NVMA Nevada Mining Association EST. 1913

Sustainability and Mining

Level: High School
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate sustainability concerns in relation to mining and how these concerns can be addressed.

Standards
NVACSS and NGSS

- **HS-ESS3-2:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- **HS-ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- **DCI:** Natural Resources; Human Impacts on Earth Systems
- **SEP:** Constructing Explanations and Designing Solutions; Engaging in Argument from Evidence
- **CCC:** Cause and Effect

Career Readiness

- **1.2.5:** Demonstrate understanding of workplace organizations, systems, and climates by identifying "big picture" issues and fulfilling the mission of the workplace.

Materials

- copy of the lesson handout for each student
- computer with internet access for each student or student pairs

Lesson Summary

Students begin by discussing what they know about the environmental issues associated with mining and conduct research on specific issues. Students then learn about the United Nations Sustainable Development Goals (SDGs) and relate a specific SDG to a specific environmental effect of mining. A virtual activity allows students to learn about mine reclamation, relating the steps to the SDG they chose to focus on. Students will then conduct research on innovations in mining that will help make progress toward the SDG they chose. The lesson concludes with students analyzing their findings to those of their classmates to consider how mining and reclamation work toward multiple SDGs.

Preparation

Go through the virtual activity in **Explain** to determine which sections you would like for students to focus on. You might also choose to do some steps as a class. Consider if you want students to print or take a screenshot of their Assessment Review at the end of the activity as a formal evaluation.

Engage

1. Ask students: *What environmental issues are associated with mining?* Record students' ideas on the board or in a shared document. As students respond, ask follow-up questions to help determine their familiarity with mining (e.g., how might mining lead to [example student named]?).

2. Split students into groups and have each read one section of this article (in increasing order of difficulty to research: land, pollution, water use, greenhouse gas emissions).

Explore Reclamation of Abandoned Mines

1. Introduce the United Nations Sustainable Development Goals (SDGs, Figure 1) using the following resources:

   a. **Overview video** that breaks the SDGs into focus groups (i.e., people, environment),

   b. A **short reading relating the SDGs to the geosciences**, with links to additional resources.

   c. The Mining and the Sustainable Development Goals handout summarizes the work of the geosciences and mining toward the SDGs.

2. Have students access the official UN SDG website to learn more and identify which SDG best aligns with their assigned section of the article from **Engage**.

   a. Each group should share their choice of SDG with the class and give a short description relating this SDG to their section of the article.

   b. They should then identify at least one specific Target and/or Indicator that might be addressed by modifying the mining process. This will be the focus of their investigation in **Explain**, **Elaborate**, and **Evaluate**.

Figure 1. The SDGs address the major challenges faced in terms of societal and environmental concerns. The SDGs can provide a context for learning about mining and how it affects aspects of human life and the environment.

Explain

1. Have students complete this **virtual activity** to understand how mine reclamation occurs.

   a. Have students take notes on the handout as a guide that will help them in the class discussion in step 2 and in **Evaluate**.

   b. As they complete the activity, students should note reclamation processes that relate to the concern they are investigating.

2. Lead a class discussion, using the following questions to guide a class discussion on mine reclamation:

   - *Why do you think the Wildlife Habitat Reclamation process begins with regarding the area?* The virtual activity discusses reducing erosion and adding soil to aid in plant growth, but students may have additional ideas about benefits of regrading the land.

   - *What categories did you sort the plants into? Which three species did you end up choosing to plant in the area?* There is more than one correct combination of plants, so you may want to discuss why some plants might still be better than others, since some plants grow slowly, require different amounts of water to thrive, and have other benefits to the environment.

   - *Which animal was indicated as non-native to the Southwest? Why is it found in the area? How might it disrupt natural food chains?*

   - *Which (copper) mine shown by remote sensing do you think has the most impact on the nearby environment? Which mine appeared to have the most successful reclamation? Describe your evidence for each choice.*

   - *Which monitoring technique do you think is most effective and why? Why might multiple techniques be used in the same area?*

Elaborate

1. Have students conduct research on innovations in mining (e.g., process, technology, laws and regulations) that help reduce the environmental impact they have been assigned and is helping achieve the Target/Indicator they have identified.

2. Provide websites for students to get started, such as:

   a. **Mining is necessary for the green transition. Here's why experts say we need to do it better.** Students can use this reading to learn more about the process of mining to get ideas about which stages of mining could benefit from innovations in technology or mining processes.

   b. **Advancing toward sustainability: The emergence of green mining technologies and practices**. Students can use to get ideas about innovations to research further.

c. **Zero-Emission Mining Technologies are Here.** A video on innovative mining technologies.

d. **Mining Waste Treatment Technology.** Images and information about wastes produced by mining and how they are mitigated.

3. Students should summarize their research on the handout.

Evaluate

1. Have students work in groups based on the topics they were assigned in **Engage** and the SDGs they chose in **Explore** to create a summary of how reclamation and innovations in mining can help in the achievement of their specific SDG.

2. Hold a class discussion or have students put their summaries from step 1 in a shared document so all students can learn about how mining (and innovations in mining) relate to the achievement of multiple SDGs.

3. Continue the discussion or have students complete a written analysis of how the work toward different SDGs can work synergistically or antagonistically. See the following examples for clarification:

   a. Synergistic Effect: Autonomous vehicles in mining are an innovation that improves efficiency in mineral extraction which reduces the amount of infrastructure needed to support underground mining, as related to SDG 9: Industry, innovation, and infrastructure. This technology also helps achieve SDG 3: Good health and well-being, in terms of improving workplace safety and reducing workers' exposure to dust, gases, and other safety issues in mines that can negatively impact human health.

   b. Antagonistic Effect: Many countries have considered deep sea mining, and recently, some nations have opened waterways to active exploration of mineral resources. Deep sea mining would reduce the effects of mining on terrestrial ecosystems, thereby helping to achieve SDG 15: Life on land; however, deep sea mining would have potential negative effects on marine ecosystems and populations, thereby impeding the achievement of SDG 14: Life below water.

HANDOUTS

Sustainability and Mining

1. Summarize the environmental issue you were assigned from the article. Why does it occur and why is it a concern?

2. Which Sustainable Development Goal did your group choose to relate to the mining issue you read about? Explain your choice.

3. How did the class discussion of the SDG you chose change or reinforce your decision?

4. Which Target(s) or Indicator(s) will you focus on as you learn about mine reclamation and innovations?

Summarize each step of the reclamation process as you go through the virtual activity.

- Focus on the purpose of each step in improving the environment.
- Record your reasoning for why you would or would not select each plant in step 4. Categorize them according to your reasoning.
- You may want to take screenshots to show the progression of changes throughout the process.

Summarize your research on an innovative technology or strategy that can be used to achieve the SDG you chose, focusing on its specific Target(s) or Indicator(s).

Mining and the Sustainable Development Goals

SDGs	The geosciences...	Mining companies...
1. No poverty	have a large number of high paying jobs.	create jobs in many local communities.
2. Zero hunger	study soil health and water quality to inform crop production.	promote responsible land use and provide minerals used in food production (e.g., iron).
3. Good health and well-being	collect data on environmental problems that can affect humans (e.g., spread of pollution).	ensure safe working conditions in and around mines.
4. Quality education	encourages learning about how Earth's systems function and interact.	offer educational programs and training for employees and local communities.
5. Gender equality	have increased the percentage of women who study and work in earth science fields.	advocate for gender diversity in the mining workforce.
6. Clean water and sanitation	can locate drinking water sources.	build infrastructure to prevent water contamination during mining.
7. Affordable and clean energy	can help identify ideal locations for solar and wind fields and can locate oil and mineral resources.	locate minerals used to make alternative energy technologies (e.g., solar panels).
8. Decent work and economic growth	includes many disciplines kind of variety of work opportunities.	support fair wages and employee rights and are a vital part of the supply chain, providing raw materials for production.
9. Industry, innovation, and infrastructure	assess bedrock and soil in areas that are being developed.	invest in sustainable mining technologies to reduce environmental impacts.
10. Reduced inequalities	can work anywhere around the world to help all human populations.	implement fair employment practices.
11. Sustainable cities and communities	assess natural hazards around the world.	collaborate with local governments to develop sustainable urban planning initiatives.
12. Responsible consumption and production	access quantities of natural resources and make predictions about future supplies.	monitor the sourcing of minerals and rocks to encourage that they be done responsibly.
13. Climate action	study climate change and its impacts.	reduce greenhouse gas emissions and engage in habitat restoration to offset environmental impacts.
14. Life below water	study conditions in marine environments.	implement practices to prevent water pollution.
15. Life on land	study how environmental conditions and changes affect ecosystems.	rehabilitate abandoned mines to reestablish local ecosystems.
16. Peace, justice, and strong institutions	share research and data so everyone around the world has a better understanding of Earth's processes and resources.	engage with local communities.
17. Partnerships for the goals	collaborate with other geoscientists and people working in other fields from around the world.	collaborate with governments to ensure best practices for sustainability.