Air Pollution 101

Grades 9-12

Length of Lesson:
One class period

Standards:
Georgia Science Standards:

- SEV2. Students will demonstrate an understanding that the Earth is one interconnected system.
- SEV3. Students will describe stability and change in ecosystems.
- SEV4. Students will understand and describe availability, allocation, and conservation of energy and other resources.
- SEV5. Students will recognize that human beings are part of the global ecosystem and will evaluate the effects of human activities and technology on ecosystems.
- SEC5. Students will assess the impact of human activities on the natural world, and research how ecological theory can address current issues facing our society, locally and globally.
- SM5 Students will differentiate the climates of Earth, how climate changes through time, and the theories regarding current climate change.

https://www.georgiastandards.org/Standards/Pages/BrowseStandards/ScienceStandards9-12.aspx

National Standards Addressed:

- **Content Standard**: **NS.9-12.1 Science as Inquiry**
  As a result of their activities in grades 9-12, all students should develop
  - Abilities necessary to do scientific inquiry
  - Understandings about scientific inquiry
- **Content Standard: NS.9-12.5 Science and Technology**
  As a result of their activities in grades 9-12, all students should develop
  - Abilities of technological design
  - Understandings about science and technology
- **Content Standard: NS. 9-12.6 Personal and Social Perspectives**

This lesson plan is available thanks to a grant from The Harland Foundation.

As a result of their activities in grades 9-12, all students should develop an understanding of

- Personal and community Health
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

http://www.education-world.com/standards/national/index.shtml

Excellence in Environmental Education: Guidelines for Learning Addressed:

- Strand 1 Questioning, Analysis, and Interpretation Skills
- Strand 2 Knowledge of Environmental Processes and Systems
- Strand 3 Skills for Understanding and Addressing Environmental Issues
- Strand 4 Personal and Civic Responsibility
  http://www.naaee.org/programs-and-initiatives/guidelines-for-excellence/materials-guidelines/learner-guidelines-strands

Focus:

The basics of air pollution; the seven main pollutants and their sources.

Description:

Students will gain background knowledge of the basic sources of air pollution, along with the overview of how air pollution affects our health, our environment, and our economy. They will then participate in a hands-on demonstration to understand visually that everyone has an impact on air pollution. Students will also complete a worksheet detailing a description of each pollutant, as well as listing three interesting facts for each pollutant.

Materials:

- Background information
- Clear, plastic (or small glass jars recycled from café) for each student – each student needs their own cup to illustrate how

"each and every one of us" impacts our air quality

- Liquid- type food coloring-set for each group/table/student. For this lesson, we used red, green, yellow, and blue.
  Note: Food coloring will stain clothing/skin
- Ground charcoal (from pet store, or ground substance that will not dissolve in water)
- Cocoa mix and lemonade drink mix (each student will need some of each mix)
- Clean water
- Large container (to hold all of students' water once they have completed the demonstration)
- Student Worksheet

Vocabulary:

- Sulfur Dioxide
- Nitrogen Dioxide
- Carbon Monoxide
- Volatile Organic Compounds
- Particulate Matter
- Ozone
- US Environmental Protection Agency (EPA)

Background:

Air pollution affects all living things. It causes health problems in humans and animals, damages plants, kills fish, pollutes water, eats away at infrastructure, and reduces visibility. It can also lead to acid rain, global warming, and smog. In the United States, for example, six out of every 10 people live in areas that fail to meet one or more federal air quality standards during some part of the year. Luckily there are agencies, like the United States Environmental Protection Agency (USEPA), that are looking out for the lungs, leaves, and gills of those who require some clean air!

Pollutants of any sort can ride the air currents for long distances. The air around is never just a local concern, but cuts across regional, national, and global boundaries. Air pollution from human sources is the result of our increasing use of large amounts of fuel from burning

coal, oil, wood, and other fuels we use to run factories, cars, and power plants that generate electricity.

See attachment for extensive information on the seven common air pollutants.

Also click on the following Web site for more information on air pollutants http://www.epa.gov/air/airpollutants.html

Procedure:
Write the words "Air Quality" on the board and ask students the following questions:

- Do you think the quality of the air in their area is good or bad?
- How do you know? What evidence is there of air pollution?
- Have you ever experienced burning eyes, itchy throat, or shortness of breath on polluted days?
- What time of the year does the air seem dirtiest?
- Tell students that the issue of "air quality;" – how good or bad the air is – air quality during the May to Sept. months are often in the GA news.
- Ask students why there is so much talk about "air quality?" Guide them to identify the importance of air for living things. Explain that bad air can contribute to a variety of illnesses such as asthma and cancer.
- Provide information and write on the board the seven pollutants mentioned in the background information.
- Allow students to give input on each pollutant such as: the sources of each pollutant and the health and environmental impacts.
- Have students take notes on the key points for each pollutant.
- Bring students to the conclusion that we are often unaware of how our everyday activities contribute to air pollution. (At the end of Activity One/demonstration, their cups of colored water provide a striking visual reminder of each student's contribution to air pollution.)

Activity One:

- Divide your class into work groups of three to six students each
- Give each student a clear plastic cup that is ¾ full of clean water
- Give each work group a set of supplies (food colorings, ground

charcoal, cocoa mix and drink mix)

- Now write on the board the corresponding food coloring or drink mix (below) and explain to the students that these colors/mixes will illustrate a particular pollutant that was discussed

Air Pollutant	Corresponding color/mix
Sulfur Dioxide (SO_2)	Pinch of lemonade mix
Nitrogen Dioxide (NO_2)	Pinch of cocoa drink mix
Carbon Monoxide (CO)	One drop red food coloring
Lead (Pb)	One drop green food coloring
Volatile Organic Compounds (VOCs)	One drop blue food coloring
Particulate Matter (PM10)	Pinch of ground charcoal
Ozone (O3)	One drop yellow food coloring

- Now tell the students that a series of "activities" will be read. If the student has participated in the "activity" within the past week, they are to add one drop/pinch of the corresponding pollutant into their cup of water. All activities will not apply to every student (for example, applying nail polish or mowing the lawn)

Here are the "activities" to read to students. Feel free to add or delete activities as they might relate specifically to the school or community.

1. You drove or were a passenger in a car/truck
    a. *1 drop red coloring*-represents ***Carbon Monoxide (CO)*** in motor vehicle exhaust
    b. *1 drop blue coloring*-represents the ***Volatile Organic Compounds (VOCs)*** produced by the engine when gasoline or oil is burned
    c. *1 pinch lemonade mix-represents* ***Sulfur Dioxide (SO_2)*** *in auto exhaust*
    d. *1 pinch cocoa-represents* ***Nitrogen Dioxide (NO_2)*** *from vehicle exhaust*
2. You enjoyed heat, air conditioning, or a warm shower
    a. *1 drop green coloring-represents* ***Lead (Pb)*** *in electricity generation*

   b. *1 pinch lemonade mix-represents **Sulfur Dioxide (SO_2)** released from electric utilities*
   c. *1 pinch of cocoa-represents **Nitrogen Dioxide (NO_2)** emitted by combustions used to generate electricity and heat water*
3. You got ready for school or work and used nail polish or hairspray
   a. *1 drop blue coloring-represents **Volatile Organic Compounds (VOCs)** in indoor air*
4. You used your computer, IPOD, or Video Games
   a. *1 pinch of ground charcoal-represents **Particulate Matter (PM10)** resulting from power plants burning coal to produce electricity*
   b. *1 drop green coloring-represents **Lead (Pb)** as a station source providing utilities*
   c. *1 pinch lemonade mix-represents **Sulfur Dioxide (SO_2)** from burning fossil fuels to create electricity*
5. You or your family burned firewood or yard debris
   a. *1 drop red coloring-represents the **Carbon Monoxide (CO)**in wood burning*
   b. *1 pinch ground charcoal-represents **Particulate Matter (PM10)** in the burning, leaving ash and soot*
6. You or your family used paint or some type of solvent
   a. *1 drop blue coloring-represents **Volatile Organic Compounds (VOCs)** when chemicals evaporate*
   b. *1 drop yellow coloring-represents **Ozone (03)** evaporation*
7. You traveled down a dirt or gravel road
   a. *1 pinch of ground charcoal-represents **Particulate Matter (PM10)** from dust*
8. You or your family used gasoline-powered equipment to mow the lawn, blow yard clippings, or whack the weeds.
   a. *1 drop blue coloring-representing the **Volatile Organic Compounds (VOCs)** in exhaust and gas vapors*
   b. *1 pinch lemonade mix-represents the **Sulfur Dioxide (SO_2)** emitted by the equipment's engine*
   c. *1 pinch cocoa-represents **Nitrogen Dioxide (NO_2)** in exhaust from burning fuel*
   d. *1 drop yellow coloring-representing **Ozone (03)** from fuel combustions and evaporation*
9. You or your family purchased gasoline at the gas station
   a. *1 drop yellow coloring-represents **Ozone (03)** from evaporation while filling tank (mostly occurs on hot, sunny day)*
   b. *1 drop blue coloring-representing **Volatile Organic Compounds (VOCs)** when chemicals evaporate*
10. You put on your favorite shirt, which your parent had dry-cleaned for you.

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a. *1 drop of blue food coloring-represents the **Volatile Organic Compounds (VOCs)** emitted by the dry-cleaning process*

11. You smoked a cigarette
    a. *1 drop red coloring-represents **Carbon Monoxide (CO)** in tobacco smoke*
    b. *1 pinch lemonade mix-represents the **Sulfur Dioxide (SO_2)** gas in tobacco smoke*
    c. *1 pinch cocoa mix -representing traces of **Nitrogen Dioxide (NO_2)**, which can be found in tobacco smoke*
12. You used office equipment such as a printer or copier
    a. *1 drop blue food coloring-represents the **Volatile Organic Compounds (VOCs)** released when equipment is used*

Activity Two: Discussion

Ask your students the following questions:

1. Look inside your cups. If the air pollution around you were this apparent, would you want to breathe the air?
2. What other sources of air pollution, beyond those mentioned in this demonstration, could you think of as being produced in a single day?
3. What could you do to reduce the number of pollutants released each day?
4. Pour each students "polluted water" into the larger container and explain how this represents some of what people breathe every day. Of course, much is diluted in the huge volume of the atmosphere, but it is getting more concentrated daily with more people increasing their activities which contribute to air pollution.
5. Help students come up with a list of things they can do to reduce their impact. Such as:
    - Drive less
    - Drive smart
    - Buy smart
    - Choose air friendly products
    - Save energy
    - Practice the 3 R's (Reduce, Reuse, and Recycle)
    - Don't smoke
    - Speak up for clean air
    - Visit the following Web site for more information – California Environmental Protection Agency at http://www.arb.ca.gov/html/brochure/50things.htm

Extension:
Rather than a lecture or question and answer format and if time permits, divide the class into seven groups and assign each group one of the six pollutants. After allowing time to research each pollutant, have the group report back to class about their group's "assigned" pollutant. Several students can even play "Reporter" and interview the groups about their assigned pollutant.

Assessment:

- Students will be assessed by participating in class discussion and activities
- Completion of Student Worksheet detailing description and interesting facts of each of the seven pollutants covered in the lesson

Follow-Up:
After you have taught this lesson plan, please tell the Clean Air Schools program about your efforts in a brief, 60-second online survey at CleanAirCampaign.org. The information you provide is invaluable in helping this non-profit education program direct its resources to improving these lesson plans and creating new materials for your students. Thanks!

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Student Worksheet for Air Pollution 101

	Brief Description	3 Interesting Facts
Sulfur Dioxide (SO_2)		
Nitrogen Dioxide (NO_2)		
Carbon Monoxide (CO)		
Lead (Pb)		
Volatile Organic Compounds (VOCs)		
Particulate Matter (PM10)		
Ozone (O3)		

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The Clean Air Schools program is helping educate future leaders about air quality and transportation. Learn more at CleanAirCampaign.org.

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