Going Batty

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Abstract:

This interactive activity introduces students to animal behavior and encourages students to consider the importance of one of the primary senses: sound. Students begin by describing their existing knowledge of bats (flying mammals). Students then model and explain sound waves. Finally, students become bats and end the activity discussing what they have learned about senses and social behavior. Students are also asked to discuss the implications of human activities and bat colonization.

Grade Level(s): 5^{th} - 7^{th}

Objectives:

- Learn about the bats found in the Chihuahuan Desert.
- Make hypotheses about bat behavior.
- Describe how sound is essential for bat survival.

National Standards:

Standard A: Science as Inquiry; Abilities necessary to do scientific inquiry
Standard A: Science as Inquiry; Understandings about scientific inquiry
Standard B: Physical Science; Motions and forces
Standard B: Physical Science; Transfer of energy
Standard C: Life Science; Regulation and behavior
Standard C: Life Science; Populations and ecosystems
Standard C: Life Science; Diversity and adaptations of organisms
Standard E: Science and Technology; Understandings about science and technology

New Mexico Standards:

Strand 1, Standard 1: Scientific Thinking and Practice; Use scientific method
Strand 1, Standard 1: Scientific Thinking and Practice; Understand process of scientific investigation
Strand 2, Standard 1: Physical Science; Transfer, change, and conservation of energy

Strand 2, Standard 2: Life Science; Structure and function of living things

Materials:

Part 1 (adapted from a Carlsbad Cavern bat module):

- tape player
- tape of soft music
- glass pan or clear container
- water dropper filled with water
- overhead projector

Part 2

- Enough blind-folds for the class (use an old sheet)
- Noise makers for half the class: Blocks of wood, rice in a yogurt container, rattles, etc. Try giving each class of students the same kind of noise maker.
- Scents for half the class: orange rind, lemon rinds, essential oils, flowers, etc. Each mother/baby pair should have different smells.

Background:

Part 1:

Sound is a wave which is created by vibrating objects, and it is propagated through a medium from one location to another. A wave can be described as a disturbance that travels through a medium, transporting energy from one location to another location. The medium is simply the material through which the disturbance is moving, which in the following case, would be air. There is an original source of the wave, some vibrating object capable of disturbing the first particle of the medium; in this case, the bat's vocal chords.

The sound wave is transported from one location to another by particle interaction. If the sound wave is moving through the air, then as one air particle is displaced from its equilibrium position, it exerts a push or pull on its nearest neighbors, causing them to be displaced from their equilibrium position. This particle interaction continues throughout the entire medium, with each particle interacting and causing a disturbance of its nearest neighbors. Because a sound

wave is a disturbance which is transported through a medium via the mechanism of particle interaction, a sound wave is characterized as a mechanical wave.

The particle of the medium through which the sound moves is vibrating in a back and forth motion at a given frequency. The frequency of a wave refers to how often the particles of the medium vibrate when a wave passes through the medium. The frequency of a wave is measured as the number of complete back-and-forth vibrations of a particle of the medium per unit of time. If a particle of air undergoes 1000 longitudinal vibrations in 2 seconds, then the frequency of the wave would be 500 vibrations per second. A commonly used unit for frequency is the Hertz (abbrviated Hz), where:

1 Hertz = 1 vibration/second

As a sound wave moves through a medium, each particle of the medium vibrates at the same frequency. The first particle of the medium begins vibrating, at say 500 Hz, and begins to set the second particle into vibrational motion at the same frequency of 500 Hz. The second particle begins vibrating at 500 Hz, and thus sets the third particle of the medium into vibrational motion at 500 Hz. The process continues throughout the medium; each particle vibrates at the same frequency. The frequency at which each particle vibrates is the same as the frequency of the original source of the sound wave.

The ears of humans (and other animals) are sensitive detectors capable of detecting the fluctuations in air pressure that impinge upon the eardrum. The human ear is capable of detecting sound between approximately 20 Hz to 20,000 Hz. Any sound with a frequency below the audible range of hearing (i.e., less than 20 Hz) is known as an infrasound, and any sound with a frequency above the audible range of hearing (i.e., more than 20,000 Hz) is known as an ultrasound. Dogs can detect frequencies as low as approximately 50 Hz and as high as 45,000 Hz. Cats can detect frequencies as low as approximately 45 Hz and as high as 85,000 Hz. Bats can detect frequencies as high as 120,000 Hz. Dolphins can detect frequencies as high as 200,000 Hz. While dogs, cats, bats, and dolphins have an unusual ability to detect ultrasound, an elephant possesses the unusual ability to detect infrasound, having an audible range from approximately 5 Hz to approximately 10,000 Hz.

Although there is a common misconception that bats are blind, in general bats have very good eyesight but use a sonar system, called echolocation, to navigate in the dark. Ask yourself, is it easier to see or hear in the dark? The sounds that bats make are generally too high pitched for people to hear.

The bat uses its relatively large and extremely sensitive ears to detect sound. As the bat emits sound waves, it closes its ear canal. The waves produced by the bat hit objects like trees, buildings, or insects, which are potential food. When the sound wave, or echo, bounces back, the bats ear canal is open to receive the echo. Their brains process sound quite well; even when hundreds of thousands of same-species bats are flying in close quarters, each bat is able to recognize and analyze its own echoes.

The resolution of bat sonar is truly astonishing. Bat sonar can detect wires that are nearly as wide as a human hair. Some species of bats can track a 3 mm fruit fly, and snatch it out of the air in 0.5 second. Using sound alone, the bat can tell the size, texture and even the direction of a moving insect. Echolocation tells a bat, not only the location of the object, but what the object is.

Part 2:

Some bats are quite large, having wing spans greater than 2.5 meters, while others are very small, having a wing span of about 6 cm. Some bats eat fruit, but most are insectivores (they eat bugs). There are no vampire bats in the United States. Vampire bats do not attack people, but prefer blood from other mammals. They lap blood after they make a tiny incision in a mammal's skin; their saliva contains an anti-coagulant that prohibits the blood from clotting. Most bats have only one pup each season, and bats roost in maternal colonies of several thousand individuals.

References:

http://www.desertusa.com/jan97/du_bats.html
http://www.nps.gov/cave/teacherguide/activities.htm
http://www.nps.gov/cave/teacherguide/fs.bats.htm (excellent)
http://www.glenbrook.k12.il.us/gbssci/phys/Class/sound/u11l2d.html (physics of sound)

Procedures:

Part 1:

1. Place all students in a circle around the room. Begin by asking students to tell you what they know about bats. They will probably have many misconceptions including that bats are blind and rabid. List everything they tell you, including things that seem ridiculous. Prompt students by asking about diet, where bats live, what their ecological role is, etc.
2. Have students close their eyes. Play a tape of soft music. Next have students cup their hands behind their ears and continue to listen.
3. Ask students the following questions: "Does cupping your hands behind your ears help you hear the music better?" "How are your cupped hands like a bat's big ears?" "Why do you think a bat has such big ears?"
4. Fill the pan with about one inch of water. Place the pan on the overhead projector. Turn the projector on, and let the water settle. When the water is calm, instruct a student to drop a couple of drops of water from the dropper into the middle of the pan.
5. Ask students the following questions: "What happened?" "Could you see the ripples move out from the source?" "What happened when the water waves reached the edges of the pan?" "Compare the water waves to sound waves from a bat."
6. Ask who has witnessed a bat in flight. Ask the following questions to those who have witnessed bats flying. "Did you hear the bats echolocate?" (No.) Did you see any of the bats hit trees, people or other bats? (No.) "Were you close enough to hear the bats just before you saw them? "If you answered yes, what sound did you hear?" (Suggest wings flapping, clicking, whining or squeaks.)

Part 2:

1. Next, allow students to explore internet sites about bats; students could be broken into groups with each group being responsible for identifying particular aspects about bat life (for example, diet, ecology, life history, social behavior, etc.). Alternatively, the instructor could prepare an in-class presentation, with photographs and visual aids, to demonstrate bat behavior,

ecology, etc. Ask students whether their initial beliefs about bat behavior are supported by the literature they read, or by your presentation.

2. Next, ask students to make a hypothesis about how a mother bat, living in a maternal roost colony of 10,000 other bats, would be able to find her young after a night of foraging for insects.
3. Provide each group with identical noise makers and scents, but do not tell them what to do with these. Ask students to discuss among themselves how a mother and baby would find each other in a large colony. Ideally, students should come to the conclusion that a mother would recognize her baby by smell and sound.
4. Ask students to divide into groups of two. One student is blindfolded, acting as the 'mother'. The other student should use the method of identification they discussed as a group (series of clicks, etc.).
5. Turn off the lights and ask the 'babies' to quietly hide in the room. Spin each 'mother' around, and tell her to find her baby. It is very important that students do not talk. Our classes had difficulty with this, so it may work best to first blindfold the entire class, then assign several students the role of mother while assigning the remaining 'babies' to each 'mother'. After the mother correctly identifies her baby, reverse the roles.
6. Next, assign several students as bats, while the remaining students become insects. Bats are blindfolded, and the insects move around the room waiting to be tagged. This is more challenging than it may initially seem. A big room or outdoors works best.
7. Ask students to discuss their solution to the problem of a mother bat finding her baby and of a bat finding insect prey.

Conclusions:

Tie in animal behavior with the ecology of bats found in your area; they are small mammals but quite important. You may want to introduce the West Nile Virus and the mosquito as a vector. Discuss how predator prey relationships between insects and bats may work to influence the distribution or transmission of this virus. Of equal importance, especially in the Southwestern United States where mining is prevalent, discuss the importance of maintaining bat habitats created by mine building. Discuss the implications of closing mine entries. Where would bats go if they did not have these human made habitats? Is the natural habitat still available for roosting? Discuss how the creation of mines may have positively

influenced bat reproduction and populations. Discuss the negative impacts of mining too.

And, bats are excellent pollinators of some night blooming cacti …….

GK12 Module Glossary

Echolocation - a system that bats use to navigate and find food. They give off high pitched sounds, and then interpret the echoes.

Frequency - how often the particles of the medium vibrate when a wave passes through the medium.

Medium - the material through which the disturbance is moving, such as air.

Sound – a wave that is created by vibrating objects; it is propagated (moved) through a medium from one location to another.

Wave - a disturbance that travels through a medium, transporting energy from one location to another location.

Going Batty: Part 1

1. Stand in a circle around the room. Discuss what you know about bats.
2. Close your eyes, and listen to the music being played; after awhile, try cupping your hands around your ears and listening. Discuss what you heard.
3. A pan will be filled with about one inch of water and placed on the overhead projector. When the water is calm, watch as a student drops a couple of drops of water from the dropper into the middle of the pan. Discuss what you see.
4. If you have ever seen a bat in flight, describe what you saw.

Going Batty: Part 2

1. At the start of this activity, you will explore internet sites and take notes about bats. Each group will be assigned a particular aspect about bat life.
2. Once the background information has been collected, you will make a hypothesis about how a mother bat, living in a maternal roost colony of 10,000 other bats, would be able to find her young after a night of foraging for insects.

Hypothesis:

3. You will be divided into groups of two, and each group will be given identical noise makers and scents. In your group, discuss how a mother and baby would find each other in a large colony.
4. One student is blindfolded, acting as the 'mother'. The other student, as the 'baby,' should use the method of identification they discussed as a group.
5. When the lights are turned off, the 'babies' should quietly hide in the room. Each mother should spin around several times and then try to find his/her baby. Do not talk; only use your method of identification.

6. Next, several students will be assigned as bats, while the remaining students become insects. Bats are blindfolded, and the insects move around the room waiting to be tagged.
7. At the end, each group should discuss their solution to the problem of a mother bat finding her baby and of a bat finding insect prey.