Lung Power and Air Pollution

In this second lesson of The Clean Air Campaign's unit on the impact of air pollution on the human body, students will determine the air quality for their area by analyzing data from monitoring stations; convert this data to an Air Quality Index value; investigate the impact of air pollution by measuring and comparing their own vital lung capacity on days with healthy and unhealthy air quality; and brainstorm strategies for protecting themselves and others from the harmful effects of air pollution. It is recommended that students complete "Every Breath You Take," the first lesson in the unit, before beginning these activities. (Environmental Education)

Education Committee	*The Clean Air Campaign*	*Fulton*	*EEinGEORGIA.org*

Primary Learning Outcomes

How can I tell whether the air is polluted and which (if any) pollutants are present? How do I conduct an experiment to measure my vital lung capacity and see whether it is affected by air pollution?

Additional Learning Outcomes

How can I protect myself from air pollution? What can be done to reduce air pollution where I live?

Assessed GPS Standards:

Grade: 7
Science Standards:
S7L2 d,e: Students will describe the structure and function of cells, tissues, organs, and organ systems.

d. Explain that tissues, organs, and organ systems serve the needs cells have for oxygen, food and waste removal.

e. Explain the purpose of the major organ systems in the human body (i.e., digestion, respiration, reproduction, circulation, excretion, movement, control and coordination and for protection from disease).

S7CS9 a-g: Students will investigate the features of the process of scientific inquiry.

a. Investigations are conducted for different reasons, which include exploring new phenomena, confirming previous results, testing how well a theory predicts, and comparing competing theories.

b. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.

c. Scientific experiments investigate the effect of one variable on another. All other variables are kept constant.

d. Scientists often collaborate to design research. To prevent bias, scientists conduct independent studies of the same questions.

e. Accurate record keeping, data sharing, and replication of results are essential for maintaining an investigator's credibility with other scientists and society.

f. Scientists use technology and mathematics to enhance the process of scientific inquiry.

g. The ethics of science require that special care must be taken and used for human subjects and animals in scientific research. Scientists must adhere to the appropriate rules and guidelines when conducting research.

S7CS4: Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities.

a. Use appropriate technology to store and retrieve scientific information in topical, alphabetical, numerical, and keyword files, and create simple files.

b. Use appropriate tools for measuring objects and/or substances.

c. Learn and use on a regular basis standard safety practices for scientific investigations.

Non-Assessed GPS Standards:

Grade: 7

Math Standards:
M7D1: Students will pose questions, collect data, represent and analyze the data, and interpret results.

a. Formulate questions and collect data from a census of at least 30 objects and from samples of varying sizes.

b. Construct frequency distributions.

c. Analyze data using measures of central tendency (mean, median, and mode), including recognition of outliers.

d. Analyze data with respect to measures of variation (range, quartiles, interquartile range).

e. Compare measures of central tendency and variation from samples to those from a census. Observe that sample statistics are more likely to approximate the population parameters as sample size increases.

f. Analyze data using appropriate graphs, including pictographs, histograms, bar graphs, line graphs, circle graphs, and line plots introduced earlier, and using box-and-whisker plots and scatter plots.

g. Analyze and draw conclusions about data, including a description of the relationship between two variables.

M7P4: Students will make connections among mathematical ideas and to other disciplines.

a. Recognize and use connections among mathematical ideas.

b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

c. Recognize and apply mathematics in contexts outside of mathematics.

M7P5: Students will represent mathematics in multiple ways.

a. Create and use representations to organize, record, and communicate mathematical ideas.

b. Select, apply, and translate among mathematical representations to solve problems.

c. Use representations to model and interpret physical, social, and mathematical phenomena.

Procedures/Activities

Step: 1 Duration: Teacher Preparation

Decide how to divide the class into six teams. Assemble supplies needed for the investigations (see Materials list). Print color copies of the Air Quality Index (Step 2) and regular copies of the Lab Report for each student (Step 3). Make a copy of experiment directions for each team (Step 5). Find a suitable outside location where the lung capacity investigations can take place. Determine boundaries for students in that area, check for safety hazards, and identify or arrange for tables that can be used for the lab set-up.

Plan for the investigations described in steps 5 and 6 to be done at different times, to maximize differences between results when air quality is good vs. unhealthy. To help schedule the experiments, the Web sites linked at this step provide information about current air quality and air quality typical for various times of year. (Urban areas, where ozone is often the major pollutant, experience worse air quality late on summer days, as ultraviolet light combines with vehicle emissions to form ozone. In such locations, it may be ideal to conduct one investigation in the morning and one in the afternoon. In areas where coal-fired power plants produce the main pollutants, there will be less of an effect on lung capacity on a windy day, when pollutants are blown to other areas, than on a calm one).

Finally, determine how the Web resources at this step will be displayed for students, and arrange for any necessary equipment. For instance, 1) Web pages may be displayed using an Internet-connected computer, scan converter, LCD projector, and screen or TV hook-up; 2) students may have access to Internet-connected computers so that they can view the Web pages as they are discussed by the teacher; 3) Web pages may be copied as transparencies and shown on an overhead projector, or 4) Web pages can be printed and copied for students. Because these Web sites are interactive, the first two options are preferred.

Web Resources for Step 1

Title: Clear the Air: The Dirty Secret about Dirty Air
URL: http://cta.policy.net/dirtypower/map.html
Annotation: The National Campaign against Dirty Power, an advocacy group which takes the position that power plant emissions should be reduced to clear the air, provides a clickable "Power Plant Air Pollution Locater" for details about emissions. This information may be especially relevant for Georgians outside the metro Atlanta area, where ozone is less likely to be the culprit in triggering air quality alerts. Click on state and then a specific power plant icon for details. Daily data is not provided. However, the teacher whose school is near a coal-fired power plant may assume that it would be appropriate to schedule one experiment for a windy day (when power plant emissions will presumably have less of an

effect on air quality in the immediate vicinity) and one on a day when the air is still (and air quality is assumed to be less healthy).

Title: Georgia Ambient Monitoring Program
URL: http://www.air.dnr.state.ga.us/amp/
Annotation: To find out more about the current air quality levels in the state of Georgia call (404) 362-4909 for an automated voice recording or visit this Web site for State of Georgia's Ambient Monitoring Program. Click on the nearest location to see current information about the major pollutant in your area, updated hourly by the Georgia Department of Natural Resources. Note that AQI levels over 100 for any individual pollutant are considered unhealthy. Schedule the experiment to be done once on a healthy air quality day, based on this information, and repeat it on an unhealthy air quality day.

Title: The Clean Air Campaign- Air Quality Forecast
URL: http://www.cleanaircampaign.com/index.php/cac
Annotation: The Clean Air Campaign offers a variety of programs and services that may be useful additional resources. If within 100 miles of the metro Atlanta area, use this Web site to plan dates and times for one experiment to take place when air quality is healthy, and one when air quality is unhealthy. Note the Air Quality Forecast in the box at the top left corner of the Web page. Click “About the Air Quality Index” for details about the previous day’s actual rating or current day’s forecast. Teachers may also register online to receive email smog alerts, which may also be of assistance in planning times for lesson experiments to take place. For AQI forecast information by phone, call 1-877-CLEANAIR.

Title: Air Quality Index Map Archives
URL: http://www.airnow.gov/index.cfm?action=airnow.currentconditions
Annotation: Select a pollutant (ozone or particulates), a geographic region, a month and a year; then click on the thumbnail map for a specific date. Three maps will appear. The top one (AQI Loop) is an animation which shows when and where pollution formed and spreads in a series of ‘snapshots’ at twenty-minute intervals throughout a day in the past. This map is color-coded to the Air Quality Index, or “AQI.” The second map shows peak pollution levels for a specific day in the past, and the third shows peak 1-hour averages.

Step: 2 Duration: 15 minutes

Introduction

Introduce the lesson by asking the class to define air pollution. (Unwanted and potentially unhealthy matter in the air). Then ask students how it is possible to know whether air is polluted. (Responses may include sensing by sight or smell;

proximity to apparent sources of pollution such as smokestacks, forest fires, and vehicles; or direct measurement of pollutants). Provide each student with a color copy of the AQI Chart (see attachment or Web link below). Have students identify the colors which reflect healthy or moderate air quality (green and yellow) as well as the colors which indicate unhealthy levels for sensitive groups (orange) and unhealthy for all people (red, purple, maroon).

Ask the class to guess which types of air pollution the index measures. [The six major pollutants measured for the AQI are ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter smaller than 10 ppm (dust), and particular matter smaller than 2.5 ppm (smoke and soot)]. Solicit opinions as to how the AQI is determined. [Monitoring stations collect data on the six major pollutants. A formula is used to combine the levels of pollutants, but the index always identifies the specific pollutant that has triggered an Alert, if air quality levels are unhealthy. If none of the six pollutants are present in unhealthy levels, the AQI reflects healthy air quality.]

Web Resources for Step 2

Title: Index and Clean Air Campaign Health Advisory
URL: http://www.cleanaircampaign.com/index.php/cac/for_schools
Annotation: Click on action item entitled "Download health advisory guidelines for children on smog alert days" on the upper right section of the Web page. This Health Advisory can be printed and shared with students and parents. See below for an Air Quality Index chart that can also be printed and shared with students.

Attachments for Step 2

Title: AQI Chart **FileName:** Air Quality Index slide.ppt
Description: PowerPoint version of AQI Chart, for use if more convenient. (See also Web link).

Step: 3 Duration: 15 – 45 minutes (depending on whether Shortcut is selected)

Pollution Detectives

Tell students that monitoring stations across Georgia collect data on pollutants every day. Display the Web resources linked at Step 1 and, paraphrasing the annotations for each Web site, show the kinds of air quality information which can be obtained for your area. Note the current Air Quality Index (AQI) level and the major pollutant of the day (if any). Distribute a copy of the Lab Report to each individual. Shortcut Option: If time is short or Internet-connected computers not available to students, the balance of Steps 3 and 4 may be omitted. To provide continuity for the rest of the lesson, students will need to remember the

previously-noted AQI level and major pollutant.

Divide the class into six teams and assign each team one of the following pollutants: ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, large particulate matter (PM10.0), and fine particulate matter (PM2.5). Each team will determine the current level of an assigned pollutant by reviewing data from the Ambient Monitoring Program with an Internet-connected computer (link at Step 1); click on “Today” next to the name of a pollutant to find out what the acceptable level is; click on a monitoring station, as selected by the teacher, to display data; and conclude whether the pollutant is present at an unhealthy level by comparing the standard to the measured level. For ozone, use raw data instead of backward-looking 8-hour averages. Note that 24-hour time is used on charts. Students should observe whether the measured level is above or below the red line (standard) on the graph. All data and conclusions should be recorded on the attached Lab Report.

[Variation: The teacher may pre-select multiple monitoring locations, and direct each member of the team to collect data for the team’s pollutant from one of those stations (except for ozone). If enough Internet-connected computers are available, this would allow every child to be fully engaged in the assignment].

Attachments for Step 3

> **Title:** Lab Report for Lung Power and Air Pollution **File Name:** Lab Report- Lung Power and Air Pollution.doc
> **Description:** Students will use this Lab Report to record all lesson activities. Each student is expected to turn in an individual report, although lab partners may feel free to collaborate on answers. Web addresses for experiment directions from TryScience (linked at Step 5), the Ambient Monitoring Program (linked at Step 1) and the AQI Calculator (linked at next step) are listed in the Lab Report, for student convenience. Graphics are from Microsoft Design Gallery Live and The Clean Air Campaign (used with permission).

Step: 4 Duration: 0 - 15 minutes

Converting Air Pollution Data to Air Quality Index Values

Using a special online formula-calculator, linked below, students should enter their team’s pollution datum from the previous step and convert it to an Air Quality Index value. To accomplish this, students will use a pull-down menu to select a pollutant, enter the concentration level, and click ‘Calculate’ to convert to the Air Quality Index. Students should be sure to scroll down and read the corresponding health advisory. While everyone is still at the computers, the teacher will call for pollution concentration levels from each team and record this on the board or on a large chart. Then direct the students to repeat the AQI conversion process for the data provided by other teams. This information should

be recorded on the table in the Lab Report. (If the teacher elected to have teams collect data from more than one monitoring station, this data should be converted too).

When all the data has been converted, review the results. Identify the overall air quality and major pollutant of the day (if any). This is important to know for the next part of the lab. Discuss factors which may affect pollution levels (proximity to an urban area, season, time of day, proximity to power plants, type of fuel power plant uses, etc.). In Georgia, most AQI alerts (unhealthy levels) in urban areas are related to vehicle emissions. Have students guess which two pollutants are most closely associated with vehicle emissions, and thus most likely to trigger AQI alerts in urban areas. (ozone and particulates). Since ozone is only formed in the presence of ultraviolet light, ask students what time of day and in which season ozone is most likely to trigger an AQI alert (afternoon and evening in summer).

Optional: Segue into the next part of the lab by displaying or directing students to the animation at the Web page linked below. Click on "Try Offline" to review materials and procedures for the lung capacity experiment.

Web Resources for Step 4

Title: AQI Calculator and Converter
URL: http://cfpub.epa.gov/airnow/index.cfm?action=aqi.conc_aqi_calc
Annotation: Students will enter concentrations for a pollutant and learn the AQI level, category and associated health risks. Minimum requirements: Internet Explorer 6.0 or Netscape version 7.01.

Title: TryScience Animation of Lung Capacity Experiment
URL:
http://www.tryscience.com/experiments/experiments_begin.html?lung
Annotation: Display the animation in the upper right corner of this Web page for the class (or allow students to view it individually). This shows how the lung capacity experiment will be conducted. Then click on "Try It Online" and review the sections titled "What You Need" and "To Do and Observe."

Step: 5 Duration: 45 minutes

Investigating Lung Capacity

Students should stay in the previously-assigned six teams. Take students and materials outside for this investigation, so that the impact of air quality can affect results. Explain that each student will be conducting a hands-on investigation to determine his or her own lung capacity, using the water displacement method. Review any ground rules or safety considerations for working outside.

Ask students how they think air pollution could impact lung capacity. [Depending on their own health and risk group, students may predict that vital lung capacities will decrease or stay the same when the air is polluted, and may predict that it would depend on the type or level of pollutant]. Ask whether every student would be affected the same way? [Because people with respiratory illnesses have damaged lung tissue, their vital lung capacity is already reduced]. Using information from the previous steps, identify the current AQI value (and major pollutant, if any) and confirm for students whether the investigation conducted today will reflect a healthy or unhealthy air pollution level. [If teacher selected short-cut option and skipped Steps 3 and 4, or if this investigation is taking place on a day other than when Step 4 was completed, refer to The Clean Air Campaign or Ambient Monitoring Program Web site at Step 1, to quickly determine current air quality conditions].

Distribute supplies and directions (linked below) to each team and instruct team members to take turns, assist each other, and share equipment (other than tubing, which each individual receives and should mark with initials). Refer students to the Lab Report (distributed at Step 3) on which all data should be recorded. Note that each student should repeat the experiment twice and average the results of the three trials.

Web Resources for Step 5

> **Title:** Lung Capacity Experiment Directions
> **URL:**
> http://www.tryscience.com/experiments/experiments_lung_athome.html
> **Annotation:** Make a copy of these directions for each team.

Step: 6 Duration: 45 minutes
Repetition of Lung Capacity Experiment at a Time of Different Air Quality
Repeat the investigation at Step 5 on a different day or at a different time of the same day, when the Air Quality Index is significantly different. The two investigations (at Steps 5 and 6) must compare vital lung capacity measured one time when air quality is good, and one time when air quality is unhealthy. To quickly determine current air quality, check the Air Quality Index (AQI) level and the major pollutant of the day (if any) at the Clean Air Campaign Web site for metro Atlanta or the Ambient Monitoring Program Web site for the rest of Georgia, both linked at Step 1.

Step: 7 Duration: 15 minutes
Graphing Data
Students should graph the data from their lung capacity experiments. The Lab Report provides grid paper for this purpose. However, if access to Internet-connected computers for the class is easy, the teacher may prefer to have

students enter data at the below-linked Web site to produce full color graphs in an assortment of formats and styles.

Web Resources for Step 7

> **Title:** Create a Graph
> **URL:** http://nces.ed.gov/nceskids/Graphing/
> **Annotation:** Students may select the graph type and colors, then enter data, to generate an eye-catching and professional-looking graph.

Step: 8 Duration: 45 - 60 minutes

Debriefing

Ask each team to present their results. Review the Conclusions sections of the Lab Report, this way: Poll students to see if there was a difference in their average lung capacities, on the day when air quality was good compared to the day when air quality was unhealthy. If results are unexpected, consider why. (Not enough contrast in air quality from first experiment to the next, not enough time outside to make a difference, different pollutants present from one day to the next, etc.) Challenge the class to think of reasons for variations in lung capacity among students, other than pollution (Different size, age, respiratory system condition, and athleticism). Ask why a runner might be at risk for respiratory health effects of air pollution. (Athletic people have greater lung capacity and can therefore breathe in more polluted air. In addition, runners often exercise in afternoon or evening, along roadsides, causing greater exposure to pollutants.

Be sure to reserve time to discuss how air pollution in your area could be reduced, and strategies for protecting lung health. The specifics of this discussion will vary according to your geographic location and the major pollutants in the area. For instance, in urban areas, students could brainstorm ways to reduce vehicle emissions. Refer to the Clean Air Campaign Web site, linked below, for ideas about reducing pollution and mitigating its health effects. In areas affected more by power plant emissions, refer to the Dirty Air web site linked at Step 1.

Wrap up by reiterating the big ideas in this lesson:

1. Lung capacity can be affected by air pollution.
2. Air pollution is measured at locations throughout the state.
3. The Air Quality Index (AQI) is a color-coded rating of the six major pollutants.
3. People can protect their lungs by avoiding exposure when air quality is unhealthy.
4. Air pollution can be reduced by cutting power plant and vehicle emissions and changing behaviors.

Web Resources for Step 8

Title: Clean Air Campaign- Pollution Solutions
URL: http://www.cleanaircampaign.com/
Annotation: Check out the Your Commute and Clean Air Lifestyle, sections, each of which feature clickable links for more information about the specific strategies listed on the left side of the Web page. See also the Air Quality and Health section for information about mitigating health effects of air pollution.

Step: 9 Duration:
Feedback
The Clean Air Campaign is pleased to provide standards-based air quality lesson plans for 4th through 8th grades. Please offer your feedback after implementing this lesson plan, as there is no substitute for real classroom experience. Send teacher name, school name and address, grade level, lesson name, comments or suggestions, and the number of students who completed the lesson to: schools@cleanaircampaign.com. Each teacher who responds will receive a Clean Air Campaign goody bag as a 'thank you.'

Materials and Equipment
For lung capacity experiment~

Each of six teams will need:
1. One 2, 3, or 4 liter plastic bottle
2. One large plastic dishpan, at least 15 cm (6") deep
3. One meter stick
4. One waterproof marking pen
5. One calculator
6. Masking tape (approx. 30 cm)
7. One graduated cylinder or beaker, 100 ml capacity
8. Source of water (e.g. gallon jug)

Each student will need:
9. One 30 – 60 cm (1 – 2 ft) length of aquarium or surgical tubing
10. One copy of Lung Power and Pollution Lab Report
11. One clipboard
12. One set of colored pencils for graphing (unless done online)
13. Internet-connected computer for monitoring and converting pollution data

Total Duration
3 to 4 hours

Technology Connection
Students will use an Internet connected computer to access a Web site where air quality data is stored, and to access an online formula calculator, for converting raw data on pollutants to the Air Quality Index (unless Shortcut Option is selected at Step 3). The teacher will use an Internet-connected computer to review Web resources for background information and to display those Web sites, as well as experiment directions and an animation of the experiment (linked at Step 5) for the class.

Assessment
Completed lab reports will be used to assess student participation and understanding of the primary learning outcomes of this lesson. A scoring rubric is attached.

Attachments

Title: Scoring Rubric for Lung Power and Air Pollution
FileName: Scoring Rubric- Lung Power and Air Pollution.doc
Description: The attached rubric may be used to score all work products of this lesson.

Extension
Remediation
Accommodation
For students with exceptional needs, what changes can be made in instruction and teaching delivery to enhance student participation and learning? Each area below is a direct link to general classroom accommodations.

Non-readers Physical Impairments Sensory Impairments
Attention/Behavior Gifted

Each disability below is a direct link to general classroom accommodations specific for that disability.

Autism
Deaf - Blind
Deaf/Hard of Hearing
Emotional and Behavioral Disorder
Mild Intellectual Disability
Orthopedic Impairment
Other Health Impairments:
Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder
Tourette Syndrome
Significant Development Delay

Specific Learning Disability
Speech - Language Impairment
Traumatic Brain Injury
Visual Impairment

Modification

For students with significant disabilities, what changes can be made in instruction and teaching delivery to allow students to participate in classroom instruction while working on IEP objectives and off grade level GPS standards. Below are suggested modifications correlated to the procedures of this lesson plan.