The New York Times Learning Network Lesson Plan

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Ice Breakers

A Lab Experience About the Effects of Global Warming on Icecaps

Related New York Times Article" *Under Antarctica, Clues to an Icecap's Fate*", By MALCOLM W. BROWNE, October 26, 1999

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Grades: 6-8, 9-12
Subjects: Geography, Science

Overview of Lesson Plan: Through participating in a number of in-class experiments using ice, students understand the effects of global warming on icecaps and the worldwide consequences that may result.
Suggested Time Allowance: 45 minutes

Objectives:
Students will:
1. Speculate on the dangers that icecaps might pose on a global scale; describe physical properties of ice.
2. Demonstrate, through a series of experiments, several physical properties of ice (ability to fracture, refreezing to other pieces of ice, melting under raised temperatures, and melting faster under pressure); hypothesize on the outcomes of each experiment; record observations and analyze the results of each experiment; relate experiments to the effects of global warming on icecaps.
3. Relate their in-class lab work to the New York Times article "Under Antarctica, Clues to an Icecap's Fate."

Resources / Materials:
-student lab books or journals
-paper
-pens/pencils
-classroom blackboard
-copies of "Under Antarctica, Clues to an Icecap's Fate" (one per student)
-small, disposable metal baking pans (one per pair of students), each pan containing the following items: small hammer, piece of cloth, paper cup, piece of brick or other heavy object
-three large ice cubes per pair (kept in a freezer until just prior to this lab)

Activities / Procedures:
1. WARM-UP/DO-NOW: Students respond to the following in their journals or lab books (written on the board prior to class): About 90

percent of the world's ice is contained in a gigantic icecap in Antarctica. What dangers do you think this icecap might pose on a global scale? (Hint: Think about what you know about global warming.) What are some of the physical properties of ice, and how might these properties relate to the possible dangers you have listed? Ask students to share their responses. Write all of the properties of ice mentioned by students on the board, and ask how they know that these properties exist based on their own observations.

2. Explain to students that they will be experimenting with ice in this lesson to better understand the dangers that icecaps pose when the global temperature rises, as it is doing now due to trends in global warming. Give each pair of students a pan containing a hammer, cloth, cup and piece of brick. Have students place the contents of the pan on their desks. Then, put three ice cubes in each group's pan. Explain the lab procedures below, following each step together as a class (notes to the teacher are written in parentheses):
--Wrap one ice cube in your piece of cloth, and place the wrapped cube in the middle of your desk. Then, use the hammer to carefully break apart the ice cube into small pieces. Open the cloth, and empty the ice pieces into the cup. Now, in your lab journal, hypothesize what you think will happen to the ice pieces after a few minutes and describe the steps of this part of the experiment. After two or three minutes, observe what has happened to the ice pieces, and record your observations in your lab book. (Ice pieces will be frozen together with many holes and tunnels in between them.) Answer these questions in your lab book: What happened when pieces of ice were allowed to touch for a short amount of time in the cup? How might this relate to what happens to icecaps? (When ice caps break apart and then pieces of ice rejoin, crevasses and tunnels form.) What do you suppose these holes between the ice pieces will allow water to do? (Water can flow through the ice, breaking the ice caps down even further and raising the level of the surrounding water, causing the sea level to rise.) Discuss your answers with your classmates.
--Look at what has happened to your other two ice cubes that are still in the pan, and answer the following in your lab book: Why have they melted at the same rate? (The temperature around both of them has remained constant.) What would you expect to happen if a heat lamp were shone upon them, and how would that represent the global warming trend? (The ice would melt faster due to higher temperatures.) What would you expect to happen if you placed the pan on a stove, and how would that represent what happens on Earth? (The ice would melt faster due to increased temperature below the surface of the Earth.) Discuss your answers with your classmates.
--Place the ice cubes at opposite ends of the pan. Write a hypothesis for what you think would happen if you put your piece of brick on top of one of the ice cubes and why. Then, balance your brick on top of one ice cube, and leave the other cube uncovered. In your lab journal, describe the steps of this part of the experiment. Observe and record what is happening to the ice cubes (the ice cube under the pressure of the brick will melt faster than the other ice cube.) After a few minutes, remove the brick and observe and record what has happened to each cube. Answer these questions in your lab book: Why would ice with pressure on it melt faster than ice without this added pressure? Where did melting seem to take place? (On the bottom of the ice cube.) How does this represent how glacier movement occurs? (Water accumulates at the bottom of the

"glacier," giving it the ability to move more.) How does the rising melted water level represent the danger of global warming on the world's icecaps? (The sea level rises, causing flooding on a global scale.) Discuss your answers with your classmates.
Have students throw out water and ice remnants and return all materials to you.

3. WRAP-UP/HOMEWORK: Students relate their in-class ice lab to the article "Under Antarctica, Clues to an Icecap's Fate" by answering the following questions in their lab books following their experiment notes (written on the board for students to copy prior to leaving class):
a. What would cause "swirls" and "ice streams" in the icecaps in Antarctica, given what you observed in your lab? What are the dangers of these streams? What two "mechanisms" propel these ice streams, and how did you demonstrate these mechanisms in the lab?
b. How has global warming affected the Antarctic icecaps?
c. What ice cap "terrain" was Radarstat able to record, and based on what you know about the properties of ice, how could these features form on an icecap?
d. Why is it "potentially bad news" that "East Antarctica, like West Antarctica, seems to have a mechanism for rapidly moving ice from the interior to the coastal sea"?
e. Why is it "important to measure ice movement in many different places at different times, to gauge overall effects"? Give examples provided in the article.
f. How does Radarstat work, and why is it a significant piece of technology in understanding the effects of global warming?
Discuss answers in a future class.

Further Questions for Discussion:
--How do icecaps form?
--What geologic and environmental events cause the many physical features of icecaps to develop?
--What are the differences between a glacier, an icecap and an iceberg?
--Why are icecaps so often researched to learn about the environment?
--What causes global warming, and what are the effects?
--What can someone your age do to slow the trend in global warming?

Evaluation / Assessment:
Students will be evaluated based on initial journal response; participation in in-class labs; thorough and accurate recording of hypothesis, observations, results and reflections on lab experiences; and thoughtful response to a New York Times article based on both information in the article and on the classroom experiments.s

Vocabulary:
tracery, arabesques, satellite, icecap, inundating, mechanism, glacier, retreat, surmise, contours, discern, holistic, crevasses, protuberances, contaminants, frictional, geothermal, exerted, channeled, latitude, waxing, waning, fruition, resolution, acquisition, interferometry, velocity

Extension Activities:
1. Write an illustrated children's book called "A Glacier Is Born!," exploring how glaciers come into existence and how the many features of glaciers form over time, as well as the effects of global warming on

glaciers.

2. Learn about expeditions to different glaciers around the world and what was discovered on each. Many Web sites, including Glacier (http://www.glacier.rice.edu/), Virtual Antarctica (http://www.terraquest.com/antarctica/index.html) and Antarctica: The Chilling Fields (http://www.discovery.com/exp/antarctica/antarctica.html) follow such expeditions through the journals and photos of the explorers.

3. Research the many causes of global warming and their current and speculated effects. Then, create a handout or guide to how we can help slow the process of global warming.

4. Create a flow chart diagramming the Greenhouse Effect.

5. Use a topographical map or globe to locate the most low-lying land areas in the world. Then, research environmental problems that these areas have in common. How would the melting of the icecaps further these problems?

6. Create an illustrated "How It Works" poster about radar or satellites, including the many uses of each of these technologies with specific examples.

7. Locate experiments online related to the properties of water in its liquid, solid and gaseous forms to use in your classroom or for students to explore at home with their parents.

8. Compare the ecosystems of extreme temperatures, such as the Arctic and the rainforest. How is life supported in each extreme? What are the geographic features of each ecosystem? How does the water cycle manifest in each ecosystem?

Interdisciplinary Connections:
Global History- Explore and map different countries' claims to Antarctica, as well as territorial disputes that have arisen.

Health- Learn about health hazards common in cold weather (such as hypothermia and frost bite), and create a pamphlet explaining their causes, physical symptoms and medical treatment. If you live in a region where these health issues may arise, make pamphlets available in the appropriate months for the student body and others in the community.

Language Arts- Investigate accounts of expeditions to icecaps found online or in books or magazines. How do these accounts recall the geographic and environmental dangers of these expeditions? Why did these expeditions occur, and what was discovered?

Mathematics/Technology- Chart the rising global temperature in the past ten years using online resources about global warming and the atmosphere. What do these charts illustrate?

References:
The experiment in this lesson was loosely adapted from the online experiment Physical Properties of Ice

(http://www.sd5.k12.mt.us/glaciereft/glac3-8.htm) found on the Glacier National Park Electronic Field Trip Web site. This site references the following source:

Douglass, L., Ellis, D., & Magnoli, M. (l985) Experiences in Earth-Space Science. Illinois: Laidlaw Brothers, Publishers.

Academic Content Standards:

This lesson plan may be used to address the academic standards listed below. These standards are drawn from Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education: 2nd Edition and have been provided courtesy of the Mid-continent Research for Education and Learning in Aurora, Colorado.

In addition, this lesson plan may be used to address the academic standards of a specific state. Links are provided where available from each McREL standard to the Achieve website containing state standards for over 40 states. The state standards are from Achieve's National Standards Clearinghouse and have been provided courtesy of Achieve, Inc. in Cambridge Massachusetts and Washington, DC.

Grades 6-8
Science Standard 1- Understands basic features of the Earth. Benchmarks: Knows factors that can impact the Earth's climate; Knows the processes involved in the water cycle
(CTSS - 'science', '6-8', '1')
Science Standard 15- Understands the nature of scientific inquiry. Benchmarks: Knows that there is no fixed procedure called "the scientific method," but that investigations involve systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations; Designs and conducts a scientific investigation; Establishes relationships based on evidence and logical argument; Knows possible outcomes of scientific investigations
(CTSS - 'science', '6-8', '15')
Geography Standard 7- Knows the physical processes that shape patterns on Earth's surface. Benchmarks: Knows the major processes that shape patterns in the physical environment; Knows the consequences of a specific physical process operating on Earth's surface
(CTSS - 'social', '6-8', 'geo3')
Geography Standard 14- Understands how human actions modify the physical environment. Benchmarks: Understands the environmental consequences of people changing the physical environment; Understands the ways in which human-induced changes in the physical environment in one place can cause changes in other places; Understands the environmental consequences of both the unintended and intended outcomes of major technological changes in human history
(CTSS - 'social', '6-8', 'geo5')
Geography Standard 15- Understands how physical systems affect human systems. Benchmarks: Knows the effects of natural hazards on human systems in different regions of the United States and the world; Knows the ways in which humans prepare for natural hazards
(CTSS - 'social', '6-8', 'geo5')

Grades 9-12
Science Standard 1- Understands basic features of the Earth. Benchmark: Knows how life is adapted to conditions on the Earth
(CTSS - 'science', '9-12', '1')
Science Standard 15- Understands the nature of scientific inquiry. Benchmarks: Understands the use of hypotheses in science; Designs and conducts scientific investigations by formulating testable hypotheses, identifying and clarifying the method, controls, and variables, organizing and displaying data, revising methods and explanations, presenting the results, and receiving critical response
(CTSS - 'science', '9-12', '1')
Geography Standard 7- Knows the physical processes that shape patterns on Earth's surface. Benchmarks: Understands the distribution of different types of climate that are produced by such processes as air-mass circulation, temperature, and moisture; Understands how physical systems are dynamic and interactive
(CTSS - 'science', '9-12', '1')
Geography Standard 14- Understands how human actions modify the physical environment. Benchmark: Understands the global impacts of human changes in the physical environment
(CTSS - 'social', '9-12', 'geo5')
Geography Standard 15- Understands how physical systems affect human systems. Benchmark: Knows factors that affect people's attitudes, perceptions, and responses toward natural hazards
(CTSS - 'social', '9-12', 'geo5')
