write an argument for or against a particular method for using or reducing the impact of waste rock from mines.

    a. Determine what elements or information your students should have in their arguments, such as:

        i. The number and quality of resources used to obtain information,

        ii. The intended audience for their argument, and how long it should be,

        iii. Whether they are to include data or diagrams with their writing, and

        iv. How they might share their argument with their classmates.

HANDOUTS

Birdseed Mining Costs and Earnings Report

Earnings:

MINERALS (BEAD COLOR)	NUMBER EXTRACTED	UNIT PRICE	TOTAL EARNINGS PER BEAD
Gold (_____)		$5	
Silver (_____)		$4	
Copper (_____)		$3	
Total Earnings:			

Costs: Environmental Damage:

DAMAGE CATEGORIES	COST PER CATEGORY	COSTS FOR ENVIRONMENTAL DAMAGE
Excessive rock waste outside mining area	$2	
Rock waste mixed with extracted minerals	$1	
Rock waste entering lake	$3	
Other	(determined by environmental monitor, not to exceed $3)	
Total Costs for Environmental Damage:		

Subtract your Costs for Environmental Damage from your Earnings to calculate your Profit:

Earnings: $_____

Costs: $_____

Initial Profit: = $_____

Reclamation:

COST AND REBATES FOR RECLAMATION	COST PER CATEGORY	CALCULATED TOTAL
Rebuilding the land	Multiply your Profit by 10%	
Reclamation Rebates (# found: _____)	Multiply the number of incentives you found by -$2	
Total Reclamation Costs (can be positive or negative):		

Subtract your Reclamation Costs from your Initial Profit:

Initial Profit: $_____

Reclamation Costs: $_____

Grand Total: = $_____

Nevada Mining and Land Withdrawal History Experience

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   b. Click through each time period and note specific trends in mining over time.

3. How do the maps correlate with the “Nevada Historic Production Values”? What is the benefit of having both visuals to describe mining over time in Nevada?