



Echolocation and SONAR: Echolocation Wrap-Up¹

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Students go through presentation slides that put the echolocation topics together and helps them understand *why* and *how* echolocation works

Science Topics	Process Skills	Grade Level
Echoes	Observing	2-12
Echolocation	Predicting	
Speed of Sound	Scientific Inquiry	
	Comparing	
	Classifying	
	Communicating	

Time Required			
Preparation	Set-Up	Activity	Clean-Up
None	5 minutes	25-40 minutes*	5 minutes

*The amount of time spent on this lesson depends on whether you've already taught the Doppler Effect (middle school) lesson, and on how long you spend discussing the various jobs in acoustics.

Learning Goals

Students will be able to...

- Describe what an echo is and how it's created at the sound wave level
- Describe how our ears or a dolphin localizes sounds
- Describe several different types of acousticians and give examples of what they do in their jobs

Materials		
In the Kit	Not in the kit	Optional
PowerPoint Slides/PDF Slides	Computers*	
	Projection/Presentation equipment	

*It's best if all students have an opportunity to use a computer to experience the website resources. If it isn't possible, you can demonstrate and make it interactive.

Set-Up

Gather materials
Set-up the computer/projector to present the [PowerPoint](#) or [PDF slides](#)
Open the videos and links to make sure they work.

Introduce the Activity

Explain that you will be going through a presentation that talks about echolocation and SONAR, and shows how dolphins use sound.

¹ This activity should be done after "Sound Rather Than Sight" & "How Dolphins Hear Sound" activities. It will also help with understanding if students have already done the "Speed of Sound" activity.

Doing the Activity

Doppler Effect – Sound Simulator*

*If you have already completed the “Doppler Effect” activity, skip this section and move on to the echolocation slide presentation.

1. Students will work through the following questions using the sound simulation. When they are finished they should have drawn a total of three different sound waves.
 - a. Look at the “Sound” simulation on the PhET.colorado.edu site. Investigate how the wave changes as you adjust the various parameters.
 - b. Pick at least two parameters and describe how each one changes the wave.
 - c. Draw a picture of a sound wave below.
 - d. Draw a wave that is a low sound and one that is a high sound. What is different between the two?
2. Have a class discussion about what the students have noticed.

Echo Introduction

It’s best if students have an opportunity to play with the website themselves if there is time now or in another class period. If they don't, this should be an interactive demonstration.

1. Have the students work in pairs or small groups to predict what will happen when a soundwave hits a barrier, then they can share their ideas with the rest of class.
2. Demonstrate the simulator:
 - a. Choose interference by reflection, the choose Pulse.
 - b. Send one pulse at a time
3. The students will discuss with each other what happened when the waves hit the barrier.

Echolocation Presentation

The notes for each slide are also included in the PowerPoint and PDF presentations.

Slide 2: Ask the class what sound does when it hits the barrier.

- Show them the picture on this slide or the tab on the simulator where it says “barrier”

Slide 3: Listen for echoes

- Echolocators listen for the sounds bouncing back
- Most echolocators produce their own sounds (such as clicks) and listen for them to come back
- People do this too, but subconsciously

Before showing the next slide (slide 4), remind students about the “Sound Rather than Sight” activity. Ask students to explain how it felt to identify objects beside them vs. objects in between their feet. Ask which of these to tasks was the hardest, then ask them why they think this is.

Slide 4: Locating Sounds

This shows how sound gets to one ear before it gets to the other ear.

- The brain automatically knows this. It tells you what side the pen dropped on because one side hears the sound first.
- Show the sound simulator to demonstrate the delay. It shows how the sound waves hit one ear before they hit the other.

Slide 5: Listen for the Delay

- The delay tells the brain how far away an object is.
- If one ear hears it first, then it knows the object is on that side.
- This is how dolphins and bats know how far away their prey is!

When students watched the sound, it had to get to the barrier then come back again. The students should come to the conclusion that sound isn't instant.

Slide 6: Speed of Sound

Sound travels through the air, and there's a delay between when you see something and when you hear it. Sound travels at different speeds through different things; sound is slowest through air, faster through water, and also through rock. This is why we can hear our neighbor's music through the walls.

It takes sound:

- approximately 5 seconds to travel a mile in air
- approximately 1 second to travel through water
- approximately $\frac{1}{4}$ of a second to travel through granite rock

When dolphins use echolocation the delay is $\frac{1}{4}$ as much as bats, which means that dolphins are more efficient hunters than bats.

Slide 7: Elephants

- Did you know that elephant babies often hang out up to a mile or so from their moms?
- Elephants can communicate reliably up to a mile and a half apart and they can tell how far away the other elephant is by the frequency range (pitches) of sound!

For example, if two elephants are close together, all sounds from low to high will be heard. If they are very far apart, only the high parts of the sound that was made will make it to the listener.

Slide 8: Acousticians

- Architectural acousticians
- Instrument makers
- Concert hall designers
- Speech scientist
- Hearing specialist

- Medical acoustics
- Animal bioacousticians
- Underwater acousticians

The goal of this activity is to talk about these people as professionals. This is to help students realize that these careers are an everyday career similar to a banker, a lawyer, or a police officer. Scientists are not always someone who is famous like Marie Curie. Science is an attainable, everyday career.

Slide 9: Career Profiles

- Each person at your table should read a different career profile
- Each person in the group describes their scientist to the rest of the group.

Point students to the explore sound website for definitions and people who do acoustics work

Explanation

In-depth background information for teachers and interested students.

Key Lesson Terminology

- Echoes – Reflections or repetitions of sound waves. Echoes can be produced and heard by clapping hands or shouting in a large empty room with hard walls or in a cave for example.
- Echolocation – A method used to detect objects by producing a specific sound and listening for its echo.
- Speed of Sound – The speed at which sound travels. This is very important for scientists who study sound. In air sound travels 343 meters in 1 second (767 miles per hour), but in water sound travels 1500 meters in 1 second (3350 miles per hour). Compare these speeds to cars traveling on the highway at 65 miles per hour.
- SONAR – Sound Navigation And Ranging, is the process of listening to specific sounds to determine where objects are located.

Optional Extensions

- Read 3 career profiles (found on exploresound.org) to the class and have them answer the following questions:
 1. What's in common regarding what they do as scientists?
 2. What's in common about the advice they give to students?
 3. How do these scientists get to where they are today?
- After the students have looked at the profiles, discuss them with the class
- Complete other activities from the echolocation unit.