IN THE AIR

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Connecting Activity #1

"Belief Statement One: The Magnitude and Urgency of Airborne Toxics Problems Have Been Greatly Overstated"

9-12 EDUCATION MODULE

EPA

Missouri Botanical Garden

Correlation with Education Standards Summary

Connecting Activity #1
"Belief Statement One: The Magnitude and Urgency of Airborne Toxics Problems Have Been Greatly Overstated"

For a narrative description of these standards, please refer to the Teacher's Guide.

National Standards

SOURCE: www.education-world.com/standards

NPH.9-12 .1 .2 .4
NL-ENG.K-12 .3 .4 .5 .6 .7 .8
NM-PROB REP.PK-12 .3
NS.9-12 .1 .2 .4 .5 .6 .7
NCSS Strands VIII, IX, X
NT.K-12.2

Missouri Show-Me Standards

SOURCE: www.dese.mo.gov/standards

Performance Standards:
GOAL 1: 1, 2, 3, 4, 7, 8, 10
GOAL 2: 3, 7
GOAL 3: 1, 4, 5, 6
GOAL 4: 1, 4, 7

Knowledge Standards:
CA 1, 3, 6
HPE 6
SC 1, 4, 5, 7, 8
SS 5, 7

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Connecting Activity #1

"Belief Statement One: The Magnitude and Urgency of Airborne Toxics Problems Have Been Greatly Overstated"

Recommended +Grade Level:
9-12
Preparation Time:
Time will be needed to read the information at: http://www.ncpa.org/bothside/krt/krt081999b.html. which summarizes views from both ends of the continuum.
Presentation Time:
Two 50-minute class periods. Time required for Extension Activities will vary depending on activity chosen.

Overview

Students examine reasons for differences of opinions about the seriousness of airborne toxics. In the process, students study the ways scientists gather and interpret data, and make predictions based on their findings.

Goals

- To provide an unbiased assessment of what scientists know and do not know about the seriousness of airborne toxics problems
- To encourage critical thinking about airborne toxics problems
- To review scientific method principles and how those principles relate to the controversies over airborne toxics problems

Objectives

When this activity is completed, students will be able to do the following:

- Define allegory as a literary device and state its uses and limitations.
- Briefly explain the viewpoint, consequences, and evidence for opposing positions on the seriousness of airborne toxics.
- State three essential steps in scientific method and how each figures into the differences of opinion about the seriousness of airborne toxics problems.
- State how and why their original position on the seriousness of airborne toxics problems changed or did not change.

Materials

Copies of the student sheet, Summaries of Opposing Positions on the Magnitude of Air Toxics Problems, one per student.

Vocabulary List

Acid rain:
Acid rain is a broad term used to describe several ways that acids fall out of the atmosphere. A more precise term is acid deposition, which can be wet or dry. Wet deposition refers to acidic rain, fog, and snow. Dry deposition refers to particles that fall out of the atmosphere.

Allegory:
A literary genre that presents real situations in metaphorical terms. In other words, stories have symbolic meaning beyond the obvious story line or plot, see supplemental information for examples.

Computer modeling:
Use of models designed for computers for solving scientific and mathematical problems or predicting what may happen.

Simile:
Likening or contrasting one thing with another for greater understanding, see supplemental information for examples.

Procedures

1. Begin the activity with allegorical tales and similies to draw attention to positions held by different groups on air pollution issues. For instance, the folktale of Chicken Little who thought the sky was falling is an allegory used by those who believe airborne toxics problems are overstated. On the other hand, those who think the problems are critical describe their opponents as ostriches with their heads in the sand. For these and other examples, see Supplemental Information for Connecting Activity One: Allegories and Similes.
2. Point out that allegories and similes are useful in making a point indirectly, but they have nothing to say about the issues themselves or why the groups in question believe as they do. For toxic air pollution, investigate the specific arguments of each side in the debate.
3. Hand out copies of Summaries of Opposing Positions on Air Toxics Problems. Remind students that the pole positions on a continuum represent the most extreme views possible. After going over the information, ask them to consider what the debate is examining.
4. Conclude that basic scientific data are not the crux of the matter. For instance, no one is saying gasoline emissions from vehicles do not pollute the air or that a hole is not in the ozone layer. The real debate is over whether the data have been interpreted reliably. In other words, the debate is about scientific method, i.e., collecting data, establishing cause and effect relationships, and making predictions, and how predictions represent the real world.
5. Before proceeding to a discussion of the principles of scientific method, ask students to indicate where they stand on the matter by checking a number in the box below the position statements on the student sheet, Summary of Opposing Positions.

6. Review the scientific method principles as they relate to the debate over the seriousness of airborne toxics problems:

   a. Collecting Data
   During the twentieth century, knowledge of the atmosphere accumulated rapidly due to a number of factors. Ask students to suggest factors that led to an acceleration of atmospheric science. (Possible responses: Invention and development of aircraft, the crucial role of aircraft in WWII, the space program; general advances in physics and chemistry; environmental awareness, anxiety over the use of nuclear power, and visible threats to air quality such as smog.) Despite the acceleration and reliability of atmospheric sciences, a good deal of skepticism still exists concerning certain data. An example is ice core research in which cores taken from deep ice sheets reveal environmental changes for the past several thousand years. (For more information about ice core research, see For Further Reading and Research.
   Extension Activity: The invention of the spectroscope for identifying gases in the atmosphere was a major breakthrough for collecting air pollution data. See For Further Reading and Research, "Making a Simple Spectroscope."

   b. Establishing Cause and Effect
   Those who fall on the overstated end of the continuum have challenged some of the reported causes and effects of airborne toxics, particularly in relation to global concerns. To be accepted, scientific findings must withstand challenges and be repeatable with the same results. Establishing cause and effect takes time and frequently cuts across many disciplines. For example, atmospheric science in this module draws upon data from chemistry, mathematics, physics, astronomy, ecology, biology, and more.
   Extension Activity: The causes and effects of acid rain and ground smog have been debated for decades. For links to acid rain and ground smog activities, see For Further Reading and Research under Scientific Method: Cause and Effect.

   c. Making Predictions
   One of the aims of scientific inquiry is making predictions. On the basis of what has been learned about airborne toxics, researchers have a responsibility to assess risks and propose remedies. Today, such predictions may be arrived at through computer modeling, i.e., software designed to solve problems and make projections. However, the output of a computer model is only as reliable as the data that goes into it. Consequently, those who construct computer models do not always come up with the same predictions.
   Extension Activity: For activities to help students learn more about computer modeling, see For Further Reading and Research under Making Predictions.

7. Have students conduct internet searches or other research (see extension activities for suggestions) on each of these principles as they relate to airborne toxics. They should look for what scientists know and do not know about this topic.

8. Have students present the results of their research to the rest of the class.

9. Have students go back to their worksheets (Summaries of Opposing Positions on Air Toxic Problems) and indicate whether their stand has changed. Ask them to write a paragraph on the reverse side about why their attitudes did or did not change. When students have finished, do a tally on a flip chart or chalkboard. As students give their before and after scores, encourage them to talk about their attitudes and why they did or did not change their minds.

Conclusion

Upon completion of this activity students will relate that sound beliefs about the environment are based on scientific facts. Students wiil begin to recognize how knowledge and attitudes influence their beliefs.

For Further Reading and Research

Climate Change:

Although airborne toxics that cause global warming and ozone depletion are in a separate category from those dealt with in this module, the following references provide excellent summaries of the status of atmospheric science.

Internet -

- "Climate Change: What Scientists Know and Don't Know About It." This is an excellent summary written in understandable terms. For more detailed information, see http://www.epa.gov/ebtpages/airatmospclimatechange.html.
- Greenhouse Warming or Aerosol Cooling? Could it be that aerosols are cooling the planet? See http://wwwindoex.ucsd.edu/ProjDescription.html.
- For a wealth of information on global warming and other problems related to airborne toxics, see the following National Oceanic and Atmospheric Administration (NOAA) website: http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html.
- For the latest report from the Intergovernmental Panel on Climate Change (IPCC), see http://www.ipcc.ch/.

Books -

- Williams, Mary E. *Is Global Warming a Threat?* San Diego, CA: Greenhaven Press, 2002.
- *Critical Thinking About Environmental Issues: Global Warming*. San Diego, CA: Greenhaven Press, 2002.
- *Opposing Viewpoints: Global Warming*. San Diego, CA: Greenhaven Press, 1996.

Scientific Method: Gathering Data

Ice Core Research

- http://www.ngdc.noaa.gov/paleo/icecore/greenland/summit/
- http://www.agu.org/sci_soc/vostok.html
- http://www.ngdc.noaa.gov/paleo/icecore.html

Spectroscope: An instrument for identifying gases in the atmosphere
In the latter half of the seventeenth century, physicist Sir Isaac Newton demonstrated that light passing through a glass prism diffuses into a spectrum of colors. Over a century later, other scientists discovered that chemical compounds in the air could be identified by their wavelengths on the spectrum. Like fingerprints, each element or compound has its own unique pattern. It was a great discovery; since gases in the atmosphere (other than oxygen and nitrogen) are so miniscule, no instruments could detect them at that time. A breakthrough occurred in 1920, when a professor at Oxford College in England developed a spectrograph that could detect stratospheric ozone, a very rare gas. By the 1950s, fourteen more atmospheric compounds had been identified. Today, more

than 3,000 such compounds are known. As the space program developed, unmanned satellites carried spectroscopes into outer space. To reduce the weight load (glass prisms are heavy), a lightweight diffraction grating was developed to act as a prism. At the following website, directions are given for making a simple spectroscope with diffraction grating purchased from hobby or science equipment stores. http://asd-www.larc.nasa.gov/edu_act/simple_spec.html.
Additional information and projects about the spectrum:

- Various simple-to-do optic experiments are provided by the San Diego Supercomputer Center. See enrich.sdsc.edu/Physics/Optics. Also see "What is a Spectrum?" at http://csc.gallaudet.edu/soarhigh/Bspectra.html.
- See "Spectra of Gas Discharges" at http://home.achilles.net/~jtalbot/data/elements/.
- See "The Visible Electromagnetic Spectrum" at http://fusioned.gat.com/Teachers/Curriculum/Curriculum-HTML/T01-visible-light.html.

Additional information about using the spectroscope method to measure air toxics:

- See the BEAM project (Breathing Easier Through Air Monitoring) at www.state.me.us/dep/air/beam/absortbeam.htm.

Scientific Method: Cause And Effect

Acid Rain

When we hear the term acid rain, we generally think of dead trees and sterile lakes, but it does not end there. Chemicals powerful enough to devastate forests and contaminate bodies of water are bound to have harmful effects on human and animal health.

- For a classroom experiment for upper class science students, see An Acid Rain Simulation Project at http://www.mste.uiuc.edu/beusch/acidrain.html.

Ground Smog

Both sites listed below contain experiments involving temperature inversions that create ground level smog.

- http://www.tnrcc.state.tx.us/air/monops/lessons/templesson.html.
- http://www.woodrow.org/teachers/chemistry/1989/20inversion.html.

Scientific Method: Making Predictions

Computer Modeling Demonstrations

If your goal is to introduce students to the concept of computer modeling, see http://www.weblakes.com/ for demonstrations of actual computer software used by professionals. Follow directions to download two free demonstrations about how scientists assess risks from airborne toxics. The topics are EcoRisk View: Ecological Risk Assessment and IRAP-h View: Human Health Risk Assessment.

Advanced Projects

- See http://www.shodor.org/master/pendulum/intro/ For a computer modeling project about The Pit and the Pendulum, a short story by Edgar Allen Poe. This project is in keeping with our overall theme of science and the creative arts. Have students read Poe's famous short story, The Pit and the Pendulum at http://www.literature.org/authors/poe-edgar-allan/pit-and-pendulum.html. Then do the computer modeling project to see whether Poe actually gave his hero time to escape the deadly pendulum, or whether he (Poe) dropped the ball in his calculations.

- For a computer modeling problem about airborne toxics, see http://www.shodor.org/master/environmental/air/photochem/index.html.

Supplemental Information: Allegories And Similies

Allegories (fictional stories that have symbolic meaning beyond the story itself) are used to make a point indirectly without naming actual names or situations. People who believe the dangers from airborne toxics have been greatly exaggerated sometimes compare their adversaries to Chicken Little, the main character in a children's story that gets hit on the head by an acorn and thinks the sky is falling. Chicken Little quickly convinces her friends (Henny Penny, Turkey Lurkey, et al.) that the sky is falling, so they all set off to deliver the bad news to the King. On the way, they meet Foxy Loxy and warn him about the imminent danger. Foxy Loxy is sure the sky is not falling, but he pretends he does and invites them into his den to discuss the problem. In the original version of the story, Chicken Little and her friends become Foxy Loxy's dinner shortly thereafter. In a less shocking version, the hapless fowls are simply made to look foolish for their hasty conclusions.

A similar story from the Zulu tribe of Africa tells about a jackal that suddenly meets a lion in the jungle. Afraid the lion will eat him, the jackal warns the lion that a great overhanging rock is about to drop on them both. The lion believes it and puts his mighty paws against the rock while the jackal goes to find a log to prop up the rock. Of course, the jackal never returns and the tale ends this way: "Lion was left all alone to struggle under the weight of the unmoving rock. How long he remained there before he realized that it was another trick, we will never know." (Clever Jackal Gets Away, A Traditional Zulu Story. For the full text, see http://www.canteach.ca/elementary/africa4.html .

On the other hand, people who believe that air pollution problems are critical describe disbelievers with similes, figures of speech that compare dissimilar things. In this case disbelievers may be compared to a person who whistles through a graveyard to calm his fears or to an ostrich that sticks its head in the sand at the first sign of danger.

An appropriate allegory for this view is Aesop's tale about the ant and grasshopper. While the ant prepares for the coming winter, the grasshopper makes fun of it and fritters away the summer in pleasurable pursuits. When winter inevitably comes, the ant is snug in its hill while the grasshopper shivers outside in the cold. To survive the winter, the grasshopper has to beg the ant for help.

Masters

Summaries of Opposing Positions on the Magnitude of Air Toxic Problems, Student Worksheet.

Summaries of Opposing Positions on the Magnitude of Air Toxic Problems

MINOR PROBLEMS		CRITICAL PROBLEMS
POSITION: PROBLEMS OVERSTATED **Viewpoint:** Separation of natural and human causes for global warming and ozone depletion has not been clearly made. Natural cycles of warming and cooling have repeated during the earth's long geologic history. Ozone levels are known to vary due to natural causes such as volcanic action and sun intensity. Furthermore, the scientific study of air pollution is relatively recent and we still have much to learn about it. **Consequences:** A rush to act without adequate proof creates hardships on the world economy by banning useful products and interfering with personal choices. Furthermore, the premise that the entire planet is in imminent danger from these sources creates a climate of fear and panic. **Proof:** Comparisons of today's air pollution problems with occurrences in the earth's geologic past. Criticism of current air pollution studies and computer modeling.	**RANGE OF OPINIONS BETWEEN**	**POSITION: SERIOUS, URGENT PROBLEMS** **Viewpoint:** Certain gases from human activities (particularly vehicle and factory emissions) have initiated global warming and caused the thinning of the ozone layer. Closer to the ground, these emissions have brought about air quality deterioration, particularly in urban industrial areas. Although some improvement has been made, the damage may already outweigh the planet's natural ability to recover. **Consequences:** If not corrected soon these conditions will produce dire consequences for the natural environment and human life and health. It may already be too late. **Proof:** Atmospheric data collected by such groups as the U.S. Environmental Protection Agency (USEPA), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA); emmissions testing and monitoring; controlled experiments; and computer modeling.

Serious Problems 1_____ 2_____ 3_____ 4_____ 5_____ Problems Overstated

- **Where do you stand? Before beginning the activity_____ After completing the activity_____**
- **Explain on the reverse of this sheet why you did or did not change your stand.**