Science Unit: ***Beluga Whale***

Lesson 2: ***Talking whales: Using sound to communicate***

School Year:	2015/2016
Developed for:	Champlain Heights Annex, Vancouver School District
Developed by:	Dr Dom Tollit (scientist); Wendy Russo, Ramona Smith, Sabrina Luk (teachers)
Grade level:	Presented to grades 1-2; appropriate for grades 1-4 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	This lesson is best undertaken outside or in the gym

Objectives

1. Learn that sound travels as waves of vibrations and is a force (Curriculum focus: properties of matter/sound).
2. Learn how animals use sound (communicate, hunt, protect territory, find a mate) with a focus on whales and dolphins (e.g., echolocation)
3. Predict how “cup on a string” telephones will work under different conditions, build them and test predictions. (Observe that “cup on a string” telephones work best with short and tight strings that best transmit vibrations without loss of energy.)

Background Information

Sound is a vibration. A vibrating object bumps any object nearby (including air molecules or water or solids) causing them to vibrate. This movement is a called a sound wave – the waves keep going until they run out of energy (like a ripple in a pond when you throw a stone in - the sound also can bounce off objects).

When we talk, our vocal cords make molecules in the air vibrate. (You can feel the vibrations by holding your hand against your throat while you talk.) Those vibrating air molecules make other air molecules around them vibrate, and so on, which is how sound travels through the air. Different pitches of sound move in waves that have different spacing between them—or "frequency." A scream is high frequency for example and growl is low frequency. Other sources of sound, such as guitar, violin or piano strings are good examples of how vibrations can generate sound.

Inside our ears and the ears of marine mammals are tiny sensitive hairs. They pick up the vibrations and transmit that information to our brains, which interpret it as sound. The brain interprets sounds as having different pitches, or tones, based on the frequency, or spacing, of the waves. Some marine mammals have better hearing than humans and can hear very low and very high frequency sounds. We can’t hear bats because they are producing very high frequency sounds.

But the molecules or particles in air are spread out from one another more than particles in a liquid or solid. So sound vibrations tend to peter out before they travel very far in air. Having a soft connective material, such as cotton string—which has a higher density, or number of molecules in a given amount of space, than air—can help the sound waves move over a greater distance.

Vocabulary

Sound:	Vibrations that travel as waves through tiny particles of matter which can be air, water or solids. Vibrations are converted to a sound by the ear.
Vibration:	Shaking motion – movement is back and forth in opposite directions

Molecule: Smallest part of a compound or object – made up of atoms

Materials

- Plastic wrap
- Large plastic cups
- Screw driver
- Handful of Rice
- Metal tray
- String (fishing line)
- Scissors
- Data sheet (included below)
- Metal spoon
- Paper clips
- Bowl

In the Classroom

Introductory Discussion

1. Short description of 'hook' to capture student's attention.
   - Ask the students what are our five senses? Ask what animals use sound for (communication, e.g., danger predator coming, finding prey e.g. echolocation in bats and dolphins and belugas, finding mates e.g., singing birds, controlling territory e.g., roaring lions or howling wolves, finding their way and not bumping into things e.g., echolocation again!).
   - Ask what students think sound is? Vibrating molecules that bounce onto nearby molecules and travel in waves like ripples in a pond.
   - Show students that sound is a vibration. Use a bowl covered tightly in plastic wrap and play 10-15 grains of rice on the surface. Hold a tin tray near to it and after warning everyone to hold their ears, tell them to carefully watch the rice. Hit the tray with a metal spoon and let everyone see how the rice bounces around. They are being moved by vibrations of sound coming from the tray.
   - Explain, today we will be making simple telephones showing how sound is a vibration and travels better through solids than air.
2. Short description of other items to discuss or review.
   - Discuss that whales and dolphins often hunt in deeper water where there is little light – this makes hearing and use of sound as the MOST important sense. Sound can also travel far further than sight or smell. Whales can communicate over 1000s of kilometers.
   - Discuss use of echolocation – finding prey by sending out clicks that then bounce off the prey's body and can be heard by the predator. Bats use echolocation to find insects. Beluga use echolocation to find salmon and also to navigate – it's hard to see further than 30m in the ocean.
3. Briefly describe science experiment/activity.
   - Build and test "cup on a string" phones, make predictions and observe how well they work when the string is tight or loose, when the string is pinched and when the string is long rather than short.
4. Briefly describe the processes of science that the students will focus on:

   Students will make predictions on how sound will travel along a string telephone and then make observations and conclusions based on these observations.
5. Briefly describe safety guidelines.
   - Request that students be careful when moving the string telephones, remind them about tripping and entanglement hazards.

Science Activity/Experiment

Activity Title: Exploring how sound travels

Purpose of Activity:

To start to learn that sound is caused by waves of vibrations. That these vibrations are a force (curriculum focus: properties of matter) and travel better through a solid like string than through air. We will make predictions and test whether sound transmits better when the string is tight, the string is short, the string is not pinched and the volume of the call is higher than when the call is quiet.

Experimental Observations:
Students will be provided with a Sound-String Telephone data sheet that shows various "sound tests". Students will use their prior knowledge to make predictions (sound heard better or worse compared to a short tight string telephone) when a) the caller pinches the string b) letting the string hang loose c) the caller talks very quietly d) the string is doubled in length.

Methods and Instructions:
Set-up prior to experiment: For grade 1, making the telephones beforehand saves time and allows one to focus on the experiment. Grade 2's enjoyed making their own telephones, but it leaves less time for experimenting.

Students work in pairs. Each pair is provided with two cups with a hole punched in the bottom of each big enough to fit string through, a 30 foot and 60 foot length of string and four paper clips. Instructions on how to make a string telephone can be displayed on the white board or scientist can quickly build one in front of the class. Some assistance with knots around the paper clip is useful.

Instructions are as follows:

1. Tie the paper clip to one end of the string.

2. Thread the other end of the string through the hole in the bottom of one of the cups. Be sure to thread it from the inside of the cup. The paperclip will keep the string from going all the way through the hole.

3. Then thread the string through the hole in the second cup, but this time do it from the outside of the cup.

4. Tie the second paper clip to the other end of the string. The paper clip should be inside the cup, just like the first paper clip.

5. Students move outside or the gym and carefully so not to tangle the string or each other. Then, pull the cups so that the string is tight and have one person talk into the cup while the other person holds the cup to their ear. Can they hear the first person talking? Alternate talking and listening, making sure the string is always tight.

6. Students then test each of the different "Sound Tests" described on the data sheet and compare the sound heard with the quality of sound heard with the first set up – a tight, short string. In the first test, the caller pinches the string (stops or dampens the vibrations), in the second test the pair let the string hang loose, in the third test the caller calls less loudly, and in the last test the pair try using a longer string (double the length of the initial short string test).

7. If there is time, students can build an extra-long telephone (one can still hear sounds through a 120 foot phone but they are very muffled) or use different sized cups (big cups are best), paper cups, holding the cup when you call (dampens the signal so worse) or listen, or using fishing line or even wire instead of string.

8. At the end, get students together in groups of four. One pair wraps one string/cup around the center of the other pair's string. All four students pull their strings tight and they test if a 4-way telephone works well or not (with one student calling and three listening). Try again with another pair of students and make a 6-way telephone. This should be the last test as it likely ends in tangles!

Closure Discussion

1. Ask students what they think is happening when they speak into the cup. Speaking into the cup creates sound waves which are converted into vibrations at the bottom of the cup. The vibrations travel along the string and are converted back into sound waves at the other end so your friend can hear what you said. So vibrations go from caller mouth, to the air inside the cup, to the cup, then to the string, then to the listeners cup, then the air inside the listeners cup and finally to the listeners ears. Sound travels through the air but it travels even better through solids such as your cup and string, allowing you to hear sounds that might be too far away when traveling through the air.
2. Ask students about each of the sound test and what results they got. Discuss why it was harder to hear sounds when the string was pinched (vibrations blocked), loose string (vibrations travel better in a solid string), long string (vibrations or sound waves run out of energy), hands around callers cup (dampening vibrations), multi-way (sound energy is split and so sounds are less loud).
3. Landline telephones feature microphones that convert sound waves into electric currents that are then sent through wires and converted back into sound waves by an earphone inside the telephone at the other end. Modern mobile phones use radio waves.
4. If sound in the ocean is blocked or covered up by human activities then dolphins and whales cannot carry on their normal lives and may be effected. Brainstorm about some of the noisy human activities that cause noise in our oceans (e.g., shipping and small boat noise, harbour construction, oil and gas exploration (seismic), sonar from fishing and navy). Very noisy activities can injury the ears of humans and marine mammals. Governments make rules to protect humans and marine mammals from bad noise effects.

References

http://www.dosits.org/animals/animalsandsoundsummary/

Extension of Lesson Plan

1. Students can build an extra-long telephone (120 foot phone still works) or use different sized cups, paper cups, metal tins, holding the cup when you call or listen, or use fishing line or wire instead of string. Students can try to make 4-way or even 6-way telephones.

STRING-TELEPHONE
Data sheet
(TEACHER ANSWER KEY)

Sound Test (collect data)	Predictions	Observations
Short, tight string	No prediction required	(Students should be able to hear caller well)
Caller pinches the string (which is still kept tight)		(Vibrations travel poorly past the pinch point – signal is WORSE)
Let the string hang loose		(Vibrations travel better in a tight string than is a loose string. In a very loose string they may hear nothing. When the string is tight the string is more solid (the molecules are closer together) and sounds travel better in solids
Use long, tight string		(Students will be able to hear the caller WORSE – the vibrations loose energy and so don't travel the longer string as well)
New test (e.g., extra-long string or four way telephone)		

Student Name: _____

STRING-TELEPHONE
Data sheet

Sound Test (collect data)	Predictions	Observations
Short, tight string	No prediction required	
Caller pinches the string (which is still kept tight)		
Let the string hang loose		
Use long, tight string		
New test (e.g., extra-long string or four way telephone)		