Lesson Eight: Chain Reactions

Grade Level: 4th Grade

Time: 60 minutes

Essential Question: How can we be stewards of Wyoming's minerals and energy to benefit current and future generations?

Objective: Students will examine cause/effect relationships related to each type of energy resource.

Purpose: Students learn that there are many causes and effects related to Wyoming's energy resources and being a steward impacts those causes and effects.

Required Materials/Resources:

- Energy Pro & Con sheets from previous lesson
- Cause and Effect Relationships graphic organizers: one cause with multiple effects, one effect with multiple causes, cause and effect chain (two copies of each organizer per student)
- Predicting Effects sheet (one per student)

TEACHER NOTE: Save Cause and Effect graphic organizers for Lesson 10.

Suggested Teacher Preparation:

- Review the Energy Pro & Con sheets.
- Create samples of the Cause and Effect Relationships graphic organizers to model for the students.
- Divide students into groups and choose a coal fact for each group to use. (See step 6.)

Standards:
Science: 4-ESS3-1 (Explicit)

Social Studies: SS5.4.1(Practiced/Encountered)

ELA: 4.RI.5 (Explicit)

Vocabulary:

- **Con** - the unfavorable factors or reasons; disadvantages
- **Pro** - the favorable factors or reasons; advantages

Instructional Procedure/Steps:

1. Ask students to review the six energy resources discussed in previous lessons by using a popcorn share in which the teacher names one of the six resources, and students quickly share facts, ah-has, or big ideas they gleaned from previous lessons. As each share out is completed, ask students to tell whether that resource is a renewable or a nonrenewable.

2. Say: **"Today, we will be examining cause and effect relationships connected to Wyoming's various energy resources. Turn to a partner and give a quick explanation of what a cause is and what an effect is."** Have several group members share out to ensure everyone has an understanding of both cause and effect.

3. Pass out the Cause and Effect Relationships graphic organizers. Model completing graphic organizers with a fact about coal. Say: **"I'm going use this fact: In 2017, Wyoming remains the nation's largest producer of coal. We will start with the graphic organizer that has one cause and multiple effects. First, write that fact in the cause box. This shows that I want to think of several things that are an effect of our state producing a lot of coal."** Continue to think aloud for

In this task, students will be engaged in the higher order thinking skill of synthesis by inferring causes and effects. They engage in analysis through work with different types of cause and effect relationships.

students as you write the three effects. See example below:
Cause: In 2017, Wyoming remains the leading coal producer in the country. (Source 1)

Possible Effects:

1. ***Coal mining provides jobs.***
2. ***Coal provides income for the state.***
3. ***We are using up a nonrenewable resource.***

4. Guide students in a brief discussion about what would happen if the fact in the cause box was to change. Say: **"If Wyoming was no longer the leading coal producer, what new effects might that have?"**

5. When finished discussing, have students help you complete each of the alternate graphic organizers using the same fact to ensure that they understand all three types of cause and effect relationships: one cause = multiple effects; multiple causes = one effect, and a cause and effect chain.
Example for multiple causes = one effect:

Effect: Wyoming remains one of the leading coal producers in the country. (Source 1)

Possible Causes:

1. ***Wyoming has large coal reserves.***
2. ***People want Wyoming coal because it is low sulfur, so it is more environmentally friendly.***
3. ***Wyoming coal is surface mined, so it's easier to access.***

Example for cause and effect chain:

Box 1: Wyoming remains one of the leading coal producers in the country. (Source 1)

TEACHER NOTE: If students struggle to identify cause and effect relationships, provide more support before moving on to step 7. Teachers may choose to add stems to the boxes for students who need that support. (Ex - Fact: One effect is… Another effect is…) Students may be given two examples and asked to tell which one is the cause and which one is the effect. All scaffolds should ensure that students are still working toward the intent of the science standard.

Box 2: Coal provides income for the state.

Box 3: Every Wyoming county has benefited from industry funds.

Box 4: Highways, community colleges, and public schools have been improved because of the funds.

6. Divide students into groups. Assign each group one of the following facts about coal:
    - Coal contributes 69% of CO_2, more than any other source (Source 2).
    - After coal is mined, they put back the dirt and rocks, and plant trees and grass. This is called reclamation (Source 3).
    - Coal can be accessed through underground mining or surface mining (Source 4).
    - Wyoming coal is low-sulfur (Source 3).

    Groups work together to complete a graphic organizer for their given fact. Once they finish one type of cause and effect relationship, they should try to complete one of the alternate graphic organizers. If they don't naturally do so, prompt students to identify the effect of the resource's use on the environment as that is the idea specifically addressed in the science standard.

7.  After about 10 minutes, pull the groups back together, and have each one take turns sharing with the whole class the cause and effect relationships that they identified. Be sure to choose examples from each of the different types of cause and effect graphic organizers. After all groups have shared, ask:
    - **"What would happen if one part of their relationship changed?"**
    - **"How would that affect the other parts of the system?"**

 In this task, students will be engaged in the higher order thinking skill of synthesis.

- **"How does predicting changes to the system help you better understand the complexities of energy production?"**

8. Next, have students independently show their understanding of cause and effect relationships by using another energy resource. Pass back students' Energy Pro and Con sheets from the previous lesson. Students will choose facts from the Energy Pro and Con sheets. Assign the following parameters, say:
    - **"First, select any of the other five resources to use."**
    - **"Choose a fact from that resource and complete a cause and effect relationship that shows how the resource's use impacts the environment."**
    - **"After completing the first graphic organizer, use the other cause and effect graphic organizers to show different types of relationships."**

9.  When students have completed their graphic organizers, pass out the Predicting Effects sheets. Students complete the sheet based on one of their graphic organizers.

 In this task, students will be engaged in the higher order thinking skill of synthesis.

Assessment: Collect completed graphic organizers and Predicting Effects sheets. Check students' work for are general accuracy and understanding of cause and effect relationships.

Credits/Sources:

1. U.S. Energy Information Administration - EIA. (2015). *Rankings Coal Production, 2015.* Retrieved July 9, 2017, from https://www.eia.gov/state/rankings/#/series/48
2. U.S. Energy Information Administration - EIA. (2018, June 8). *FAQs: How much of U.S. carbon dioxide emissions are associated with electricity generation?* Retrieved October 6, 2018, from https://www.eia.gov/tools/faqs/faq.php?id=77&t=11
3. Wyoming Mining Association. (n.d.). *Coal.* Retrieved June 26, 2017, from https://www.wyomingmining.org/minerals/coal/
4. The NEED Project. (2019-2020). *Elementary Energy InfoBook: Coal* (Publication). Retrieved October 14, 2020, from https://www.need.org/wp-content/uploads/2019/10/Elementary-Energy-Infobook.pdf