i-LEARN TEACHING RESOURCES

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Understanding Greenhouse Gases

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Abstract: Students will conduct hands-on experiments to see how greenhouse gases interact with the Earth's atmosphere and how greenhouse gases affect temperature. This lesson introduces National Geographic's Geo-Inquiry Process, where students will identify a Geo-inquiry question, collect data, and create a project around the answer to their question. Students will then present their findings to their peers and evaluate their Geo-Inquiry process.

Lesson Description:

Grade Level: Grade 7-12

Estimated Time for Completing Activity: Two 40-minute class periods (allows for lab, time to use electronic graphing tool, and for research)

Learning Outcomes:

- Students will learn about greenhouse gases and their impacts on the planet.
- Students will learn how to formulate a scientific question relating to greenhouse gas emissions.
- Students will work in groups to accomplish tasks.
- Students will collect data and synthesize this data into a project.
- Students will present projects to self-identified audiences.

South Dakota Standards of Learning:

Standards (Acronym definitions are at the end of this paper)

Science

- **HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in change in climate.

- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's system.

Social Studies

- **9-12.G.1.1** Use maps and other geographic representations tools and technologies to acquire, process, and report information from a spatial perspective.
- **9-12.G.4.1** Recognize the components, processes, interdependences and spatial distributions of Earth's physical systems.
- **9-12.G.7.2** Elaborate upon the interaction of physical and human systems and their influence on current and future conditions.

English

- ELA 6-8.W.6 Using technology to research.
- ELA 6-8.SL.1 Collaborative discussion.
- ELA 6-8.SL-2 Presenting information

Oceti Sakowin Essential Understandings and Standards
(*https://indianeducation.sd.gov/documents/OcetiSakowinEUS.pdf*)

- Essential Understanding 1: Indicator 1: Analyze the land base and natural resources of the nine reservations in South Dakota.
- Essential Understanding 1: Indicator 2: Analyze the interrelationships of Oceti Sakowin people, places, and the environment as they relate to all reservations in South Dakota.

Prerequisite: Pre-lab discussion – ask students what they believe happens when CO_2 increases in our atmosphere.

2-4 Liter pop bottles (have students provide), Utility knife, Packing tape, Alka-Seltzer, Small potted plants, Plastic beverage cups, Potting Soil, Thermometers, Grow lights (or heat lamps per group), Graph Paper, Data collection sheet, Scissors, Water

Vocabulary:

- Greenhouse gases, Global warming, Infra-red radiation

Lesson Links:
https://www.youtube.com/watch?v=sTvqIijqvTg

Background:

The greenhouse effect refers to the ability of the atmosphere to trap the sun's heat, increasing the temperature of the planet. When the sun's energy reaches Earth, the atmosphere absorbs some of it on the way down, and plants absorb some of it for photosynthesis. Some of the remaining energy heats the earth's surface. The heated crust of the earth then radiates energy, which the atmospheric gases absorb during the day. This trapped energy heats the atmosphere, increasing the overall temperature of the planet and distributing warmth to its night side, when solar heating is unavailable. The denser the concentration of heat-absorbing gases and molecules in the atmosphere like water vapor, methane and carbon dioxide, the more energy the atmosphere retains as it passes through.

Procedure:

- As a student team, decide on how you are going to demonstrate what happens to temperature if there is an increase in CO_2 in the atmosphere. You must have a control as part of your experiment. Each team receives 2-4 pop bottles.
- Prepare the number of greenhouses you will be using for your experiment. Cut the top third of the pop bottle off and save, as you will eventually replace this to form an airtight greenhouse setting.
- Bottle 1 will have water; bottle 2 will have water and Alka-Seltzer. If you do a 3rd and/or 4th bottle, the decision is yours. You may select from any of the supplies on the supply table to conduct additional experiments.
- Tape a thermometer inside the pop bottle. This needs to be high enough in the bottle not to come in contact with the water and low enough that the top third can be replaced. Use packing tape to hold the thermometer in place.
- Fill bottles 1 & 2 with the same amount of water, approximately 2-3 ml. Replace the tops and tape them securely.
- Place the bottles under a grow light or a heat lamp, which serves as an energy source. A heat lamp may expedite the reaction inside the bottles. Make sure that the control and experimental bottles receive equal amount of energy.
- Record the initial temperature of each bottle.
- Add your Alka-Seltzer to bottle 2.
- On the data table provided, record the temperature of each bottle every minute for a ten-minute period.
- Clean up your work area.
- We will use Excel or an on-line graphing tool to chart the data collected.

- (Optional) Have students research what areas of the United States have more carbon dioxide emissions and/or have students research what areas of the world have more carbon dioxide emissions.
- Graph your data using Excel or an on-line graphing tool.
- Complete a 3-2-1 exit ticket on what was learned during the experiment.

Extensions:

Research to find where CO_2 emissions are higher. This could be limited to the United States, or done worldwide.

Teacher Notes:

Encourage students to do a third and/or fourth set up. Encourage students to be creative in their lab set-ups.

One factor that might affect the outcome of demonstration is the temperature of the table the experiment is being conducted. Simple cardboard insulation between the bottle and the table is recommended.

Assessment:

Discussion questions:

1. What greenhouse saw the greatest change in temperature? Why did this happen?
2. What greenhouse saw the least change in temperature? Why did this happen?
3. How do greenhouse gases affect us? Other living components?
4. How are greenhouse gases affecting the earth's temperature?
5. Do our human activities affect the amount of greenhouse gases?
6. What can we do to slow down greenhouse gases?
7. Can we slow down greenhouse gases too much?
8. Is there a necessary level of greenhouse gases that are needed?
9. Are greenhouse gases higher in some parts of the United States than others? In other parts of the world?
10. How would you modify the experimental design if you were to show that plants can lower the greenhouse effects?

References:

- https://scied.ucar.edu/teaching-box/greenhouse-effect
- https://www.nationalgeographic.org/education/programs/geo-inquiry/

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