CLUE into CLIMATE

KQED education network

Science ready to EXPLORE

Lesson 1b: The Greenhouse Effect and Climate Change

SUBJECTS

Earth Science

Life Science

Physical Science

GRADE LEVELS

4–8

CA SCIENCE STANDARDS

Grade 6: Heat (Thermal Energy) (Physical Sciences). 3. Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature. (d)

Grade 6: Energy in the Earth System. 4. Many phenomena on Earth's surface are affected by the transfer of energy and through radiation and convection currents. (b)

ESSENTIAL PRINCIPLES OF CLIMATE LITERACY

#1: The sun is the primary source of energy for Earth's climate system. (A)

#6: Human activities are impacting the climate system. (A, B)

OVERVIEW

Increasing greenhouse gases are contributing to global warming, which is changing our climate. In this lesson, students will learn about the greenhouse effect and find out how scientists use data collected from ice cores to study climate change. Prior to engaging in this lesson, students will need to have a general knowledge of climate.

ESSENTIAL QUESTIONS

1. What is the greenhouse effect? How does the greenhouse effect cause global warming? *(Energy [radiation] from the sun passes through the atmosphere, where most of it is absorbed by Earth. Some infrared radiation [heat] is reflected back into space. Greenhouse gases act like a blanket, trapping some of this infrared radiation and warming Earth and its atmosphere, a process called the greenhouse effect.)*
2. How do human activities produce greenhouse gases and cause climate change? *(By far the largest component of greenhouse gas emissions is carbon dioxide, which has exponentially increased in the atmosphere since the preindustrial age. Most of this increase comes from the burning of fossil fuels, which releases carbon dioxide into the atmosphere. In the United States, burning coal, petroleum, and natural gas provides us with electricity, power for our cars, and the energy to run factories; but the by-products of these activities include about 6 billion metric tons of carbon dioxide released into the atmosphere.)*

MEDIA RESOURCES

Diagram: The Greenhouse Effect and Greenhouse Gases
Link: http://www.kqed.org/education/educators/clue-into-climate/greenhouse-gases.jsp
Through interpreting this diagram, students will learn:

- How the greenhouse effect is a normal process for our planet
- How human activities are producing greenhouse gases
- How the greenhouse effect causes global warming

***QUEST* Web extra video: "At the Core of Climate Change"**
Video length: 19 minutes, 29 seconds
Link: http://www.kqed.org/education/educators/clue-into-climate/greenhouse-gases.jsp
Through watching this video, students will learn:

- How scientists collect and analyze data from ice cores to learn about climate change
- How ice cores show a record of climate that goes back hundreds of thousands of years
- About the linkage between greenhouse gases and climate change
- About climate models and how scientists predict the future climate

VOCABULARY

climate
the long-term record of temperature, precipitation, and wind for a region

climate change
a change in long-term average weather patterns; can be natural or the result of human activities

ecosystem
a group of living and nonliving things in a certain region

greenhouse effect
Energy (radiation) from the sun passes through the atmosphere, where most of it is absorbed by Earth. Some infrared radiation (heat) is reflected back into space. Greenhouse gases act like a blanket, trapping some of this infrared radiation and warming Earth and its atmosphere, a process called the greenhouse effect.

greenhouse gas
gases, such as carbon dioxide and methane, that absorb energy and prevent the release of this energy (heat) from Earth's atmosphere

ACTIVITY 1: INTERPRETING A DIAGRAM

Time: 30-45 minutes
Materials:

- Computer with Internet access
- Projector
- Whiteboard/chalkboard
- Pencil and paper
- Copies of The Greenhouse Effect and Greenhouse Gases diagram

Procedure:

1. Draw a chart on the board with three columns. Label the columns Know, Want to Know, and Learned. Have students draw the same chart on a piece of paper.
2. Lead a class discussion about what the students know and want to know about the greenhouse effect and greenhouse gases. Record points from the discussion on the board (students should also record these points in their chart).
3. Hand out the diagram The Greenhouse Effect and Greenhouse Gases.
4. Have students work in groups of two or three to try to interpret diagram. Students should record questions they have about the diagram under the Want to Know column of their chart.
5. Help students understand the diagram by clarifying their interpretations. As a class, begin a list in the Learned column with new information. Students should write down what they have learned and keep a record of additional questions they have about the greenhouse effect.
6. Optional extension: Students turn over the diagrams and draw their own diagram complete with an explanation of the greenhouse effect and greenhouse gases.

ACTIVITY 2: HOW DO WE KNOW?

Time: 45-60 minutes
Materials:

- Computer with Internet access
- Projector with speakers
- Handout: Student Worksheet

Procedure:

1. Watch "At the Core of Climate Change." Pause the video as necessary so students can answer the following viewing questions (see attached Student Worksheet).
    - What question does Dr. Kendrick Taylor ask about climate change at the beginning of the video? *(How do we know that humans are causing climate change?)*
    - What is the first experiment that he illustrates? *(the greenhouse effect)*
    - Why is polar snow interesting? *(It contains chemicals and gases that are characteristic of the climate when the snow fell.)*
    - At 300 feet deep, what happens to the snow? (*It gets compressed into ice.)*
    - The ice contains a record of the climate going back how many years? *(100,000 years)*
    - The South Pole is the best place to study what? *(how greenhouse gases influence climate)*
    - To keep the gas sample trapped in the ice, at what temperature do they have to store the ice cores? *(–20° C)*

WHAT CAN WE DO?

- Help stop the creation of excess greenhouse gases—instead of driving somewhere, take public transit, walk, or ride a bike.
- Encourage friends and family to use public transportation when possible by making it easier for them. Help them find routes that will get them where they need to go—work, stores, movie theaters, and so on. Research maps or websites that can help them find their way!
- Carpool to school if you cannot ride public transportation.

ACTIVITY 2 CONTINUED

- Look at the thin slice of the ice core. What color are the gas bubbles? *(white)*
- What is one measurement that scientists collect in the field? *(how old the ice is)*
- How many labs make measurements on ice cores? *(25 labs)*
- What do scientists do at the Oregon State University lab? *(They extract air to measure gases such as carbon dioxide.)*
- What are the two interesting things about the EPICA Dome C record? *(It shows a linkage between greenhouse gases and temperature and that the current level of carbon dioxide is higher than at any time in the last 600,000 years.)*
- To predict what will happen to climate in the future, what do you need? *(climate models)*
- How do scientists check the accuracy of the climate models? *(They compare the real climate with the calculated climate.)*
- What do the climate models predict will happen if we keep increasing production of greenhouse gases? *(that Earth's climate will get warmer)*

2. Go over the answers as a class.
3. Discuss the following question as a class: Did Dr. Kendrick Taylor convince you that humans are causing climate change? Why or why not? What questions or concerns do you still have?

CLIMATE CAREERS

Activity: Who works in climate science and what jobs will be important in the future?
Working in pairs, students create an interview with someone who works in a climate career. Together the pair will come up with questions they would like to ask the "expert." The students will research the answers to their own questions and create a script, with one student acting as the interviewer and one student acting as the expert. Students can either perform their interview in front of the class or record it. If possible, invite a climate scientist to speak with students about his or her career.

ABOUT THE AUTHORS

Karen Bioski is a former science teacher who taught integrated science, biology, and chemistry using a hands-on, project-based approach to curriculum design. She has done curriculum development for KQED and also through the Stanford Research Network to help improve science education. She now works as a vice principal at a San Francisco high school and still works closely with the science team at her school.

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www.kqed.org/education

ASSESSMENT IDEAS

- Complete K-W-L charts at the end of the lesson.
- Students write a paragraph about what they can do to help stop global warming.

ADDITIONAL RESOURCES

Climate Change: A Wisconsin Activity Guide, Wisconsin Department of Natural Resources (grades 7–12)
http://dnr.wi.gov/org/caer/ce/eek/teacher/Climateguide/pdf/01-1823-icecores.pdf
Explore ice cores in more detail with this hands-on experiment.

Global Warming and the Greenhouse Effect, Earthguide
http://earthguide.ucsd.edu/earthguide/diagrams/greenhouse/
This website from Earthguide, a part of the geosciences research division of the Scripps Institution of Oceanography, provides a simple animated breakdown of how the greenhouse effect works.

Global Warming FAQ, NOAA Satellite and Information Service
http://www.ncdc.noaa.gov/oa/climate/globalwarming.html
The National Oceanic and Atmospheric Administration created this page to help kids (and adults!) learn more about the greenhouse effect and how it is impacting our planet.

Global Warming Movie, EPA Kids Site
http://epa.gov/climatechange/kids/global_warming_version2.html
This website, from the Environmental Protection Agency, provides an animated step-by-step breakdown of the greenhouse effect. The animation is narrated by two young students and is presented in kid-friendly language.

Photosynthesis, Trees, and the Greenhouse Effect, National Geographic Xpeditions
http://www.nationalgeographic.com/xpeditions/lessons/08/g68/brainpopphoto.html
Designed for grades 6–8, this lesson plan leads students in a lab that will help them understand where greenhouse gases come from and also help them begin to think about how we can regulate greenhouse gases.

SUPPORT

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"At the Core of Climate Change" Viewing Questions

1. What question does Dr. Kendrick Taylor ask about climate change at the beginning of the video?

2. What is the first experiment that he illustrates?

3. Why is polar snow interesting?

4. At 300 feet deep, what happens to the snow?

5. The ice contains a record of the climate going back how many years?

6. The South Pole is the best place to study what?

7. To keep the gas sample trapped in the ice, at what temperature do scientists have to store the ice cores?

"At the Core of Climate Change" Viewing Questions

8. Look at the thin slice of the ice core. What color are the gas bubbles?

9. What is one measurement that scientists collect in the field?

10. How many labs make measurements on ice cores?

11. What do scientists do at the Oregon State University lab?

12. What are the two interesting things about the EPICA Dome C record?

13. To predict what will happen to climate in the future, what do you need?

14. How do scientists check the accuracy of the climate models?

15. What do the climate models predict will happen if we keep increasing production of greenhouse gases?