Too Cool for School – The Greenhouse Experiment

Science

Note: This lesson is broken into two parts to take place in at least two class periods.

PART ONE

Goal: To understand the definition, types and origins of the major greenhouse gases.

Objectives: Students will …

- Create a town with all the elements to sustain human life.
- Discuss how the activities of the people in the town may create greenhouse gases.
- Make a connection between small unrelated activities and their cumulative affects on emissions of greenhouses gases.

Materials (for a class of 30):

- 8 sets of crayons or markers (1 per group)
- Tape for displaying created towns
- Scissors
- Butcher paper or end roll of newspaper

Time Required: 45-60 minutes

Standards Met: S2, S3, S4, S7, G4, G5, LA4, LA5, LA12

Procedure:

- Draw 8 very simple ecosystems with a mountainous area, small stream and larger river on a roll of butcher paper. (About 4 feet per group)
- Arrange these sections around the room on separate tables with markers at each station.
- Instruct the students that they are owners of this land. They have unlimited supplies and resources to create their ultimate town. The only requirements are that the town must have a way of providing food and shelter and energy for its people.
- Tell students to think of all the things they like to have in their life and make sure that it will be provided for them within their town.
- Explain to the students that they have 20 minutes to create their ultimate town.
- Tape the towns to the walls around the classroom so that the whole group can see. Have each group explain their town.
- Hand out the Too Cool for School – GHG Information Sheet.
- Read over the gas definitions.
- Ask students to now go back to their town and identify where and what type of GHG's their town may be emitting.
- Have each town present their findings.
- Lead a discussion about which of the GHG's are anthropogenic (caused by humans) and which are natural.

PART TWO

Goal: Students use a scientific model to collect temperatures and investigate the greenhouse effect.

Objective: Students will …

- Increase understanding of the greenhouse effect and GHGs
- Recognize how different gases can trap heat in the atmosphere
- Be able to explain the usefulness of scientific models in understanding the phenomena of the greenhouse effect

Materials (For class of 30 working in groups of 3)

- 30 plastic tennis ball containers (clear) with caps
- 30 thermometers (digital work best)
- 10 sets of equipment to produce CO_2 (from Trapping CO_2 lesson)
- 10 – 100 watt lamps with sockets
- 10 tongue depressors
- 10 metric rulers
- 30 rubber bands
- 30 pairs of safety glasses
- 30 copies of Too Cool for School – Student Sheets
- 30 copies of Too Cool for School – Data Table
- 30 copies of Too Cool for School – Line Graph
- 30 copies of Too Cool for School – Questions for Thought
- 1 copy of Too Cool for School – Questions for Thought Teacher Key
- 1 bag of top soil

Time Required: 45-60 minutes

Standards Met: S1, S2, S3, S5, S6, LA4, LA5, M4, M6, M7

Procedure:

PREP

- Set out the equipment at 7 workstations.
- Drill holes in the tops of the tennis ball containers and tongue depressors just large enough to let the digital thermometers fit through. Remove any plastic sheeting around the containers.
- Fill each of the containers with 5cm of top soil.

PART ONE

- Begin by reviewing the concept of a model with the students. See *Developing Models* lesson for additional information.
- Ask students to share their ideas of what a model is.
- Solicit examples of models they have seen or heard about.
- Explain that scientists use models to help them understand things that are difficult to test in a lab setting.
- Ask students how they think scientists might test what is happening in the atmosphere. Because it is so large, a model can be used to see what is happening on a smaller scale.

- Explain to students that models are not perfect replicas of the 'real thing,' but they can be helpful in understanding the ideas involved.

PART TWO

- *Optional: You may want students to complete the lab and reach their own conclusions about what the bottles model.*
- Explain that students will be using a model to learn more about the greenhouse effect. They will build small greenhouses to investigate the effects of greenhouse gases on temperature change.
- Review the concept of a greenhouse with students. How do they stay warm even during cool weather? How are they typically designed? Remind students that greenhouses typically have clear walls and ceilings that allow the sun's energy to enter.
- Divide the students into 10 groups of three and assign each group to a different workstation.
- Hand out one of each of the following: Too Cool for School – Student Sheet, Too Cool for School – Data Table, Too Cool for School – Line Graph, and Too Cool for School – Questions for Thought.
- Review student directions on an overhead.
- Using the materials at their station, students should create three "greenhouses" and complete the lab.
- When students have completed the Too Cool for School – Questions for Thought, review the experiment and data with the entire class.
- Explain that this is an example of a model used to look at the large scale idea of the earth as a greenhouse.

Home/Community Connection:

- Challenge students to discover how the temperature varies in a car exposed to the sunlight with its windows left open, compared to a car with its windows closed? Ask students to design and conduct an experiment to find the answer to this question. Encourage them to make a list of the variables they controlled in their experiment. They should summarize what they did and what they discovered.
- Ask students who they could contact to discover the average temperature for a particular month over the past 20 years? Once they get this data, ask them to prepare a bar graph displaying the results.
- Encourage students to watch the evening news or read the local newspaper to find out how temperature and cloud cover is related.
- Arrange a fieldtrip to a local greenhouse.

Extensions:

- You might want to continue the study of the greenhouse effect with The Greenhouse Experiment – Extension Activity.
- 70.8% of the Earth's surface is covered with water. Ask students if they would expect their greenhouse model to give similar results if water were used in the model rather than soil? Encourage students to test their hypotheses.
- Why do greenhouses sometimes whitewash their windows? During what seasons does the whitewashing occur?

Assessments:

- Participation in the lab and discussions
- Completed Too Cool for School – Student Sheet
- Completed Too Cool for School – Data Table
- Completed Too Cool for School – Line Graph
- Completed Too Cool for School – Questions for Thought

Too Cool for School-
Greenhouse Gas (GHG) Information

To many people, the term "greenhouse effect" conjures up dire images of Earth's future. Yet without it, Earth would be a frigid planet, with average temperature around zero degrees Fahrenheit instead of the 60 degrees it is today.

The natural greenhouse effect keeps our planet warm. As the sun's energy reaches Earth's surface, some of it is reflected back and some absorbed. The absorbed energy warms the earth, which in turn radiates heat back towards space as infrared energy. Water vapor, carbon dioxide and other gasses in the atmosphere absorb some of the outgoing infrared energy, which heats them. These molecules then radiate the energy in all directions, including back to Earth. In effect, some of the energy remains trapped in our atmosphere, warming the planet.

GHGs that are created or emitted by human actions are called anthropogenic.

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned. Carbon Dioxide accounts for 9% – 36 % of greenhouse gases.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Methane is also given off from agriculture such as growing rice.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Chlorofluorocarbons (CFC) are emitted from refrigeration systems, aerosol cans and some manufacturing processes.

Water Vapor is naturally occurring and accounts for 36%-70% of the greenhouse effect. Water vapor is vital to the greenhouse effect which sustains life on earth but, if the atmosphere warms with added carbon dioxide, this can increase the natural amount of water vapor in the air because more water vapor can evaporate into warm air than into cold air.

Too Cool for School – Questions for Thought Teacher Key

1. Diagram and/or describe why the containers heat up.

Both light and heat energy from the sun passed through the plastic walls of the containers and warmed the air and soil inside the bottles causing their temperatures to increase.

2. Explain why the final temperatures of the three containers were different.

The air inside each of the bottles is heated up. The heat in the open container can escape and mix with the cooler air in the room. The air in the closed containers is trapped, so the temperature in these containers increases more than the open container. Not all gases trap the same amount of heat due to their molecular structure and density.

3. The plastic bottles in your experiment were acting as a model of the greenhouse effect. Good models try to use things that behave similarly to the "real thing". In this case, the real thing is the Earth's atmosphere and the sun. List those parts of your model that were the same for the real greenhouse effect and those parts that only represented what might be happening in the actual atmosphere.

Parts that were the same
both are exposed to direct light
both involve a gas heating up
both have soil present
both have moisture in the air
Parts that were different
plastic bottles represent the Earth & its atmosphere
the temperature of the Earth varies at different times of the year
the Earth's atmosphere does not have a physical barrier, like the plastic cap. Instead, it is held down by gravity
the real atmosphere is much larger than the layer of air trapped in the bottle.

4. A second grade girl asks you to explain how a greenhouse works. How would you go about answering her question? Remember, you are talking to a second grader! (You may include drawings in your explanation and should also try to tie in some everyday experiences the second grader might have had with the greenhouse effect.)

Student answers will vary.

Too Cool for School – Student Sheet

Background: People have been using greenhouses to help plants flourish for a long time. Light enters the greenhouse through the glass. Light and heat energy from the sun is absorbed by the objects within the greenhouse. While light easily passes into and out of the glass, heat does not. A greenhouse has also been called a "hot house" because the heat becomes trapped inside the glass room. The greenhouse effect is the name given to the role the atmosphere plays in warming the Earth. Many believe that certain gases in the atmosphere trap heat in the air. This could lead to a gradual "warming up" of the Earth. In this activity, your job is to develop and test a model that will illustrate what happens to the temperature of the air around the Earth when heat is trapped within the Earth's atmosphere.

Your job is to discover the answer to the following question:

How does the air temperature in an open container compare to that of a closed container with air and another with CO_2,, all of which are exposed to direct light from the sun or 100 watt bulb?

NOTE: As is the case with any good experiment, you must be very careful to control variables. Here are some of the things you will need to think about in your model:

- placement of the thermometer in each container
- placement of each of the bottles
- comparison of the three thermometers to each other (What will you do if the starting temperatures of the three thermometers are different?)

Materials:

- 3 plastic tennis ball containers (clear) with 2 caps that each have a hole in them
- All materials needed from the CO_2 production lab (Trapping CO_2 lab)
- 3 thermometers
- 3 rubber bands
- 100 watt lamp with socket
- tongue depressor with hole drilled in it
- metric ruler
- 3 pairs of safety glasses
- 3 cups of soil
- 3 copies of Too Cool for School – Student Sheets
- 3 copies of Too Cool for School – Data Table
- 3 copies of Too Cool for School – Line Graph
- 3 copies of Too Cool for School – Questions for Thought

Procedure:

- Put on your safety glasses.
- Set up the CO_2 collection equipment.
- Place about 5cm of soil in the bottom of each container.
- In two of the containers, place the thermometer through the hole in the tennis ball container top and adjust it so that the thermometer bulb is suspended in

the middle of the container. A rubber band can be used to stop the thermometer from sliding through the hole if necessary.

- In the third container, place the thermometer through the tongue depressor so that when the depressor is placed across the top of the container (no cover on this container), the bulb of the thermometer is again suspended in the middle. Use another rubber band, if necessary, to prevent the thermometer from sliding through the opening.
- Place the tubing from the CO_2 production device in the bottom of one of the tennis ball containers.
- Begin producing CO_2 and allow the gas to collect at the bottom of the container. (Because CO_2 is denser than air, it will collect near the bottom). Produce the gas rapidly and then quickly remove the tubing and seal the container with the cap with the thermometer in it.
- Cap a second container (with thermometer) with just air in it.
- Place the tongue depressor with the thermometer over the open last container with air.
- Place all of the containers equal distance (about 5cm) from the 100 watt light bulb and socket (do not turn on the bulb yet).
- Record the temperature of each thermometer before you start the experiment in Too Cool for School – Data Table under 0 time.
- Turn on the light bulb and record the temperature data of each thermometer every minute. Record your data in Too Cool for School – Data Table. Be sure to record the temperature of the three containers in the same sequence each time.
- Make a line graph of the data collected from each of the three containers on Too Cool for School – Line Graph. Be sure to label each axis with the correct dependent and independent variable and make a key for each of the containers that are plotted.
- After 10 minutes have elapsed, your instructor will tell you how to clean up your equipment.
- Complete the Too Cool for School – Questions for Thought.

Too Cool for School – Data Table

Time In Minutes	**Temperature (°C) of Open Container with Air**	**Temperature (°C) of Closed Container with Air**	**Temperature (°C) of Closed Container with Carbon Dioxide**
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total Change in Temperature from 0 to 10 Minutes			

Too Cool for School – Line Graph

Too Cool for School – Questions for Thought

1. Diagram and/or describe why the containers heat up.

2. Explain why the final temperatures of the three containers were different.

3. The plastic tennis ball containers in your experiment were acting as a model of the greenhouse effect. Good models try to use things that behave similarly to the "real thing". In this case, the real thing is the Earth's atmosphere and the sun. List the parts of your model that were the same for the real greenhouse effect and the parts that only represented what might be happening in the actual atmosphere.

Same as the 'real thing':

Representation of the 'real thing':

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WORKSHOP COPY

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WORKSHOP COPY

Too Cool for School – Line Graph

Too Cool for School – Questions for Thought

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