Teachers Guide
Indiana's Temperature: How Hot Will It Get?

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Activity Focus: Students learn how global carbon dioxide emissions are causing the Earth's temperature to increase and how this global warming is changing the Earth's climates, specifically temperature. Students analyze temperature data for the state of Indiana to determine how global warming is impacting Indiana's atmospheric temperature.

Major Concepts: Global greenhouse gas emissions are causing the Earth's temperature to increase. This human caused global warming is changing the Earth's climates, impacting temperature, precipitation, humidity, wind, and cloudiness of the atmosphere; the day-to-day weather, for any given area on the Earth, including Indiana. Because temperature drives the weather, scientists use temperature as a key indicator of climate and climate change. Climate is the average temperature (or other weather condition) for a location for a 30-year time period. Looking at annual temperature data for at least 30 years or longer makes it easier to identify changes and trends in climate over time. Temperature plays a vital role in maintaining healthy ecosystems, societies, and people. Climate change is and will impact temperature levels across the United States, affecting different states and regions of the country in different ways, including Indiana.

Objectives: After completing this activity students will be able to:

1. Explain the relationship between greenhouse gases and the Earth's temperature.
2. Describe past temperature data for Indiana and explain how greenhouse gas emissions have impacted the state's temperature.
3. Describe predicted temperature data for Indiana that is based on different greenhouse gas emission scenarios.

Five Critical Topics: This activity aligns with the following critical topics that every student should know about global warming and climate change.

> Topic 1, Weather, Climate, and Climate Change. Students need to understand the relationship between weather and climate. Weather is a snapshot of day-to-day conditions at a location. Climate is the long-term average of weather conditions over 30 years or more. Knowing how climate data are generated and what those data actually represent are essential to understanding the concepts of climate variability and climate change.
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> Topic 3, Earth's Energy Budget and Greenhouse Effect. Students must understand that some of the heat radiating from Earth's surface toward space is absorbed by greenhouse gases in Earth's atmosphere, thereby increasing the atmosphere's

temperature. This process, known as the greenhouse effect, is responsible for making the wide variety of life on Earth possible. However, the greenhouse effect is intensified as humans add carbon dioxide (CO_2) to the atmosphere, resulting in global warming.

Materials and Preparation: You will need to prepare the following materials before conducting this activity.

- Copy the *Indiana's Temperature: How Hot Will It Get?* (make 1 copy per student). You may want to make a color copy for each group of students.
- You may want to make a PowerPoint slide for each data set for use in the class discussion.

Procedures: Students may work individually or as a group to complete the activity.

1. Organize students into small groups of 3-4 or have students work independently on completing the activity. If students are working in small groups have them read and discuss as a group each question before recording a consensus response. The exception being the "Engage Your Thinking" questions, in which students' answer individually. Students will work best in the same group throughout the module.
2. Introduce the activity by asking students to identify some of the ways global warming might be impacting climate in the U.S. and in Indiana. List these climate impacts on the board and compare how students think the climate is changing in the U.S. and in Indiana.
3. Have students answer the "Engage Your Thinking" questions before starting the activity. Discuss student responses. Note, what is important here are the students' ideas not that they answered the questions "correctly".
4. Next have students read and work through the "Explore and Explain" section. Discuss students' responses to the "Think about it" questions. Depending on students' abilities, they may need assistance with graphing. You may want to make a class graph.
5. Have students read and work through the "Extend Your Thinking" section. Discuss the students' responses. If you are interested in the current average temperature data for your community go to the U.S. Climate Data website: https://www.usclimatedata.com/.
6. Have students work through the "Apply What You Have Learned" section. Discuss the students' concept maps; you might want to have students share and compare concept maps, looking for similarities and differences in their ideas.
7. Finally, have students complete the "Reflect on What You Have Learned" questions. Emphasize that students should think about how their ideas have changed, not on getting the correct answer. Ask students to share how their ideas and ways of thinking have changed.
8. Collect student/group responses.

Assessment: To assess students' learning, have students answer the following questions:

1. Explain the relationship between greenhouse gases and the Earth's temperature.
2. Global warming is causing Indiana's temperature to increase over time. Which season is likely to have the greatest increase in temperature by 2100 and why?
3. Describe how increasing greenhouse gas emissions will impact Indiana's temperature.
4. List and describe three ways global warming will impact Indiana.