ENVIRONMENTAL HEALTH INVESTIGATORS

Curriculum for Grades 6, 7, and 8

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Program Background

The Environmental Health Investigators program was funded by the National Institutes of Health (NIH), National Institute of General Medical Sciences (NIGMS), Science Education Partnership Award (SEPA). The NIH's Science Education Partnership Awards aim to encourage partnerships among biomedical and clinical researchers and teachers, schools, museums, science centers, media experts, and other educational organizations.

Project Overview

The Environmental Health Investigators program was designed to emphasize students taking an active role in community-based research to address environmental health. Throughout the three modules, the curriculum shows students how to become Environmental Health Investigators in their community. The activities are designed to help generate and sustain interest in health sciences through authentic investigations in a real-world context that connects to the participants' community. The Environmental Health unit introduces students to causes and health consequences of air, noise, and soil pollution in their communities. The Photovoice module leads students through collecting photographs as qualitative data of their environment. The Student Research portion of the project encourages teamwork, problem-solving, and critical-thinking skills while students put the scientific process into practice to collect data on, analyze and share about environmental issues in their communities. We know from environmental justice research that underserved and marginalized communities are even more likely to be affected by environmental health risks. This project engages youth in authentic science activities which develop skills that can empower communities to protect their environmental health and generate interest in health science and health-related careers.

Curriculum Design Method

This curriculum was first developed for a middle school out-of-school program, but it can be adapted to most formal and informal classroom settings. Our intention is that by participating in authentic and relevant scientific content that connects to the students' community, students will develop a strong interest in and personal connection with science. The curriculum has the flexibility to support informal learning with variations in student background knowledge and attendance, and is cohesive enough to fit into formally structured classrooms. The curriculum includes a total of three modules, each with its own focus and arc of connected activities.

We hope that these modules will foster a natural progression in student learning, allowing students to identify relevant environmental health concerns in their community, learn ways to monitor these concerns, and finally apply those monitoring skills to research environmental concerns and possible solutions. The curriculum focuses on environmental health topics like air pollution, noise pollution, and soil pollution and helps students to connect these topics with their own health and the health of their families and communities.

Cultural Context and Diversity, Equity and Inclusion

We developed and implemented this curriculum in the context of the Metro East region of Southwest Illinois, directly across the Mississippi River from St Louis, MO, an area with a history of environmental injustice that still impacts the community.[1] We recruited participants from multiple schools with varied student demographics, and hope that our engagement with these student populations will help build a diverse cohort of youth in the greater St. Louis metropolitan area who are prepared for, and interested in, advanced education in environmental health-related careers. We have included counterstereotypical imagery in the course content where applicable, and have included numerous place-based examples and datasets that our students could directly relate to. We have also included content in some of the activity plans that explores environmental justice issues. We highly recommend that curriculum users replace some of our place-based content with examples grounded in the region where the curriculum is being implemented.

Accessibility and Navigation

The headings in the Table of Contents allow readers to jump to that section. The beginning of each curriculum module shows an overview of the section and lists supplies that would need to be purchased, borrowed, and/or prepared ahead of time. Each activity plan contains hyperlinks that will open a window to download supplemental materials needed to complete the activity plans, as well as hyperlinks to external online resources. For users who may be working from a printed paper copy, we have also written out the full URLs for external links in the Resources section of each activity plan. We have included alternate text descriptions of images within the activity plans to make the curriculum more accessible for those using screen readers, and a Microsoft Word version is also available upon request.

Assessment

We developed this curriculum in informal science learning contexts, thus formal, graded assessment was not a focus in our original implementation. While we sought to maintain a high level of academic rigor and alignment to NGSS standards, we intentionally designed the activity plans to be applicable to either a formal or informal learning context. We have included rubrics for some activities that could become graded evaluations if desired. Each activity also includes discussion questions that can be used to evaluate student learning, and these questions could also be incorporated into graded assessments if desired.

Accessing Equipment

An important component of this curriculum is interaction with working scientists and real scientific tools. If the user is in proximity to the SIUE campus in

[1] Gonzalez, J., Feng, L., Sutherland, A., Waller, C., Sok, H., Rob Hesse, P., & Rosenfeld, P. (2011). PCBs and dioxins/furans in attic dust collected near former PCB production and secondary copper facilities in Sauget, IL. Procedia Environmental Sciences, 4, 113-125. https://doi.org/10.1016/j.proenv.2011.03.014

Southwestern Illinois, we encourage instructors to contact the STEM Center for assistance in connecting with guest scientists and to inquire about borrowing materials like environmental sensors from our lending library. Wherever you are located, nearby universities or state extension offices can be good resources for connecting with working scientists and borrowing scientific tools.

Curriculum Overview and Standards Alignment

The lesson plans in this curriculum are designed to be used alongside other content that supports the complete fulfillment of the educational standards listed in the table below. This curriculum is multidisciplinary in its nature and we have listed alignment with English and language arts standards as well as math and science standards where applicable.

The majority of the curriculum is aligned to content in the Earth Space Science and Physical Science domains of the Next Generation Science Standards (NGSS) and partially fulfill a Disciplinary Core Idea (DCI) and Performance Expectation (PE). All activities also incorporate at least one science and engineering practice (SEP) and cross-cutting concept (CCC).

	NGSS Disciplinary Core Concepts	**NGSS Science & Engineering Practices**	**NGSS Cross-cutting Concepts**	**Art, ELA, & Math Alignment**	**Number of sessions**
Optional Lesson 0 - Living in our Environment					1
Environmental Health Module	*ESS3.A* *ESS3.C* *PS4A*	1,2,3,4,5,6	1,2,3,4,7	*6-8.R.ST.3* *6-8.R.ST.7* *K-12.MP.2-6* *6.SP.1-5*	9
Environmental Photovoice Module	*ESS3.C*	1,6	1,2,7	*VA:Cr.1,2,3* *VA:Pr.4,5,6* *VA:Cn.10,11* *6-8.W.3,4,5*	8
Student Research Module	*ESS3.A* *ESS3.C*	All 1-8	1,2,3,4,7	*6-8.W.1-6* *6-8.R.ST.3* *6-8.R.ST.7* *K-12.MP.2-6* *6.SP.1-5* *7.SP.1-2*	9*

*Some lesson plans can be repeated to allow students more time to work on projects. Each activity plan is designed for a one-hour session.

This lesson may be used as an introduction to the whole curriculum, especially for students who have little prior knowledge about the environment's impact on their health. Alternately, this activity could be used in place of the Environmental Health module before moving on to Environmental Photovoice or the Student Research module if a shortened implementation is needed.

NIH SEPA Environmental Health Investigators
Activity 0
Grade Level: Middle School
Duration: 50-60 minutes

Living In Our Environment

Introduction

The health of the environment affects the health of its inhabitants. In this lesson, students will define what an environment is and discuss how environments affect human health.

Objectives

1. Students will be able to define the environment.
2. Students will be able to explain the type of environment they live in and the impact this type of environment can have on their health.

Materials

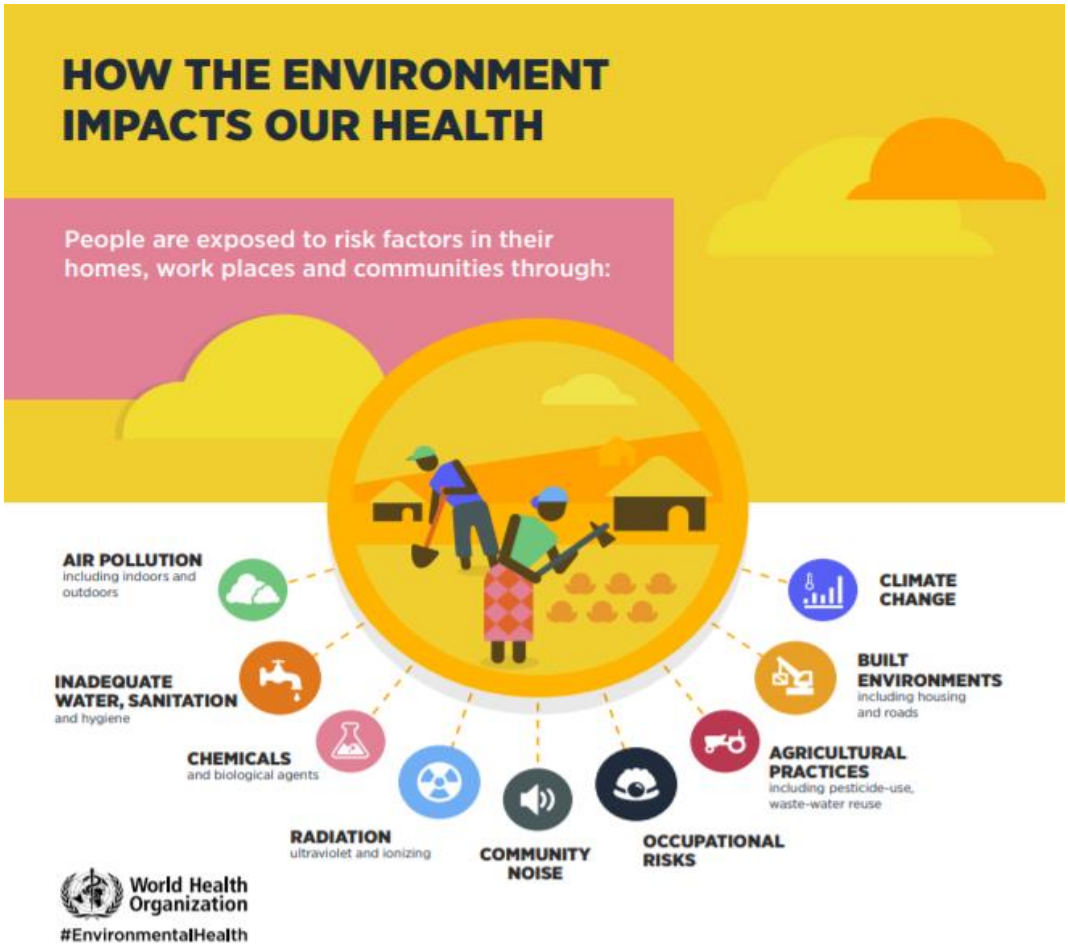
- Projector/smartboard
- Living in Our Environment slides

Keywords: environment, interaction, health, photography

Engage

There are living and nonliving parts of the environment, from microscopic organisms to large animals. Humans are also a part of the environment, interacting with all the other living and nonliving elements of it. Use the Living in Our Environment slides to get the students thinking about their environment. Make sure to spend ample time on the example pictures leading students to think about the connections between humans' impact on the environment and how the environment impacts human health. You can also replace some of the pictures with pictures from your local area. Be sure to ask students about environments that are meaningful to them like favorite places or how they feel in certain places in their neighborhood.

Discuss how interactions between people and the environment could be healthy or not healthy. As the group brainstorms, have a student record a list of healthy and a list of potentially unhealthy factors on the board. *What factors can potentially contribute to how the environment impacts human health?* Give students examples of environmental-



related diseases (i.e. cancer, diabetes, lung diseases) and encourage them to give examples that they know. Guide students to think about the systemic impacts of the environment on health rather than focusing on individual healthy or unhealthy choices. *How are these diseases related to the quality of the environment? Ask students for examples of environmental characteristics that would have positive impacts on human health as well as examples of negative impacts.* According to the World Health Organization, 24% of all global deaths are linked to the environment, which is roughly 13.7 million deaths a year. The health of the environment affects the health of the people regularly exposed to that environment. Clean air, soil, water, and healthy noise levels support human health.

Mission

This week, journal about one outside place in your environment. What do you observe that defines the environment? How does it make you feel?

Resources

- Living in Our Environment slides
- "Environments Episode 1: What is the Environment?": https://www.youtube.com/watch?v=S_XhwQmpzoE
- The article *What is the environment in the context of health?* defines what an environment is and how it relates to health: https://www.who.int/quantifying_ehimpacts/publications/preventingdisease2.pdf
- The material *Environment and Health A to Z* indicates how the environment impacts our health and describes some diseases that are caused by unhealthy environments: https://www.niehs.nih.gov/health/materials/environment_and_health_a_to_z_508.pdf

MODULE ONE: Environmental Health

The Environmental Health portion of the curriculum focuses on air, noise, and soil pollution and how these issues can impact human health. Students learn about soil formation and soil nutrients with hands-on activities that let them use real scientific collection and testing tools. The noise pollution activities teach students about sound waves and about how sound pollution is shaped by the characteristics of the landscape. Students learn about air pollution like particulate matter and use data visualizations to communicate about environmental conditions. Throughout this module, students get to explore environmental monitoring tools such as sound monitors and air quality meters.

Environmental Health Module Lesson Plan Overview

1) Introduction to Pollution and Environmental Health

Introduction

In this lesson, students will be introduced to environmental health, specific types of environmental issues that can affect their health, and how scientists can use research to learn and address these issues.

Objectives

1. Students will be able to define and discuss topics in environmental health.
2. Students will be able to identify how noise, air, and soil can affect human health.

Materials

- Student notebooks
- Student computers with internet
- Sticky notes with words prewritten from Table 1 (sources and effects)
- Handout Types of Pollution

2) Introduction to Soil and Soil Pollution

Introduction

In this activity, students will learn about soil, how healthy soils affect human health, and standard scientific measures of soils. They will collect soil today that they will use in a later lesson.

Objectives

1. Students will be able to describe how soil forms.
2. Students will be able to describe the components of soil.
3. Students will be able to use scientific instruments to collect soil samples.

Materials

- T-probes, handheld GPS or cell phone (optional), resealable plastic bag, sharpies, metal spoon or trowel [one set per group]
- Soil collection datasheet

3) Soil Nutrients and Pollution

Introduction

In this activity, students will use soil samples they collected in the last lesson to test acidity and nutrient levels, and learn about how soil nutrients themselves can become pollutants.

Objectives

1. Students will be able to explain nutrient pollution and how it occurs.
2. Students will be able to use scientific instruments to collect and analyze soil samples.

Materials

- Soil collection datasheet
- Previously collected soil samples, settled overnight according to kit directions
- Soil chemistry test kits (such as those available at Lowes)

4) Noise Pollution I

Introduction

One form of pollution that many of us are exposed to daily, but cannot see, is noise pollution. In this activity, students will learn how to identify noise pollution by learning more about sound waves. They will use noise monitoring technology to explore noise levels in their own environment and collect noise data to learn about how different physical characteristics of the environment affect noise.

Objectives

1. Students will be able to explain how sound waves form.
2. Students will be able to use a sound meter or app to measure sound.
3. Students will be able to explain how physical characteristics of the environment affect noise and the level of noise pollution people may experience.

Materials

- Khan Academy video
- Hand-held noise monitors OR student tablets/mobile devices with Decibel X app

5) Noise Pollution II

Introduction

This session covers how sound waves produce sound and how that sound is measured through decibels. They will understand what noise pollution is and its potential health impacts. They will also use a citizen science app to explore noise pollution data.

Objectives

1. Students will be able to accurately compare common sounds and their noise levels.
2. Students will understand the logarithmic scale and how it relates to measuring noise pollution.
3. Students will understand environmental health impacts of noise pollution.

Materials

- Hearing Loss Simulation
- "How Loud is It?" sheets
- Comparison: Loudest Sound video
- Powers of Ten video
- Student tablets/mobile devices with Noise Project app

6) Noise Pollution III

Introduction

In this lesson, students will learn how sound is received by the human brain. They will then discuss what makes sound become noise pollution, and what local citizens and officials can do to reduce this pollution.

Objectives

1. Students will be able to describe how sound is received by the human brain.
2. Students will be able to collect data and use it to understand the auditory landscape of their environment.

Materials

- Noise monitors OR student tablets/mobile devices with app
- Journey of Sound to the Brain video
- Access to a variety of locations indoor/outdoor

7) Air Pollution I

Introduction
In this session students will learn some background about types of pollution and their potential health implications. They will also learn one of the ways that air pollution specifically is described and measured and create DIY air samplers to collect their own data on large particulate matter.

Objectives
1. Students will be able to define air pollution, how air pollution is measured, and its implications for human health
2. Students will be able to create an air pollution sampler and use it to collect data

Materials
- Student Journals/notebooks
- Chromebooks
- White paperboard (paper plates, paper cartons, or poster board)
- Hole punch, string, petroleum jelly
- Note: Dry weather for next 3 days or covered location needed for outdoor collection

8) Air Pollution II

Introduction
This session introduces students to the air quality rating system that helps us understand when air pollution can be a threat to our health. They will also return to their DIY air samplers to collect their own data on large particulate matter. Students will create graphs of air quality in their community using the data the class has collected.

Objectives
1. Students will be able to describe different levels of air quality and their potential health impacts.
2. Students will be able to record and interpret data collected from their own air samplers for particulate matter.
3. Students will be able to create data visualizations from the data they have collected.

Materials
- Instructor computer, projector
- Student computers with internet
- Student computers with internet

- Macroscopic Particulate Matter Datasheet
- Magnifying glass (optional)
- Graph paper (optional)

9) Air Pollution III

Introduction

In this session, students will review the definition of air pollution and how it is measured. They will explore air quality data from one of the program's PurpleAir monitoring network sites and collect their own data on air quality using handheld devices. Students will learn how to graph air quality data.

Objectives

1. Students will be able to recognize patterns in air quality data.
2. Students will be able to collect data on air quality.
3. Students will be able to graph data quality data.

Materials

- Environmental Health Investigators Research Journal
- Chromebooks for students
- Handheld air quality monitors

Standards Alignment for Environmental Health Module

NEXT GENERATION SCIENCE

Performance Expectations

MSESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Disciplinary Core Ideas

ESS3.A: Natural Resources

Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

ESS3.C: Human Impacts on Earth Systems

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But

changes to the Earth's environment can have different impacts (positive or negative) on different living things.

PS4.A: Wave Properties

A sound wave needs a medium through which it is transmitted.

Science and Engineering Practices

1. Asking Questions and Defining Problems: A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

2. Developing and Using Models: A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

3. Planning and Carrying Out Investigations: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

4. Analyzing and Interpreting Data: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

5. Using Mathematics and Computational Thinking: In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

6. Constructing Explanations and Designing Solutions: The products of science are explanations and the products of engineering are solutions.

Cross-cutting Concepts

1. Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. Cause and effect: Mechanism and explanation: Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. Scale, proportion, and quantity: In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. Systems and system models: Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
7. Stability and change: For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

ENGLIGH & LANGUAGE ARTS

Reading in Science and Technical Text

6-8.R.ST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
6-8.R.ST.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

MATH

Statistics and Probability

6.SP.1-3: Develop understanding of statistical variability.
6.SP.4-5: Summarize and describe distributions.

Mathematical Practices

K-12.MP.1: Make sense of problems and persevere in solving them.
K-12.MP.2: Reason abstractly and quantitatively.
K-12.MP.3: Construct viable arguments and critique the reasoning of others.
K-12.MP.4: Model with mathematics.
K-12.MP.5: Use appropriate tools strategically.
K-12.MP.6: Attend to precision.

NIH SEPA Environmental Health Investigators
Environmental Health 1
Grade Level: Middle School
Duration: 50-60 minutes

Introduction to Pollution and Environmental Health

Introduction

In this lesson, students will be introduced to environmental health, specific types of environmental issues that can affect their health, and how scientists can use research to learn and address these issues.

Objectives

1. Students will be able to define and discuss topics in environmental health.
2. Students will be able to identify how noise, air, and soil can affect human health.

Keywords: environmental health, research, noise pollution, air pollution, soil pollution

Materials:

- Student notebooks
- Student computers with internet
- Handout Types of Soil Pollution
- Sticky notes with words prewritten from Table 1 (sources and effects)

Opening

Ask students to define and describe environmental health as a class. What areas of environmental health are they already familiar with? What is an environment and how do they think that relates to human health? You can write or have a student write the responses on the board while the rest of the class write in notebooks.

Once the class has discussed responses for your questions, explain that the focus of the session's activity will be on noise, air, and soil quality in the environment. Ask the students what they know about noise, air, and soil quality and pollution. Do they think they experience noise, air, or soil pollution? What objects or issues in their environment might cause this? These responses can be written in their notebooks as well.

Engage

Explain to students that there are many topics that scientists can research to understand and attempt to improve environmental health conditions. Have the students visit The National Institutes of Environmental Health Sciences website and start with all the students reading What Does an Environmental Analyst Do? Once they have read this letter, they can return to the main "Meet the Scientist" webpage where they can choose another link to read about what working scientists in the environmental health science careers do for a living: *Meet the Scientist | Kids Environment Kids Health - National Institute of Environmental Health Sciences*. You may want to provide more

structure by assigning each pair or student a scientist on the website to read about. After each student/pair has had a chance to read about one of the scientists, have each group share the name and one scientific skill that their person uses in their job aloud to the class.

Next, they can pair up to discuss what areas of environmental health they would be interested in studying. These topics of interest can be written or drawn in their notebooks. How do these areas relate to their everyday lives? What questions about environmental health would they like to try and answer?

Now that we have explored a few environmental science careers, we are going to look more closely at what it would look like to be an environmental scientist who focuses on how pollution affects human health. Students will get the opportunity to act as environmental scientists and collect data in their community during this program to see how various areas of their environment could potentially be affecting their health. Students will build on this knowledge further in following sessions in preparation to collect data.

Next, students will learn the basics of the meaning of noise, air, and soil pollution. You can start with what the students already know about noise, air, and soil pollution and their health effects and add more information from below. Students can answer the questions on the types of pollution handout as you go along, or afterwards as a review.

Noise Pollution: Sound is formed through sound waves. Waves transport energy through a medium, such as air, without transporting the medium itself. Sound waves vibrate the eardrum which in turn vibrates the inner ear bones. This starts a reaction that eventually sends a message to the brain that it is hearing a sound. When sound is unwanted or excessive and can have negative effects on human health or environmental quality, it is considered noise pollution. Being exposed to noise pollution over long periods of time can cause health problems such as high blood pressure, anxiety, and hearing loss among other things. Demonstrate the result of hearing loss to the students by sharing this hearing loss simulation with them.

Air Pollution: Air pollution is a high concentration of certain substances or particles that causes the atmospheric environment to become toxic enough to have adverse impacts on human health and the environment. Air pollution can cause respiratory conditions such as asthma and emphysema, cancer, cardiovascular disease, and more.

Soil Pollution: Soil pollution is the presence of pollutants or contaminants in soil, in high enough concentrations to pose a risk to human health or the environment. Soil can affect human health directly such as skin and eye irritation by contact, or indirectly such as containing chemical toxins that leach into food sources causing illness. Environmental Health is an area of public health that monitors and/or mitigates those factors in the environment that affect human health and disease. Environmental health scientists use research to identify the relationships and risks of the physical

environment around us on our health. Their research can then be used to try to understand and improve the public's health by addressing these environmental risk factors.

Do

Next you and the students will create and fill in a version of Table 1 together on the board. Begin by writing the types of pollution at the top in three different sections of the board (air, noise, soil), and create a column for sources and a column for health effects for each type of pollution. Next use the sticky notes you have prepared ahead of time with some of the sources/examples or health conditions written down from Table 1. Have the students take turns placing the health condition under the related type of pollution. For example, if the sticky note says “lawnmower 90dB”, the student would place that sticky note on the board under Noise Pollution Source, if the sticky note says “asthma” the student would place that note under Air Pollution Health Effects.

Table 1. Environmental Pollutant Cause and Effects

Pollution Type	**Sources/Examples**	**Possible Health Effects**
Air	Carbon monoxide from car exhaust, nitrogen oxides, sulfur oxides, and particulate matter from manufacturing (pollen, dust, smoke, liquid droplets, etc)	Allergies, lung disease, asthma, heat disease, chronic bronchitis, emphysema
Noise	Road traffic sounds, lawnmowers and leaf blowers, air conditioner sounds, sounds of industrial manufacturing, noise of construction equipment	Hearing loss, high blood pressure, heart disease, sleep disruption, mental stress and anxiety
Soil	Accidental oil spills, acid rain, pesticides, herbicides, ammonia, petroleum hydrocarbons, lead, nitrate, mercury	Nausea and vomiting, cancer, nervous system damage, kidney and liver disease, skin rashes

Wrap Up

Have students review what they have learned by filling out the handout or by asking the questions aloud and having students respond as a group.

Resources

- NIH National Institute of Environmental Health Sciences website: https://www.niehs.nih.gov/
- World Health Organization Environmental Health webpage: https://www.who.int/health-topics/environmental-health#tab=tab_1
- National Geographic Pollution webpage: https://www.nationalgeographic.org/encyclopedia/pollution/
- Gizmos Effect of Environment on New Life Form simulation webpage: https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=397
- Starkey Hearing Loss Simulation: https://www.starkey.com/hearing-loss-simulator/simulator

NIH SEPA Environmental Health Investigators
Environmental Health 2
Grade Level: Middle School
Duration: 50-60 minutes

Introduction to Soil and Soil Pollution

Introduction

In this activity, students will learn about soil, how soil health affects human health, and standard scientific measures of soils. They will collect soil today that they will use in a later lesson.

Objectives

1. Students will be able to describe how soil forms.
2. Students will be able to describe the components of soil.
3. Students will be able to use scientific instruments to collect soil samples.

Keywords: parent material, soil, sampling, outdoors

Materials

- T-probes, handheld GPS or cell phone, resealable plastic bag, sharpies, metal spoon or trowel [one set per group]
- Soil collection datasheet

Engage

Before the students begin learning about soils, ask them if they know how soil forms and where does soil come from?

To start the activity, the instructor and students will work together to build a conceptual model of how soil forms. Begin by drawing a representation of soil on the board. How do students think soil formation starts? What is in soil and how did the components and other objects in soil get there? Soil components are the materials that make up soil (including minerals, water, organic material like dead plants and animals, gasses, and living microorganisms).

Soils begin to form when rocks that are at the surface of the Earth start to disintegrate, or break down (Figure 1). Wind, water, gravity, and freezing and thawing cycles cause the rock (the parent material) to break down into smaller pieces. As the rock cracks, plants are able to sink their roots in the cracks of the rocks. As more plants grow in the broken-down rocks, the plants release a mild acid after they die and decompose, further disintegrating the rocks. Over time, the rocks fully break down into soil where plants and animals can thrive. Although the soil is now fully formed, biological, chemical, and physical weathering continue, which continues to lead to new soil environments.

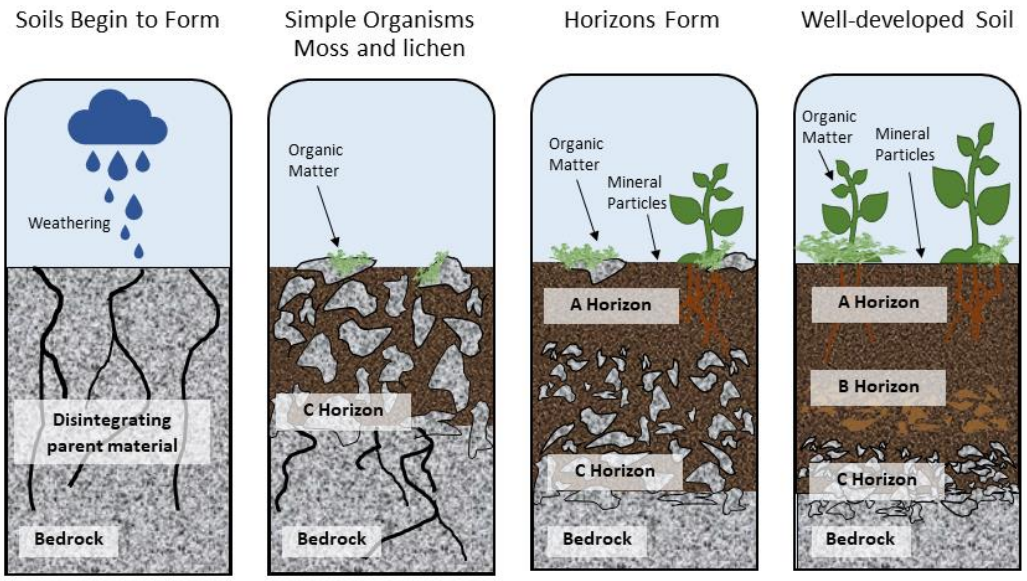


Figure 1: Example of conceptual model of soil formation.

As you work with the students to draw out and explain the conceptual model, prompt them to consider rocks, the physical, biological, and chemical processes that weather rocks (gravity, wind, climate, freezing and thawing cycles, water), and living organisms like plants and animals.

Remind students that there is no end point to which all soils will develop—all soils will continue to change and evolve over time and all soils are different from one another. Soils that form from a similar parent material, under similar environmental conditions with similar living organisms will likely result in similar soils, but all soils are unique. This is why tropical soils are different from prairie soils, but many tropical soils will be similar to one another.

Soil plays a vital role in the health of the planet. Soils provide the foundation for plants to grow by being the anchor for roots. Soils also hold water and other nutrients that support plant growth. Soils are the primary habitat for a host of organisms and microorganisms. Without soil, human society would not be possible. Humans need soil to grow the agricultural products that feed us and the animals we eat. We also build buildings, highways, bridges, and other structures on soil. On Earth, soil is one of a few key substances that allows life, including human society, to thrive.

Do: Collecting soil samples

Now that students have learned how soil forms and a little more about what soil is made of, we are going to do some hands-on soil exploration. *Before collecting soil samples,*

make sure you have permission from the property owner. The process of collecting soil samples will make a small, 2-cm sized hole (less than one inch) in the ground. The hole will not pose a tripping hazard and will naturally and quickly fill back in.

Break students into teams based on the number of T-probes available to your class. Have the students go outside and select a location to collect their soil sample (see note below about location selection safety and sampling depth before allowing the students to take the sample). Once the students have their location selected, have them record observations about that location in their notebooks or on their soil collection datasheet. Good observations include nearby human-built structures like buildings, parking lots, sidewalks, retention ponds, or natural features of the landscape like the base of a hill.

It is also a good idea to prepare the sample bag before collecting the sample. Ask the students what information they should include on their sample bag. Good information to include on the sample bag includes the sample number, group taking the sample, and the date. Point out to the students that when scientists take soil samples, they will have the information written on their sample bag before they take this sample.

Once the supervising staff has approved the students sample location, have the students use the T-probe to sample the soil. The T-probe should go into the ground relatively easily if the soil is not compacted or very dry. Assist students who may need help. Once they have placed the probe about one foot into the ground, have them rotate the probe (twisting the probe clockwise or counterclockwise) one quarter. This will trap the sample in the probe. Once they have rotated their probe, have them gently remove the probe. Again, students may need help with this. Sometimes, there could be resistance getting the probe out of the ground.

After they have the T-probe out of the ground and the sample in the probe, the students should write down observations on their soil collection datasheet. Descriptions of the soil can include the soil moisture level (does the soil appear dry), the number of layers they sample (the stratigraphy of the soil). If they have a camera, they also might want to take a picture of their sample before removing it from the probe.

Reflect

Save samples since the students will conduct further testing on their soil in the next session. *Look ahead at the directions for the soil testing kit and see if you need to let the samples settle in water overnight.* They will keep their datasheet to continue recording in the next session.

Resources

T-probe sampling safety:

There are a few things you should be aware of when students select their sample location. If you are in a developed area (e.g., school grounds) many of the soil around

the school will be heavily modified soils and sediments. Before construction begins, construction crews move soil around to create flat ground or they bring in sediment. Some areas that are heavily modified by people can be difficult to sample because they are so compacted. Given the difficulty sampling these areas, students may want to change locations if they are meeting heavy resistance when trying to collect their sample

The opening for the T-probe, the portion of the tool that is plunged into the ground, is relatively small, approximately 2 centimeters. Because the opening is so small, gravel can easily get in the opening, which makes it impossible to collect a good soil sample. Construction crews often bring in gravel to support structures and assist with drainage, so gravel is frequently nearby human-built structures. If the students encounter a lot of resistance when they try to take their sample, have them remove the probe and check to see if gravel is not blocking the opening. If an area is heavily graveled, the students likely will not be able to get a soil sample using the T-probe.

People also bury a number of pipes, wires, cables, and other utilities underground. In most cases, cables and wires will be enclosed in protective piping, but this is not always the case. Make sure that students do not place their T-probes near the electrical boxes for structures, near light posts, or near other features on the ground's surface indicating that buried utilities are nearby. In most cases, buried utilities are required to be buried at least two feet underground. If you are in a developed area, make sure students do not insert their probes more than one foot into the ground. The one-foot mark on the T-probes is indicated with electrical tape. If students are in an area that is not developed and buried utilities are not present, students can sample deeper than one foot.

- https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/
- https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/
- https://www.americangeosciences.org/education/k5geosource/content/soils/how-do-different-types-of-soils-form
- https://soils.landcareresearch.co.nz/topics/understanding-soils/how-do-soils-form/
- https://soils.landcareresearch.co.nz/topics/understanding-soils/how-do-soils-form/soil-profile/
- https://climate-woodlands.extension.org/basic-soil-components/

NIH SEPA Environmental Health Investigators
Environmental Health 3
Grade Level: Middle School
Duration: 50-60 minutes

Soil Nutrients and Pollution

Introduction
In this activity, students will use soil samples they collected in the last lesson to test acidity and nutrient levels, and learn about how nutrients themselves can become pollutants.

Objectives
1. Students will be able to explain nutrient pollution and how it occurs.
2. Students will be able to use scientific instruments to collect and analyze soil samples.

Keywords: soil, nutrients, nutrient pollution

Materials
- Previously started soil collection datasheet
- Previously collected soil samples, settled overnight according to kit directions
- Soil chemistry test kits (such as those available at Lowes)

Engage: Environmental Health and Soil Chemistry
Remind students that soil plays a vital role in the health of the planet. Soils provide the foundation for plants to grow by being the anchor for roots. Soils also hold water and other nutrients that support plant growth. Humans need soil to grow the agricultural products that feed us and the animals we eat. In order to feed the rapidly growing number of humans who inhabit our planet, we use modern agricultural techniques including herbicides, pesticides, and fertilizers to increase crop yields. However, these additions to the environment can become pollutants if they are not carefully managed. Nutrient pollution is caused when nutrients that are usually beneficial like phosphorus and nitrogen, get into the environment at concentrations much stronger than would occur naturally, usually through overapplication or runoff from agricultural fertilizers.

One way that farmers can reduce their contribution to nutrient pollution is by testing their soil before they decide how much and what type of fertilizer to use. Testing the pH of soil can also help farmers and gardeners know what type of plant might grow well in their soil that matches with the level of soil acidity.

Do: Testing Soil Chemistry
Conduct the soil chemistry testing. Depending on what soil test kit you have available, follow the directions to test for phosphorus, nitrogen, potassium, and/or pH. In general,

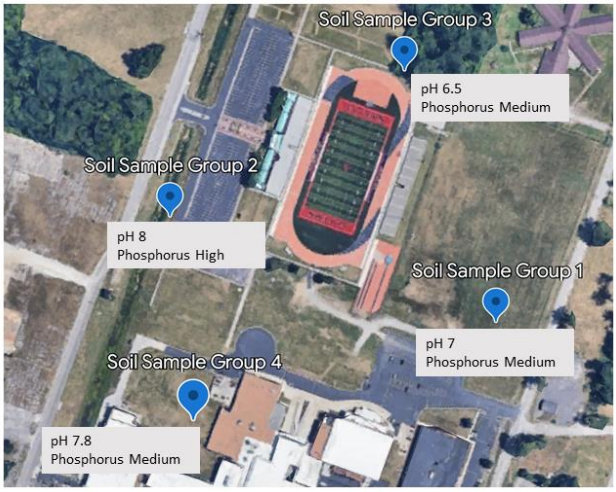
the directions will probably involve adding water and a reagent for each element and then matching color change to the key provided. Most kits can be used multiple times for several groups to share. Have each group record their results on their soil datasheet.

Once each group has obtained their results you can map their findings for the whole class. You can use Google Earth to do this if you recorded GPS coordinates, or you can have students draw maps (see example Figure 1). Combine all groups data onto the same map to look at patterns in their findings across the landscape. How do the samples vary? Does the variation seem to relate to other characteristics of where the samples were taken? Which spot on the map would be good to grow vegetables and why?

Reflect

Discuss what are the potential impacts of the measured soil pH on plant growth and lead release. Note that as pH declines, lead in the soil will become more bioavailable. How can understanding soil chemistry prevent nutrient pollution?

Figure 1. Example map of soil sampling locations



Resources

- https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/
- https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/
- https://www.americangeosciences.org/education/k5geosource/content/soils/how-do-different-types-of-soils-form
- https://soils.landcareresearch.co.nz/topics/understanding-soils/how-do-soils-form/
- https://soils.landcareresearch.co.nz/topics/understanding-soils/how-do-soils-form/soil-profile/
- https://climate-woodlands.extension.org/basic-soil-components/

NIH SEPA Environmental Health Investigators
Environmental Health 4
Grade Level: Middle School
Duration: 50-60 minutes

Noise Pollution I

Introduction

One form of pollution that many of us are exposed to daily, but cannot see, is noise pollution. In this activity, students will learn how to identify noise pollution by learning more about sound waves. They will use noise monitoring technology to explore noise levels in their own environment and collect noise data to learn about how different physical characteristics of the environment affect noise.

Objectives

1. Students will be able to explain how sound waves form.
2. Students will be able to use a sound meter or app to measure sound.
3. Students will be able to explain how physical characteristics of the environment affect noise and the level of noise pollution people may experience.

Keywords: sound waves, noise pollution, sound meter

Materials

- Khan Academy video
- Hand-held noise monitors OR student tablets/mobile devices with Decibel X app

Engage

Ask students what they know about sound. How is sound created? How do we hear sound? Show students the Khan Academy video.

Sound is formed through sound waves. Waves transport energy through a medium, such as air or water, without transporting the medium itself. Sound waves produce rapidly moving vibrations in the air. That air reaches the eardrum which in turn vibrates the inner ear bones. This starts a reaction that eventually sends a message to the brain that it is hearing a sound. When sound is unwanted or excessive and can have negative effects on human health or environmental quality, it is considered noise pollution. Being exposed to noise pollution over long periods of time can cause health problems such as high blood pressure, anxiety, and hearing loss among other things.

Scientists have developed terms to describe the components of sound waves (Figure 1). As sound waves change and sound different, components of the wave change.

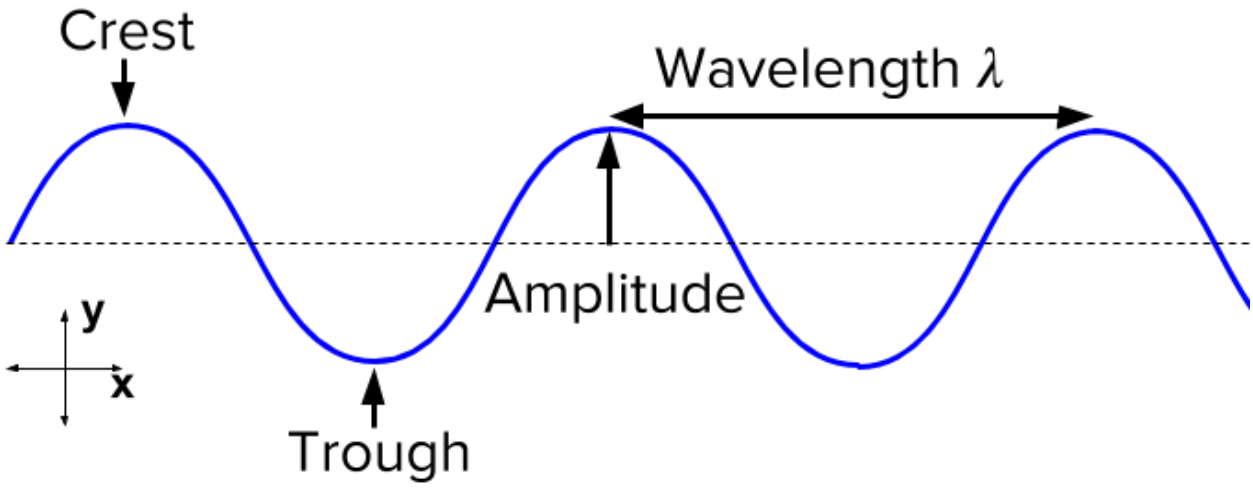


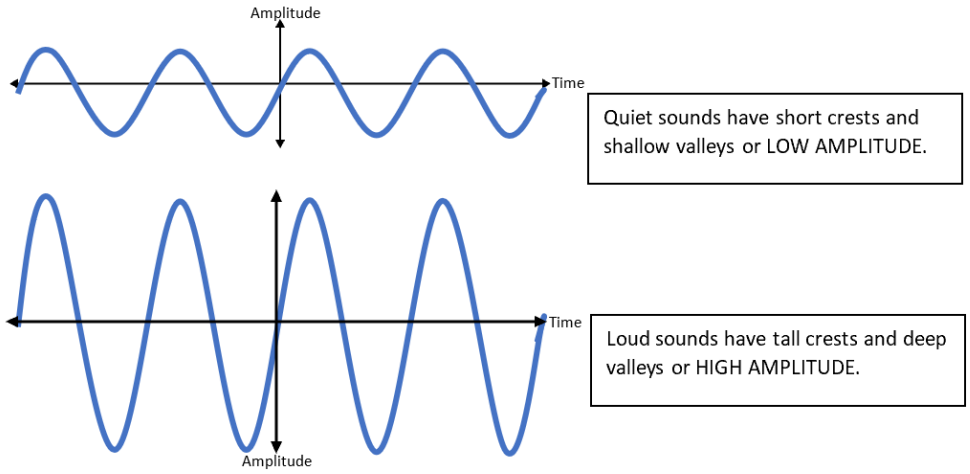
Figure 1. Components of a sound wave.

Within a wave, there is the wavelength, amplitude, crest, and trough (Figure 1). The crest is the highest point of the wave and the trough is the lowest point. The wavelength of a sound wave is the distance between two adjacent crests (maximum points) or troughs (minimum points). The amplitude of a wave is the maximum amount of displacement from its resting position.

What makes a sound loud? What makes a sound quiet? Sound waves that have very low amplitudes are quiet, and sound waves that have high amplitudes are loud.

Assess that students understand this concept. Have students draw two models of sound waves, one that is loud and one that is quiet in their EHI notebook or on the board. Ask the students to point out the crests, troughs, and have them include a label for wavelength and amplitude. Examples are in Figure 2.

Figure 2. Quiet sound with a low amplitude sound wave (top wave) and loud sound with a high amplitude sound wave (bottom wave). These examples have the same number of waves per time period, so they have the same frequency/pitch.



Do: Collecting Data

For this activity you can use hand held noise monitors (available to borrow from the STEM Center) or a tablet/mobile app. If using the app, make sure **The Decibel X App** is already downloaded onto tablets ahead of time, or take a few minutes to have students download this app onto phones.

Using the app or noise monitor, be very quiet and look at the reading. What do you notice about the noise level? Now make a loud noise like speaking loudly or clapping your hads. What did you notice about the value? Have students record the noise levels from where they are sitting. Students can also monitor the noise for a set time period, like every 5 seconds for 30 seconds, and record the minimum, maximum, and average.

Once the students understand the basic use of the app or noise monitor, they will explore how different surfaces affect sound absorption and reflection. This activity can be done in student groups or as an instructor demonstration and needs one device to play sound as well as one device to monitor sound. Have students place a phone, tablet, or laptop on a desk in a stationary position and play a song at a selected volume. Place the phone or your laptop so that the screen/speaker is facing the wall. Have another student in your group hold their tablet or noise monitor up one foot behind the first device, measured with a ruler. Record the sound level using the noise monitor or Decibel X app for 30 seconds. Once you stop the recording, write down the minimum, mean, and maximum of those data. Next, students will place items such as a pillow, a jacket, a piece of cardboard, or a towel along the wall where the music device is facing– different student groups can try different materials. Have the students play the song again, making sure to keep the volume and position of the device consistent. Again, hold the sound-monitoring device a consistent one-foot distance behind the music-playing device and record the sound level for 30 seconds.

Reflect

Have students return to their seats and ask what they observed. How did the different surfaces affect the noise levels they observed? What do the data suggest about the way the physical environment may interact with noise pollution?

Now that students have seen the effects of how solid surfaces input the reflection of absorption of sound waves, ask them to think of a city. What are some common features of a city? (we want students thinking about the solid surfaces of buildings, streets, etc.) How does this compare to less populated areas like in the country, woods, or forest? (we want students to think about the lack of objects that would reflect sound). Where would you think sound waves would more likely reflect off of solid surfaces and where would they more likely be absorbed?

Resources

- Khan Academy *Production of Sound* video: https://www.khanacademy.org/science/ap-physics-1/ap-mechanical-waves-and-sound/introduction-to-sound-waves-ap/v/production-of-sound
- NIH How Do We Hear webpage: https://www.nidcd.nih.gov/health/how-do-we-hear#:~:text=Sound%20waves%20enter%20the%20outer,malleus%2C%20incus%2C%20and%20stapes
- National Institute of Health (NIH) video: https://www.youtube.com/watch?v=eQEaiZ2j9oc
- NASA website video: https://www.nasa.gov/specials/X59/science-of-sound.html#:~:text=Sound%20waves%20are%20longitudinal%20waves,and%20its%20pitch%20(frequency).

NIH SEPA Environmental Health Investigators
Environmental Health 5
Grade Level: Middle School
Duration: 50-60 Minutes

Noise Pollution II

Introduction
In this session students will review how sound waves produce sound and learn how sound is measured through decibels. They will understand what noise pollution is and its potential health impacts. They will also use a citizen science app to explore noise pollution data.

Objectives
1. Students will be able to accurately compare common sounds and their noise levels.
2. Students will understand the logarithmic scale and how it relates to measuring noise pollution.
3. Students will understand environmental health impacts of noise pollution.

Materials
- "How Loud is It?" handouts
- Loudest Sounds video
- Powers of Ten video
- Student tablets/mobile devices with Noise Project app

Keywords: noise pollution, sound meters, decibels

Opening
Environmental science is a branch of science concerned with the physical, chemical, and biological conditions of the environment and their effect on living things. According to the World Health Organization, 24% of all global deaths are linked to the environment, which is roughly 13.7 million deaths a year. Clean air, soil, and healthy noise levels are essential for human health and quality of life. Environmental scientists use research to identify concerns and conditions of the physical environment, and how they can address environmental risk factors that pose a threat to living organisms.

Noise Pollution: Sound is formed through sound waves. Waves transport energy through a medium, such as air, without transporting the medium itself. Sound waves vibrate the eardrum which in turn vibrates the inner ear bones. This starts a reaction that eventually sends a message to the brain that it is hearing a sound. When sound is unwanted or excessive and can have negative effects on human health or environmental quality, it is considered noise pollution. Being exposed to noise pollution over long periods of time can cause health problems such as high blood pressure,

anxiety, and hearing loss among other things. Demonstrate the result of hearing loss to the students by sharing this hearing loss simulation with them.

Engage

Ask students about various sounds they have heard throughout their lives. What is the loudest sound that you've ever heard? What about the quietest? How did they make you feel? What was the loudest sound that you heard today? Do you think it would be considered noise pollution? Have students write their responses on the board and organize the sounds according to what they think is the loudest, and in decreasing order of loud. Remind them that there are no right answers, this is just an opportunity to reflect on our experience with noise. Pass out the "How Loud is It?" sheets and have students try to fill out the first section on their own. Share the Comparison: Loudest Sound video to illustrate sound comparisons and have students try to find the sounds from their list to. Then, as a class, go through the correct ranking on the answer key and discuss how sound is measured in decibels. Go through the second section on the sheet as a group to further explain how decibels measure sound. Be sure to include the negative health effects on the eardrum and hearing from long turn sound pollution exposure.

We measure sound intensity, or sound pressure levels, in decibels (dB). A bel is named after Alexander Graham Bell. It is a logarithmic unit that describes a ratio of two intensities, such as two different sound pressures or two different voltages. Silence is 0dB and sounds loud enough to be considered noise pollution, such as a lawn mower, are around 85dB or more.

Before we start looking at sound data and noise pollution, it is important to know a little about how measuring volume with decibels works. Decibels are not like most scales of measurement you are familiar with. Most measuring devices we use, like a ruler and a balance are linear, but the decibel scale is logarithmic. To understand this, let's first think of how we measure distance. If a building is 100 meters tall and you build another 10 meters, the building will be 10% taller. This is a linear scale. The building at 100 meters is going to seem pretty tall, and a building at 110 meters is going to seem just a little taller. There is not that much difference between a building that is 100 meters tall and a building that is 110 meters tall. They are both very tall.

Using the logarithmic decibel scale, if a sound is 100 decibels and we add another 10 decibels, the sound will be ten times more intense and will seem twice as loud to your ears. So for decibels, there is a big difference between 40 and 50 decibels. Show students the Powers of Ten video to illustrate the concept.

When sound is unwanted or excessive and can have negative effects on human health or environmental quality, it is considered noise pollution. Noise pollution can occur in several ways. We can be exposed to very loud sounds (high amplitude) for a short period of time like fireworks (fireworks are around 110 dB). We can also be exposed to loud sounds, but quieter than fireworks, for long periods of time like listening to your music loudly with headphones (85 - 90 dB). Both types of exposures can be harmful

and are considered noise pollution. Being exposed to noise pollution over long periods of time can cause health problems such as high blood pressure, anxiety, and hearing loss among other things.

Do: Collecting Data

Noise pollution can have harmful health effects including increasing the chance of heart disease, diabetes, lower birth weight, and learning difficulties in children. Noise pollution can also make it difficult to concentrate and make people more irritable. We also know from national data that noise pollution is disproportionately concentrated in low-income communities that have higher proportions of Native American, Asian, Black, and Hispanic residents. In order to document and address this problem, the Noise Project has created a national citizen science program started by community organizations in Atlanta, San Diego, Cancún, México and more, along with scientists from Cornell University.

Pass out tablets with the Noise Project App already installed or give students time to download and install the app on mobile devices. Give the students time to explore the educational features of the app, and explore the map showing where noise data have already been collected. Have each group or pair of students explore different sections of the app. They can also experiment with how different sounds affect the meter readings or explore different locations – they should not record and upload their observations to the Noise Project right now since they are just practicing.

Reflect

Have each pair or group of students report back with one interesting fact or new word they learned from the app. What are two potential ways that noise pollution can affect health? (Try to emphasize both physical hearing loss and mental fatigue and stress) Why does even a small increase in Decibels matter so much when it comes to noise pollution?

Resources

- "How Loud is it?" Answer Key
- US Department of Health and Human Services “Where is the Noise” webpage: https://www.noisyplanet.nidcd.nih.gov/kids-preteens/where-is-the-noise
- Gizmos “Waves” webpage: https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=1053
- Khan Academy *Production of Sound* video: https://www.khanacademy.org/science/ap-physics-1/ap-mechanical-waves-and-sound/introduction-to-sound-waves-ap/v/production-of-sound

- NIH How Do We Hear webpage: https://www.nidcd.nih.gov/health/how-do-we-hear#:~:text=Sound%20waves%20enter%20the%20outer,malleus%2C%20incus%2C%20and%20stapes
- National Institute of Health (NIH) video: https://www.youtube.com/watch?v=eQEaiZ2j9oc
- NASA website video: https://www.nasa.gov/specials/X59/science-of-sound.html#:~:text=Sound%20waves%20are%20longitudinal%20waves,and%20its%20pitch%20(frequency).

NIH SEPA Environmental Health Investigators
Environmental Health 6
Grade Level: Middle School
Duration: 50-60 minutes

Noise Pollution III

Introduction

In this lesson, students will delve into how sound is received by the human brain. They will then discuss what makes sound become noise pollution, and what local citizens and officials can do to reduce this pollution.

Objectives

1. Students will describe how sound is received by the human brain.
2. Students will collect data and use it to understand the auditory landscape of their environment.

Materials:

- Journey of Sound to the Brain video
- Noise monitors OR student tablets/mobile devices with app
- Access to a variety of locations indoor/outdoor

Keywords: noise pollution, sound waves

Engage

Begin with sharing the Journey of Sound to the Brain video. To review, sound waves produce rapidly moving vibrations in the air. That air reaches the eardrum which in turn vibrates the inner ear bones. This starts a reaction that eventually sends a message to the brain that it is hearing a sound. Share the photo of the inner ear and discuss how sound travels to the ear, and eventually the brain, through sound waves (Figure 1).

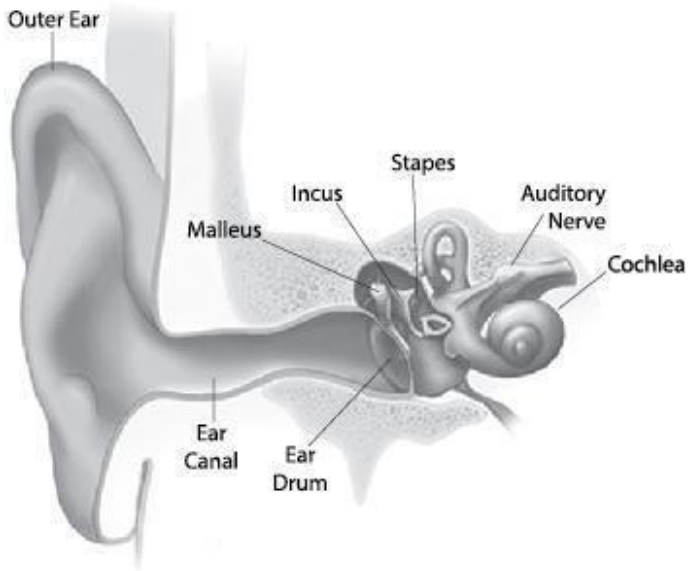


Figure 1: Diagram of inner ear from NIH.

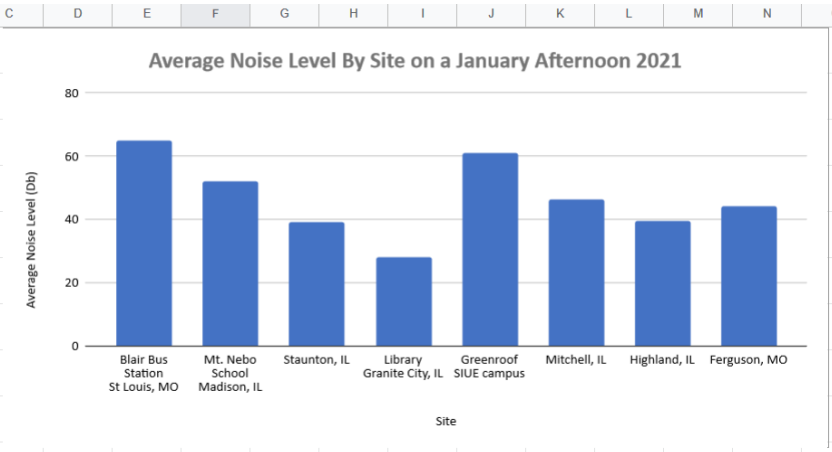
Do: Collecting Data

Put students in small groups and review how to use the NoiseProject App (You could also use the DecibelX app or hand-held noise monitors if preferred). Have students go to at least 5 locations around the inside of the school and record sound data readings on their "Sound Collection Datasheets". Tell groups to meet back in the classroom at a designated time.

Reflect

Once students have regrouped, compile their data in a centralized location such as a classroom Google Sheet or in a table on the board. Have students create a graph, either by hand using graph paper, or in Google Sheets or Excel of the noise levels at different locations. You can show them this example graph showing the mean/average noise level in multiple locations.

Site	Average Noise Level (Db)
Blair Bus Station St Louis, MO	65
Mt. Nebo School	52
Staunton, IL	39
Library Granite City, IL	28
Greenroof SIUE campus	61
Mitchell, IL	46
Highland, IL	39
Ferguson, MO	44



What is the loudest area they recorded? What did the students think about using the app? Why does the app also ask about mood when submitting noise data? Remind students about the potential mental health effects of noise pollution. Let students know that they can also collect data in their neighborhoods to submit to the project and tell their family about the project. Using everything they have learned about sound and noise, what are some possible strategies or solutions to address the problem of noise pollution?

Optional extension

A recent article, reports that Town and Country, a nearby city, has approved prohibiting continuous noise in excess of 55 decibels from 10 p.m. to 7:30 a.m., and in excess of 65 decibels other hours of the day. It mentions that having set volume measurements is important to ensure everyone is treated fairly so authorities do not address noise levels unless they are exceeding the maximum volume allowed.

Lead a discussion about student views on this policy. Would you like a decibel level to be set by your city to keep noise pollution in check? Why or why not? Who is this benefiting? How do you think they enforce this policy? Do you think if people understood noise pollution and learned the information about sound like you have in this program, they would be for or against this new policy? If you could alter this policy to make it better, how would you change it?
Give students the following scenario: each student is hired by their city of residence to come up with an idea to help reduce or prevent noise pollution. They must find a way to incorporate a reliable tool, such as a monitor or app to support their suggestion.

First, put students in pairs or small groups to brainstorm about all of the sources of noise pollution in their community. What specific noise problem would they like to address? Has this problem ever affected them personally? What solution do they propose? How will they incorporate a tool? Give everyone a set time to return to the group to share. Discuss student proposals as a group and give feedback.

Resources

- Khan Academy *Production of Sound* video: https://www.khanacademy.org/science/ap-physics-1/ap-mechanical-waves-and-sound/introduction-to-sound-waves-ap/v/production-of-sound
- NIH How Do We Hear webpage: https://www.nidcd.nih.gov/health/how-do-we-hear#:~:text=Sound%20waves%20enter%20the%20outer,malleus%2C%20incus%2C%20and%20stapes
- National Institute of Health (NIH) video: https://www.youtube.com/watch?v=eQEaiZ2j9oc
- NASA website video: https://www.nasa.gov/specials/X59/science-of-sound.html#:~:text=Sound%20waves%20are%20longitudinal%20waves,and%20its%20pitch%20(frequency).
- US Department of Health and Human Services “Where is the Noise” webpage: https://www.noisyplanet.nidcd.nih.gov/kids-preteens/where-is-the-noise

NIH SEPA Environmental Health Investigators
Environmental Health 7
Grade Level: Middle School
Duration: 50-60 minutes

Air Pollution I

Introduction
In this session students will learn some background about types of pollution and their potential health implications. They will also learn one of the ways that air pollution specifically is described and measured and create DIY air samplers to collect their own data on large particulate matter.

Objectives
1. Students will define air pollution, how air pollution is measured, and its implications for human health.
2. Students will create an air pollution sampler and use it to collect data.

Materials
- Environmental Health Investigators Research Journal
- Chromebooks
- White paperboard (paper plates, paper cartons, or poster board)
- Hole punch, string, petroleum jelly
- Note: Dry weather for next 3 days (or covered location) needed for outdoor collection

Keywords: air pollution, air quality monitors, particulate matter

Opening
Ask students to define and describe air pollution. What is air pollution? What are ways that people are affected by it? Ask students to write their responses in their journals. Remind the students that there are no right or wrong answers. We are just brainstorming and writing down what we think and know. Discuss responses.

Engage
Air pollution is a high concentration of certain substances or particles that causes the atmospheric environment to become toxic enough to have adverse impacts on human health and the environment. Air pollution can cause respiratory conditions such as asthma and emphysema, cancer, cardiovascular disease, and more.

Watch the first two minutes of the video What's in the air you breathe? (by Amy Hrdina and Jesse Kroll from TEDEd)

Discussion: Ask students to name potential particles that can be found in the air and write them down on the board (for example: pollen, mold, dust, smoke). Ask students to

try to rank them from the smaller to the larger particle size. Show the graph below (Figure 1) and try to find the particles the students suggested. Note that the size scale is “backwards” - the smallest size is on the left and the larger size is on the right.

Was there anything surprising about the size of the particles? What are some particles that we can see in the air? What are some particles we cannot see?

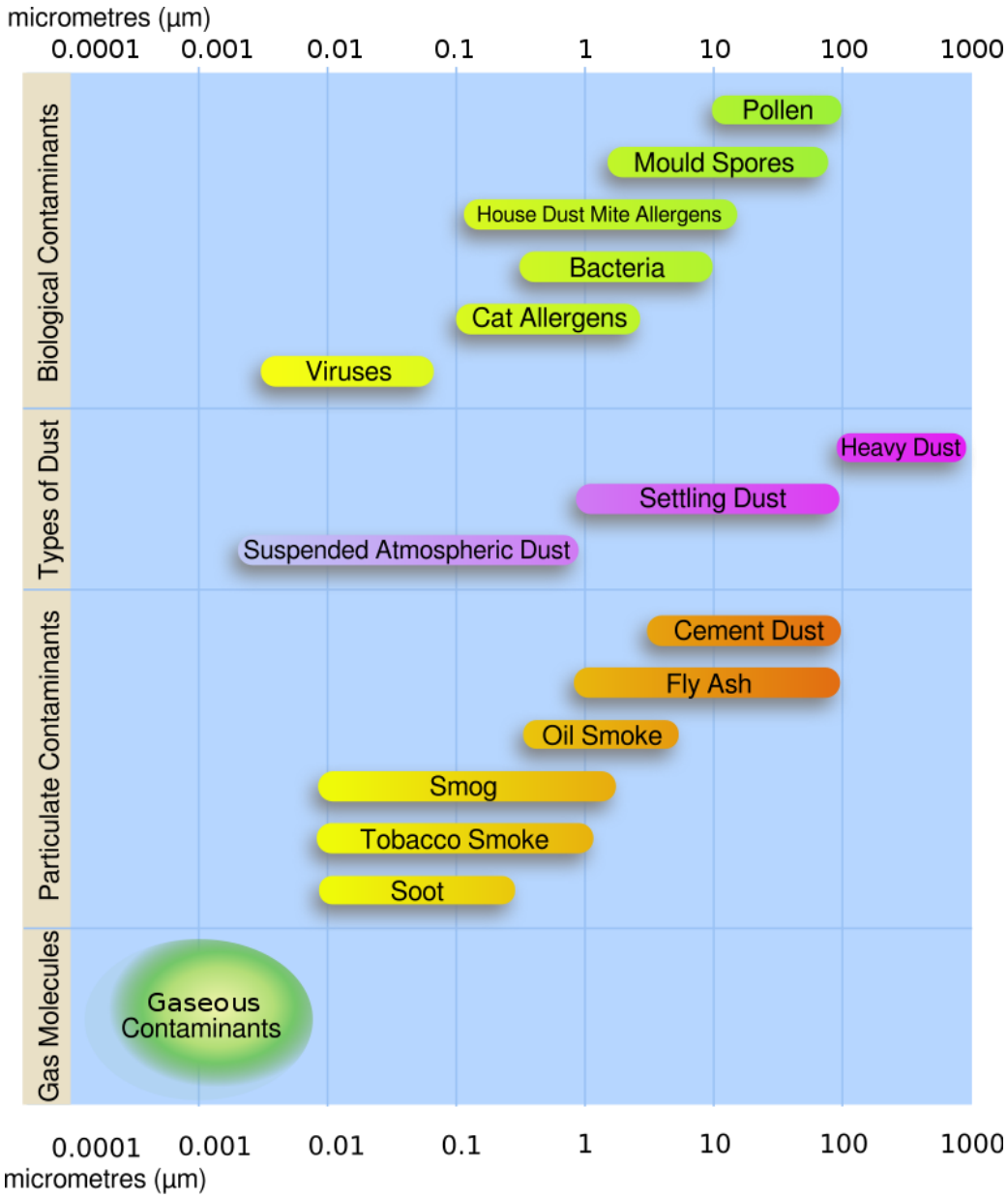


Figure 1 - (https://en.wikipedia.org/wiki/Particulates) - Airborne particles are commonly either biological contaminants, particulate contaminants, gaseous contaminants, or dust. This diagram shows the size distribution in micrometers (µm) of various types of airborne particles.

Measuring Air Pollution

We measure particles in the air (air particulate matter) by both concentration and size. Particulate matter is material suspended in air in the form of tiny solid particles or liquid droplets. When collecting a concentration of matter that is a particular size it is denoted as PM (diameter of particle size). We will focus on particulate matter that is 2.5 micrometers in size (PM2.5).

Particulate matter is material suspended in air in the form of tiny solid particles or liquid droplets. We measure particles in the air (air particulate matter) by both concentration and particle size (Figure 1). When collecting particulate matter that is a particular size it is denoted as $PM_{(diameter\ of\ particle\ size)}$. For example $PM_{2.5}$ represents particulate matter that is 2.5 micrometers (μm) in size and PM_{10} represents particulate matter that is 10 micrometers (μm) in size. Share the particulate matter image (Figure 2) and describe the size of the $PM_{2.5}$ particles. Another good comparison is that a single grain of salt is about 100 micrometers while a single grain of powdered sugar is around 50 micrometers. When we talk about PM_{10} we are talking polluting particles in the air that are even smaller than a single grain of powdered sugar, and $PM_{2.5}$ is even small than that.

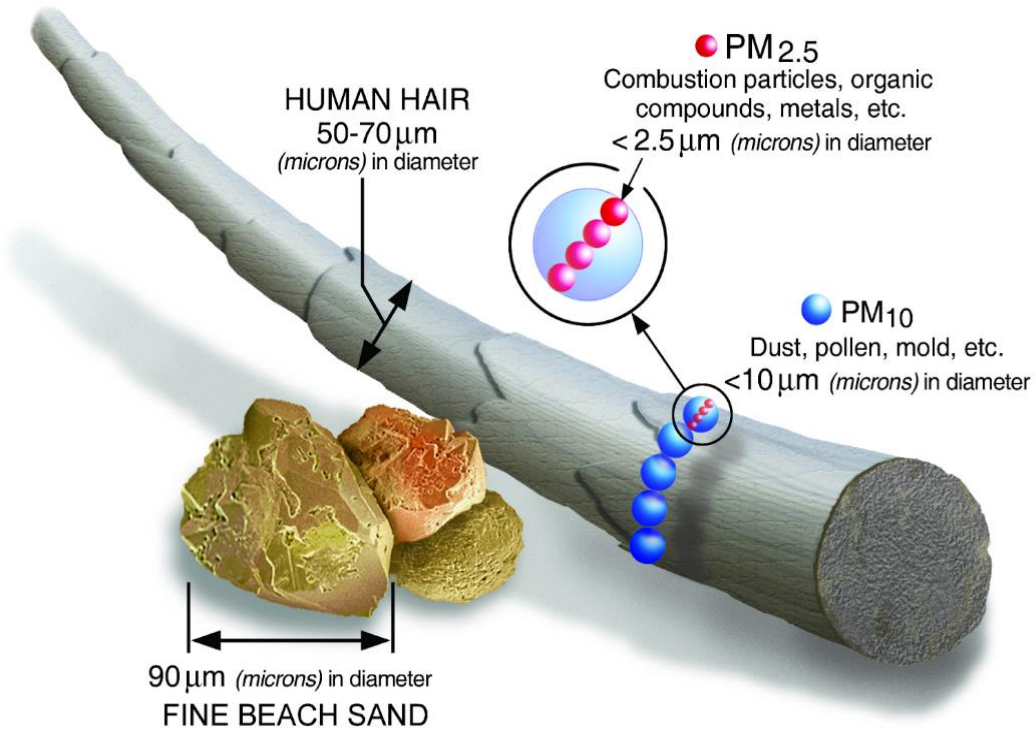


Figure 2. Comparison of particle sizes from the United States Environmental Protection Agency (EPA)

Do: Collecting Macroscopic Airborne Particulate Matter
Credit: Jess Purcell, Thoughtfully Sustainable

** Note this activity is weather-dependent. It will be more successful if there is no rain for at least 3 days following the day you put the collection squares in outdoor locations. If you anticipate rain, you can try putting the samplers in covered locations, such as covered porches or under awnings. Be aware that if the samplers get wet they may not accurately collect the particles.*

In this activity students will make their own DIY, analog air samplers that will collect airborne particulate matter. These collectors are designed to collect macroscopic particulate matter. These are particles large enough to see with the naked eye, so several times bigger than PM_{10}. For this activity you will need some recycled paper milk cartons, or pieces of white poster board, or white paper plates. Working in pairs or small groups, have the students cut the paperboard into square pieces, so that each piece is 3 inches long and 3 inches wide. Each group should create 3 squares. To make your collection more accurate each square should be exactly the same size (see Figure 3), or you can have students draw a precise square of the same size in the middle of each. Next, have students punch a hole in one corner of each square using a hole punch and tie a string through the hole. Each group will choose an outdoor collection location where they will hang their squares to monitor for particulate matter in the air. The groups should all choose different locations, but each group will have all 3 of their squares at the same spot for repeated samples of that location. These can be locations around the school or you can have some groups take their squares to one member's home to hang in their own yard or neighborhood. Once the locations are decided and approved by the instructor, have each group write on their squares the name of their location, and then label each square uniquely as sample A, B, or C.

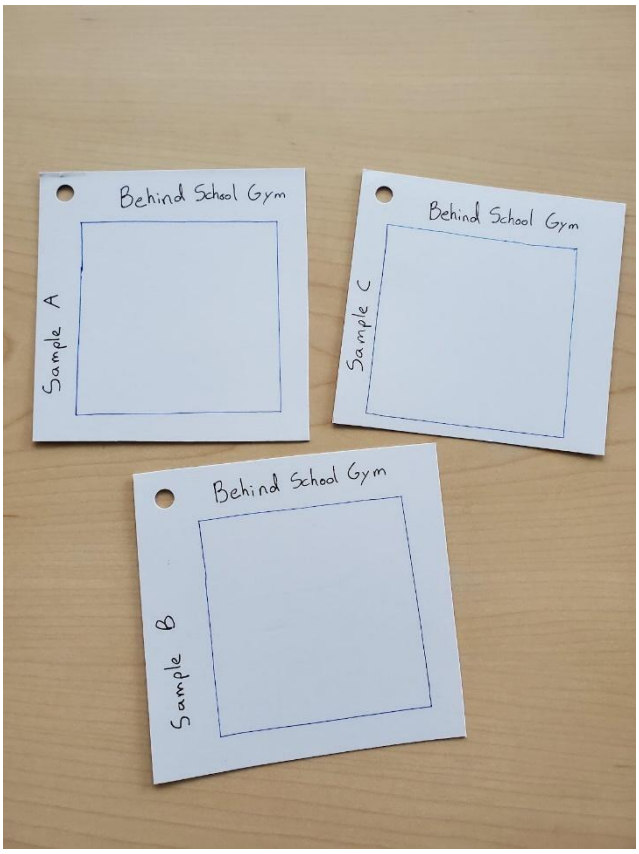


Figure 3. DIY air samplers. Petroleum jelly will be added to collect macroscopic particulate matter.

Every group will need a small amount of petroleum jelly to act as their collection medium, but they should wait to actually apply the petroleum jelly until they are at their collection location. At their collection sites, the students should tie their string to the limb of a tree branch or somewhere the square will be able to hang freely but not blow into any buildings or other structures. Students should smear the petroleum jelly in a thin layer, evenly covering the whole collection area of each of their squares. Be sure to leave time for students to clean up and return to the classroom if they have gone outside to install their air sampler squares. The squares should stay out for 3-7 days, and will be collected and examined in a later session. Reminder, *this activity is weather-dependent* and you should not allow the squares to get wet.

Resources

- Visualizing Air Quality for Kids. The airborne particulate matter data collection activity previously described by Jess Purcell as part of her website: Thoughtfully Sustainable

NIH SEPA Environmental Health Investigators
Environmental Health 8
Grade Level: Middle School
Duration: 50-60 minutes

Air Pollution II

Introduction

This session introduces students to the air quality rating system that helps us understand when air pollution can be a threat to our health. They will also return to their DIY air samplers to collect their own data on large particulate matter. Students will create graphs of air quality in their community using the data the class has collected.

Objectives

1. Students will be able to describe different levels of air quality and their potential health impacts.
2. Students will be able to record and interpret data collected from their own air samplers for particulate matter.
3. Students will be able to create data visualizations from the data they have collected.

Materials

- Instructor computer, projector
- Student computers with internet
- Student computers with internet
- Macroscopic Particulate Matter Datasheet
- Magnifying glass (optional)
- Graph paper (optional)

Keywords: air pollution, air quality index, particulate matter, human health, data, graphing

Engage: Air Quality Index and Health

Begin with showing the students this national geographic video about air pollution as well as reviewing what they learned about air pollution last session. *How is air pollution measured and categorized?* Today students will learn more about how air quality is rated, communicated to the public, and used to help make public health decisions.

When you breathe in, particulate matter and other air pollutants can enter your lungs along with the air. High concentrations of particulate matter in the air can damage the tissues of your lungs and block the movement of oxygen. Breathing clean air is important for keeping you and your lungs healthy. Because of the importance of clean air to our health, state and federal government agencies track air quality. They use a

measurement scale called the air quality index (AQI) to calculate and communicate the quality of the air in a particular place and time. The air quality index makes it easy to understand the quality of the air where you live by breaking down air quality into a scale from 0 to 500 (Figure 1).

On the air quality index, the higher the value, the worse the air quality. Any value that is under 50 is good air quality. Under these conditions, the particulate matter and other pollutants in the air do not pose a risk to the health of most people. When the air quality index is over 100, people in sensitive groups may experience health effects from breathing in this air. The sensitive groups include people with lung or heart disease or

Air Quality Index (AQI) Category and Color	Index Value	Description of Air Quality
Good Green	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk
Moderate Yellow	50 to 100	Air quality is acceptable. However, there may be risk for some people. Particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups Orange	101 to 150	Members of sensitive groups may experience health effects, The general public is less likely to be affected.
Unhealthy Red	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy Purple	201 to 300	Health alert: The risk of health effects is increased for everyone.
Hazardous Maroon	301 and higher	Health warning of emergency conditions: everyone will be affected.

diabetes, older people, children, or people of lower socioeconomic status. When the air quality index is over 150, anyone active outside may experience health effects. Finally, when the air quality index is over 300, the air will not be healthy to breathe for anyone.

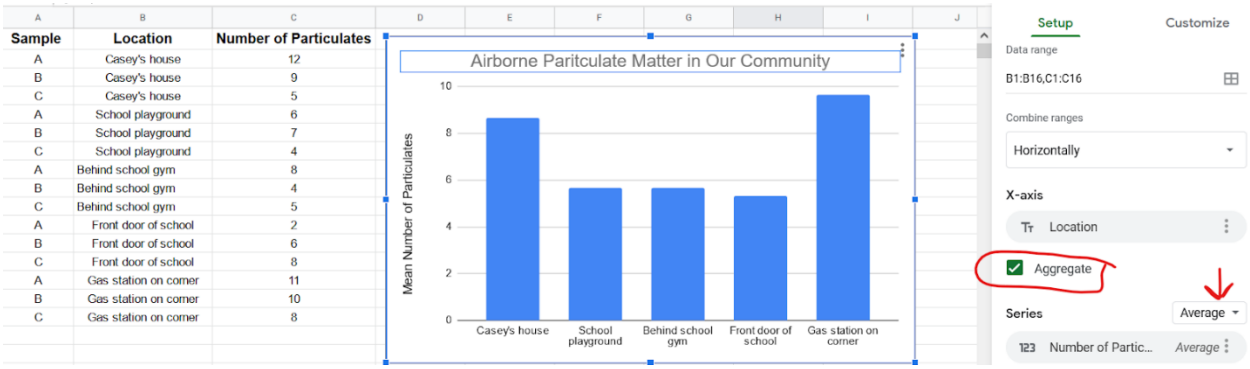
Review with students some health problems related to air quality and air pollution (from the previous lesson: respiratory conditions such as asthma and emphysema, cancer, cardiovascular disease, etc.)

Figure 1. Environmental Protection Agency's Air Quality Index (AQI).

Have students pull up the AirNow webpage on their computers to see the air quality forecast for their city. To do this, have them type in the name or zipcode of their school or home in the search bar. *What is the air quality like today in your zip code? In the nearest bigger city? In Los Angeles?* (note that this webpage only shows air quality within the United States)
(Alternatively, open the AirNow webpage on the instructor's computer and use a projector to show the map to the whole class).

Do: Collecting Macroscopic Airborne Particulate Matter (Continued)
Credit: Jess Purcell, Thoughtfully Sustainable

In the previous session, students put out DIY particulate matter collectors to monitor for airborne particulate matter at various locations. After you have waited 3-7 days, it is now time to collect data from the students' sample squares. As the students retrieve their squares from their collection locations, they should be careful not to let the squares touch each other or let the petroleum jelly touch anything else. Using their naked eye/and or a simple magnifying glass, have each group count the number of visible particles they see stuck in the petroleum jelly inside the boxed area. Ask each group to report their numbers to the instructor, and record this data in the Macroscopic Particulate Matter Datasheet



Now you can have students each make a graph on their own computers by sharing the document, and/or the instructor can demonstrate how to make the graph on their computer. Take some time to review how to create a graph, and point out more of the graph customization options. (The Google Sheets Graphing Tutorial video can be shared with the students or used as a reference.) In order to make a bar/column graph in Google sheets that will show the mean amount of particulate matter at each location across the 3 samples, you can use the "aggregate" and "average" features in the graph setup menu. Make sure students understand how to title and label the graph correctly.

Alternatively, ask students to graph their data using graph paper. Work with students to design a table for collecting the data (the table should be similar to the one on the Macroscopic Particulate Matter Datasheet). Students should copy the table on their notebooks and the instructor will have a larger copy of the table on the board or projected on the screen. Once students have completed their tables, show them how to calculate the average for each location and how to create a bar graph on graph paper. Discuss with the class what are the two variables (location and number of particles) and which one should be on each axis. This instruction sheet How to Make a Bar Graph from ThinkScience! can be used as a guide, if needed. Once students have completed their own graphs on paper, use the data from their tables to fill out the classroom table using the Macroscopic Particulate Matter Datasheet.

Reflect

After the students have examined a graph of their class data, they can think about what the results mean. At which sites did you pick up the most particulate matter of the kind that is visible with the naked eye or a magnifying glass? Is this what you expected? Were each of your three counts the same or different? What do you think this tells you about the amount of particulate matter in the air at each location? Do you think your data allows you to make general conclusions about the overall air quality of the sites you tested? Why or why not? What might be different if you collected samples right after a heavy rain? Pollutants may be removed from the air by rain, but they don't disappear, they are simply moved to terrestrial or aquatic habitats (think about acid rain).

Resources

- The AirNow website shows current air quality and forecasts in many locations throughout the United States
- Visualizing Air Quality for Kids.The airborne particulate matter data collection activity previously described by Jess Purcell as part of her website: Thoughtfully Sustainable
- How to Make a Bar Graph from ThinkScience! by Ms. Gould

NIH SEPA Environmental Health Investigators
Environmental Health 9
Grade Level: Middle School
Duration: 50-60 minutes

Air Pollution III

Introduction

In this session, students will review the definition of air pollution and how it is measured. They will explore air quality data from one of the program's PurpleAir monitoring network sites and collect their own data on air quality using handheld devices. Students will learn how to graph air quality data.

Objectives

1. Students will be able to recognize patterns in air quality data.
2. Students will be able to collect data on air quality.
3. Students will be able to graph data quality data.

Materials

- Environmental Health Investigators Research Journal
- Chromebooks for students
- handheld air quality monitors

Keywords: air pollution, data, graphing, particulate matter

Opening

Begin by reviewing content from the last session, like *what does the Air Quality Index tell us about air pollution and health?* Today students will explore a citizen science project that collects and shares air quality information across the country and the world, and also collect their own data on air pollution.

Show the WHO Video on Air Pollution. Hold a discussion about how air pollution can affect your health. What are some health conditions that air pollution can cause? What can you do to protect yourself against certain types of air pollution?

Engage: the Purple Air Monitoring Network

Share the following two air quality websites with the students and hold a discussion:

First, show students the AirNow website. Students already explored this website in a previous session, so this is a good moment to recap the discussion from the previous session. Search for the student's school or home location. Scroll through the main web page and note the similar and/or unique features.

Second, have students pull up the map of the Purple Air monitors that are set up throughout the United States and the world by clicking on the “View the Map" button. Explain that Purple Air sensors measure real-time particulate matter concentrations (discussed in EHI LP 7). These sensors are set up by both scientists and members of the general public, making these citizen science data. Discuss initial observations that students notice about the map. Each circle represents a monitor. Circles outlined in black are located indoors, and circles that are not outlined in black are located outside. Scroll and zoom on the map to identify any monitors that have been set up near their school. If there are no monitors set up near their school, find the monitor closer to the school location.

Hold a discussion comparing the two air quality monitoring websites. Which site do they like best and why? Do they have the same features and uses?

Now that the students have been introduced to several reputable air monitoring sites, focus the conversation on the PurpleAir site. This is the instrument used in our program’s monitoring network. Click on the circle that represents a local monitor and talk through what the information means, and how to get to the numerical dataset as well. The large number on the top right of the bubble indicates the current Air Quality Index reading for that location. Air Quality Index averages over time are listed as well. The data are also represented in a line graph that will appear when a monitor is selected. Students can close the bubble with the line graph, and then click on the light bar on the top left of the web page to manipulate what data are represented on the graph such as the averaging period or type of background map.

Give the students a few minutes to explore the map and find a monitor location to look at in more depth. As they look at the numeric results and the graph for that location, they should think about possible explanations for trends they see in the data. Have the students turn to a partner and show their partner the location they are looking at and share their ideas about the trends in the air data. The student pairs can also compare similarities and differences between the two sites they have chosen.

Do

Show students how to use the handheld air quality monitor (see instruction sheet on supplemental materials). Then use a dry-erase marker/sharpie, humidifier, or diffuser to temporarily alter the air quality inside the room. For example, you can scribble with a dry erase marker on the board and let the air monitor record the volatile organic compounds that are released when using the marker (these are usually labeled as VOC or HCHO depending on the specific air monitor you may be using). You can also use a humidifier to release water vapor into the air which will be sensed by an air quality monitor as particulate matter ($PM_{2.5}$) The air monitor may take a few seconds to register the change in air quality and you will have to hold the monitor close to the source.

Applying Concepts: Measuring and Graphing Air Data (Option 1)

Divide students into small groups (3-5) and distribute one air quality monitor per group. Ask each group to assign roles for their group members, and say that roles will rotate during the lesson period. Ask each student group to choose 2 locations in their school. Encourage groups to pick places where they expect to find differences in air quality (inside a classroom, outside near the parking lot, bathroom/science lab/cafeteria/gym, etc.). In their notebooks, students will write down the two locations and their predictions for how they will differ in air quality and why. Instruct students to create a table similar to the one they use on Activity Plan LP 8 for collecting data. Each group of students will collect three measures on each location and write down the numbers on their tables. Remember to rotate roles so all students in the group have a chance to hold and use the air quality monitor.

When students return to the classroom, walk them through the same instructions for drawing graphs on Activity Plan LP 8.

Reflect

After students have explored the air data by creating their own graphs, ask them to think about what the graphs mean and what trends they see in the data. What differences are there between the data from the two locations they selected? Possible answers: The average for the Location 1 is higher than the average for Location 2, indicating higher air pollution exposure at Location 1. Was anyone surprised by their results? Are there ways in which they could improve their data collection?

Once their graphs are ready, combine two groups and do a “think-pair-share” where each group takes 1 minute to report their findings to the other group and vice-versa.

After each group had a chance to share their results, have a whole group discussion about air quality in their school and human health. How do your group’s results relate to air quality broadly? What are some potential health implications of your findings? Is there anything we would want to change in our school?

Resources

- Pollution. National Geographic Resource Library. A broad summary of pollution sources and effects.
- EPA Particulate Matter (PM) Basics webpage: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics
- AirNow Air Quality website: https://www.airnow.gov/?city=Edwardsville&state=IL&country=USA
- PurpleAir website: https://www.purpleair.com/map?opt=1/mAQI/a10/cC0#11/38.8394/-90.0067

- WHO: Breathe Life - How air pollution impacts your body video: https://www.youtube.com/watch?v=GVBeY1jSG9Y

This Google Sheets Graphing Tutorial video can be shared with the students or used as a reference

MODULE TWO: Environmental Photovoice

The Environmental Photovoice module guides students through environmental health activities that position the student as the co-creator of qualitative environmental health research. The activities are designed to trigger student's science interest as students conduct qualitative research that is relevant to their community and the health of people living in their community. Students will become participants in authentic study of places that are personally relevant to them.

The Environmental Photovoice activities draw upon an established method in health-related fields such as public health and needs assessment. Environmental Photovoice is a unique application of this established method. Using Environmental Photovoice, youth are able to document their perceptions of their environment and pollution in their environment (i.e., air, noise, and soil pollution) with photography. Students then reflect on the implications of the images they captured through structured discussion that allows them to express their concerns about their environment and how their environment may impact their health and the health of others in their community. This photography project can take place on school grounds, a field trip site, or students can take photos on their own outside of class time. This module also includes student missions that students can work on independently outside of class.

Environmental Photovoice Module Lesson Plan Overview

1) Introduction to Environmental Photovoice

Introduction

In this lesson, students will be introduced to Environmental Photovoice. They will learn how to use the SHOWeD method to describe to others what is happening in photographs of the environment. Photovoice is an evidence-based technique for community-engaged research that has been used by many researchers across several disciplines since the 1990s.

Objectives

1. Students will be able to define and describe the Photovoice method and how they can use this method to document their environment.

2. Students will be able to apply the Photovoice method to interpret the environmental health implications of their environmental photographs.
3. Students will be able to explain that the purpose of the Photovoice method is to use photos and narratives to tell stories about some of the most important places and environmental topics in their lives.

Materials

- Projector/smartboard
- Intro to Environmental Photovoice slides
- "Photovoice SHOWeD w/ Prompts" handout (1 per student)
- Cameras (1 per student)
- Slides of Photovoice Final examples

2) Understanding Photography and SHOWeD Method Practice

Introduction

In this lesson, students will choose one of their photographs to describe using the SHOWeD method. They will identify environmental problems or successes in their community and reflect on how to improve or foster these aspects.

Objectives

1. Students will be able to show and narrate the photographs they have taken using the Photovoice method.
2. Students will be able to describe the reasoning behind their personal photo choice.
3. Students will be able to identify solutions to the problems or ways to foster successes represented in their photos.

Materials

- Photovoice SHOWeD w/ Prompt handout (1 per student)
- Photovoice SHOWeD Blank handout (1 per student)
- Cameras (1 per student)
- Guest photographer (optional)

3) Photography Field Trip

Introduction

Students will take a trip to areas in their community to photograph images that represent environmental health concerns such as pollution, or images that represent something improving or sustaining the health of the environment.

Objectives

1. Students will use photography to capture areas of personal interest in their community's environment.
2. Students will identify sources of strength and concern, specifically related to environmental health, in their community.
3. Students will interpret how these instances of strengths or concerns may potentially affect human health.

Materials
- Digital cameras (1 per student)
- Transportation (bus, walking, etc.)

4) Using the SHOWeD Method

Introduction
Students will choose one of their photographs to feature in their final Photovoice project. They will use the SHOWeD method to describe the image in the photograph and their view on how this image represents the health of their community. They will then use their SHOWeD responses to compose a first draft of a narrative for their final projects.

Objectives
1. Students will be able to communicate in writing how their environment can impact them and their community.
2. Students will be able to convert their writing prompts about their photographs into a cohesive narrative.
3. Students will be able to recognize the importance of editing, peer review, and making multiple drafts.

Materials
- Student photos from last session (stored in digital folders or cameras)
- Photovoice SHOWeD w/ Prompts handout (1 per student)
- Photovoice assessment rubric below (or alternate rubric with grading scale)
- Narrative Drafting handout (1 per student)
- SHOWeD Method and Narrative Examples
- "Writing a Personal Narrative: Writing a Draft" video

5) Narrative Final Draft

Introduction
In this lesson, students will give each other feedback on their draft narratives. They will incorporate edits and create a final narrative for their Environmental Photovoice projects.

Objectives

1. Students will be able to communicate in writing how their environment can impact them and their community.
2. Students will be able to recognize the importance of editing, peer review, and making multiple drafts.
3. Students will be able to revise previously constructed work to compose a final draft of their narrative.

Materials

- SHOWeD Method handout (completed from previous session)
- Narrative Drafting handout (completed from previous session)
- Student photos (chosen from previous session)
- Colored pen for editing suggestions (1 per student)
- Computer/tablet (1 per student if available)
- Writing a Personal Narrative: Revising for Kids video
- Final Photovoice examples

6) Poster Creation

Introduction

In this lesson, students will use their photographs and narratives to create a poster to present at the final showcase.

Objectives

1. Students will be able to develop an understanding of poster format and design.
2. Students will be able to manipulate photographs using computer-based applications and understand color palettes.
3. Students will be able to use images and combine content and information from different sources to engage in an argument from evidence.

Materials

Materials will depend on the format you decide for final presentations

- 8x10 inch printed photo (1 per student)
- Printed/written final draft of narratives (completed during previous session)
- 11x17 inch poster boards (1 per student)
- Supplies to make poster (glue, scissors, construction paper, writing materials, etc.)
- Photovoice final poster examples

7) Presentation Practice

Introduction

In this lesson, students will learn key components of effective science communication. Students will practice their final poster presentations to prepare for the showcase.

Objectives

1. Students will be able to develop presentation skills.
2. Students will be able to explain their projects to an audience.
3. Students will be able to have an informative discussion with others.

Materials

- Student final posters (previously completed)
- How to Deliver an Effective Presentation video

8) Environmental Photovoice Final Showcase

The purpose of the Environmental Photovoice event is to showcase the students' final projects. These projects highlight environmental concerns or assets that are important to the students. Sharing this with community members will help foster discussions about what aspects of their environment promote human health as well as what areas could be improved. Students should also discuss potential solutions.

Standards Alignment for Environmental Photovoice Unit

NEXT GENERATION SCIENCE

Performance Expectations:

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to the Earth's environment can have different impacts (positive or negative) on different living things.

Science and Engineering Practices

1. Asking Questions and Defining Problems: Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.

6. Constructing Explanations and Designing Solutions: The products of science are explanations and the products of engineering are solutions.

Cross-cutting Concepts

1. Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

2. Cause and effect: Mechanism and explanation: Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is

investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
7. Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

VISUAL ARTS

Creating

VA:Cr.1- Generate and conceptualize artistic ideas and work.
VA:Cr.2- Organize and develop artistic ideas and work.
VA:Cr.3- Refine and complete artistic work

Presenting

VA:Pr.4- Select, analyze, and interpret artistic work for presentation.
VA:Pr.5- Develop and refine artistic techniques and work for presentation
VA:Pr.6- Convey meaning through the presentation of artistic work.
VA:Cn.10- Synthesize and relate knowledge and personal experiences to make art.
VA:Cn.11- Relate artistic ideas and works with societal, cultural, and historical context to deepen understanding.

ENGLIGH & LANGUAGE ARTS

Writing

6-8.W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
6-8.W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
6-8.W.5: With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

NIH SEPA Environmental Health Investigators
Environmental Photovoice: Activity Plan 1
Grade Level: Middle School
Duration: 50-60 minutes

Introduction to Environmental Photovoice

Introduction

In this lesson, students will be introduced to Environmental Photovoice. They will learn how to use the SHOWeD method to describe to others what is happening in photographs of the environment. Photovoice is an evidence-based technique for community-engaged research that has been used by many researchers across several disciplines since the 1990s. You can read more about this technique in the summary at the end of the resources section below.

Objectives

1. Students will be able to define and describe the Photovoice method and how they can use this method to document their environment.
2. Students will be able to apply the Photovoice method to interpret the environmental health implications of their environmental photographs.
3. Students will be able to explain that the purpose of the Photovoice method is to use photos and narratives to tell stories about some of the most important places and environmental topics in their lives.

Materials

- Projector/smartboard
- Intro to Environmental PhotoVoice slides
- Photovoice SHOWeD handout (1 per student)
- Cameras/tablets/phones (1 per student)
- Photovoice Final Poster Examples slides

Keywords: environmental Photovoice, SHOWeD method, photographs, environment

Engage

Use the Intro to Environmental PhotoVoice slides to assist throughout this lesson. In addition to the prompts on the slides, you can also engage students in discussion by asking, *"What comes to mind when you see this photo?" How does this photo make you feel? What do you think the photographer is saying? What do you think this picture is about?*

After going through the slides about privacy, safety, and accuracy, move on to explain the SHOWeD method and walk through each step. Show examples of using the SHOWeD method to analyze photos with students, and have students practice before showing the example answers. Explain that there are no right answers but it is important

to follow the steps of the method. The SHOWeD method will eventually lead to a narrative that thoroughly describes what is happening in the photo. This is a method used to identify health concerns in our environment through photography while explaining the photographed concern or asset and possible future actions through a structured narrative.

Using the example photos in the slides, have students work in pairs and use the SHOWeD method handout to describe the photo. They can either write out their responses or they can do the SHOWeD method outloud, interview-style, where one person reads the questions and the other person answers. After students have worked through the SHOWeD prompts, have each team share their responses with the whole group. *How do the individual group responses compare to each other?*

Show the students the Photovoice Final Poster Examples with the full cohesive narratives. This will be the end product they produce at the end of this unit. They will use the SHOWeD method on photos that they take and turn their answers to the question prompts into a cohesive narrative. Explain to students that their photographs will be a type of qualitative data about their environment, and that together their photos and narratives will tell an informative story about the environments in their community. **Their goal for this module will be to use photos and narratives to tell stories about some of the most important places and environmental topics in their lives.**

Do
Pass out cameras that students will be using for the project. Spend some time going over the basic features and operation of the cameras you will be using. Also clarify how students will save and share their photographs (SD cards, Google Drive, or other cloud-based sharing depending on what you have available). Have students practice taking photos so they can get the hang of using the features. Remind them to ask permission before taking a picture of any of their classmates.

Reflect
Have the students review the purpose of the SHOWeD method and how the questions serve as a guide. Review: What makes an environment healthy or unhealthy and why is this important? How can we use this photography method to address environmental issues?

Mission
This week's mission is to take a picture of one environment students visit this week and come prepared to share and explain it. Encourage students to take photos of aspects of the environment that interest them, while keeping in mind the purpose of the project—to capture an image of something in their environment that they see as a strength or a weakness (or a positive or negative), or something that they would like to learn more about. If they have the ability, for example, if they are using a cell phone, encourage them to take multiple photographs of that image to practice capturing the image from different angles and lighting.

Resources

- The Community Tool website describes Photovoice and how to use it: https://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources/photovoice/main
- The article *Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment* explains what the Photovoice methodology is in detail: http://strive.lshtm.ac.uk/sites/strive.lshtm.ac.uk/files/wang%20concept%20and%09%20methodology.pdf
- The *Facilitator's Toolkit For A Photovoice Project* describes how to facilitate a Photovoice project, as well as the SHOWeD method in Appendix E: https://www.gocolumbia.edu/institutional_research/photovoice_page_documents/Facilitators_Toolkit.pdf to understand how this method is related to Photovoice.
- The Nova Scotia Participatory Food Costing Project also describes how to facilitate a Photovoice project: https://foodarc.ca/makefoodmatter/wp-content/uploads/sites/3/VOICES_PhotovoiceManual.pdf.
- The Spruce Crafts and The Photography Life websites provide some tips for beginner photographers: https://www.thesprucecrafts.com/introduction-to-photography-tips-for-beginners-2688546_and https://photographylife.com/photography-basics
- Cornwall, A. and Jewkes, R. (1995). What is Participatory Research? Social Science and Medicine. 41(12), 1667-1676. https://www.civitas.edu.pl/pub/nasza_uczelnia/projekty_badawcze/Taylor/what_is_participatory_research.pdf
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- Wang, C. (1999). Photovoice: A Participatory Action Strategy Applied to Women's Health. Journal of Women's Health. 8(2), 185-192. https://bestler.public.iastate.edu/arts_based_articles/1999_Liebert_Photovoice.pdf

PhotoVoice Summary

Participatory research encompasses a broad range of research methods in which themembers of the community being studied help define issues that will be investigated and then participate in the subsequent action (Cornwall & Jewkes, 1995). Involving members of the community can enhance project buy-in and effectiveness. Photovoice is one type of participatory research method. Photovoice projects have three main goals: 1) enable people to record and reflect their community's strengths and concerns; 2) promote dialogue and knowledge about important issues through group discussions; and 3) reach policymakers to encourage change (Wang & Burris,1997). Specifically, through the use of their photographs, participants identify, represent, and define the benefits and challenges in their community (Wang & Burris,1997).

In “Environmental Photovoice”, participants photograph their environment - where they live, where they work, where they play - to learn about its health as well as to better understand its impact on connected issues in their communities. Those photographs communicate the community members’ perspectives on the environment to the broader public, which is intended to facilitate change in their community. As part of the Photovoice process, participants describe images using the “SHOWeD” method. With SHOWeD, participants use their photographs to answer the questions,“What do we see?”, “What is really happening?”, “How does this relate to our lives?”, “Why does this concern exist?”, and “What can we do?” (Wang, 1999). By thoughtfully responding to these questions, participants critically reflect on the situations captured through the photos in their own voices. Following the completion of the SHOWeD process, participants can then create a meaningful narrative to thoroughly and succinctly describe their photographs. Group discussion among project participants can be used to identify and elevate common themes that the participants observed. Presentation of the images and narratives to community members and stakeholders provides the opportunity to share insights and build support for needed action and change.

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 2
Grade Level: Middle School
Duration: 50-60 minutes

Understanding Photography and SHOWeD Method Practice

Introduction

In this lesson, students will choose one of their photographs to describe using the SHOWeD method. They will identify environmental problems or successes in their community and reflect on how to improve or foster these aspects.

Objectives

1. Students will be able to show and narrate the photographs they have taken using the Photovoice method.
2. Students will be able to describe the reasoning behind their personal photo choice.
3. Students will be able to identify solutions to the problems or ways to foster successes represented in their photos.

Materials

- Photography Tips slides
- Photovoice SHOWeD handout (1 per student)
- Cameras/tablets/phones (1 per student)
- Guest photographer (optional)

Keywords: photographs, SHOWeD method, research questions

Note: If possible, invite a guest photographer to join you for this session to talk about best-practices for taking photographs and give students feedback on their photos.

Engage

Use the Photography Tips slides to explain the rule of thirds and the importance of lighting, perspective, patterns, angles, etc.

After going through the photography tips, review the SHOWeD method with the students. Have students recall what the SHOWeD method stands for and why we use it to help us explain photographs. The students will now have a chance to try the SHOWeD method on one of their own photos.

Do
Students should have taken one or more photographs as a part of their mission from the last session. For this session, they will choose one of their photos to work with. Let them feel free to choose the photo they think is best. Their reasons might have to do with the importance of the subject to them and/or the aesthetics of the photo. Put students in pairs so they can help each other fill out the SHOWeD method handout based on their chosen photos. Depending on how you are collecting and sharing photos, you can have students upload their chosen photo with their name, or have students email their photo to you, and/or show each other the photos on the camera itself while they work on the SHOWeD handout. Have each pair work together on one photo, then switch and work on the second photo, using the SHOWeD method. Walk around the room helping students understand and fill out the SHOWeD method handout. Remind the students to focus on identifying environmental health concerns or benefits in their photos, as well as potential ways to improve the situation. Pay attention to what students struggle with while they are working on this activity (e.g., sometimes students have difficulty transferring their ideas into writing). It is important that students finish this activity so the instructor can identify if students understand the SHOWeD method and can complete the process on their own. Have students briefly share aloud their chosen photos and the SHOWeD questions they have completed.

Reflect
Have each group briefly share aloud their chosen photos and the SHOWeD questions they have completed. Give students the opportunity to ask questions or raise difficulties, and assess how all students are doing with the SHOWeD method.

Weekly Mission
They can use the tips they learned to practice taking photographs at home, or find existing photographs and critique them.

Optional Extension
In this activity students will use virtual online tours of museum photography exhibits to think about and discuss what they like and don't like in a photograph, what makes a photograph an interesting piece of art, and how artists present their photographic work to others. Have the students visit one or more of the virtual museum tours below and look at the photography collections. Encourage students to relate the goals of their projects to their understanding of what a photographic museum exhibition looks like.

- Photos From the Civil Rights Movement
  https://artsandculture.google.com/story/VgURPkiyouv-Lw
- The Museum of Fine Arts Houston
  https://artsandculture.google.com/search/asset/?p=the-museum-of-fine-arts-houston&em=m068jd&categoryId=medium

- The Museum of Modern Art, New York https://www.moma.org/collection/?utf8=%E2%9C%93&q=&classifications=7&date_begin=1920&date_end=2020&with_images=1&on_view=1

Discussion questions following virtual museum tour

1. What do you notice about the photo? Is it black and white or color? Is it indoors or outdoors? What time of day is it? How far away from the subject is the photographer?
2. What do you like about the photo?
3. Are there people in the photograph? Do they know they are being photographed and are there any potential ethical implications of this?
4. What is happening in the photo? Imagine a short 4 sentence story based on what you see in this photo.
5. What do you think the photographer could have done differently or what would you do differently to make the photo even better?

Resources

- The *Facilitator's Toolkit For A Photovoice Project* describes how to facilitate a Photovoice project, as well as the SHOWeD method in Appendix E: https://www.gocolumbia.edu/institutional_research/photovoice_page_documents/Facilitators_Toolkit.pdf. Use this material to review the SHOWeD method and photovoice.

- The Spruce Crafts and The Photography Life websites provide some tips for beginner photographers: https://www.thesprucecrafts.com/introduction-to-photography-tips-for-beginners-2688546 and https://photographylife.com/photography-basics

- Facilitating a Photovoice Project: What you need to know! https://foodarc.ca/makefoodmatter/wp-content/uploads/sites/3/VOICES_PhotovoiceManual.pdf

NIH SEPA Environmental Health Investigators
Photovoice: Lesson 3
Grade Level: Middle School
Duration: 50-90 minutes

Photography Field Trip

Introduction

Students will travel to areas in their community to take photographs that represent environmental health concerns such as pollution, or images that represent something improving or sustaining the health of the environment that also supports human health.

Objectives

1. Students will be able to use photography to capture images of areas of personal interest in their community's environment.
2. Students will be able to identify community strengths and concerns, specifically related to environmental health.
3. Students will be able to interpret how these strengths or concerns potentially affect human health.

Materials

- Cameras/tablets/phones (1 per student)
- Transportation (bus, walking, etc.)

Engage

Briefly review the concept of "environment" from earlier sessions. Explain the day's photography field trip. They will be traveling to a location based on the class's input from the previous session. This is where students will go to take photographs of their environment. These photos should be of images that represent their environment and how it impacts the health of people in their community. Images can include areas of concerns that students have, areas where they see environmental assets, and areas that interest them.

Do

Once you arrive at the site, remind students of the goals of their photography. They will eventually be asked to use the SHOWeD method to explain the significance of their photos as it relates to the environment in their community. They can photograph aspects of the environment that are positive, negative, or that illustrate elements of both, as long as what they are photographing has significance to them and relates to human health and the environment. You can also review tips for good photographs, like paying attention to lighting and composition. Each student should aim to take photos of 5–20 different subjects or scenes so that they have options to choose from for their final narrative.

Hand out assigned cameras and remind students to handle the cameras with care. Prepare how the photographs are stored and organized ahead of time. Have a camera sign out sheet, or assign camera numbers. If cameras are used by multiple students, save all photographs under the students' names between sessions. The class will travel to the designated location where students will decide to take photographs of things that they think accurately represent their environment and impact the community's health. As they explore their environment while taking photographs, tell them to keep an eye out for things that interest them or questions they may have. These observations could help them think of actionable steps to improve the environment in their community.

Reflect

Review what the students saw on the trip and the different types of environmental images they captured. *Why did they choose to capture these images? Did any of these images inspire questions?* This discussion can happen during the transport back to the classroom to save time.

Extension: If you have the time, it can be beneficial to repeat this activity in a future session and allow students to take more pictures at additional sites. This allows students to have a wider range of pictures and environmental issues or strengths to choose from for their final project.

Weekly Mission

The mission this week is to ask family members and/or friends about environmental issues and assets that they see in the community. Have students write this down and consider if they have any questions about the environmental concerns or assets mentioned.

Resources

- The article *Beginning a Partnership with Photovoice to Explore Environmental Health and Health Inequities in Minority Communities* by Kovacic, M. B. et al explores the Photovoice method: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4245604/.

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 4
Grade Level: Middle School
Duration: 50-60 minutes

Using the SHOWeD Method

Introduction

Students will choose one of their photographs to feature in their final Photovoice project. They will use the SHOWeD method to describe the image in the photograph and their view on how this image represents the health of their community. They will then use their SHOWeD responses to compose a first draft of a narrative for their final Environmental Photovoice projects.

Objectives

1. Students will be able to communicate in writing how their environment can impact them and their community.
2. Students will be able to convert their writing prompts about their photographs into a cohesive narrative.
3. Students will be able to recognize the importance of editing, peer review, and making multiple drafts.

Materials

- Student photos from last session (stored in digital folders or cameras)
- Photovoice SHOWeD handout (1 per student)
- Photovoice SHOWeD assessment rubric
- SHOWeD Method and Narrative Examples
- "Writing a Personal Narrative: Writing a Draft" video

Keywords: environmental health, photographs, SHOWeD method

Engage: SHOWeD Method

Give students access to their saved photos from previous sessions. Students will review the photos they took during the last session's field trip. Students will choose their favorite photo for their final project. This will be the one they will share with the public. The chosen photograph should be one that conveys characteristics of the student's environment and addresses a health concern or benefit that affects them or people in their community. Pass out the SHOWeD method handouts. Once the students choose their photographs, have them record what image/file name they chose on the top of their handout so that instructors have the option to print the chosen photo for the final poster. Review the SHOWeD method with students using the SHOWeD Method and Narrative Examples. Optionally, you can use the Photovoice SHOWeD assessment rubric to guide students and/or evaluate their work.

Have students complete the Photovoice SHOWeD worksheet with their chosen photo. Have students work on this individually using their own photos. Students will go through

each step of the SHOWeD method and write their response on the handout. Review why we are using the SHOWeD method to narrate our photos for others. The purpose of the Photovoice method is to use photos and narratives to tell stories about some of the most important places and environmental topics in their lives.

Do: Drafting a Narrative

Students will now take their SHOWeD method responses and turn them into a narrative. Watch "Writing a Personal Narrative: Writing a Draft" video. Ask students to reflect on the video and discuss why creating a draft of work before a final version is important. Explain to students that a narrative is a story; a written account of events. Discuss narratives and how students likely encounter different forms of narratives throughout the day, from informally creating them in conversation to reading and writing formal text for school.

Review the examples of how to turn the SHOWeD questions into a cohesive narrative. Discuss how some details might get added and some might get deleted from their original worksheet. Remind students that the goal of the environmental Photovoice project is to share their environmental health concerns, successes, and/or interests with others, as well as any solutions they have thought of that may address these concerns or sustain these successes. The students' goal today is to create a first draft of their narrative. In the next session, students will give feedback on each other's drafts and make edits for their final version.

Weekly Mission

This week's mission is to write a journal entry about a memory of interacting with their environment. This can include any memory from mowing the grass, to fishing, to walking to their favorite neighborhood spot. This could be a memory of anything that made that student feel positive or negative about their environment. The entry should be at least one paragraph.

Resources

- The article *Engaging Youth through Photovoice* by Strack, R. W. et al describes a youth Photovoice project and explores the use of the SHOWeD method: https://journals.sagepub.com/doi/pdf/10.1177/1524839903258015
- *Narratives about Teaching Writing* from the National Council of Teachers of English book instruct teachers how to support students to write good narratives: https://secure.ncte.org/library/NCTEFiles/Resources/Books/Sample/03898Chap02.pdf.
- The website of the National Council of Teachers of English offers writing resources to teachers: https://ncte.org/resources/writing/.
- The *Facilitator's Toolkit For A Photovoice Project* describes how to facilitate a Photovoice project, as well as the SHOWeD method in Appendix E : https://www.gocolumbia.edu/institutional_research/photovoice_page_documents/Facilitators_Toolkit.pdf.

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 5
Grade Level: Middle School
Duration: 50-60 minutes

Narrative Final Draft

Introduction
In this lesson, students will give each other feedback on their draft narratives. They will incorporate edits and create a final narrative for their Environmental Photovoice projects.

Objectives
1. Students will be able to communicate in writing how their environment can impact them and their community.
2. Students will be able to recognize the importance of editing, peer review, and making multiple drafts.
3. Students will be able to revise previously constructed work to compose a final draft of their narrative.

Materials
- SHOWED Method handout (completed from previous session)
- Student photos (chosen from previous session)
- Colored pen for editing suggestions (1 per student)
- Computer/tablet (1 per student if available)
- Writing a Personal Narrative: Revising for Kids video
- SHOWeD Method and Narrative Examples
- Photovoice Final Poster Examples slides

Keywords: narrative, environmental health, photographs, SHOWED method

Engage
Watch the Writing a Personal Narrative: Revising for Kids video about how to revise their narrative. You can also review examples of narrative writing and the examples of what a final Photovoice project might look like. Discuss the video and what the students learned. Ask the students why they think writing various narrative drafts and having others edit those drafts is important. After the student discussion, explain the purpose of a revised final draft. Emphasize that this is the final time they will be able to work on their Photovoice narratives. A final draft should not have mistakes and should be clearly written.

Do: Revising Narratives
Have students exchange their draft narratives they created during the previous session with a partner to get feedback on their work. In science and many other fields, offering constructive, respectful and helpful feedback is an important way that colleagues interact with each other. Peer reviewers can silently read the other's handout and make

suggestions and edits with a different color pen. Peer reviewers should point out any spelling or grammar mistakes, and anything that is unclear. There should be a beginning, middle, and end, and the narrative should include how the memory impacted their feelings about the environment. They should also look for copy editing issues like spelling mistakes or missing words. Peer reviewers can use these questions as a guide to help them: *Have they left out important details? Would the reader or listener understand the setting and its significance*? *Are there still things you are wondering about after reading the narrative? Can you tell how the author feels about the photo? Does the narrative flow easily from one sentence to the next? Does the narrative explain how the photo relates to the environment in the community?*

As time allows the instructor can also rotate around the room and look over student drafts and make suggestions orally or in a different color pen than the students.

Typing Final Narratives

Students will now type or write out a clean version of the final draft of their narratives. Have students first read over the suggestions, comments, and corrections that their classmates and instructors have made. Students should consider these comments as they revise their previously drafted narrative. They will then create the narrative that will be showcased during their final presentations. Encourage students to type this narrative or write very neatly so that other people can easily read their narrative. This activity is done individually, however, students may talk to their peers during this time to clarify comments and questions.

Weekly Mission

Their mission is to begin practicing a short presentation of their final Photovoice project. It is important that students can communicate in both oral and written form about their chosen image and its significance.

Resources

- *Narratives about Teaching Writing* from the National Council of Teachers of English book instruct teachers how to support students to write good narratives: https://secure.ncte.org/library/NCTEFiles/Resources/Books/Sample/03898Chap02.pdf.
- The website of the National Council of Teachers of English offers writing resources to teachers: https://ncte.org/resources/writing/.
- The *Facilitator's Toolkit For A Photovoice Project* describes how to facilitate a Photovoice project, as well as the SHOWED method in Appendix E : https://www.gocolumbia.edu/institutional_research/photovoice_page_documents/Facilitators_Toolkit.pdf.
- Writing a Personal Narrative: Revising for Kids video https://www.youtube.com/watch?v=HLcjb0t6SRI

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 6
Grade Level: Middle School
Duration: 50-60 minutes

Poster Creation

Introduction

In this lesson, students will use their photographs and narratives to create a poster to present at the final showcase.

Objectives

1. Students will be able to develop an understanding of poster format and design.
2. Students will be able to manipulate photographs using computer-based applications and understand color palettes.
3. Students will be able to use images and combine content and information from different sources to engage in an argument from evidence.

Materials

Materials will depend on the format you decide for final presentations. An alternative option can be a digital gallery show using a slide deck and projector.

- 8x10 inch printed photo (1 per student)
- Printed/written final draft of narratives (completed during previous session)
- 11x17 inch poster boards (1 per student)
- Supplies to make poster (glue, scissors)
- Photovoice Final Poster Examples slides

Keywords: Photovoice, photographs, narratives, poster

Do: Creating Posters

Students will use their narrative and printed photograph to create a final product that they will present to the class, teacher, and/or other community members attending the final presentation. Look at the Photovoice Final Poster Examples slides and explain to students the process they will use to create posters for their final presentation. Depending on the availability of supplies and how you will present the student work, they may be gluing printouts of their photos and narratives onto poster board, or putting their photos into a frame or matboard, or creating a PowerPoint slide show, etc. Explain the guidelines, setup, and expectations for the final poster (for example, photo on top, narrative on bottom, with optional colored borders). Pass out printed photos, narratives, poster boards, and any necessary supplies. The final product should not have any mistakes, so students should have the instructor review the poster layout and give verbal approval for the student to proceed with the final product.

Weekly Mission

This week's mission is for students to continue to practice on their own what they will say during the presentation. In their journal, write down questions they think people will have for them. How would they answer these questions?

Resources

- The Yale Poorvu Center for Teaching and Learning gives some tips for Implementing Posters in the Classroom: https://poorvucenter.yale.edu/ImplementingPosters
- Scientific Poster Design: How to keep your poster from looking like an "abstract painting": https://live-hsp-3.pantheon.berkeley.edu/wp-content/uploads/2020/10/ScientificPosters.pdf

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 7
Grade Level: Middle School
Duration: 50-60 minutes

Presentation Practice

Introduction

In this lesson, students will learn key components of effective science communication. Students will practice their final poster presentations to prepare for the showcase.

Objectives

1. Students will be able to develop presentation skills.
2. Students will be able to have an informative discussion about their environment with others.

Materials

- Student final posters (previously completed)
- How to Deliver an Effective Presentation

Keywords: Photovoice, community, environment, presentations

Engage

Watch the video How to Deliver an Effective Presentation. Have a brief discussion about why it is important to present the Environmental Photovoice projects to the community. *In what way is communicating what you learned important in sharing the projects' messages? What are the most common types of environmental issues they have noticed? What are the environmental assets they see in their community? How do these issues and assets affect members of their community? How do these issues and assets affect the health of people who live in their community? What solutions have they come up with to address these issues or sustain assets? How can they convey these relevant issues, assets, and interests effectively to community members?*

Do: Presentation Practice

Students will practice the presentation of their Environmental Photovoice poster projects. Explain who their audience will be (community members, classmates, teachers, school leaders, etc.) and provide tips on how to best communicate with that audience. Remind students that it is important to share their findings with the community to generate awareness and support for environmental change. Posters will be presented during the next program session with additional peers or teachers invited, or if possible, at an event with community members. The goal of the student Environmental Photovoice presentations is to share their environmental health concerns, successes, and interests with others, as well as solutions to address these concerns or sustain these assets.

Work with the students to arrange their posters around the room or have one student present at the front of the room at a time, depending on available space and time. You may want to divide the class into two so that one group can view posters while the other stands by their posters, and then have the groups switch. Have presenting students stand next to their posters and practice explaining their photos and narratives. They will then receive input and questions from the instructor and other students. Practice discussing and answering questions about their posters.

Discussion: Ask students to point out the positives and some challenges they faced while practicing their presentations. Have students consider what questions audience members might ask, and have students think about answers to those types of questions. Ask students what else they can or should practice prior to the presentation on their own time.

Weekly Mission

This week's mission is to come to the final showcase prepared to present their final Environmental Photovoice projects with community members to help spread awareness and positive change concerning their environment and how these concerns relate to the health of people in their community. Discuss any other expectations for the event (e.g. attire, arrival time)

Resources

- How to Deliver and Effective Presentation
  https://youtu.be/0QzhQwHqtXY
- University Nebraska-Lincoln. Presenting a Research Poster.
  https://www.unl.edu/gradstudies/connections/presenting-research-poster

NIH SEPA Environmental Health Investigators
Photovoice: Activity Plan 8
Grade Level: Middle School
Duration: flexible

Environmental Photovoice Final Showcase

Introduction

The purpose of the Environmental Photovoice event is to showcase the students' final projects. These projects highlight environmental concerns or assets that are important to the students. Sharing this with community members will help foster discussions about what aspects of their environment promote human health as well as what areas could be improved. Students should also discuss potential solutions.

Objectives

1. Students will be able to explain their projects to an audience, emphasizing connections between the environment and human health in their community.

Materials

Environmental PhotoVoice Showcase Planning Checklist:

Item/Task	Details	Completed
Projects	Have students complete their final Environmental Photovoice projects to display.	
Logistics	Set the date, time, and location.	
Guests	In collaboration with the students, decide on and invite other guests from the community to attend.	
Refreshments	Plan what food and drinks will be served.	
Jobs	Assign jobs to the students to help at the beginning and end of the event when they are not standing next to their projects. Example jobs: serve food, welcome guests, sign up list, mc, tech, clean up, etc.	
Document	Document the event with photographs, sign up sheets, observations such as writing down guest questions, etc., to help support improving the event for next year.	
Other		

MODULE THREE: Student Research

The Student Research module leads students through the process of conducting their own original environmental research projects. While the previous Photovoice module focused on qualitative data, this research module will focus on collecting quantitative data using environmental monitoring tools. Students will choose a topic that interests them to investigate in their local environment. Ideally, instructors can arrange a field trip to allow students to collect data at an off-campus study site, but students can also collect data on school grounds if necessary. Students will use the data they collect to perform data analysis and data visualization. Finally, they will create a scientific poster to share their research findings. The module materials contain examples of student projects from previous implementations of the program.

Student Research Module Lesson Plan Overview

Day 1: Introduction to Research Projects

Introduction

Students will be introduced to the resources available to them as they plan a research project. Throughout the unit, they will work in teams to collect data to answer a question of their choice. They will then analyze that data, and share their findings with community members.

Objectives

1. Students will be able to identify connections among science, self, and community.
2. Students will be able to recognize the resources available to them for collecting and interpreting data.

Materials

- Student computers with internet access
- Tablets w/ showcase apps (examples listed below)
- Research Resources Showcase Table Handout
- Student notebooks
- Research tools and materials (examples listed below)

Day 2: Understanding Data

Introduction
In this session students will review measuring units for different types of pollution. They will learn about quantitative and qualitative data and practice collecting data to answer research questions using a fun hypothetical research prompt.

Objectives
1. Students will understand what data are, and the difference between quantitative and qualitative data.
2. Students will be able to use data to answer a research question.

Materials
- Student notebooks
- Tape measures
- Data collection sheet

Day 3: Research Project and Poster Planning

Introduction
In this activity students will learn about their final research product, a research poster that they will share at a community event. They will begin planning how to successfully produce this final product as a team throughout the unit.

Objectives
1. Students will be able to interpret research posters.
2. Students will be able to write a research question for a study they want to do.
3. Students will be able to list project steps and team responsibilities for research.

Materials
- Streamlined Research Poster Examples
- Research Project Planning Document

Day 4: Observational Studies and Sampling Design

Introduction
Students will learn more about types of variable and types of scientific studies as they continue to plan for collecting data for their own research projects. Optionally they can do a simulation activity to understand appropriate sample size for study design.

Objectives
1. Students will be able to understand what appropriate sample size means and apply this to their own study designs.

2. Students will be able to execute their data collection plan.

Materials:

- "What Are Observational and Experimental Studies" video
- Explanatory and Response Variables in Observational Studies PowerPoint
- Optional: Fun size M&M packets for each student
- Optional: M&M Sampling Data Collection Sheet

Day 5: Understanding Variables and Using Data Tables

Introduction
In this activity students will practice entering and formatting data into a usable table, and collect data in their community to contribute to their chosen research question. They will apply changes to improve data collection based on team discussion and feedback from the previous session.

Objectives

1. Students will be able to create and manipulate digital data tables, filling in cells and using simple formulas.
2. Students will be able to execute their updated data collection plan.

Materials

- Explanatory and Response Variables in Observational Studies PowerPoint
- Example Data Steel Mill Impacts Google spreadsheet

Day 6: Data Visualizations–Making the Right Graph

Introduction
An important step in the scientific process is knowing what to do with data once you have collected it. Depending on why you collected the data, there may be various ways you could explore the meaning of the data, from simple statistics like finding means, to creating graphical representations that visually summarize trends in the data. Developing graphs help researchers interpret the data and communicate findings to others. In this activity, students will explore examples of how to make graphs from a data table and understand mistakes to avoid. They will also begin to interpret and visualize the data they have collected. In addition they will interact with a guest scientist to learn more about the authentic scientific process.

Objectives

1. Students will be able to create graphs of their data.

2. Students will be able to understand how to identify trends in their data and create data visualizations that communicate effectively.

Materials
- How to Improve Graphs spreadsheet
- Computers for each student group with either Excel or Google Sheets available

Day 7: Science Communication

Introduction
In this session students will create a scientific poster of the findings from their project.

Objectives
1. Students will be able to effectively communicate their research project results.

Materials

- Laptop/tablet (1 per group)
- Student poster files created from the poster template in previous session
- Data visualizations, graphs, diagrams, etc. completed from previous session
- Written poster sections completed from previous session
- Poster examples
- Poster Templates
- Poster board (1 per group if cannot print digital posters)
- Optional Poster Rubric

Day 8: Presentation Preparation

Introduction
Students will continue working on their posters and begin practicing their presentations.

Objectives
1. Students will be able to construct research project posters that effectively communicate their scientific findings.
2. Students will be able to present their scientific findings clearly and with confidence.

Materials
- Laptop/tablet (1 per group)
- Student poster files created from the poster template in previous session
- Data visualizations, graphs, diagrams, etc. completed from previous session
- Written poster sections completed from previous session

- Research Poster examples
- Poster board (1 per group if cannot print digital posters)
- Optional Poster Rubric

Day 9: Poster Presentation

Introduction: In this activity, students will present to the class on the environmental health project they have explored.

Objectives

1. Students will be able to communicate the major findings of their project, what they did, and why it matters.

Materials

- Optional Poster Rubric
- Printed/assembled students poster OR computer and projector if using digital posters

Standards Alignment for Student Research Module

NEXT GENERATION SCIENCE

Performance Expectations

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to the Earth's environment can have different impacts (positive or negative) on different living things.

Science and Engineering Practices

1. Asking Questions and Defining Problems: A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

2. Developing and Using Models: A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

3. Planning and Carrying Out Investigations: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

4. Analyzing and Interpreting Data: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

5. Using Mathematics and Computational Thinking: In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

6. Constructing Explanations and Designing Solutions: The products of science are explanations and the products of engineering are solutions.

7. Engaging in Argument from Evidence: Argumentation is the process by which explanations and solutions are reached.

8. Obtaining, Evaluating, and Communicating Information: Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Cross-cutting Concepts

1. Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. Cause and effect: Mechanism and explanation: Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. Scale, proportion, and quantity: In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. Systems and system models: Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

7. Stability and change: For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

ENGLIGH & LANGUAGE ARTS

Writing

6-8.W.1: Write arguments focused on discipline-specific content.

6-8.W.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
6-8W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
6-8W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
6-8W.5: With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
6-8W.6: Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.

Reading in Science and Technical Text

6-8.R.ST.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
6-8.R.ST.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

MATH

Statistics and Probability

6.SP.1-3: Develop understanding of statistical variability.
6.SP.4-5: Summarize and describe distributions.
7.SP.1-2: Use random sampling to draw inferences about a population.

Mathematical Practices

K-12.MP.1: Make sense of problems and persevere in solving them.
K-12.MP.2: Reason abstractly and quantitatively.
K-12.MP.3: Construct viable arguments and critique the reasoning of others.
K-12.MP.4: Model with mathematics.
K-12.MP.5: Use appropriate tools strategically.
K-12.MP.6: Attend to precision.

NIH SEPA Environmental Health Investigators
Student Research 1
Grade Level: Middle School
Duration: 50-60 minutes

Introduction to Research Projects

Introduction
Students will be introduced to the resources available to them as they plan a research project. Throughout the unit, they will work in teams to collect data to answer a question of their choice. They will then analyze that data, and share their findings with community members.

Objectives
1. Students will be able to identify connections among science, themselves, and their community.
2. Students will be able to recognize and understand the function of the resources available to them for collecting and interpreting data.

Materials
- Student computers with internet access
- Tablets w/ showcase apps (see Table below)
- Research Resources Showcase Table Handout
- Student notebooks
- Research tools and materials (see Table below)*

**Examples of tools used in the original program include T-probe soil collectors, mobile citizen science apps, portable XRF soil testers, drones, portable sound meters, and handheld air quality monitors.*

Keywords: research, research question, resources, investigation, data

Engage
Give a brief overview of what the program is and what the semester will look like. Students will work in teams to conduct a research project to answer a question of their choice. The question should center on human exposure to environmental factors (e.g., noise, air pollution, soil contamination, or physical environment) or human impact on the environment around them. Throughout the academy they will devise/research ways to mitigate that exposure or impact. They will collect data, analyze that data, develop a solution, and share their findings.

Environmental Health in our community
Put students into small groups and discuss the question, “What kinds of **natural** factors are in our environment that could affect our health or well being?”. Have students brainstorm and add their ideas to a table with two columns. Then have them think about

“What kinds of **human-made** factors are in our environment that could affect our health or well being?”and add these to the second column in their table. When finished, each group will briefly share what they came up with and elaborate on what they mean. The instructor should offer feedback and add other factors the students may not have thought of.

Do: Research Resource Showcase

Pass out the Research Resources Showcase Table Handout to each student. Explain that students will rotate around stations that showcase all the resources that are at their disposal when planning and carrying out their research projects. Students will visit each station for about 3 minutes. They can travel in teams or groups, but each student needs to fill out their individual tables with notes on all of the resources to ensure they go to each station. They do not know what their research project is about yet, they are exploring what is available to them so that they can come up with a research topic during the next session. The research resources available to the students should be set up at various tables/desks for students to visit and manipulate. If staffing allows each station can have a teacher or volunteer to explain the item, or each station can have a written summary of the tool. An example of the tables of tools from the original implementation of the program is below. Depending on your resources you may want to include things like water quality test kits, handheld air monitors, phone/tablet based apps that can monitor noise, microscopes, soil test kits, etc. You can also borrow tools from the SIUE STEM Center or contact nearby extension services or universities to inquire about borrowing environmental testing equipment.

Resource	**Setup/Activity**
Soil collection tools (t-probe, trowel, and sample bags) and soil chemistry test kits	Show the t-probe and soil test kit and remind students how they are used.
PurpleAir and handheld air quality monitors	An air monitor to show and have the PurpleAir map displayed on a laptop to explore.
Environmental Monitoring Apps for phones/tablets	Apps displayed on ipads for exploring. Suggested apps: Decibel X, Noise Project, Globe Observer
Sound meters	Sound meters out for students to explore. Provide an image with labels of the parts of the noise monitor, how to turn it on, set it up, etc. Also show a document of what the noise data look like in a spreadsheet.

Reflect
Once you have discussed and demonstrated all the research tools available, give students a chance to share as a group which tools they found most interesting and why. In the next session they will be forming smaller research teams based on who would like to work together with the same topic and tool.

Resources

- PurpleAir map
- iNaturalist
- Bee.Watch
- SpiderSpotter
- BeeSpotter
- Decibel X

Relatively low cost environmental research tools to consider purchasing:
https://www.carolina.com/catalog/detail.jsp?prodId=652567&gclid=CjwKCAjwl6OiBhA2EiwAuUwWZSnJFr0kSzhgQ1GV7VzLIIC24vm0ZoRRRuNnsiNFSzhLxU6fVZajdRoCiPoQAvD_BwE

https://temtopus.com/products/temtop-lkc-1000s-air-quality-detector-professional-formaldehyde-monitor-temperature-and-humidity-detector-with-pm2-5-pm10-hcho-aqi-particles?pr_prod_strat=use_description&pr_rec_id=6637a89be&pr_rec_pid=2238045257776&pr_ref_pid=2237224255536&pr_seq=uniform

https://www.grainger.com/product/EXTECH-EXTECH-Sound-Level-Meter-with-9WTE8

https://www.lowes.com/pd/Soil-Test-Kit/999989630?cm_mmc=shp-_-c-_-prd-_-lwn-_-ggl-_-LIA_LWN_123_Live-Goods-_-999989630-_-local-_-0-_-0&gclid=CjwKCAjwl6OiBhA2EiwAuUwWZRRY0yX_E-s-FCaWSpt7WRlADrjyl6dYUGCwXwRXCx3vjXTt3Mm5ERoCfSQQAvD_BwE&gclsrc=aw.ds

NIH SEPA Environmental Health Investigators
Student Research 2
Grade Level: Middle School
Duration: 50-60 minutes

Understanding Data

Introduction

In this session students will review measuring units for different types of pollution. They will learn about quantitative and qualitative data and practice collecting data to answer research questions using a fun hypothetical research prompt.

Objectives

1. Students will understand what data are, and the difference between quantitative and qualitative data.
2. Students will be able to use data to answer a research question.

Keywords: environmental health, research, noise pollution, air pollution, soil pollution, measuring units

Materials

- Student notebooks
- Tape measures
- Data collection sheet

Engage

Tell students that we will begin by reviewing what we discussed during the previous module. Ask them to define and describe environmental health, as well as areas of environmental health that can be studied. They should write their responses in their notebooks.

In this module, students will get the opportunity to collect their own environmental data. The students learned about how pollution is measured in the previous module, but make sure they remember or become familiar with the measuring units used to quantify different types of pollution. Allow students to ask questions to ensure they are comfortable with the standard units of measure that will be used throughout the semester.

We measure sound intensity in decibels (dB), which they may remember from the previous module are on a logarithmic scale. Silence is 0dB and sounds loud enough to be considered noise pollution, such as a lawn mower, are around 85dB or more.

We measure air particulate matter by both concentration and size. When collecting a concentration of matter that is a particular size it is denoted as PM (diameter of particle size). We will focus on particulate matter that is 2.5 micrometers in size (PM2.5).

To describe the concentration of something, such as the concentration of pollution within soil, we use parts per million (ppm). For example, if lead in a soil sample is 75 ppm, then for every million particles of soil, there are 75 particles of lead.

The students will also explore an example that has the opportunity to collect qualitative data, which does not have distinct measurement units.

Do: Collecting quantitative and qualitative data

Next students will use a fun example to learn about collecting data and using that data to answer a research question.

Quantitative Data

Have students work in small groups to solve the following problem: The principal has decided to implement Hat Day Fridays where all students will be given tophats to wear every Friday. Some of the teachers are concerned that students will not be able to easily fit through the doors when wearing their tophats. Your task is to answer the question: Can students easily fit through the doors at school when they have their hats on? The top hats measure 45.72 cm high.

Data Collection: Ask students the types of data they should collect to determine if they are going to be able to fit through doors when wearing their top hats. Make sure that students are aware that not all door openings in the school are going to be the same height and not all students walking through the doors will be the same height either. Have students break into groups and come up with a data collection plan that will allow them to answer the question of whether the hats will fit. Provide students with the door opening data collection sheet and a measuring tape. Students should measure various heights of door openings around the school (make sure to do multiple openings like bathrooms, classrooms, metal detector, cafeteria, etc.). Guide the students as needed about what they should be measuring: doors, openings, door frames, etc. Provide students 10 minutes to collect data. Have all students work in centimeters.

Data Analysis: Once students return to the classroom, ask them to share some of their measurements. On the board, record this data. Point to the minimum, maximum, and range. What is the mean door height opening at the school and what is the median opening? Use these data to answer the question: Will students be able to move through the doors when wearing the top hats? Emphasize that students collected quantitative data to answer a question. If time allows, you can also calculate means and medians.

Qualitative Data

Some of the teachers are also concerned that students might not enjoy wearing top hats all day long, while others think it will be a fun experience for the students. The teachers feel it is important to understand how students might feel and what their concerns might be. Ask students what kind of data they would want to collect to answer this question. Qualitative data can be an equally important type of information to consider when conducting research. Ask students to write down some questions they might have for their fellow students to understand how students feel about Tophat Fridays (Are you concerned that the hats will be too hot? Do you have a hair style that doesn't easily fit inside the hats? How do you feel about hats as a fashion accessory? etc).

You can split the students into 2 or more groups and have one group interview members of the other group and take notes on their responses. Once they have had a chance to collect qualitative interview data each group can review their notes and consider any themes or important points that were raised. Based on their qualitative AND quantitative research, have the students decide what recommendations they would make to the principal about student feelings toward Tophat Fridays.

Reflect

Emphasize that the purpose of collecting data is to answer questions, and that when they collect data to answer questions like they did today, they are doing science. Discuss with students what questions they might have about their community related to how the environment affects their health. What types of data would they like to collect to address these questions? Recap that students will have the opportunity to collect data on the quality of the air, soil, and the noises in their environment and how this might impact their health.

Resources

- Britannica Inch webpage: https://www.britannica.com/science/inch

NIH SEPA Environmental Health Investigators
Student Research 3
Grade Level: Middle School
Duration: 50-60 minutes

Research Project and Poster Planning

Introduction
In this activity students will learn about their final research product, a research poster that they will share at a community event. They will begin planning how to successfully produce this final product as a team throughout the unit.

Objectives
1. Students will be able to interpret research posters.
2. Students will be able to write a research question for a study they want to do.
3. Students will be able to list project steps and team responsibilities for their research.

Keywords: research poster, research, descriptive stats, mean, range, min, max

Materials
- Streamlined Research Poster Examples
- Research Project Planning

Engage: Poster Examples
This session will jump right into showing students examples of their end goal for their environmental research project. Use the slide presentation of Streamlined Research Poster Examples to show students the expected end product after they complete their research projects. Point out each section of the poster and tips on how to gather and organize content for that section during their project.

Do: Research teams plan for data collection
Help students break up into small groups of 2 to 5 students based on their interests and pass out the Research Project Planning document. Have them begin to fill out the first three rows as a team (each student should complete their own). What research questions do they want to attempt to answer? What resource from the Research Resource Showcase (air quality monitor, noise monitor, camera, app, etc.) would they like to use? What resources or materials outside of the showcase will they need? How will these resources and the data they plan to collect help them answer their research question? This is a time to talk through their project with their teammates as well as you, the instructor, to choose a project that is realistic within the logistical parameters of your program setting. This is an opportunity to delve into an issue that potentially affects them and to come up with information or solutions to eventually share with their community at a showcase. Be sure to stop by each group and talk through each prompt

they are to answer. Give them suggestions on how to make their project a successful reality.

Data Collection Plan
The teams should decide what tasks they need to do to collect data and who is responsible for those tasks. This should be recorded under the “Data Collection” section of their planning documents.

They also need to identify everything they will need for data collection. They would write this list of materials clearly in the “Materials” row. Inform the groups that this is how they will communicate to you what materials they need for data collection during the next session. **Touch base with each group to make sure their materials list is sufficient to help answer their research question, as well as manageable for you to provide**. Have each group save their planning documents electronically or physically (just be consistent with the format with the entire class throughout the project).

Reflect
Have each group share a brief summary of their plan with the class. This also provides a chance for students to learn from each other. Ask each team to share:

- What is their research question?
- What data will they collect to help answer this question?
- Where do they plan to go and which members are doing what to contribute to data collection?
- What is their hypothesis or what do they predict they will find through this project?

Resources

- https://www.npr.org/sections/health-shots/2019/06/11/729314248/to-save-the-science-poster-researchers-want-to-kill-it-and-start-over

NIH SEPA Environmental Health Investigators
Student Research 4
Grade Level: Middle School
Duration: 50-60 minutes

Observational Studies and Sampling Design

NOTE: Have all the students wash their hands before doing this activity to prevent the spread of germs!

Introduction

Students will learn more about types of variable and types of scientific studies as they continue to plan for collecting data for their own research projects. Optionally they can do a simulation activity to understand appropriate sample size for study design.

Objectives

1. Students will be able to understand what appropriate sample size means and apply this to their own study designs.
2. Students will be able to execute their data collection plan.

Keywords: data, research, sampling, data collection

Materials:

- "What Are Observational and Experimental Studies" video
- Explanatory and Response Variables in Observational Studies PowerPoint
- Optional: Fun size M&M packets for each student
- Optional: M&M Sampling Data Collection Sheet

Engage

Observational studies

Begin by watching the video "What Are Observational and Experimental Studies". Ask students for examples of the two different types of studies to assess their understanding of the differences. Observational studies may be different from examples of science experiments they've heard about in the past where researchers are adding an ingredient like a manipulation. Next, ask them to think about what type of study their project will be. *Will they be performing a manipulation or adding a treatment they created?* Most students will likely have projects that are observational studies, so help them understand how their research projects relate to the characteristics described in the video.

Types of Variables

Show the Explanatory and Response Variables in Observational Studies slides (the animations will work better in PowerPoint than Google slides). Explain the difference between explanatory(independent) and response(dependent) variables using the noise levels and race track example. For observational studies, researchers are not manipulating the explanatory variable, they are just observing the response variable across some pre-existing difference or phenomenon. Use the other examples in the PowerPoint to ask students which variable is which. Then *ask them to define the explanatory and response variables in their own studies*. Some groups may simply be monitoring an environmental variable over time, and this is a valid type of study design. There is a possibility that some groups may have a study that is more of a correlation between two variables without a clear explanatory and response variable, so if this is the case you can discuss this study variation as a group.

Do: Sampling size simulation (optional)

If your students are ready to collect data and have the opportunity to do so, this session can be used for them to start collecting data. If they are not ready to collect data or planning to collect data on a different day, they can use the rest of this session to continue planning and do this sample size simulation described below. The sample size simulation is intended to encourage students to think about sampling size for their own research projects and collecting the right number of samples data to get a good estimate of environmental conditions to answer their research question.

In order to design their experiments, students will need to choose a sample size. Explain that a sample is a subset. A sample is made up of the sites or subjects on which data will be collected in a study out of all the possible subjects/sites available. Sample size tells you about how many measurements researchers plan to collect, such as interviewing 20 people out of all the possible people at the school, or picking 20 spots to collect air quality data out of all the possible sites in the area.

Students will complete a simulation activity to help them learn about appropriate sample sizes. Students will use M&Ms to explore sampling a subset of a larger group using the M&M Sampling Data Collection Sheet

Pass out one fun size packet of M&Ms to each student. Have them record the numbers of each color in their pack and calculate the proportion for each.

Pause after the first sample and ask the groups to share what proportions they got aloud with the group and make guesses based on the students' counts what the real proportions are as set by the M&M factory. When they are manufactured M&Ms have set proportions for the colors, but they depend on the factory where the candies were produced.

The New Jersey factory uses the following proportion of colors for plain M&M's:

Red=0.125,
Orange=0.25,
Yellow=0.125,
Green=0.125,
Blue=0.25, and
Brown=0.125,

Cleveland, Ohio has a little more even distribution of colors with
Red=0.131,
Orange=0.205,
Yellow=0.135,
Green=0.198,
Blue=0.207, and
Brown=0.124.

If your candies are from the Cleavland factory, they will have a code on the package with CLV, such as 632GCLV20. If they are from Hackettstown, NJ they will have HKP. The students may find that there is a very wide variation in the numbers of each color that the different students counted and some may not be very close to the proportion set by the factory. A fun size pack is a fairly small sample size–how close are the proportions in a fun pack to the overall proportions produced by the factory?

Next, students will find a partner and double their sample size by adding the numbers together from two fun size packs. They can once again compare the proportions to the known proportions set by the factory.

Finally, all the students in the class can add their numbers together and calculate the color proportions for the class as a whole. Because this is a much larger sample size, the color proportions for the class as a whole will likely be closer to the true color proportions of all the M&Ms produced by the factory.

Reflect

Ask students what they noticed about how the proportions changed between small and larger sample sizes? Did they reach a sampling number where they had a pretty accurate estimation of the true proportions? Guide them to thinking about how this applies to their own projects by using a more real world example such as taking temperature measurements. What would happen if we only took one temperature measurement in one sunny spot in the middle of the day? Would we have an accurate idea of the usual temperature of that area? What might be a better sampling approach to understand the temperature of that area more accurately? As they plan for collecting their own data, they should think carefully about how to design their sampling protocols to make sure they have a big enough sample that is still reasonable within the time

available. With any time remaining, students can continue to discuss their research plan with their group.

Resources

- Sampling Methods | Types and Techniques Explained
- The distribution of colors for plain M&M candies

NIH SEPA Environmental Health Investigators
Student Research 5
Grade Level: Middle School
Duration: 50-60 minutes

Understanding Variables and Using Data Tables

If the students need more time to collect or process data, the first section of this lesson plan can be shortened or used on another day, and/or additional sessions can be devoted to data collection and processing.

Introduction

In this activity students will practice entering and formatting data into a usable table, and continue to work towards answering their chosen research question.

Objectives

1. Students will be able to create and manipulate digital data tables, filling in cells and using simple formulas.
2. Students will be able to execute their data collection plan.

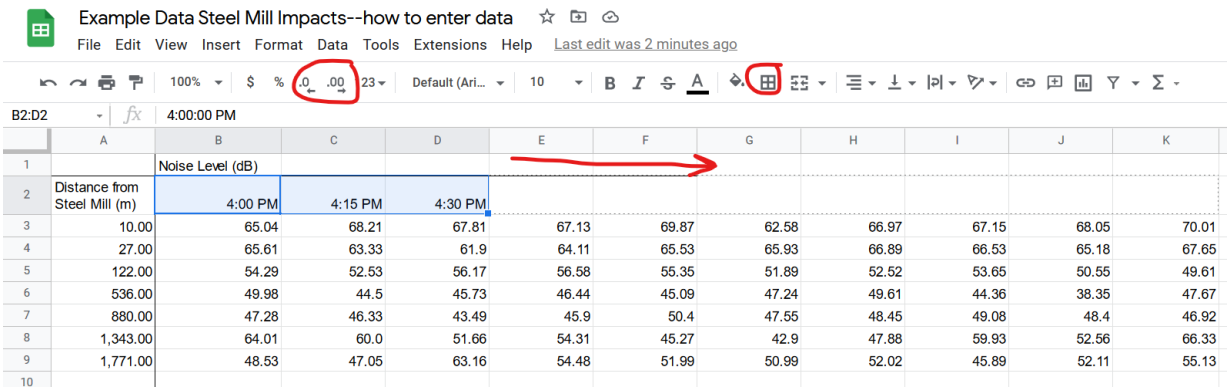
Keywords: data, research data collection, data tables, data entry, variables

Materials

- Example Data Steel Mill Impacts
- TBD based on student Research Plans

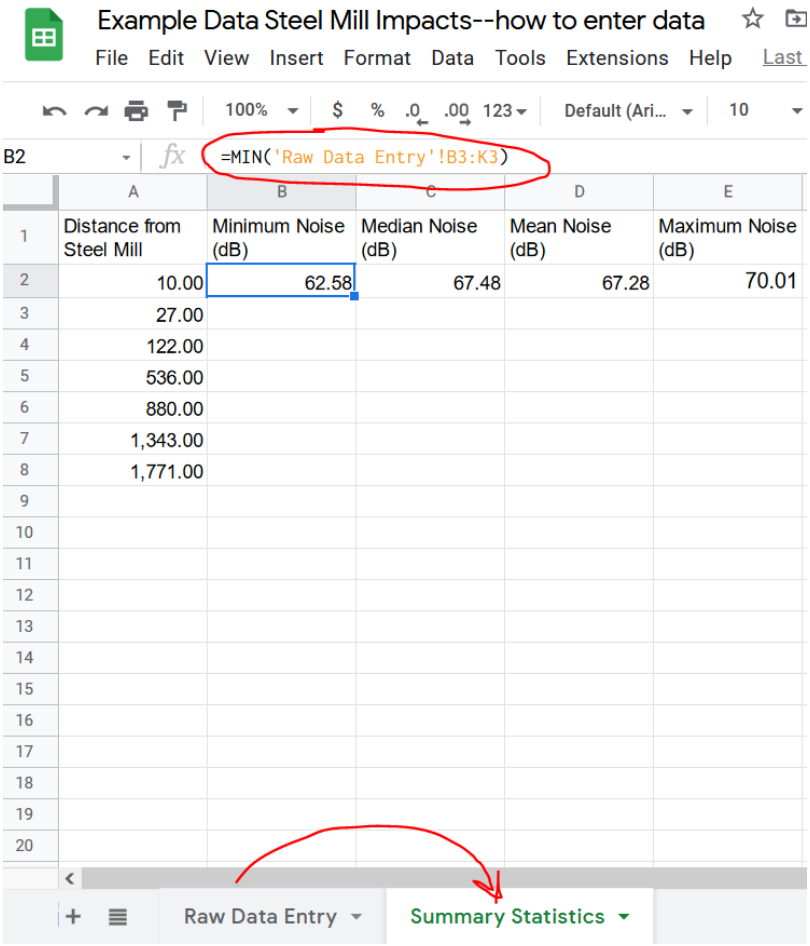
Engage

Show the Example Data Steel Mill Impacts spreadsheet to the group. Open the spreadsheet in either Google sheets or Microsoft Excel depending on what the students will be using to enter and analyze their data. First, ask them to identify components of the data sheet such as variable names, types of variables, and units of measurement. Demonstrate how to do simple formatting changes like increasing or decreasing decimal places and adding gridlines. Show how to fill in the rest of the time intervals using the autofill tool.



	A	B	C	D	E	F	G	H	I	J	K
1		Noise Level (dB)									
2	Distance from Steel Mill (m)	4:00 PM	4:15 PM	4:30 PM							
3	10.00	65.04	68.21	67.81	67.13	69.87	62.58	66.97	67.15	68.05	70.01
4	27.00	65.61	63.33	61.9	64.11	65.53	65.93	66.89	66.53	65.18	67.65
5	122.00	54.29	52.53	56.17	56.58	55.35	51.89	52.52	53.65	50.55	49.61
6	536.00	49.98	44.5	45.73	46.44	45.09	47.24	49.61	44.36	38.35	47.67
7	880.00	47.28	46.33	43.49	45.9	50.4	47.55	48.45	49.08	48.4	46.92
8	1,343.00	64.01	60.0	51.66	54.31	45.27	42.9	47.88	59.93	52.56	66.33
9	1,771.00	48.53	47.05	63.16	54.48	51.99	50.99	52.02	45.89	52.11	55.13
10											

Using the second tab/sheet, demonstrate how to enter simple formulas for calculating summary statistics based on the data entered in the first sheet. How will they have to change the formulas in the second row to calculate the numbers at 27 m from the mill? You can also show them how to autofill formulas (in a similar way as autofilling the dates on the first sheet) by highlighting the cell with the formula and then dragging down the rest of the column.



	A	B	C	D	E
1	Distance from Steel Mill	Minimum Noise (dB)	Median Noise (dB)	Mean Noise (dB)	Maximum Noise (dB)
2	10.00	62.58	67.48	67.28	70.01
3	27.00				
4	122.00				
5	536.00				
6	880.00				
7	1,343.00				
8	1,771.00				
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Give students time to discuss in their small groups how they will record and enter their data and to ask instructors for any help they may need. If they have not done so already, they may want to create spreadsheets where they will enter data directly or for copying data from their notebooks. You can also explore the other tabs of the spreadsheet which shows examples of air quality data tables.

Do: Collect Data

Give students time to collect data according to the Research Plans they have been working on. Instructors can troubleshoot data collection procedures and proper use of scientific tools. Depending on the type of data being collected, students may need additional session to process their data, such as time to test soil samples. Other students may acquire their data more quickly if they are simply taking noise level measurements in multiple locations and will not have any samples to process.

Reflect

Leave a few minutes for students to put away materials and discuss with their group and the instructor what went well or what help they may need before next time.

Resources

- Scientific variables– (in this video “dependent variable”= response and “independent variable” =explanatory) https://youtu.be/0A55QRyJHPM
- Beginner’s Guide to Microsoft Excel https://www.youtube.com/watch?v=rwbho0CgEAE
- How to Use Google Sheets https://www.youtube.com/watch?v=Rus4buFP_a4

NIH SEPA Environmental Health Investigators
Student Research 6
Grade Level: Middle School
Duration: 50-60 minutes

Data Visualizations–Making the Right Graph

If the students need more time to collect data or process samples, they can wait to begin creating their graphs until a later session.

Introduction

In this activity, students will explore examples of how to make graphs from a data table and understand mistakes to avoid. They will also begin to interpret and visualize the data they have collected.

Objectives

1. Students will be able to create graphs of their data
2. Students will be able to understand how to identify trends in their data and create data visualizations that communicate effectively their data

Keywords: data visualization, graph, data analysis, research

Materials

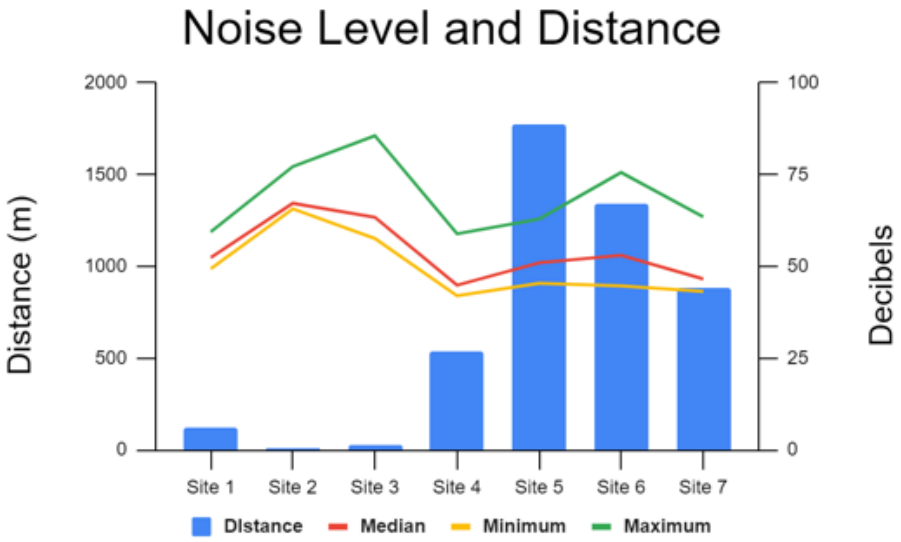
- Computers for each student group with Google sheets
- Types of Graphs and when to use them video
- How to Improve Graphs

Engage

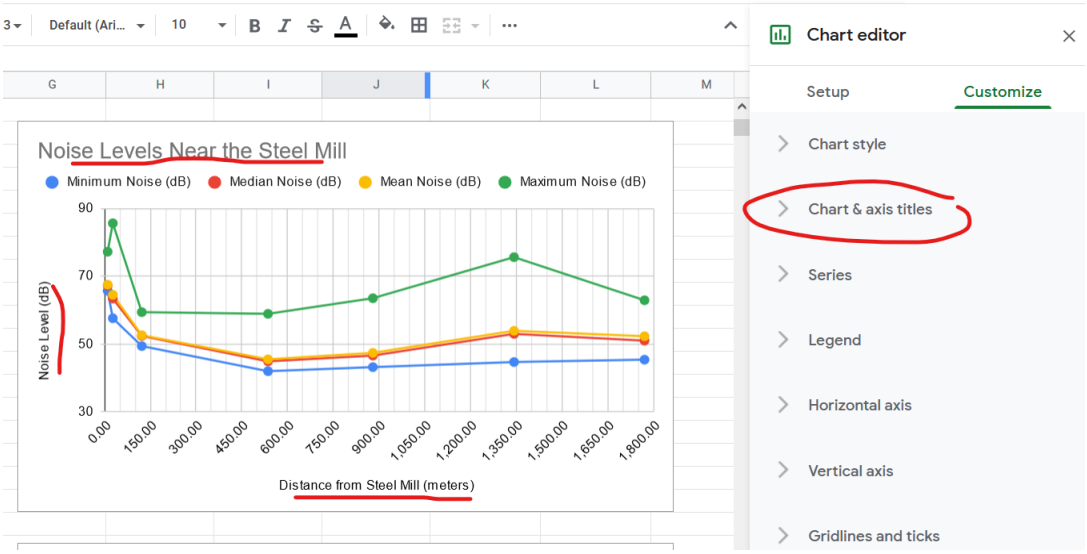
An important step in the scientific process is knowing what to do with data once you have collected it. Depending on why you collected the data, there may be various ways you could explore the meaning of the data, from simple statistics like finding means, to creating graphical representations that visually summarize trends in the data. Developing graphs help researchers interpret the data and communicate findings to others. Ask students to share either in their small groups or as a whole group discussion: What is the goal of creating a data visualization? What are they hoping to understand and communicate about their data by making a graph? Watch the video Types of Graphs and When to Use Them and ask students what type of graph might fit their data best and why.

Students will now explore real data collected by other students. We will use the spreadsheet How to Improve Graphs to demonstrate the difference between less effective and more effective graphs. *(These graphs were made in Google Sheets and should be opened there to display properly)*. First give a little background on the study–students collected data using air and noise monitoring tools at varying distances from a

nearby steel mill. Ask the students to look at the original graphs first and interpret what they are showing. Can they tell whether noise levels are higher near the steel mill? The students may have difficulty interpreting the graphs because the setup is not very intuitive, but they should at least be able to identify what type of graph it is and what variable is depicted on each axis. Ask them for suggestions about what would improve the graphs and help the graphs communicate more effectively about the data. The instructor should make sure to point out that the site numbers are not meaningful as numbers–they are really just names given for convenience by the research team–so it is not logical to order them along an axis as though “site number 7” is somehow hierarchically bigger than “site number 1”.

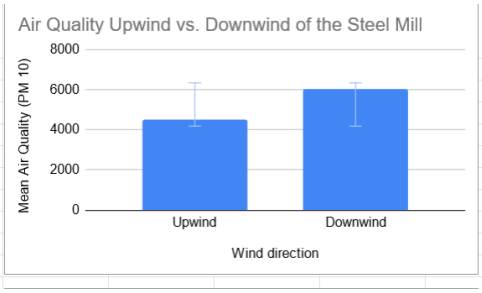


Next, you can show the improved graphs, making sure the students understand the graphs are depicting the exact same data, just in a different way. Ask students what is different compared to the original graphs, including what type of graph is used and what variable is on each axis. Encourage students to notice that the distance from the steel mill is now organized along the x-axis. This organization of the graph is more logical than using site numbers, because the distance from the mill is a meaningful number with an order that goes up as your eye moves to the right along the axis. The instructor should demonstrate how the graphs were made and highlight the graphing tools they may want to use. Highlight the descriptive title, axis labels, and units of measurement.



There is also an example on another sheet of air quality data separated into two categories (Upwind and Downwind) for a bar graph. Depending on what type of data the students have collected, one type of graph may be more appropriate for representing their results.

Distance from Steel Mill (m)	Wind direction	Minimum Air Quality (PM 10)	Median Air Quality (PM 10)	Mean Air Quality (PM 10)	Maximum Air Quality (PM 10)
10.00	Upwind	4700	6550	6890	12400
27.00	Downwind	5500	6800	6870	8900
122.00	Downwind	5000	5750	5880	7300
536.00	Upwind	2200	3150	3110	3600
880.00	Downwind	4200	4900	5620	10000
1,343.00	Upwind	2200	3700	3510	4500
1,771.00	Downwind	4300	5700	5740	7200



Do

Give students time to work in their groups to create graphs. They can explore different ways of visualizing their data, try out different colors and gridlines for the axes, and edit titles and axis labels to create a clear and communicative graph.

Reflect

Pair up groups and have one group try to interpret the meaning of the data visualizations made by the other group, as well as provide general feedback about how easy the visualization is to understand. The groups can then switch and reflect on the other group's graph. Students should take notes of how they may want to change or

improve their graph next time. Give students an opportunity to ask instructors about anything they may need help with or still do not understand.

Resources

- How to Create a Graph in Google Sheets
- How to Create Charts in Microsoft Excel
- Descriptive Statistics in Excel with Data Analysis Toolpak
- Excel Charts & Graphs: Learn the Basics for a Quick Start

NIH SEPA Environmental Health Investigators
Student Research 7
Grade Level: Middle School
Duration: 50-60 minutes

Science Communication

Introduction

In this session students will create a scientific poster of the findings from their project.

Objectives

1. Students will be able to effectively communicate their research project results.

Materials

- Recommended - Student computers with Google slides or PowerPoint
- Optional - posterboard, paper, scissors, art supplies
- Streamlined Research Poster Examples
- Poster Templates for student use
- Optional Poster Rubric

Engage

First, ask to students to brainstorm words that have at least two very different meanings, ideally a science meaning and a nonscience meaning. One student can suggest a word to write on the board and then the class can offer multiple definitions. Some examples of words the instructor can suggest that may have one meaning in one context and another meaning in a science context are: *feedback, charge, cell, fault, kingdom, mass*. After you have come up with a variety of examples, lead the class into thinking about how to make our meaning clear when we are trying to communicate with others. Information can be perceived differently depending on the perception of the audience, as well as how clearly information is communicated by the presenter. Information can be shared in various forms such as an image, model, written, or verbal communication. Now that the students have completed their research projects, they need to work on clearly communicating their results to others using a research poster.

Do: Poster Creation

Put students into their research groups, show them the Streamlined Research Poster Examples
and talk through its components and effectiveness. Share the Poster Templates for student use
with the students digitally and have them pull it up on their computers. (If printing digital posters is not an option, students can make hard copies of their posters on poster boards instead.) Have students take a few minutes to assign responsibilities among their group members. Each group will need to highlight their main finding, and also

provide some background on the purpose, description of their data collection procedure, a visual graph of their results, a related picture, and brief acknowledgements thanking anyone who contributed. They will spend the rest of the class time working on these drafts and gathering all of the necessary parts to their posters. Periodically provide input on their design and remind them to be clear in their communication. The instructor should look through the written sections for each group and offer feedback and edits to students. Optionally, you can use the Poster Rubric as a guide for students and/or an assessment tool.

NIH SEPA Environmental Health Investigators
Student Research 8
Grade Level: Middle School
Duration: Flexible

Presentation Preparation

Introduction

Students will continue working on their posters and begin practicing their presentations.

Objectives

1. Students will be able to construct research project posters that effectively communicate their scientific findings.
2. Students will be able to present their scientific findings clearly and with confidence.

Materials

- Recommended - Student computers with Google slides or PowerPoint
- Optional - posterboard, paper, scissors, art supplies
- Streamlined Research Poster Examples
- Poster Templates for student use
- Optional Poster Rubric

Engage

Begin by asking students to share tips they already know about how to make a good presentation. Next, watch the video How to Deliver an Effective Presentation for more suggestions and have the students discuss the characteristics of an effective presentation as a class.

Do

Break students into their research group and have them finish any remaining work on creating their posters. They should then begin making a plan for who will say what during their presentation and start practicing with each other in their group.

Reflect

Pair up the groups and have each group practice presenting to the other group. The audience group can then give suggestions and feedback to the presenting group before switching to become the presenting group. Remind students to give constructive, helpful feedback.

NIH SEPA Environmental Health Investigators
Student Research 9
Grade Level: Middle School
Duration: Flexible

Poster Presentation and Taking Action

Keywords: science communication, environmental health

Introduction

In this activity, students will present to the class/community on the environmental health project they have explored.

Objectives

1. Students will be able to communicate the major findings of their project, what they did, and why it matters.

Materials

- Printed student posters or computer and projector with student files of posters
- Optional Poster Rubric
- Optional Science to Action worksheet and answer key

Engage

Remind presenters to take their time during their presentation and also when listening to follow up questions to make sure they have understood the question before answering. If the presenters have any graphs in their presentation, remind them of techniques for explaining graphs, such as beginning with clearly defining axes and units on any graph.

Do

Give students time to view each other's posters and ask questions, as well as present their own poster, by having group members rotate. Optionally, you can use the Poster Rubric as a guide for students and/or an assessment tool.

Optional Extension/Alternate

If it is not feasible to organize a presentation of student posters, or if you have the opportunity to add additional sessions, you can have students explore other ways to take action to protect and improve their environment. Use the Science to Action worksheet to help students learn more about how to take action. Depending on prior knowledge you may want to complete the worksheet together as a class, or have students work in pairs to research the answers. Once worksheets are completed ask:
1) Based on their research projects during the program, what message or information would like to send about their environment?
2) Who would they like to send that message to?
3) What do they want to ask that person/people to do to improve their environment.