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ABSTRACT

The paper describes teaching the phenomena of sound in the outdoor classroom to enhance learning experiences. Methods for demonstrating sound travel and speed are explained. Activities cover listening to natural sounds, determining tone and volume, and constructing instruments from natural sources. The suggested lesson plan for exploring sounds out-of-doors includes objectives, concepts, vocabulary, materials, instructional procedures and activities, and evaluation questions. (KM)

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EXPLORING SOUND IN THE OUTDOOR CLASSROOM

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Sound of Boom

Boom is the sound of big-terrible.
Boom is as fat as noon,
Round-sound much like the bursting
Of a too-blown-up balloon.

Mary L. O'Neill

In today's world noise is no longer just a small price we have to pay for technological advantages - just an irritating but necessary by product of the manifestation of community activity. Noise has become a threat to human health and happiness when it reaches proportions beyond the threshold of human tolerance. A golden opportunity for both teacher and class is to explore the area of sound and its concomitant effects in the outdoor environment as a part of their elementary school science program.

Sound is something everyone with functional ears can hear. It is a form of energy that the ear, which is like a very sensitive microphone, picks up from a source that is vibrating or shaking, nearby or far away. Sound is everywhere, but few people ever stop to wonder what creates it and how it travels.

Man from his most humble beginning utilized his ear for a variety of purposes. This sense of hearing informed him of approaching dangers, sensitized him to recognize a variety of animal communications as well as his own grunts and growls. Sound and man's unique mechanism for producing it within his own body enabled him to communicate with others of his own kind. A sophisticated and refined method of communication known as the spoken language became his best means of communication. It is not always the most effective means; however, it is the most available means at man's disposal.

Early man also began to imitate the sounds that he heard. Perhaps the first sounds he imitated were those emitted by the animals he hunted in order to entice them within range of his spear, club, or arrow. Later, as early man began to reflect on his environment, he interacted with the sounds from the natural environment and, hence, the beginning of the first musical combinations of sounds formed the basis for his religious and ceremonial contemplations about the mystery of life and the unknown. As man became an agricultural being instead of a forager and hunter, sounds increased in diversity due to the manifestations of his agrarian activities.

Settlement patterns also induced new sounds as man-made objects began to move back and forth at a regular rate.

It would be unrealistic to pretend that the outdoor classroom has no limit with regard to the teaching and enhancement of sound. It would also be unrealistic to say that the outdoors does not offer opportunities and circumstances which can render consideration and support to an elementary school science program concerned with teaching about sound. The greatest contribution the outdoor environment makes to the science program is that of providing direct experiences with the phenomena to be learned; thereby enhancing the motivation to learn. Exploring sound is no exception. It is true that experiments with sound can be conducted in the classroom or indoor laboratory; however, these same experiences indoors should be vitalized and expanded to include experiences in the outdoor laboratory.

Classroom teachers should take the opportunity to move beyond the four walls and explore the out-of-doors right on the school-site for possible opportunities for enriching the unit on sound. The school-site can offer a variety of activities which can reinforce basic concepts previously discussed in the classroom.

The first thing a teacher can do with the class is to demonstrate how sound travels. The best activity for this is to find a small body of water, such as a stream, brook, pond, puddle, mirror pool, bird bath, or other small water impoundments where the water is fairly still. A student can drop a small stone into the water and the class can observe the ripples emanate from the source in increasing number and circumference. Essentially, this is what happens with sound waves as they move away from the object vibrating. The sound wave pattern of travel can also be demonstrated with a section of clothesline rope. Have one of the students tie one end to a tree, post, pole or building. Have the student move the rope by lifting the free end up and down in a vertical motion. A traverse wave can be generated in this manner and serve to illustrate the same principle of wave motion demonstrated by the water ripples. The students can, through these simple demonstrations, conceptualize that vibrations are transmitted through a medium by wave motion. It also will enforce the concept that this wave motion is the passage of energy through a medium from particle to particle, with each particle remaining in the same relative position when the energy has passed.

Another concept that can be demonstrated with the small body of water is to place a leaf or a small stick in the water. Have one of the students drop a pebble into the water a short distance from the leaf or stick. Ask the students what happens to the stick or leaf. Did it move forward with the advancing ripples or did it bob just up and down. The mechanical energy of the pebble dropping in the water produced an up-down motion. The motion then was transferred to the water. This mechanical energy was transported by the water ripples and some of the energy affected the stick or floating leaf and, hence, the object bobbed up and down. Sound can also be transmitted through a solid. There can also be a transfer of sound energy as well as mechanical energy. To demonstrate this, the teacher can have one of the students strike a log or tree with a stick and the students can take turns listening to the vibrations. A metal railing or pipe is another excellent source for this demonstration. In order for the demonstration to be dramatic, the pipe or railing should be of sufficient length to insure adequate separation between the student making the noise and those who listen.

Another technique which may be utilized to demonstrate how sound waves travel involves the use of tongue depressors and a heavy object. The tongue depressors are placed part way into the ground. One student walks away from the rest of the class who are kneeling by their tongue depressors. At a signal from their teacher, the students place their teeth on the tongue depressors. At another signal from the teacher, the student with the heavy object drops it. The other students should be able to feel the vibrations caused by the object striking the ground. The same procedure should be repeated, only this time the students place their ear to the ground when the object is dropped. This is much like the technique used by Indians to detect advancing herds of buffalo or horses. It would be interesting to note whether the frequency (number of vibrations per second) increases with an increase in the weight of the object dropped.

Another interesting technique is to have the class stand or sit still and list in their data books all the different sounds they hear. This can be accomplished by simply listing the source of the sound, such as train whistle, or bus engine. A variation of this would be to use a descriptive word to identify the sound. Such words as rustle (leaves), chatter (squirrel), neigh (horse), bark (dog), chirp (sparrow), buzz (bee), hiss (steam), splash (stone falling in water), thud (falling weight), patter (rain drops on pavement), crunch (stepping on gravel or crisp snow), swish (ice skates), bang (door closing), tramp (feet), bang (garbage cans), crackle (wood on a fire), moan (trees bending in the wind), rattle, pop, bubbles, boom, tinkle, rumble, clatter, etc.

Another similar technique would be to have the class walk individually or in small groups over a variety of surfaces, such as gravel, concrete, grass, leaves, snow, sand, wooden bridge, metal bridge, grating, bare soil, rock, etc. Here the students can use descriptive adjectives to describe what it sounds like to walk on various surfaces, i.e. swish (in tall grass). Both of the above activities will enhance not only sound perception and identification, but will also serve to increase the language art skill of vocabulary. An added procedure which will stimulate perception will be to blindfold the students or just have them close their eyes and identify, describe and find the direction of the sound source.

An added feature which will clearly demonstrate the effectiveness of a larger sound receptor would be to have each student make a cone or ear horn from a piece of manila paper or oak tag. The cone will amplify the sound and students can listen to the sound both with and without the paper cone. The cupping of the hands behind the ears will also serve as a means of amplification of sounds. A correlation can be made with animals that have large ears, such as the rabbit, fox, mule deer, etc.

The speed of sound can also be demonstrated out-of-doors. At first, a student can stand a designated distance away from the rest of the class and clap his hands. A stop watch can be used to time the moment his hands come together and when the sound is heard by the group. The same exercise can be conducted with the use of a starter's blank pistol and a smoke blank cartridge. The stop watch is activated at the puff of the smoke and stopped when the sound is heard. Sound travels at a speed of approximately 1,100 feet per second. If the sound took 4 seconds to reach the main group, then the gun was 4 times 1,100 feet away or 4,400 feet.

An interesting innovation would be for the group to stand with their backs to the student with the blank pistol and see if it takes any longer to hear the sound. One student with the stop watch must face the source of the sound. Another departure would be to clasp hands behind the ears or using the paper cones to see if the sound is heard any faster than without them.

Another concept which can be enriched through outdoor activity is that sounds can be produced by percussion. Students can strike various size trees and listen for the loudness of the sound;however, the sounds will have no definite pitch.

Stones of graduated sizes can be utilized for demonstrating loudness of sound; however, the blow with a stick or object must be the same. Sometimes the stones might give a degree of pitch which is determined by the frequency of vibrations per second. The graduated stones perform much in the same way as a xylophone and they can be referred to as a stone-o-phone. However, the one concept that is clearly demonstrated is that the greater the striking force, the greater the volume.

Another notion that can be demonstrated is that sound can be either absorbed or reflected by a vertical surface, such as a wall of a building or a fence. The hard surface will reflect and the soft one will absorb. Have the students use homemade megaphones and have them shout through them, facing a hard surface. Next have them face a soft surface, such as a shrub or tree line or possibly a sheet draped over a line, and shout through the megaphone. Compare the loudness of the sounds. One will be softer because of absorption of energy and the other will be louder because of reflection.

Another interesting activity would be to have each youngster fill in the data required by a Sound Clue Chart. This chart can be duplicated on a 5 x 8 index card and could include such headings as: Source of Sound, Force Making Sound, Vibrating Part, Volume, Pitch, etc. Wave length could be included if the students knew how to compute it. Knowledge of how many times the sound producer vibrates per second is necessary. If an object vibrates 100 times per second and sound travels 1,100 feet per second, then the first vibration is heard at that distance and the other 99 vibrations are all within this distance. Hence, if you divide 1,100 by 100, you would get 11. The wave-length then is 11 feet.

An interesting activity is to listen to birds and to plot their calls on a data sheet. Each sheet should have a line indicating the division between high pitch and low pitch. For example, a Bob-White Quail could be listened to and then recorded. The first part of his call goes between the medium line and the latter part rises above this line. The Quail's call then resembles a check mark as it is recorded on the data card.

The following are offered as suggested activities:

1. Recording with a tape recorder and parabolic ear sounds of fields, ponds, forests, streams, waterfalls, rustling noises of tree limbs, leaves, grasses, birds, insects, frogs, etc. and composing a symphony of natural sounds. This can also be accomplished with sounds of the urban complex. All activity is directed at perceptual awareness of the world around us.

2. Striking various objects found in the outdoor classroom and recording the various sounds such as hollow trees, logs, stones, trees with different bark thickness, etc.

3. Finding objects which will give graduated tones, such as rocks or stones struck with a heavy stick (stone-o-phone).

4. Walking over various surfaces, such as gravel, pavement (concrete, asphalt), wooden bridge, sand, grass field, on short grass such as a lawn, snow, ice, listening to the sounds of skis, snowshoes, ice skates, toboggans, sled runners, etc.

5. Construction and playing of sound instruments, such as a hollow log, drum, willow or bass-wood whistles, wooden flutes, stringed instruments with natural or found materials, etc. Have the students experiment with producing sounds and rhythms using natural objects. Acorn caps or grass held between the hands and blown upon can produce whistling sounds. Pebbles shaken in hollow gourds or wooden containers can make fine rattles, as do black locust seeds. Sticks or rocks struck against each other or against a log on the ground can be

used to manufacture rhythm. Tree branches bearing leaves can be waved in the air or struck against the ground to make rhythmic sounds.

6. Listening and interpreting the variety of bird songs and animal sounds will assist the students in noticing the various moods expressed through sound. Imitating bird calls and seismographically depicting them on paper.

7. Magnify sound receptors, such as ears. Make cardboard cones and hold to ears, hold hands cupped to the ears. Experiment with a cardboard parabola.

8. Students can collect sounds, such as the passing of the wind through various substances, through trees, through buildings, alleyways, through various materials, such as canvas, sheets, burlap, or wire screening; collecting sounds of the dump, a city street, and other sounds which are natural, man-made, and machine-made.

9. Rubbing various materials together, such as soil, gravel, sand and wood, either between the fingers or held in the hands.

10. The students can record the sounds they hear with a decibel meter (if one is available). The students should start at the threshold of hearing (the point where a sound can be heard) and begin to measure such various sounds as a whispering voice, a normal level conversation, the level of traffic on a busy street, a creaking door, average factory noise, average office, police whistle, noisy factory, subway train, bus, automobile, motorcycle, jet aircraft, thunder, etc. The decibel meter or sound level meter will indicate the loudness of some common sounds and identify those that are dangerous to the sense of hearing (110-120 decibels).

11. The students can explore the Doppler Effect (the phenomena of the change

in pitch proceeding from an approaching or receding source). It is called the Doppler Effect after the Austrian physicist, Christian Doppler (1803-1853), who was the first to explain the phenomena.

One of the students will have to whirl a referee or police whistle about his head while blowing it through a long rubber tube. Any whistle which will fit tightly into the end of a rubber tube will suffice providing that it does not warble; for example, a whistle with no ball inside is best for this demonstration. The rest of the class acting as observers are asked to note whether there is a regular rise and fall in pitch as the whistle moves in its circle. At one moment the whistle is moving toward the observers and at another moment the whistle is moving away from them. The students will note a change in pitch. When the whistle is moving toward the observers, they will hear a note higher in pitch and when the sound is moving away from them, they will hear a note lower in pitch. This change will be heard only when the motion changes from approach to recession, or from recession to approach. Further investigation will illustrate to the class that there is a crowding up of the sound waves because there is a decrease in the distance between successive wave crests. A greater number of waves hit the observers' ears per second as another way of saying that the frequency increases and the pitch rises.

Another variation of this is to have a student ride a bicycle and at the same time operate a sound maker such as a bell or whistle. Observers will note whether there is a change in the pitch of the sound as their classmate rides rapidly past them.

Still another variation is to stand by the roadside where cars pass by at forty to sixty miles per hour. Students from a safe observation station should note whether the sound made by the tires changes in pitch as the car passes. Perhaps another adult can participate in driving a car past the students and at the same time blowing his horn. Again the students will note the change in pitch as the car passes by.

The following is a suggestive outdoor lesson plan for exploring sound out-of-doors. It is by no means conclusive or restrictive:

Topic: Exploring Sounds Out-of-Doors

Objectives:

1. To develop an awareness of the physical world through listening to sounds out-of-doors.
2. To learn to delimit source of sounds.
3. To discover how different objects or forms of life in the physical world make sounds.
4. To recognize differences between sounds emanating both from the natural environment and the man-altered environment.

Concepts:

1. Sounds are all alike in one way in that they are produced by vibrations which can travel through solids, liquids and gases.
2. There are many different sounds. Some sounds are very loud and some are soft.
3. The volume of sound is related to the amount of force used.
4. The pitch of sound depends upon the frequency of its vibrations.

Sub-Concepts:

1. Listening to sounds is a language activity.

2. Listening to sounds is a natural approach to enjoyment of the world around us.

3. Listening to sounds is important in communication.

Vocabulary:

vibration	reflection	amplitude
tone	volume	receptor
pitch	speed	source
wave	echo	energy
timing		

Materials:

manila folderhalves (for ear horn)
manila folder for megaphone
field notebooks (each pupil should have one)
pencils
6 pieces of old broom handles 8" long for striking purposes
1 tongue depressor for each pupil
glass jug (for second timer)
stop watch

Instructional Procedure and Activities:

1. The class will sit down out-of-doors and listen attentively to all sounds they can hear. Each student will record all the sounds heard. A comparison will be made to see if some sounds were more audible than others.

2. The students will use the technique of cupping hands behind the ears to assist in hearing sounds. They will also cup hands around their mouths to compare intensity of sound.

3. Ear horns will be made out of manila folders and each student will

listen for the sounds of birds, insects, mammals, and other animal sounds. The students will dr[illegible] the sounds are like by sketching the sound as it mov[illegible] from high to low levels of tone.

4. Gather various sizes of stones and then place them on the ground in order of graduate size. Proceed to strike each stone with a broom handle stick and record tone of sound.
5. Listen to soil particles rubbed between fingers and held to the ear. Compare sound with that of sand particles rubbed between fingers.
6. Have the students time sound moving across a body of water and compare the time required to that of sound traveling the same distance over land. Have the class time sound going up a slope and compare to the time of sound going down a slope. Is there any difference?
7. Place a tongue depressor into the soil. Have each student bite the tongue depressor with his teeth and maintain that position. Drop a heavy object on the ground nearby and compare vibrations that are closer to the point of impact to those that are farther away.
8. Have two students stand back to back at one end of an open area. One should clap his hands loudly and the other student should clap his hands as soon as he hears his partner clap. His partner

should then clap again when he hears a clap. Each student repeats his clap as soon as he hears his partner clap. Use a stop watch to record the time needed for a certain number of claps. Next have the stuoents move to opposite ends of the open area facing each other with their eyes closed. The total clapping activity should be repeated with each child clapping when he hears a clap from the far end of the area. Time period for the original number of claps to occur and compare this with the time it took when the students stood close together. The difference in time, divided by the number of trips the sound made traveling back and forth between the students, will be the speed of the sound between ends of the open area.

$$\frac{\text{Difference in Time}}{40} = \text{Speed of Sound between Points A \& B}$$

Evaluation Questions:

1. Do the students understand that all sounds are made by vibrations?
2. Do the students understand that sound waves travel through air, water and other materials?
3. Do the students understand that it takes time for sound to travel a certain distance?

As mentioned earlier, the above lesson plan is only suggestive and any modification or refinement needed to meet specific objectives is certainly permissive. A better understanding of sound and how it is important to communication, how it is affected by a variety of circumstances, will be more effectively assimilated by a class of students as they move beyond the four walls of the school to the outdoor laboratory.

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