404 - Air Quality Monitoring

Supports PA STEELS Standards

- 3.2.6-8.A Develop models to describe the atomic composition of simple molecules and extended structures
- 3.3.6-8.M Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
- 3.3.6-8.N Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems.
- 3.4.6-8.D Gather, read, and synthesize information from multiple sources to investigate how Pennsylvania environmental issues affect Pennsylvania's human and natural systems
- 3.4.6-8.E Collect, analyze, and interpret environmental data to describe a local environment.

Summary and Timing

Students use hand-held air quality monitors to measure particulate (PM2.5 and PM10) and carbon dioxide. Students design the investigation to measure air quality in different locations inside the school and the schoolyard. Expand the lesson to engage your students in a MWEE. The kit includes 8 hand-held air quality monitors. Suggested timing 3+ class periods.

Materials *Teacher Provided (view materials)

- Air Quality Monitors
- *Materials to create air pollution test strips

Safety

Establish safe working boundaries for measuring air quality in the schoolyard.

Guiding Questions/Phenomena

What is our local air quality? What human and natural activities affect air quality? How can we improve air quality?

Local Context

- PA DEP Air Monitoring Station Data (Arendtsville, PA is the Adams County monitoring location)
- Purple Air citizen science data maps

Credits and Document Version

Written by Kami Greenawalt (Bermudian Springs School District, PA) for Advancing Science's PACE project. The National Oceanic and Atmospheric Administration provides funding through B-WET Grant Number NA22NMF4570323

404 - Air Quality Monitoring

Procedure

1. What is the atomic composition of the atmosphere?
    a. Read an Introduction to the Atmosphere (PDF) from NOAA
    b. Read the Chemistry of the Air (PDF) from UCAR Center for Science Education

2. What parameters can we measure to describe the quality of the air?
    a. Read about the Air Quality Index Categories (PDF) from AirNow.
    b. Read about Particulate Matter (PM) Basics (PDF) from the US EPA.

3. What activities (human and natural) impact the quality of the air?
    a. Manipulate the Air Pollution Model (HTML) from Concord Consortium to see how pollution and weather impact air quality.

4. What is the air quality in our community?
    a. PA DEP Air Monitoring Station Data (HTML) (Arendtsville, PA is the Adams County monitoring location)
    b. Purple Air (HTML) citizen science data maps

5. Analyze real-time Purple Air Sensor Maps to view Air Quality regionally and worldwide. Purple Air is a citizen science network of sensors deployed at homes, businesses, and schools worldwide. You can adjust the data layer to view US EPA PM2.5, US EPS PM 10, and different weather parameters.
    a. I notice and I wonder – worldwide air quality map, students zoom in and out while looking at various locations of interest to them from around the world. As they examine the map, students should record what they notice and wonder about the world's air quality.
    b. I notice and I wonder – local air quality map, students zoom in and out while looking at local locations they are familiar with or are located near areas they are familiar with. As they examine the map, students should record what they notice and wonder about the world's air quality.

6. Students review satellite maps of the schoolyard to identify locations for air quality testing. Students can mark up a screenshot or printout of a Google Earth satellite map. Students may choose to test near parking areas, roads, building mechanicals, natural areas, inside the building, etc. To measure air quality at the selected locations, students can:
    a. Use AdvSci's handheld air quality monitors (refer to instructions below) and/or
    b. Deploy paper test strips (PDF) to collect particulate. This EPA lesson plan provides a low-tech way to monitor air quality by collecting particulate on sticky tape traps. This low-tech version complements the hand-held monitors and will allow students to visualize the particulate that is reported by the hand-held monitors and online air quality maps. The sticky traps can be deployed for up to a week (but shouldn't get rained on) and can be taken home for students to measure air quality around the community. Use hand lenses or Advancing Science brock scopes to examine the sticky traps for particulate.

404 - Air Quality Monitoring

7. Create a data table to record testing locations, times, and measurements. A sample data table is included below, add or remove columns to align with your investigations. The air quality monitors included in the Advancing Science kit measure PM 2.5, PM 10, and CO_2 levels.

Location	Time	Observations (What activities are occurring? What is the weather?)	Air Quality Measurements			AQI Index (calculator)
			PM2.5	PM10	CO_2	

8. Predict which locations will have the best air quality. The worst air quality. Why?
9. Review safety guidelines for outdoor measurements.
10. Practice using the air quality monitor by taking a group measurement and reviewing the data. Review the quick-use guide included in the lab kit and at the end of this document.
11. Collect air quality data at different locations.
12. Convert your air quality measurements to Air Quality Index category using this calculator (HTML) from AirNow.
13. Compare data between classes – Did the results vary by time? By date? Do patterns exist? What locations had the best air quality? The worst?
14. Revisit Purple Air Sensor Maps. Have a class discussion about air quality patterns, outliers, and gaps in sensor data.
    a. Analyze the data for patterns, outliers, and gaps in sensor data.
    b. What activities (human or natural) might explain the patterns? Transportation, industrial areas, agriculture, wind patterns, forest fires, etc.
    c. Compare your air quality data with nearby sensors.
    d. What solutions could be implemented to improve the air quality?
15. Encourage a class discussion around solutions to air pollution. Emphasize local solutions that students can engage in to educate their community and improve local air quality. Student ideas may include: carpools, biking/walking instead of driving, no idle zones, use of electric-powered equipment, composting/recycling instead of burning garbage/yard waste, planting trees, litter cleanup, community education, and more. Support your students by providing guidance, an audience with decision-makers in the school district/community, opportunities to share/display their results through posters/media, and/or contribute their data to citizen science.

References

- Clean Air Act Summary from the US EPA
- PA Air Quality Standards from the PA DEP
- PA Air Monitoring Station Data (Arendtsville, PA is the Adams County monitoring location)
- Eastern Pennsylvania Alliance for Clean Transporation
- Alternative Fuel Station Locator
- Biofuels vs. Fossil Fuels Lesson

404 - Air Quality Monitoring

- Purple Air
- World's Air Pollution: Real-time Air Quality Index
- Biofuels
- Mason Dixon Farm
- Biofuels Lab - United States Naval Academy
- Everything Science video, What are biofuels and where are they going?
- Air Strips Lesson Plan - EPA

404 - Air Quality Monitoring

Air Quality Monitors – Quick Guide

Main display screen
Use arrows to scroll up/down, use power button to select

Power on/off
OK/select

Menu (view graph)

Back

Scroll up

Scroll down
Collect/pause data

PM 2.5 and 10 Screen

CO2 Screen

All Information Screen

To view the graph for PM2.5 or CO2 - click the "menu" button, arrow down to highlight "display the curve", press "ok"