

Engineering

 Level: K-2
 Facilitator Guide

LESSON DETAILS

Objective: Students will use different tools to model mining and relate the shapes and materials tools are made of to their function.

Standards

NVACSS and NGSS

- **K-ESS3-3:** Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
- **2-PS1-2:** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- **K-2-ETS1-3:** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
- **DCI:** Planning and Carrying Out Investigations
- **SEP:** ESS3.A: Natural Resources
- **CCC:** Systems and System Models

Career Readiness

- **1.1.3:** Demonstrate teamwork skills by contributing to the success of the team, assisting others, and requesting help when needed.

Materials

- flour
- water
- sand
- school glue
- large bowl
- mixing spoon
- **colored glass craft gems**
- parchment paper or a drop cloth
- paintbrushes
- cotton swabs
- digging tools (e.g., craft sticks, metal and plastic straws and spoons, spatulas, toy or garden shovel)
- small bins or bowls filled with soil, kinetic sand, clay or play dough to represent mining sites

Lesson Summary

Students begin by making and carrying out a plan to dig colored glass gems (representing minerals) out of a hard clay substrate. They then use different tools in a larger model to consider how the shapes and materials tools are made out of affect their ability to dig in different types of sediment. Students then relate the shapes of tools they have used to those used in the mining industry, including large vehicles for excavation and transport. A discussion helps students consider the environmental effects of digging and building mines. The lesson concludes with students designing and carrying out a plan to dig a mining site model in a way that will reduce environmental impact in terms of creating rock waste.



Preparation

For **Engage**, make enough mineral dig setups for students to work in small groups so they can discuss plans to dig and work through problems together. Follow the **instructions on making a dig setup**, replacing the toy dinosaurs with colored glass gems that will represent minerals (as written, the recipe can make one or two setups). It is recommended that students or groups have setups with varying numbers or locations of minerals (some of which might be partially visible, even before they dig). This can facilitate a discussion on the real-world challenges in locating mineral sources or estimating the size of a mineral deposit.

For **Explore**, set up “mining sites”—small containers each with different type of sediment (e.g., soil, kinetic sand, clay, hardened play dough, or others). For loose sediment, press firmly to compact it into the containers. Have a range of tools on hand that are different shapes and made of different materials.

For **Evaluate**, provide each small group with a mining site similar to **Explore**, but with each containing the same sediment and a glass gem buried to represent a mineral deposit. To make the results easier to compare, place the glass gem in the same spot at each site. You may want to put down drop cloths to reduce mess as students transfer “waste rock” from the mining site to the bowl used to collect waste.

Engage

1. Give each student group a mineral dig setup.
 - a. Allow students to make observations of the dig setup and consider how they might extract the mineral(s) from it.
 - b. Distribute the same tools to each group or allow them to choose from a selection of safe tools you have available.
 - c. Ask groups to make a plan for how they will extract the mineral(s) from the dig set up with the available tools.
 - d. Give groups time to dig, encouraging them to take turns or to consider.
2. Discuss students’ experiences digging.
 - ▶ *What tools or methods worked best in digging out the mineral pieces?*
 - ▶ *Did you follow the plan you discussed before you started digging? What about your plan worked well? What did you change and why?*
 - ▶ *Once you found the mineral, did you keep digging? Why or why not? If you did keep digging, did you find more minerals? If you didn’t, what made you think there were not any more minerals to find?*



- ▶ *How much of your dig setup is untouched? Did you think about this at all as you were planning or digging?*

Explore

1. Have “mining sites” around the room as stations for groups of students to visit. Place the same tools at each mining site for students to test out digging.
 - a. Allow students to first observe the mining sites and tools.
 - b. Have students share their ideas about which tools they think will work best (their answers may be specific to a particular mining site or may apply to all the sites).
2. Have student groups visit at least two mining sites, depending on class time, and try out each tool.
 - a. Before students move on to the next site, have them compact the loose sediment so the next group has a clean site to work with.
3. Have a class discussion on the use of various tools for digging:
 - ▶ *Did all tools work well at the mining sites you visited? Have students give specific examples of what worked well and what did not.*
 - ▶ *How did the shape of each tool affect how well it worked?*
 - ▶ *How did the material that each tool was made of affect how well it worked?*
 - ▶ *Which mining site was easiest to dig in no matter what tool you used? Which was the hardest to dig in? What about these sites might make them easier or harder to dig?*
 - ▶ *What other tools (or tool shapes or materials) might we try? Have students explain their reasoning. Optionally, demonstrate other tools that may not be safe for kids to use, such as a drill, hammer and chisel, or other larger tools.*
 - ▶ *How do you think the tools used in mining differ from the ones we used in this activity?*

Explain

1. Show students an **image of hand tools** that can be used in mining.
 - a. Discuss what students think they are made of and what they do. Have them use the color, relative size, and shape of the tools to explain their answers.
 - b. You may also want to relate their shapes to the tools students used in **Engage** or **Explore**.



2. Watch parts of a video on **Excavators, Trucks, and Loaders**:
 - a. Play 0:40–2:42, pausing to talk about each vehicle. Compare parts of some of the tools students used in **Explore** to the parts of these mining vehicles (e.g., a spoon can carry materials like the scoops of excavators). Students might also compare parts to other objects that they did not use.
 - b. Mute the video and play from 16:45–17:51, pausing between vehicles to have students describe what each one is doing. Also, discuss specific parts of each vehicle that help it do its job (e.g., treads versus wheels, baskets versus blade).
 - c. Then play from 20:29–20:52 (with or without sound) to have students see and discuss how each vehicle does a different job to work together.
3. Mute and skip through this video on **large drillers used in mining** to show a few different types of drills or the vehicles that carry them. Discuss differences in shape and size and how those properties match their function.

Elaborate

1. Begin by discussing digging in a sandbox, yard or garden. Ask:
 - ▶ *What might you be looking for if you were digging?*
 - ▶ *What tools would you use to help you dig?*
 - ▶ *How could digging affect what is already living there?*
2. Then, expand the discussion to have students consider how mines are built and how digging can disrupt nearby plants, animals, and the environment.
3. Show students **this short video** (no audio), and pause as each new image appears, briefly discussing the types of mines.
4. If possible, refer to students dig setups from **Engage** to relate to each type of mining (e.g., subsurface mining if they “tunneled” into a part of the setup or their mineral was not near the surface).
5. Ask students if they think the same tools are used for each type of mining. Have a few students explain their answers. You may want to reshow the images or videos from **Explore** to have students consider which tools and vehicles are shown underground.

Evaluate

1. Give students a mining site, similar to what they used in **Explore**, but so that each small group has the same type of sediment with one mineral buried in the middle of the site.



- a. Ask students to locate and extract the mineral while causing the least amount of damage to the site as possible.
 - b. Give each group a small bowl to collect “waste rock.” Their success will be measured by how much waste rock they remove.
 - c. Allow each group to choose two tools.
 - d. Students should work as a team to discuss and carry out a plan for extracting the mineral.
2. Discuss the results from each group:
 - a. Compare the amount of waste rock that was collected.
 - b. Discuss students’ plans and any challenges they may have faced while mining.
 - c. Have students share which tools they used, especially focusing on the tools used by the group that had the smallest amount of waste rock. Also, allow everyone to observe the site this group mined.
3. Have a class discussion around the group that had the smallest amount of waste rock.
 - a. Ask students to discuss how the shape and materials the tools were made of helped this group to be successful.
 - b. You might also discuss their plan and parts of it that helped them locate and extract the mineral.