3M Young Scientist Lab

Classroom Activity | Grades 6-8

It's Too Loud

GUIDING QUESTION

When noise becomes too loud, how can it be decreased? What can be done to protect the ears?

LEARNING OBJECTIVES

Students will be able to:

- work together to measure sound levels.
- collect, organize, display, and analyze data about sound levels.
- investigate the effect of wearing ear protection on the attenuation of sound.

OVERVIEW

Sound and noise are all around us. Hearing sounds in order to work and survive in an environment is beneficial. Sometimes the sounds can become too loud and we need a way to reduce it to a safer and more pleasant level. In this lesson, young scientists will investigate the effect of using ear protectors to reduce sound levels.

NEXT GENERATION SCIENCE STANDARDS

- PS4.A: Wave Properties
  - A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
  - A sound wave needs a medium through which it is transmitted. (MS-PS4-2)
- ETS1.B: Developing Possible Solutions
  - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
  - Models of all kinds are important for testing solutions. (MS-ETS1-4)
- ETS1.C: Optimizing the Design Solution
  - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide

useful information for the redesign process-that is, some of the characteristics may be incorporated into the new design. (MS-ETS1-4) (secondary to MS-PS1-6)

LESSON TIME FRAME

This lesson requires three 45-minute sessions. One session is to engage students and introduce the activity, a second session is for students to carry out the investigation, and the third session will be to discuss and share results.

BACKGROUND INFORMATION

Sound, a form of energy, is an acoustic wave that results when a vibrating source, such as a machine, produces a disturbance in an elastic substance like air or water. Sound that is unwanted is usually considered to be noise. It can be subjective: sound to one person could be noise to another. Sound has several qualities that identify and describe it: frequency, wavelength, speed, and loudness. Controlling sounds can be a major concern in schools, workplaces, homes, and public spaces. If sounds become too loud, hearing loss can result. One way to address this problem is to reduce the level of sound in an environment; another way is to provide ear protection for people within the environment.

This lesson involves young scientists collecting sound attenuation data by wearing ear protection. The data students will collect in this inquiry lesson will be subjective because it will be based on student perceptions. (If you had access to expensive and specialized equipment, students would be able to collect objective data, i.e. data based on observable facts.) The nature of the data collected will be the distance from a sound source to a place at which students can no longer hear the sound. Since this involves students' perceptions (plural), there will be variability in the data. Most likely there will be a range of distances reported, so the data will need to be looked at statistically and an average value calculated. The situation here is somewhat analogous to having a class of students throw a ball as far as they can with and without a jacket on then looking at the distances the ball was thrown to see if wearing a jacket affects how far a student can throw a ball. Instead of multiple throws by one student, we will look at one throw from many students.

To demonstrate that sound level diminishes with distance, a fundamental concept in this lesson, you can demonstrate and reinforce the concept in several ways. One method would be to ask a student to move away from a constant-loudness sound source and report how loud the sound is at increasing distances from the source. A second method involves specialized equipment. If you have access to a sound-level meter, use that to illustrate the phenomenon. Perhaps you can use the input volume level for the built-in microphone available on your school computer or a video conferencing tool.

This lesson plan is meant to be flexible and can be adapted depending on the materials and equipment available to you, your situation, and the environment in which you're teaching.

MATERIALS

Teacher Materials/Prep

- Blackboard or chart paper
- Sound level meter (optional)
- Computer with sound application (optional)
- Sound source (radio, alarm clock, buzzer, electric fan or another motor, etc.) several meter sticks
- Print copies
    - Home Connections Resource to send home with students
- Print copies and cut out
    - Six Word Story Summary Student Capture Sheet

Student Materials

- Ear protectors*
- Notebook and pencil
- Six Word Story Summary Student Capture Sheet
- Home Connections Resource

* If you choose to use 3M™ Disposable Earplugs, acquire enough so each student has their own pair. If you use 3M™ Ear Muffs, wipe them with a cloth moistened with an antibacterial soap or alcohol after each student use.

CLASSROOM ACTIVITY

Day 1

Engage

1. Take a survey of students by asking how many have ever been asked by their parents to turn down the volume of the music they're listening to. Use student responses to initiate a discussion about sound, loudness of sound, hearing, and the human ear. Make note of responses so you can tailor the lesson to student levels of understanding, including misconceptions, about sound and hearing.
2. Ask students if protecting one's hearing is important. Further, ask students to share what they know about protecting hearing. List these ideas on the board or chart paper. Student ideas may include: not standing too close to loudspeakers, using ear protection such as plugs or protectors, turning music down, and holding hands over their ears.

Explain

1. Ask students to describe what happens to the loudness of sound when the sound gets further away. Can they share experiences when they've noticed this? Ask a student to demonstrate sound getting softer as the source of the sound moves away. If you have access to a sound-level measuring device or a computer that can show the volume of a sound, use this technology to demonstrate in a measurable way how sound diminishes with distance.
2. Explain to students that the investigation in this lesson will use subjective data instead of the more traditional objective data. Explain and discuss the difference with students. Further, explain that they will be collecting data (about sound) that varies from person to person, just as does the height of individual students in a class. Briefly discuss how heights of students, if displayed on a number line, would be distributed with a few short students, more students with medium heights, and a few tall students. Mention and review the concept of range and average.
3. Write the following prompt on the board: Does wearing ear protection reduce the loudness of a sound, and if so, by how much?

Day 2

Explore

1. Group students in fours and give them time to brainstorm the design of an investigation to answer the prompt above. Share designs as a class.
2. Use one group's design if possible; otherwise present this design:
    a. Find a quiet location and gather all students together. Turn on the sound source and have student 1, without ear protection, carefully back away from the sound, stopping at 1 meter intervals to listen for the sound. If they can hear the sound, they should continue backing away from the sound until they can no longer hear the sound. Record this distance for student number 1. Repeat for additional students; the more students, the better. Use only whole meter intervals, not fractions. One student could record the data on the board for all students to see and copy.
    b. Repeat the step above but this time each student will wear ear protection. (To keep the variables as consistent as possible, all students should wear the same type of hearing protection. If this is not possible, use that fact as an opportunity to talk about the importance of keeping as many variables in an investigation as possible the same.)
    c. Plot the distances measured with no hearing protection on a number line and calculate an average distance. Record the data using hearing protection in the same way and calculate the average distance.

d. Possible sound sources: radio, alarm clock, buzzer, electric fan or another motor, etc. The sound source should be fairly consistent and not vary in loudness from student to student.

e. Possibilities for ear protection:

- 3M Conservation Products can be researched at this website: http://solutions.3m.com/wps/portal/3M/en_US/Health/Safety/Products/Catalog/?PC_7_RJH9U5230GE3E02LES9MG812H2_nid=7QZ6QNF15LbeQQFFG1G8R7gl

  These include ear plugs, hearing protectors, and ear muffs. Another option could be to use audio earphones without the input signal. (Again, if you do use earphones, wipe them with a cloth moistened with warm water after each student use.)

3. Let students work in their groups to chart, discuss, analyze the data and answer the prompt.

Day 3

Explain

1. Gather students together to discuss the class data and each group's conclusions. How did they answer the prompt? Was there any difference between the two averages? Was there a big spread in the data? What were some of the issues with this particular design? How could it be made better to answer the question?

Extend

1. There are several opportunities for students to research on the internet. Young scientists could visit the Occupational Safety and Health Administration (OSHA) site to research the science behind this lesson (http://www.osha.gov). Another OSHA site (https://www.osha.gov/noise) provides in-depth information about noise. The Canadian equivalent of our OSHA website (http://www.ccohs.ca/oshanswers/phys_agents/noise_basic.html#_1_15) provides information about sound, noise, the workplace, and the scale of power as it applies to sound waves.
2. Sound waves travel through solids as well as air and water. Provide opportunities for students to experience sound travelling through meter sticks, tabletops, floors, walls, and other easy-to-access solids. Can they detect a reduction in loudness in solids as the distance between source and listener increases?

Evaluate

1. Name some ways to reduce the loudness of a sound.
2. Describe evidence that supports the idea that wearing ear protection reduces the loudness of sound.

SCORING KEY FOR EVALUATE

1. The loudness of sound can be reduced by turning down the volume of the source of the sound, moving away from the source of the sound, wearing ear protection, or holding your hands over your ears.
2. When we moved away from the source of a sound, the sound was not as loud. At a certain distance, we couldn't hear the sound any more. When we wore ear protection, the distance where we couldn't hear the sound anymore was less.

REFLECTION

Young scientists will reflect on their learning by completing the Six Word Story Summary. Print off the Six Word Story Summary Student Capture Sheet, cut them out, and distribute one to each student. Alternatively, students may create this reflection activity in their science journal:

SIX WORD STORY SUMMARY

Exit Ticket:

Summarize your learning in **six** words.

_____ _____ _____ _____ _____ _____

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HOME CONNECTIONS

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Activities to do with your young scientist

1. Demonstration: Your young scientist could demonstrate the attenuation of sound as distance increases by moving a source of sound away from you in increments. Sources could include a portable radio, alarm clock, buzzer, bell, etc.
2. Short activity: Is sound attenuated when it has to travel around corners? Does the distance sound travels depend on the frequency or pitch of the sound?
3. Problem to solve: One room of your home seems particularly noisy and loud. Is there something you and your student can do to the room to make it less noisy?
4. Research: You and your young scientist could use the internet to research the science of sound and how our ears detect sound.
5. There are a number of free applications available on the internet that enable your computer to measure, record, and analyze sound. Your computer might even have a built-in application that controls the sound input for the microphone built into most computers.