

LESSON:

Controlling Pollutants: A Look at California's Model

Summary: Students read a news article about the progress of environmental legislation in California. Then they create a time line labeling and identifying 10 important past and future events, analyze the benefits and drawbacks of one piece of recent legislation, and finally discuss these efforts in light of climate change or global warming.

Lesson Type: Extension Lesson—This lesson extends a topic in the *EHP* article; Integrated Lesson—This lesson extends beyond traditional science content and can be used in other academic subjects.

EHP Article: "Environment: California Out in Front"
EHP Student Edition, June 2007, p. A144–A147
<http://www.ehponline.org/members/2007/115-3/spheres.html>

Objectives: By the end of this lesson, students should be able to

1. outline important air pollution legislative initiatives in the state of California;
2. contrast the benefits and drawbacks of legislative initiatives to control pollution;
3. describe the relationship between greenhouse gases and global warming; and
4. argue positions on environmental issues using scientific evidence.

Class Time: 60–90 minutes

Grade Level: 9–12

Subjects Addressed: Earth and Space Science, Environmental Science, Social Studies, Language Arts

► Prepping the Lesson (30 minutes)

INSTRUCTIONS:

1. Download the entire June 2007 *EHP Student Edition* at <http://www.ehponline.org/docs/2007/115-3/toc.html>, or download just the article "Environment: California Out in Front" at <http://www.ehponline.org/members/2007/115-3/spheres.html>.
2. Review the Background Information, Instructions, and Student Instructions.
3. Make copies of the Student Instructions and article

MATERIALS (per student):

- 1 copy of the June 2007 *EHP Student Edition*, or 1 copy of "Environment: California Out in Front," preferably in color
- 1 copy of the Student Instructions
- graph paper, or paper and a ruler

VOCABULARY:

- air pollution
- Clean Air Act (CAA)
- emissions
- endocrine
- global warming
- greenhouse gas
- lobbyist
- ozone
- particulate matter
- photochemical oxidants
- sprawl
- Toxic Substances Control Act (TSCA)



BACKGROUND INFORMATION:

The evidence for global warming is a wonderful concept for teaching students about the nature of science. Debate using data and evidentiary support is how scientists arrive at new perspectives. In a similar way, a moderated discussion in the classroom can both bring this characteristic to light and be used to dispel some of the common misconceptions about both the processes of science and the issue of global warming itself.

Students tend to see science as a collection of abstract ideas that are not a part of their everyday lives. The issue of climate change, and this article in particular, give the teacher an opportunity to show students how scientific concepts do connect to other subject areas and many aspects of "real life."

Greenhouse gases trap thermal energy from the sun and include carbon dioxide, water vapor, methane, and nitrous oxide. The greenhouse effect is a natural and necessary phenomenon that keeps our planet warm. Without these gases, Earth would be too cold for life as we know it to exist. Global warming is a rise in Earth's temperature, generally accepted as a result of increased greenhouse gas concentrations in the atmosphere from both man-made and natural sources.

Perhaps more importantly than the dramatic prospect of melting glaciers, global warming will also result in the thermal expansion of water, which is anticipated to cause coastal flooding well in advance of ice caps diminishing. At the current time, latitudes closer to the poles are experiencing spring sooner each year, and equatorial phenomena such as El Niño are occurring with increased frequency. These factors can, in turn, affect crop success and even human health.

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, <http://ehp.niehs.nih.gov/>. Choose Climate Change, Laws/Regulations/Policy

National Resources Defense Council, California signs landmark global warming legislation (news article), <http://www.nrdc.org/globalWarming/ncalifornia.asp>

NOAA Satellite and Information Service, Global climate change, <http://www.ncdc.noaa.gov/oa/climate/climateextremes.html>

Pew Center on Global Climate Change, <http://www.pewclimate.org/>

Union of Concerned Scientists, Global warming: early warning signs (maps and basic information on Earth changes as a result of global warming), <http://www.climatehotmap.org/>

U.S. Climate Change Science Program, <http://www.climatechange.gov/>

U.S. Environmental Protection Agency, Climate change, <http://www.epa.gov/climatechange/>

U.S. Global Change Research Information Office, <http://www.gcric.org/>

U.S. Global Climate Change Research Program, <http://www.usgcrp.gov/>

► Implementing the Lesson**INSTRUCTIONS:**

1. Hand out the article and the Student Instructions.
2. Have students complete the Student Instructions, working either individually or in pairs.
3. Briefly discuss using a rubric with your students for the class discussion portion of the lesson(see sample components to include in Step 5 of Assessing the Lesson). Add/subtract components, and assign point values based on your own needs. This may be done in advance if students are familiar with rubrics.
4. Discuss student opinions on legislation such as AB32 becoming more common. Use the discussion to identify student misconceptions and clarify them.
5. Discuss the pros and cons of such legislation, both in the United States and globally.
6. Proofread, correct, and send the students' letters. Await a response, and ask students to bring replies into class.

NOTES & HELPFUL HINTS:

1. You may wish to use an overhead projector or board space to develop a discussion rubric together as a class. If a rubric is developed as a class, be sure that all students are involved.
2. It is important to note that ozone is a problem in the troposphere, as it is a respiratory irritant, so higher concentrations can be detrimental. Higher ozone concentrations can be a by-product of increased temperatures. Ozone in the



stratosphere has been depleted, which is a concern because more ultraviolet rays are reaching Earth's surface. However, ozone itself is not directly related to global warming. This common student misconception should be addressed.

3. Students may use the Student Instructions during the discussion or turn them in beforehand.
4. Discussion questions are meant as a less formal assessment and to probe for understanding. Thus, you may need to alter these questions to fit your teaching context.
5. This lesson can take the shape of a more formal debate with additional structure added after students complete the Student Instructions. You may choose to assign roles individually or have a pro and con debate with only two sides.
6. If a more formal debate format is desired, students can select or be assigned to which "side" they are part of for the debate, depending on student ability.

▶ Aligning with Standards

SKILLS USED OR DEVELOPED:

- Communication (oral, written)
- Comprehension (listening, reading)
- Critical thinking and response

SPECIFIC CONTENT ADDRESSED:

- Climate change
- Greenhouse effect
- Global warming
- Civics
- Science and technology

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Science Content Standards

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement

Science as Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science Standard

- Structure and properties of matter

Earth and Space Science Standard

- Energy in the Earth system
- Geochemical cycles

Science and Technology Standard

- Understanding about science and technology

Science in Personal and Social Perspectives Standard

- Environmental quality
- Natural and human-induced hazards

History and Nature of Science Standard

- Science as a human endeavor
- Nature of scientific knowledge



▶ Assessing the Lesson

Step 2: The timeline should have the following dates and descriptions on it, spaced relative to when they occurred/will occur, not equidistantly.

1965: California sets legal limits on vehicle exhaust (hydrocarbons and carbon monoxide)

1967: The California Air Resources Board sets the first national air quality standards for suspended particulates, photochemical oxides, sulfur dioxide, nitrogen dioxide, and other pollutants

2002: AB1493 is passed, requiring automakers to reduce greenhouse gas emissions for passenger vehicles

2006: AB32 is passed, requiring industry to reduce greenhouse gases by 25% in 13 years.

2007: Legislation is under development to address green chemistry, which would go beyond federal requirements

2009: AB1493 is implemented, and automakers must now begin reducing greenhouse gas emissions in cars sold

2010: Under AB32, "discrete early actions" are now phased in for greenhouse gas emissions

2012: Under AB32, emission credits for greenhouse gases are now phased in (credits can be bought and sold)

2016: AB1493 requires that vehicle emissions now be reduced by 30% over 2002 levels

2020: AB32 requires that greenhouse gases now be 25% less than 1990 levels; carbon content of transportation fuels must have been reduced by 10%

Step 3: Pros:

- AB32 is the first legislation in the world to regulate and introduce market mechanisms to reduce greenhouse gases
- AB32 covers all industries, not just vehicles (it's more comprehensive)
- AB32 allows global trading of emissions credits
- AB32 encourages simple and early actions to reduce greenhouse gases
- AB32 encourages developing biofuels
- AB32 could attract investment in alternative energies

Cons:

- AB32 raises prices for goods, including gasoline and cars
- AB32 may cost California jobs and cause companies to move to different states
- Companies that move to different states may be able to pollute more than they could if they had stayed in California, depending on the laws of the state they move into.

Step 4: Answers will vary, but should include at least three stars in the table for Step 3, and scientific support of the student's agreement with those factors.

Step 5: Answers will vary, but should include at least one underlined statement in the table for Step 3, and an explanation of the student's disagreement with those factors.

Sample Discussion Rubric

You and your students may add other components, remove some components, and assign point values as a group just prior to the discussion/debate portion of the lesson. A copy for each student may be used for the purposes of recording a formal grade, if desired.

Content:

1. Science concepts are used accurately.
2. Scientific support of details is used to explain the concepts.
3. The vocabulary is appropriate to both the scientific content and the audience.



Presentation:

4. Student actively participates in discussion (verbally).
5. Student is visibly engaged (uses notes, takes notes, nonverbal participation).
6. Student gives the audience time to think.
7. Student responds well to questions of peers or teacher.

Sample Discussion Questions

You may add your own questions depending on the level of your students and how the discussion flows. The important factor in the class discussion is to get at the heart of students' understanding of global phenomena and to have them defend their opinions with scientific evidence instead of emotion.

- What are greenhouse gases?
- What is global warming? How is it different from the greenhouse effect?
- Are global warming and climate change necessarily the same thing?
- What effects might global warming have on the United States?
- Is it important to take steps to reduce the impact that humans have on the planet? Why or why not?
- Would AB32 be a good idea for your state?
- Should it be adopted by the United States?
 - What parts might you change for your state?
 - What parts might you change if the whole United States were going to participate? (Consider funding, economics, and timing.)
- Europe is adopting policies similar to what is proposed in AB32. Is it important to be good "global neighbors" and strive for similar laws as other nations?

► Authors and Reviewers

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Give us your feedback! Send comments about this lesson to ehpscienced@niehs.nih.gov.



STUDENT INSTRUCTIONS:
**Controlling Pollutants:
 A Look at California's Model**

- Step 1:** Read the article "Environment: California Out in Front."
- Step 2:** Create a time line, labeling and identifying 10 important past and future events related to environmental legislation in California. Years should be properly scaled between events to show any unequal time intervals.
- Step 3:** AB32 has passed the California legislature, and requires that industries must reduce all greenhouse gas emissions by 25% over the next 13 years. According to the article, there are many potentially favorable effects of this law, but there may also be some potential drawbacks. Use the article to identify at least four pros and two cons given for AB32.

AB32 Pros	AB32 Cons
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.

- Step 4:** Place a star (★) next to three possible effects of AB32 that you strongly agree with in your table from Step 3. You may agree with either pros or cons. Provide scientific support for your statement; you may use the article or other information, including prior knowledge.
- Step 5:** Underline one possible effect from your table in Step 3 that you disagree with, and explain why you think it is not well founded. You will use your answers to Steps 4 and 5 in a class discussion of AB32 and the issue of global warming.

