

Healthy Air Matters

Student Objective

The student:

- will learn about the specific gases and particulates that we call ‘air pollution’
- will learn how these pollutants can affect a person’s health
- will learn about current air pollution regulation
- will learn about the current political discussion concerning air pollution regulation

Materials:

- resource materials, such as books, magazines, and the internet
- posterboard, markers, crayons and/or paints (optional)

Key Words:

carbon monoxide
criteria air pollutants
ground level ozone
lead
nitrogen oxide (NOx)
particulate matter
particle pollution
sulfur dioxide

Time:

1-1 ½ hours discussion and group work
½ - 1 hour class presentations and discussion

Background Information

Air pollution occurs when the air contains gases, dust fumes or odors in harmful amounts. Due to the number of vehicles on the roads burning petroleum products in the United States, the number one cause of air pollution in the U.S. is vehicle emissions.

The average adult breathes over 3,000 gallons of air a day. Air pollution is implicated in a number of health problems, including heart disease, lung cancer, asthma, and interference with the growth and work of the lungs. The Environmental Protection Agency (EPA) has identified six primary pollutants that present a threat to human health: carbon monoxide, ground level ozone, lead, sulfur dioxide, nitrogen dioxide, and particulate matter.

Carbon Monoxide: Carbon monoxide is a colorless, odorless, poisonous gas, produced by incomplete burning of carbon-based fuels including gasoline, oil and wood as well as combustion of many natural and synthetic products such as cigarettes. When carbon monoxide gets into the body, it combines with chemicals in the blood and prevents the blood from transporting oxygen to the cells of the body.

Ground Level Ozone: Ozone is a gas that is a variation of oxygen which contains three atoms of oxygen instead of two. Ozone occurs in nature; it is the cause of the sharp smell you notice near a lightning strike. Ozone is found in large concentrations in the stratosphere where it protects the earth from ultraviolet radiation. Ground level ozone is the main component of smog, and is a product of reactions during the combustion of coal, gasoline and other fuels, and also chemicals found in products including solvents, paints and hairspray. In humans, it can cause

lung tissue damage, and create high incidences of asthma and allergic reactions. Plants exposed to high ozone concentrations lose their chlorophyll and food manufacturing abilities.

Lead: In the U.S., there has been a dramatic 92% decrease of lead in the atmosphere since the element was removed from gasoline in 1995. However, there are still many sources of lead in our environment, such as large furnaces, incinerators, and battery plants. Lead in the atmosphere can deposit into lakes and streams where it may be ingested by fish and eventually by humans. The physical effects of lead poisoning are mental impairment, central nervous system damage and high blood pressure.

Sulfur Dioxide: Sulfur dioxide is a gas produced by burning coal (most notably in power plants) as well as some industrial processes such as paper production and the smelting of metals. Sulfur dioxide plays an important role in the production of acid rain. Sulfur dioxide can cause nose and throat irritation and lung problems such as bronchitis.

Nitrogen Dioxide: Nitrogen Oxides (NO_x) are produced from burning fuels including gasoline and coal. The major sources of NO_x are power plants and transportation--vehicles that burn gasoline and diesel. Nitrogen Oxides react with organic compounds to form smog, and are also major components of acid rain. Nitrogen Dioxide can decrease lung function and can increase the risk of respiratory disease.

Particulate Matter or Particle Pollution: Particulate Matter (PM) is sometimes called particle pollution and includes dust, soot and other tiny bits of solid materials that are released into and move around in the air. U.S. health standards for air quality are based on the concentration of particles small enough to be inhaled deep into the lungs, which are particles with a diameter of less than 10 microns. Particulates are produced by many sources, including burning of diesel fuels, incineration of garbage, mixing and application of fertilizers and pesticides, road construction, industrial processes such as steelmaking, mining operations, agricultural burning and the operation of fireplaces and woodstoves. Particulate pollution can cause eye, nose and throat irritation and other health problems. Fine-particulate air pollution (particles with a diameter of 2.5 microns or less) tends to deposit in the alveoli of the lungs where it remains for a long time. Fine-particle pollution typically contains soot, acid condensates, sulfate and nitrate particles. This type of pollution is thought to pose greater health risks not only because the particles can be inhaled more deeply into the lungs, but also because they are more likely to be toxic than larger particles.

Air Quality Legislation: In 1970 amidst the celebration of Earth Day, the creation of the Environmental Protection Agency (EPA) and NOAA (National Oceanic and Atmospheric Administration), Congress passed the Clean Air Act which was the first environmental law in the U.S. that authorized the development of federal and state regulations, backed with enforcement. This legislation set the stage for federal (as opposed to regional) air quality standards and statutory deadlines for compliance. Pollutants covered under the act are known as **criteria air pollutants**. The law sets emissions standards for stationary sources such as power plants as well as mobile sources such as automobiles and trucks. As a result, air pollution emissions have decreased. Legislation in 1977 and 1990 further defined the National Ambient Air Quality Standards.

Under the Clean Air Act, the EPA sets limits on how much of a pollutant can be in the air anywhere in the United States; however, the law allows individual states to have stronger pollution controls than the federal model. The states are required to develop State

Implementation Plans (SIPs), a collection of regulations that they will use to clean up their polluted areas, and submit their plans to the EPA for approval.

The 1990 legislation also enabled the EPA to fine violators of the Clean Air Act, as well as grant incentives in the form of credits that can be used to offset violations. For instance, gasoline refiners can get credits if they produce cleaner gasoline than required. These credits can then be used when their gasoline doesn't quite meet the clean-up requirements. Also as part of the 1990 amendments to the Clean Air Act, emission standards were established for the production of new cars and other vehicles. Because of these emission standards, current vehicles are roughly 99% 'cleaner' for common pollutants than 1970 vehicles. Additionally, phase two of the 1990 amendment restricts the amount of sulfur allowed in gasoline and diesel fuel.

Procedure

1. **Engage:** To introduce the subject, show one of the videos listed in the Internet Sites section below—either *Air Quality: A Tale of Three Cities*, or *Breathe Life—Clean Air, Healthy Future*. The former which is a talk by a NASA scientist is good for upper level students, offers a more detailed discussion, and graphically shows pollution that can be detected from space. The latter is good for lower level students and weaker learners, or when class time is limited.
2. Discuss the video with the class. Points to include could be:
 - Have you ever experienced bad air pollution or smog? Where? What body symptoms did you experience?
 - In Florida, why don't we see the levels of smog and air pollution that other areas experience? (*sea breezes blow the pollution out to sea*)
 - Were you surprised by the amount of disease and deaths that are caused by air pollution?
 - What can we do to cut the amount of air pollution...individually? as a consumer? as a nation? globally?
 - How do we solve the problem of getting everyone to participate in a collective action?
3. **Explore:** Show the class some political cartoons. Links to some sources of cartoons are in the Internet Sites section below, and a couple that you can use with a document camera are on the following pages. Discuss the political cartoons, and what elements are used in political cartoons to add humor and meaning. Help the students understand that the use of cartoons may be effective in reaching people that documentaries or news articles may not.
4. Break the class into small groups.
5. Explain to the students that each group will be given a topic to research that relates to fuel emissions, its effect on human health, regulations and the political climate surrounding the issue. They will then use this information to draw a political cartoon that they will present to the class for discussion. (Note: groups could be assigned to draw poster-sized cartoons that could later be hung in the classroom, school or neighborhood).
6. Assign each group one of the following: carbon monoxide, low level ozone, lead, nitrogen oxide, or particulate matter (particle pollution) and sulfur dioxide.

7. Team members should work cooperatively on their assigned topic as they search the internet, books, magazines and other resource materials to find information about the effects of that air pollutant on the human system, how it is currently produced, the levels that are currently being released into the atmosphere, the regulations that are currently in effect, and how different groups feel about these regulations. Remind students that they should assess the validity of the sources that they use for their information.
8. **Explain:** On discussion day, teams should present their cartoon, explain the research and background information behind it and answer questions from the class.
9. **Extend / Elaborate:** After all the teams have presented their cartoons to the class, show the video *Let's Pollute* (link in Internet Sites section), and lead a discussion on their thoughts on the effectiveness of this type of 'reverse-psychology' tactic.

Key Words & Definitions

- **carbon monoxide** - a colorless, odorless, poisonous gas that is formed as a product of the incomplete combustion of carbon
- **criteria air pollutants** - six common air pollutants (carbon monoxide, lead, low level ozone, nitrogen oxide, sulfur dioxide, and particulate matter) that the EPA monitors and sets recommended maximum levels
- **lead** - (Pb) as a true metal, lead is highly resistant to corrosion. Because of this property, it is used to contain corrosive liquids (e.g. sulfuric acid). In some countries it is found in transportation fuels to decrease engine knocking.
- **low level ozone** - a gas which is a variation of oxygen containing three atoms of oxygen instead of two. Ground level ozone is the main component of smog, and is a product of reactions during combustion of coal, gasoline and other fuels, and also chemicals found in products including solvents, paints and hairspray.
- **nitrogen oxide** - nitrogen oxides (NO_x) is a generic term for the various nitrogen oxides produced during combustion
- **particulate matter** - particulate matter (PM) is sometimes called particle pollution and includes dust, soot and other tiny bits of solid materials that are released into and move around in the air
- **particle pollution** - a generic term for the particulate matter found in the atmosphere
- **sulfur dioxide** - sulfur dioxide (also sulphur dioxide, sulfurous anhydride or sulphurous anhydride) has the chemical formula SO₂. The gas is irritating to the lungs and is frequently described as smelling of rotten eggs.

Related Research

1. Working in groups, design a future city incorporating solutions to limit air pollution. Cities can be presented as a model, a series of drawings or an animated video.
2. Research carbon sequestration. From your research, draw conclusions on the future costs and benefits of this technology.

Related Reading

- ***American Political Cartoons: The Evolution of a National Identity, 1754 - 2010*** by Sandy Northrop (Routledge, 2011)
An entertaining history of political cartoons from the beginning of the United States until now, chronicling the nation's highs and lows.
- ***How to Grow Fresh Air: 50 House Plants that Purify Your Home or Office***, by B.C. Wolverton (Penguin Books, 1997)
The author, who worked with NASA to create a breathable environment for a NASA lunar habitat, shows how to grow and nurture 50 plants that can filter common pollutants out of the air, and rates each on its effectiveness in removing various pollutants and its ease of growth and maintenance.

Internet sites:

Videos for this lesson

<https://www.nasa.gov/content/goddard/air-quality-a-tale-of-three-cities>

Air Quality: A Tale of Three Cities, Dr. Bryan Duncan, project scientist for NASA's Aura Mission compares data from three cities, discusses what caused their air quality problems and what has been done so far to mitigate the problem.

<https://www.youtube.com/watch?v=n3DM5scRpns>

World Health Organization's *Breathe Life—Clean Air, Healthy Future*. Good video for younger or weaker learners.

<https://www.youtube.com/watch?v=uBAyvqWP-VI>

Let's Pollute, 2011 Oscar nominated short film. Animated video gives a 'comical', reverse psychology twist to environmental concerns. Great for pulling in reluctant students, as well as a good discussion starter.

Sources for political cartoons

<http://www.chrismadden.co.uk/cartoon-gallery/category/environment/pollution-cartoons/>

Chris Madden political cartoons

https://www.cartoonstock.com/newscartoons/directory/a/air_pollution.asp

Air Pollution cartoons from various artists

<http://www.intoon.com/>

Mike Keefe political cartoons

Related sites:

<https://airnow.gov/>

AirNow - get real time air pollution data, including ozone maps and forecasts, and detailed daily reports from selected states.

<http://www.epa.gov/oar/caaac/>

Clean Air Act Advisory Committee

<https://www.epa.gov/environmental-topics/air-topics>

Information from the EPA on air pollution

<http://www.dep.state.fl.us/>

Florida Department of Environmental Protection - Site includes recent news and

legislation.

<https://www.youtube.com/watch?v=FKBVwX8dVhI>

Global Pandemic - Air Pollution, TEDx talk by Romain Lacombe

<https://www.youtube.com/watch?v=lvxfttfjqpo>

The Dying Planet, animated video

Healthy Air Matters



Cartoon by Jason Togyer, Tube City Almanac



Cartoon by Ed Heng, New York Times

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Florida NGSS Standards & Related Subject Common Core

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nature of Science																					
Standard 1	SC.912.N.1.	X			X																
Standard 4	SC.912.N.4	X	X																		
Earth and Space																					
Standard 6	SC.912.E.6.						X														
Life Science																					
Standard 14	SC.912.L.14.						X														
Standard 17	SC.912.L.17.											X		X		X	X	X			X
Social Studies Standards		SS.912.A.1.5, SS.912.A.7.12, SS.912.C.2.10, SS.912.C.2.11, SS.912.C.2.13, SS.912.C.3.5																			
Language Arts Standards		Grades 9 - 10: LAFS.910.SL.1.1, LAFS.910.SL.1.2, LAFS.910.SL.1.3, LAFS.910.SL.2.4 Grades 11 - 12: LAFS.1112.SL.1.1, LAFS.1112.SL.1.2, LAFS.1112.SL.1.3, LAFS.1112.SL.2.4, LAFS.1112.3.7																			
Visual Arts Standards		VA.912.C.1.5, VA.912.S.1.3, VA.912.H.3.3																			

Standard 1: The Practice of Science

- SC.912.N.1.1 – Define a problem based on a specific body of knowledge, and do the following: 3) examine books and other sources of information to see what is already known, 4) review what is known in light of empirical evidence, 7) pose answers, explanations, or descriptions of events, 10) communicate results of scientific investigations, and 11) evaluate the merits of the explanations produced by others.
- SC.912.N.1.4 - Identify sources of information and assess their reliability according to the strict standards of scientific investigation.

Standard 4: Science and Society

- SC.912.N.4.1 - Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.
- SC.912.N.4.2 - Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

Standard 6: Earth Structures

- SC.912.E.6.6 - Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies.

Standard 14: Organization and Development of Living Organisms

- SC.912.L.14.6 - Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

Standard 17: Interdependence

- SC.912.L.17.11 - Evaluate the costs and benefits of renewable and nonrenewable resources, such as water, energy, fossil fuels, wildlife, and forests.
- SC.912.L.17.13 - Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
- SC.912.L.17.15 - Discuss the effects of technology on environmental quality.
- SC.912.L.17.16 - Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.
- SC.912.L.17.17 - Assess the effectiveness of innovative methods of protecting the environment.
- SC.912.L.17.20 - Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

Social Studies Standards

American History

- SS.912.A.1.5 - Evaluate the validity, reliability, bias, and authenticity of current events and internet resources.
- SS.912.A.7.12 - Analyze political, economic, and social concerns that emerged at the end of the 20th century and into the 21st century.

Civics and Government

- SS.912.C.2.10 - Monitor current public issues in Florida.
- SS.912.C.2.11 - Analyze public solutions or courses of action to resolve a local, state, or federal issue.
- SS.912.2.13 - Analyze various forms of political communication and evaluate for bias, factual accuracy, omission, and emotional appeal.
- SS.912.C.3.5 - Identify the impact of independent regulatory agencies in the federal bureaucracy.

Language Arts Standards

Standards for Speaking and Listening

- LAFS.910.SL.1.1 & LAFS.1112.SL.1.1 - Initiate and participate effectively in a range of collaborative discussions with diverse partners on grades 9-10 (11-12) topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- LAFS.910.SL.1.2 & LAFS.1112.SL.1.2 - Integrate multiple sources of information presented in diverse media or formats evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- LAFS.910.SL.1.3 & LAFS.1112.SL.1.3 - Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.
- LAFS.910.SL.2.4 & LAFS.1112.SL.2.4 - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of

reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Reading Standards for Literacy in Science and Technical Subjects

- LAFS.910.RST.1.2 - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- LAFS.1112.RST.1.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- LAFS.1112.RST.3.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media.

Visual Arts Standards

Critical Thinking and Reflection

- VA.912.1.5 - Analyze how visual information is developed in specific media to create a recorded visual image.

Skills, Techniques and Processes

- VA.912.S.1.3 - Interpret and reflect on cultural and historical events to create art.

Historical and Global Connections

- VA.912.H.3.3 - Use materials, ideas, and/or equipment related to other content areas to generate ideas and processes for the creation of works of art.

National Next Generation Science Standards

Earth and Human Activity

- HS-ESS3-4 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

National Common Core Arts Standards

Creating

- Cr1.1.11a - Visualize and hypothesize to generate plans for ideas and directions for creating art and design that can affect social change.

Responding

- Re.7.2.11a - Evaluate the effectiveness of an image or images to influence ideas, feelings, and behaviors of specific audiences.

Note: Related **National Common Core Language Arts Standards** are listed in the Florida section above.

Healthy Air Matters

1. List the chemical or air pollutant your group has been assigned to investigate:
2. Use the internet, books, magazines and other resource materials to find information about the **effects of this pollutant on the human body**. Record 3 - 5 facts from your research that you and your group feel are the most important.
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3. Use the internet, books, magazines and other resource materials to find information on the **regulations in effect** to control the release of your pollutant into the atmosphere. Record 3 - 5 facts from your research that you and your group feel are the most important.
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4. Use the internet, books, magazines and other resource materials to find information about **conflicting opinions** on the value and effectiveness of the regulations. This might include those who think the regulations are not strong enough, those who think the regulations strangle growth, those who think the government should stay out of regulating states or industries, etc. Record 3 - 5 opinions from your research that you and your group feel are the most important.

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5. As a group, work on an idea for an editorial cartoon that picturizes facts and opinions from your research. Working together, draw the cartoon that your group will share with the class, and prepare for your groups to share your research and background information for your cartoon.

After sharing your cartoon and seeing the other cartoons created by your class, answer the follow-up questions below.

6. Which was your favorite cartoon? What made it so good?
7. What was the most difficult part of the project for you? Why?
8. What did you learn from this activity that you will share with another person?
9. What leaders or other people in your community would be interested in knowing about your research? How could you share this information? What would you expect as a result of your exchange of information?

