



Echolocation and SONAR: How Dolphins Use Sound Powerpoint

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Students learn about people and animals that use echolocation and how it works through video and discussion with their peers.

This activity can stand-alone or be done in correlation with the other lessons in the echolocation unit. It can be used as a supplement for before, during, or after the echolocation unit.

Science Topics	Process Skills	Grade Level
Echoes	Observing	1-12
Echolocation	Predicting	
Speed of sound	Scientific Inquiry	
	Comparing	
	Classifying	
	Communicating	

Time Required			
Advanced Preparation	Set-Up	Activity	Clean-Up
Gather materials	5 minutes	50 minutes*	5 minutes

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

We've used this as a homework, but it has not been tested in class yet.

Learning Goals

Students will be able to

- Explain and provide examples of how humans can use echolocation
- Define and echo
- define SONAR and Echolocation and give examples of several animals that use these tools.
- Describe how far and what size objects dolphins can echolocate
- Describe different methods of dolphin communication

Please forward any questions or comments to:
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Materials

- Power Point
- Computers
 - [Echolocation Video](#)
 - “[Sound](#)” simulation from the PhET.colorado.edu site*
 - <http://www.DOSITS.org>
 - audio gallery – humpback whale – whales off the coast of Hawaii
 - audio gallery – common dolphin – two sound clips
 - <http://www.dosits.org/audio/interactive/-/50>
 - <http://www.dosits.org/audio/marinemammals/toothedwhales/spermwhale/>

*It’s best if all students have an opportunity to play with the website. Show them, and then have them play with the simulation. If it isn’t possible for all students to play with the simulation, it can be done as an interactive demonstration.

Advanced Preparations

- Gather materials

Set Up

- Set up the computer/projector to present the power point.
- Open videos to make sure they will play

Introducing the Activity

Explain that you will be going through a power point that talks about echolocation and sonar, and shows how dolphins use sound.

Doing the Activity

We present this activity as a group discussion. First discussion between groups that can then share out with the whole class. That gets the most kids involved. Otherwise, this is an easy lesson to passively listen to and then drift away.

Echolocation Movie

- Show the [video](#) of the boy who learned to use echolocation
- ★ Ask the class the following questions, and have them discuss their ideas with each other
 - Why does this person use echolocation?
 - What is the range this person is capable of?
 - Do you think you could learn to echolocate?

Sound Sim

It's best if the students have an opportunity to play with the website themselves if there is time in another class period. If this isn't possible, it should be an interactive demonstration.

- ★ Have the students work in pairs or small groups to predict what will happen when a sound wave hits a barrier, then they can share their ideas with the rest of the class.

Demonstrate the sim. Choose interference by reflection, then choose Pulse. Send one pulse at a time.

- ★ The students should discuss with each other what happened when the waves hit the barrier.

Echo Introduction

- ★ Ask the students the following questions:
 - Have you heard of echoes?
 - What are echoes
 - What causes echoes?

Echo

- An echo is when sound hits an object then bounces back.
- When we hear an echo, we hear the bounce.
- In the image, the blue wave travels towards the barrier and hits. The red shows the wave bouncing back towards us.

- ★ Discuss the idea of echoes with the students
 - Where are some places that we can find echoes?
 - Who uses echoes?

SONAR

Explain that this uses this idea of sound bouncing back. Scientists know how fast sound travels in water.

- They send out a sound and then wait for it to come back.

- The time it takes to come back tells them how far away objects are.
- Of course they need to send lots of sounds in very specific directions and then they can tell not only how far away but where and how big the objects are.

The picture shows sound waves hitting the fish, then bouncing back to the boat.

Bat, Dolphin and Whale communications

Watch the video at <http://www.dosits.org>,

- Choose “Audio Gallery”, choose Humpback Whale, scroll down to the video of humpback whales off the coast of Hawaii.



Ask the groups to decide if they can see or hear the whales easier.

After watching the video and asking the question, show the video again to ensure everyone understands.

- You can always hear the whales, but it is difficult to see through the murky water. The sound travels well through the water, but our eyes can’t pick up the images as clearly.

Types of Dolphins

While humans rely primarily on sight to perceive their environment, scientists all agree that dolphins communicate with one another by using sounds and body language.

Discuss the following types of dolphins:

- Bottlenose Dolphins
 - Dolphins and porpoises are the smallest toothed whales.
 - Bottlenose dolphins, like Flipper the TV star, are the most familiar.
- Oceanic Dolphins
 - Including orcas and pilot whales, there are 32 species of oceanic dolphins
- River Dolphins
 - •There are 5 species of river dolphins
- Porpoises
 - There are 6 species of porpoises.
 - All dolphins are porpoises, but orcas and beluga whales are also porpoises.
 - Flipper, a bottle nosed dolphin, is the kind most people think of when they hear the word “dolphin”

Dolphin Communication



Ask the groups to explain to each other: How do we recognize different people’s voices?

Discuss the ways dolphins communicate with each other.

- **Clicks** and **whistles** are the two main types of dolphin vocalization.
- Each dolphin has its own “signature whistle”

- Signature Whistle: This is a series of whistles (like a dolphin Morse code) distinct from any other member of the group.
- Dolphins recognize each others' whistles

Echolocation

★ Ask each group if they've heard of echolocation before, and if they know what it is.

Echolocation refers to an ability that enables bats, dolphins and whales to essentially "see" with their ears by listening for echoes. This helps these animals to find and capture food.

- They echolocate by producing clicking sounds and then receiving and interpreting the resulting echo.
- Dolphins produce directional clicks in trains. Each click lasts about 50 to 128 microseconds.

Explain that echolocation is nature's SONAR.

Dolphin's Echolocation

- Sound waves travel 4 times faster through water- much faster than sound travels through air!
- These sound waves bounce off objects in the water and return to the dolphin in the form of an echo.
- This is similar to the sound simulation and how the sounds hit the barrier and bounce back

Click Trains

Go to <http://www.dosits.org/audio/marinemammals/toothedwhales/spermwhale/> and scroll down to Sperm Whale Removing Fish from Line.

★ Ask the groups to figure out: What happens to the sounds as they get closer?

You may need to play this video more than once. Help students understand that the clicks get faster as the whale gets closer (to narrow location) and the whale can clearly see, but he also using echolocation in addition.

(Notes: The video camera is on the bottom of the fishing line looking up. The whale isn't stuck, he's just holding on with his teeth.)

Anatomy of a Dolphin's Head – Sound Reception

Show the picture of the dolphin's head and discuss the ways dolphins receive sound.

- Show the path of click trains in a dolphin's head
 - The click trains pass through the melon (the rounded region of a dolphin's forehead), which consists of lipids (fats).

- The melon acts as an acoustical lens to focus these sound waves into a beam, which is projected forward into water in front of the animal.

Optional - More Information

- The major areas of sound reception are the fat-filled cavities of the lower jaw bones. Sounds are received and conducted through the lower jaw to the middle ear, inner ear, and then to hearing centers in the brain via the auditory nerve.
- The brain receives the sound waves in the form of nerve impulses, which relay the messages of sound and enable the dolphin to interpret the sound's meaning.
- By this complex system of echolocation, dolphins and whales can determine size, shape, speed, distance, direction, and even some of the internal structure of objects in the water.
- Bottlenose dolphins are able to learn and later recognize the echo signatures returned by preferred prey species.

How Far Can a Dolphin Echolocate?

★ If you've already done the Echolocation Part 1 activity from Physical Science (Echolocation Speed of Sound from lower elementary), have the groups recal what was hardest, what they could and could not do when only using sound compared to sound and sight. Report out to the class.

Some dolphins can use echolocation to detect a 15 centimeter (6 inch) long fish a football field away!

- High frequency sounds don't travel far in water.
- Low frequency sounds travel farther because of their longer wavelength and greater energy.
- Echolocation is most effective at close to intermediate range because dolphins and whales use high frequency sounds.
- Their range is about 5-200 meters for targets 5-15 centimeters in length
- This would be like clearly identifying a banana from 2 football fields away.

Echolocation vs. Sight

Discuss that dolphins and bats are not actually blind, but use echolocation as their primary tool. Whales and dolphins see better than bats

- Despite the effectiveness of echolocation, studies show that a visually-deprived dolphin takes more time to echolocate on an object than a dolphin using vision in tandem (at the same time) with echolocation.

Common Dolphin Sound Clips

Go to <http://www.dosits.org/audio/marinemammals/toothedwhales/commondolphin/>, go to the audio gallery and choose "common dolphin." Listen to the two sound clips.

★ Ask the class the following questions. The students should discuss this amongst themselves.

- What did you hear in each sound clip?
- How are the two sounds different from each other?

Dolphin Communication/Sounds

Discuss the different methods dolphins have of communicating. These include

- Dolphins produce non-verbal sounds by slapping a body part against the surface of the water, which makes both a sound and a splash. Tail or fluke slapping is also common.
- Kerplunks are another non-vocal sound made by the tail. Other parts of the body used to produce noise in a slapping manner are pectoral fins and the whole body.
- Finally, jaw claps are made either above or underwater.

Explanation

In-depth background information for teachers and interested students

Key Terms:

- 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.
- SONAR – Sound Navigation And Ranging, is the process of listening to specific sounds to determine where objects are located.
- Clicks and Whistles – The two main types of dolphin communication

Optional Extensions /Modifications

Modifications:

Optional Extensions:

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