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The Physics of Sound: How We Produce Sounds

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With the strong emphasis on literacy and mathematics in the primary grades science is often a neglected area of the elementary school day. Science is an area where often students working below grade level in other subject areas may be motivated and able to excel. This provides an outlet for students' curiosity about the way things in their environment work, while providing hands-on experiences to build knowledge. This curriculum unit aims to serve as a meaningful and appropriate science unit, which is designed with the State of Connecticut Performance Standards in Science and Language Arts for grades K-4 in mind. While this curriculum is written with first grade in mind, all of these activities could be modified for grades K-2.

This curriculum unit aims to give students the opportunity to explore one aspect of physics in their day to day lives. Children often wonder how and why things work. However sound is something they usually take for granted. The children will be engaged throughout this unit due to their underlying curiosity of the world around them. This unit will also serve as a springboard into the wide world of physics, hopefully opening the minds to all of the possibilities.

Composition of My Class

I am currently a first grade teacher at Bishop Woods Elementary School in New Haven, which is a Title 1 Priority School. The learning community of my class is diversely populated. It consists of eighteen students, twelve boys and six girls. The students are from various racial, ethnic, and economic backgrounds. My students range from above to below grade level in their academic achievement. There are two mainstreamed special education students who receive resource, speech and language, and/our social work assistance. There are also three English Language Learners in my classroom. Music and athletics are common interests for the majority of my students. Their interest in music will increase their curiosity of how sound is produced. Many of my students take an enthusiastic and active approach to learning.

Objectives and Standards

The five main objectives for this unit are aligned with the Connecticut Performance Standards:

1. Students will understand and experiment with sound.
2. Students will conduct hands-on experiments that will explore the different measures of sound as one of their five senses.
3. Students will understand that sounds are produced by vibrations, and that the sound waves and pitch cause different sounds to be produced.
4. Students will produce their own musical instruments using various vibrating objects and observe the differences in sounds between each of them.
5. Students will demonstrate strategic reading skills during read alouds.

Sound is often taken for granted because children are surrounded by sound in their everyday lives. One of the objectives of this unit is for students to understand and experiment with the way sounds are produced. The second objective is to give students the opportunity to conduct hands-on experiments that will allow them to explore different measures of sounds and sound as one of their five senses. This objective aligns with Connecticut Performance Standard 1.1 and 1.2. Performance Standard 1.1, Students will acquire and practice the ability to do scientific inquiry. This standard states that students will:

a. Ask questions about objects, organisms and events in the environment
b. Plan and conduct simple investigations
c. Use simple equipment and tools to gather data and extend their senses
d. Use data to form reasonable explanations
e. Communicate, both verbally and in writing, their investigations and explanations.1

Performance Standard 1.2, Students will understand the process of scientific inquiry. This standard states that students will:

a. Conduct scientific investigations which ask questions and compare answers to what they have learned previously
b. Use different kinds of investigation, including observation and description to achieve broad understandings in science.2

The concept of sound waves is a complex topic and may be difficult for young students to understand. However by simplifying the concept through hands-on experiments and demonstrations children will gain a greater understanding of the sounds they can produce and hear around them. The third objective of this unit on sound will be to increase students' awareness of the sounds they hear, such as higher intensity sound waves produce louder sounds and that all sounds are produced by vibrating objects, such as strings, straws, glasses, and their vocal chords. This objective aligns with Connecticut Performance Standard 2.2, Students will understand that objects have position and motion and that forces can affect change over these objects. This objective states that students will:

a. Learn that sound is produced by vibrating objects.
b. Understand how pitch can be varied by changing the rate of the vibration.3

Experiments for the students to conduct will include making strings sing, playing on crystal glass, talking cups, and making an echo.

With the strong emphasis that is placed on literacy in our district, this unit was designed to also address Performance Standards in Language Arts. Specifically Performance Standard 1.3, students will demonstrate strategic reading skills before, during, and after specific reading tasks. This objective states that students will:

a. Establish a purpose for reading (gathering information)
b. Use prior knowledge to connect the new material to what they already know
c. Design questions which focus on the selection.4

Throughout this unit I will collaborate with the music teacher, Ms. Stone. She will introduce the children to a wide range of musical instruments, the children will compare the different sounds they make, as well as how the sound is produced. As a culminating activity students will produce their own musical instrument using various objects that will produce different sounds when they vibrate. Each student will share their instrument with the class. Students will listen and observe the different sounds each makes, and state the physics of why they sound different.

Unit Outline

I. What is sound?

II. Sound Production

III. Sound Waves

IV. Speed of Sound

V. Echoes

Each of the topics covered in this unit will be explored through hands-on experiments and demonstrations. Through their explorations students will learn the simplified concepts of sound and related vocabulary. As a culminating activity the students will create different sound producing instruments.

Sound Production

Sound is a sensation or feeling that we hear. We produce sounds by doing something. The motion of materials or objects causes vibrations. A sound originates in the vibration of an object, which makes the air or another substance around the object vibrate. The vibration of the air moves outward in all directions in the form of a wave.5 The following are examples of how certain sounds are produced.

Human Voice

The human voice is produced in the larynx, which is a part of the throat. There are two small pieces of tissue that stretch across the larynx with a small opening between them, these tissues are our vocal cords. As we speak, muscles in our larynx tighten the vocal cords making this small opening become narrower. When air from our lungs passes through the tightened cords a vibration is produced. This vibration produces vocal sounds. The tighter the vocal cords, the more rapidly the vocal cords vibrate and the higher the sounds that are produced. This is what causes the human voices to have different pitches.6

Animal Sounds

Animals also produce sounds. Almost all mammals, birds, and frogs have vocal cords or similar structures, which allow them to produce sounds in a similar way to humans. However, many other animals produce distinctly different sounds. For example, bees buzz as they fly because of the rapid movement of their wings. Their wings make the air vibrate producing a buzzing sound. A cricket produces a singing type sound as it scrapes parts of its front wings together. Some types of shellfish produce clicks by tapping their claws together.7

Musical Sounds

Musical instruments produce many different sounds in various ways. There are three categories of musical instruments, percussion, string, and wind. Some instruments need to be struck by an object in order to produce a sound, these are called percussion instruments. For example when the membrane of a drum is hit the membrane vibrates, producing a sound, or when a bar of a xylophone is struck, a sound is produced. Each bar of a xylophone produces a different note when struck. String instruments, such as a harp or violin, produce sounds when one or more of their strings are plucked, causing them to vibrate. This vibration causes parts of the body of the instrument to vibrate, creating sound waves in the air. The pitch of a stringed instrument depends upon the string's thickness, its length, the distance stretched, and the number of times it vibrates. Wind instruments, such as a flute or trumpet produce sound when a column of air inside the instrument vibrate. For example, with a trumpet it is the vibrating lips of the player which makes the air

column vibrate.8 Sounds produced by musical instruments are usually pleasing for us to hear. "A musical sound is a regular vibration." 9

Noise

Humans, animals, and instruments are not the only sounds we hear, many of us come across various other sounds or noise every day. For example thunder is caused when lightning heats the air, causing the air to vibrate. A car makes a rather loud noise, which is produced when the engine vibrates, causing the other parts of the car to vibrate.10 These types of noises are produced by irregular vibrations occurring at irregular intervals. This is what makes noise a rather unpleasant sound.11

Sound Waves

A sound wave is a transfer of energy as it travels away from a vibrating source. Sound waves are formed when a vibrating object causes the surrounding medium to vibrate. A medium is a material (solid, liquid or gas) which a wave travels through. As sound waves move through a medium the particles vibrate forwards and backwards. A sound's volume, how loud or soft it is, depends on the sound wave. The more energy put into making a sound or a sound wave, the louder the volume will be. The father a sound wave travels, the more it spreads, this makes it more difficult for us to hear a sound. So the nearer you are to a sound the louder it sounds to us. A sound wave enters the ear and is changed into nerve signals, which are interpreted by the brain.12

There are three aspects of a sound wave that cause different types of sounds to be produced, frequency, wavelength, and amplitude. Sound waves vibrate at different rates or frequencies as they move through the air. Frequency is measured in cycles per second, or Hertz (HZ).13

1 Hertz = 1 vibration/second

Sound travels at 330 meters per second or 740 miles per hour. Sound travels the fastest through solids and the slowest through gases. The faster an object vibrates the higher the frequency, which causes the pitch of the sound to be higher. The higher the frequency sounds come from shorter wavelengths. A wavelength is one aspect of a sound wave. A wavelength is the length of one cycle of sound. The period of a sound wave is the time taken for one wavelength to pass a certain point before a new wave begins to pass by. Longer wavelengths have a lower pitch. The lowest tones that your ears can hear are about 16 vibrations per second, or 16 Hz. Amplitude specifies the sound's loudness. A low amplitude will produce a soft sound and a higher amplitude will produce a louder sound.14

Speed of Sound

The speed of a sound wave refers to how fast the disturbance or wave is passed from particle to particle. Since the speed of a wave is defined as the distance which a point on a wave travels per unit of time, it is often expressed in units of meters/seconds (m/s). The speed of any wave depends upon the properties of the medium through which the wave is traveling. The density of the medium will affect the speed the wave will travel at. A sound wave will travel faster in a less dense material rather than in a more dense material. The equation for the speed of sound is speed = distance/time. The following is an example of the equation.15

S = 330 meter/seconds

S = (330 X 60 X 60 X 3.3)/5280

S= 330M/s X 3.3ft./M X 3600sec/hr X 1 mile/5280ft.

Sound travels at 330 meters per second or 740 miles per hour.16 It is very interesting that sound travels much slower than light. Light travels at 186,000 miles per second; this is how we can see something happen on Earth at practically the instant that it happens in the sky. Sound on the other hand, takes some time to reach us. This explains why when you watch a fast airplane soar through the sky, the sound seems to be coming from a point in the sky that is far behind where you see the airplane.17 Only the Concorde and military aircraft travel faster than sound.

The speed of sound can also allow us to figure out how far away a distant lightning flash occurs by measuring the time for its sound, thunder, to reach you. Sound travels a mile in about 5 seconds. For the distances over which you can hear thunder, the light travels almost instantaneously. For example, if you hear thunder 20 seconds after you see a flash of lightning, then the lightning occurred 4 miles away.18

Echoes

When you make waves in the center of a sink you can see the waves reflect or bounce off the sides of the sink and return to the starting point. Just like this sound waves can also be reflected. The reflection of your voice is called an echo. Echoes can be heard from almost any large surface such as a large wall, building, or cliff. The surface must also be relatively flat, perpendicular to the source of the sound, and far enough to notice the time difference, but not so far away that the echo is too weak.19

The further you are physically from the surface the more time that is needed for the sound wave to reach it and bounce back to your ear. This increases the time between when a sound is made and when you will hear its echo. By knowing the speed of sound and measuring the time it takes to hear the echo, you can calculate the distance of the object. The equation for this is: Distance = ½ X (Speed of Sound) X (Time until you hear the echo). The ½ is there because the sound travels the distance twice, both there and back.20 For example, the sound waves travel outward, bounce or reflect off a flat surface and return producing an echo. So the sound wave travels to the flat surface and back again.

Conclusion

Sound is a part of our everyday lives, but yet we never stop to think how or why we sound the way we do. Through this unit the children will experiment with how different types of sounds are produced. They will also experiment with how aspects of sound, such as frequency and amplitude effect the way a sound is heard. This unit will serve as a fun and meaningful, hands-on experience that will change the way they view simple sounds that they hear in their everyday lives.

Vocabulary List

- Ear
- Echoes
- Frequency
- Larynx
- Noise
- Percussion Instrument
- Pitch
- Sound
- Sound Wave
- Stringed Instrument
- Vibration
- Wavelength
- Wind Instrument

Annotated Resource List for Teachers

Ardley, Neil. 1995. *How Things Work: 100 Ways Parents and Kids Can Share the* Secrets of Technology. Reader's Digest Adult. This book looks at items children see in their everyday lives, such as household appliances and basic machines and simplifies how they work. This book is filled with excellent explanations and experiments.

Barron's Science Wizardry for Kids. 1992. Barron's Educational Series. This book is filled with simple activities with clear instructions. This is a great resource for any science program.

Cassidy, John. 1991. *Explorabook: A Kids' Science Museum in a Book.* Klutz Press. This is a great source for science demonstrations and experiments that can be done by the children with adult supervision. Many science topics are covered including, light waves and magnetism.

Hann, Judith. 1999. *How Science Works.* Reader's Digest Adult. This is an excellent resource. Hann takes simple household ideas and designs hands-on experiments for children to explore science. Many topics are covered including light and sound, force, and motion.

Herbert, Don. 1968. *Mr. Wizard's 400 Experiments in Science.* Book Lab. This book has some great demonstrations and experiments on many topics, especially sound. It also gives simple background on each topic.

Johnstone, Leslie. 2002. *Science Experiments With Sound and Music.* Sterling Publications. This book is recommended for children ages 9-12. This can also serve as a good resource for students when producing their musical instruments for the culminating activity. Students can be careful paired with better readers or an adult can help.

Macaulay, D. 1998. *The Way Things Work.* Dorling Kindersley: Toronto. Book & CD. This book and CD set answers many questions on how things work. The CD could be more interactive, but it does have sound and can also be used by students.

Nankivell-Aston, Sally & Jackson, Dorothy. 2000. *Science Experiments with Sound.* Franklin Watts Inc. This is another book filled with great experiments, this book focuses only on concepts of sound.

Potter, Jean. 1995 *Science in Seconds for Kids.* John Wiley & Son, Inc. This book has great, quick experiments to explore science concepts. You can find most of the materials needed around the house.

VanCleave, Janice. 1991. *Janice VanCleave's Physics for Every Kid: 101 Easy* Experiments in Motion, Heat, Light, Machines, & Sound. John Wiley & Sons. This book is recommended for children ages 9-12. This can also serve as a good resource for students when producing their musical instruments for the culminating activity. Students can be careful paired with better readers or an adult can help.

Videos

The Magic School Bus: Inside the Haunted House. The Magic School Bus Series. Scholastic: New York, NY, 1999. This is a good video that children will enjoy. Mrs. Frizzle's class explores sound on the field trip of the haunted house.

Annotated Student Resource List

Aliki. 2000. *My Five Senses.* Harper Trophy. This book is recommended for ages 4-8. It is a simple introduction to the concept of the 5 senses. There is also a Spanish version of this book.

Baker, Wendy. 2000. *Sound (Make It Work! Science)* . Two-Can Publishing. This book is good for more advanced readers who are reading above grade level. It is recommended for children 9-12. The easy to follow instructions encourage children to explore science with a hands-on approach.

Carle, Eric. 1997. *The Very Quiet Cricket.* Putnam Publishing Group. This book is recommended for preschool age children, and will be good for more struggling readers. My students have always loved to reread this story of how the cricket finds his "voice". The illustrations are also wonderful.

Chapman, Jane. 1999. *Very Noisy Night.* Penguin Putnam Books. This book is recommended for children ages 4-8. Children will love and relate how Little Mouse hears simple sounds such as the wind or an owl and imagines these wonderful things such as ghosts and burglars.

Charles, Veronica Matenova. 1997. *Hey What's That Sound?* Stoddart Kids. This book is recommended for children ages 4-8. It is a great book for a read aloud. Children will love making the sounds that are mentioned in the story.

Cole, Joanna & Degan, Bruce. 2001. *The Magic School Bus Explores the Senses.* Scholastic. This book is recommended for children ages 4-8, however the text is scattered throughout the page and may be difficult for struggling readers to follow. As with other books in this series Mrs. Frizzles' class has an exciting adventure while studying the 5 senses.

Cole, Joanna & Degan, Bruce. 1995. *The Magic School Bus: In the Haunted Museum.* Scholastic. From the same series as the last book, scattered text may be difficult for struggling readers, but concepts about sound are introduced through an exciting adventure.

Gallo, Frank. 2001. *Bird Calls (Play the Sounds Pull the Tabs)* . Innovative Kids. This is acute book recommended for children ages 4-8. Children will need to guess which animal is singing based on the clues and by listening to the sound.

Gallo, Frank. 2001. *Night Sounds (Play the Sounds Pull the Tabs).* Innovative Kids. This book goes great with *Bird Calls.* Also recommended for children ages 4-8. This times children read or listen to the riddle and hear the sound to guess what is making the sounds they hear at night.

Glover, David. 2002. *Sound and Light (Young Discoverers: Science Facts and* Experiments). Houghton Mifflin Co. This book is recommended for children ages 4- 8, however it is also a good resource for teachers. Students will learn through the simple explanations and hands-on activities.

Hurwitz, Sue & Watts, Franklin. 1995. *Hearing (The Library of the Five Senses and the* Sixth Sense). Franklin Watts Inc. This book is recommended for children ages 4-8. This book would be great as an extension to challenge advanced students. This allows students to learn about hearing the sounds they have just learned about throughout unit. This book gives a basic explanation of how your ear works and how you hear sounds.

Johnstone, Leslie. 2002. *Science Experiments with Sound and Music.* Sterling Publishing. This book is recommended for children ages 9-12. This can also serve as a good resource for students when producing their musical instruments for the culminating activity. Students can be careful paired with better readers or an adult can help.

Kim, Sunnie. 1999. *Catch a Wave: The Story of Sound and Light.* Science Kids. This book is recommended for children ages 9-12. This is an activity book on sound and light waves, which would be good as an extension to challenge advanced students.

Lawrence, Mary. 2002. *What's That Sound? (Science Solves It!).* Kane Press This book is recommended for children ages 4-8. This is another good book about a child with a wonderful imagination. Tim and his family are spending 2 weeks in a house and Tim thinks it is haunted because of the sounds he hears. He turns simple sounds in to some scary thoughts.

MacMillian, Bruce. 1994. *A Guessing Game for the Five Senses.* Scholastic. This book is recommended for children ages 4-8. This is a good book to tie in multiculturalism to science. This story is set on Caribbean Island of Culebra, and features some words and phrases in both English and Spanish. Two children explore the island's foods, plants, instruments, etc. using their five senses.

Mora, Pat. 2001. *Listen to the Desert / Oye Al Desierto.* Clarion Books. This book is recommended for children ages 4-8. This is another good multicultural book to use that is repeated in English and Spanish. This book teaches students about some of the animals and sounds commonly found in the Southwestern desert.

Pfeffer, Wendy. 1999. *Sounds All Around (Let's-Read-And-Find-Out-Science, Stage 1).* Bt Bound. This book is recommended for ages 4-8. In this story Pfeffer explains how various sounds are produced. She begins simply with finger snapping and builds up to vocal cords. Children will love the beautiful illustrations.

Showers, Paul. 1991. *The Listening Walk.* HarperCollins Children's Books. This book is recommended for Preschool, so this will be a good story for even the struggling readers. This book is about a child that takes a walk with her father and hears many different sounds.

VanCleave, Janice. 1991. *Janice VanCleave's Physics for Every Kid: 101 Easy* Experiments in Motion, Heat, Light, Machines, & Sound. John Wiley & Sons. This book is recommended for children ages 9-12, this book can be used by students reading above grade level, or with help from an adult. The book has 101 experiments, which are fun, safe, easy, and well explained. Children can do these at home or in the classroom, a fun way to explore physics, covering a variety of topics.

http://www.scholastic.com/magicschoolbus/games/sound/index.htm This is a cute game, childrenneed to match the sound to the object. (7/1/03)

Lesson Plans

Lesson One: Introduction to Sound

I will begin this lesson with sensory activity. For this lesson, you will need to record a variety of indoor and outdoor sounds (such as a doorbell, a car horn, lawn mower, phone ringing). Students will close their eyes and listen to the tape without talking. Then students will be asked to identify the sounds that they heard on the tape and record their responses on chart paper. Then replay the tape and compare the actual sounds to their responses. Some sounds may be more difficult to identify, so I will guide them through correctly identifying each sound.

Next, I will proceed to construct a KWL chart on chart paper with the class. I use chart paper in all of the lessons so that we can revisit what we have already done. First I will record the students' responses to what they already know about sound, the K section. Next, to promote inquiry, the students will generate questions

about what they would like to learn about sound, the W section on the chart. The L section, what they have learned, will be filled over the next 6 days, as we progress through the unit.

Finally, I will end the lesson by reading the story *The Very Quiet Cricket* by Eric Carle. This is a popular favorite about a cricket that is unable to talk when it is born. Many insects including a bigger cricket all try to help him, but when he rubs his wings together no sound is produced. Finally in the end he meets another quiet cricket and is able to find his voice. As I read the story the students will use their think aloud strategies, such as making connections to the text, picturing, wondering, noticing, and figuring out.

Lesson Two: What is Sound?

Today's lesson will introduce the concept that sounds are made of vibrations. I will explain to the students that every sound they hear is produced by vibrations. Vibrations are the rapid back and forth movement of any given object. This concept will be will be explored through three quick demonstrations.

First, students will each receive a ruler and will be instructed to place it on the edge of their desk. They will use one hand to hold the ruler down firmly, the other hand will carefully bend the ruler and then let it go. The students will observe the ruler's vibrations and the sound that it produces. They will be able to repeat this process, changing the length of the ruler that hangs of the desk, observing the different sounds that are produced.

For the next demonstration, each student will receive a comb. They will rub the teeth of the comb with their fingers and against a hard object. They will be able to feel the vibration against their fingers, and hear the sounds that are produced.

The third demonstration allows the children to feel the vibrations of a radio. Turn a radio on loud and have each student place the palm of their hand in front of the speaker. They will be able to feel the air vibrate. They can observe and compare the differences of the vibrations, by changing the volume of the radio.

Finally I will conclude this lesson by discussing what we have learned today. The students' responses will be recorded in the L section of our KWL chart.

Lesson Three: Sound Production: The Human Voice

Today we will begin the lesson by reviewing what we learned yesterday about vibrations. The KWL chart can be referred to if prompting is needed. Next I will give the students a few minutes to use their voices at different levels or volumes. I will then ask them, how their voice is produced. They will be given the chance to explain their ideas of how they think their voice works. After that I will explain to the students that the human voice is produced in a section of their throat called the larynx, or voice box. It will also need to be explained that two pieces of tissue called vocal cords, cover their larynx. It is these two pieces of tissue that produce sounds, when air rushes between them, causing them to vibrate. A diagram of the vocal cords will be shown, as the explanation is given, in order to touch upon all modalities for better understanding.

There are two demonstrations to explore this topic. First students will speak, while touching the front of their throat with the palm of their hand. This will allow them to feel the vibrations that are producing their voice. For the next demonstration each student will receive a balloon and will be instructed to inflate it. They will need to hold the neck of the balloon between their thumb and their index finger of each hand. Then they will slowly open and close the opening of the balloon, allowing air to be released from the balloon. They will observe the

different sounds they are able to produce. This will simulate the action of the vocal cords. The air filled balloon is similar to their lungs, which push the air through their vocal cords. Again I will conclude this lesson with a discussion of what we learned, adding student responses to our KWL chart.

Lesson Four: Sound Production: Musical Instruments

I will begin this lesson by showing examples of each of the three different type of instruments (stringed, wind, and percussion) to the students. We will discuss the different ways each produces a vibration, for example, the strings on a guitar are plucked, air is blown across the mouthpiece of a flute, and striking the membrane of a drum. Each student will get a chance to produce a sound from one of the instruments and compare the different sounds that are produced.

Next the students will close their eyes and listen to a tape of instrumental music. I will then challenge them to name any types instruments (stringed, wind, or percussion) that they may have heard. These responses will be recorded on chart paper. Finally each student will be given a set of pictures of musical instruments and a piece of plain white paper. They will divide their paper into three sections: string, wind, and percussion, and then classify their instruments.

Again, I will conclude this lesson by discussing what we have learned and adding it to our KWL chart.

Lesson Five: Sound Production

This lesson will begin by having the students tell me everything they know about how different sounds are produced. Then the students will devise a list of questions they still have about the way certain sounds we have not explored are produced. Prompting will be provided if necessary. Next I will introduce and read the story *Sounds All Around* by Wendy Pfeffer. In this story Pfeffer explains how various sounds are produced. She begins simply with finger snapping and builds up to vocal cords. After the story the students will write a letter to a friend describing how a specific sound is produced.

Lesson Six: Sound Waves

I will begin this lesson by explaining how sound travels in waves. These waves spread out from the vibration and travel away allowing the sound to be heard. It will also be explained that these waves can travel through solids (a wall), a liquid (water), and gases (air). The following demonstration will be done to explore this concept. First a large pan will be filled half way up with water. Next, a toothpick, broken into three pieces, are put on top of the water to represent water molecules. It is important that the pieces of the toothpick are not touching. Finally use a eye dropper to drop one drop of water into the middle of the pan. The students will see ripples. They will then be asked to answer the following questions based on their observations:

1. Which way do the ripples go?
2. Do the toothpicks move as fast as the ripples?
3. The ripples move across the water but the toothpicks do not move with them. Just like the toothpicks, the molecules in the water do not move with the ripples. So what is moving?

We will answer these questions together as a class and record our responses on chart paper.

Lesson Seven: Speed of Sound

The lesson will begin with the students sharing what they have already learned about sound waves. Then I will explain that the speed of a sound wave is how fast the wave is passed from particle to particle. We will discuss a thunderstorm to illustrate the speed of sound. We will discuss how thunder and lightning originate at the same time, however, it does not seem that way to us. We see the lightning before we hear the thunder. This is because light (lightning) travels to our eyes faster then the sound (thunder). Sound travels faster than cars and most airplanes, but it is slow enough to trick our ears. The following experiment will be conducted to illustrate this concept.

The class will be divided into pairs for this experiment. Each pair will receive 1 paper towel tube and 2 rulers. They will begin with their back to their partner. One person puts the end of the paper towel tube up their left ear, and closes their eyes and keeps them closed. Next the other person taps the rulers together on the right side, about 1 foot from their partner's ear. Then the rulers are tapped together on the left side near the end of the tube. After this the rulers are tapped in different places without the partner knowing where they are. After each trial the partner needs to say either: on the right side, left side, or directly behind your head. These results are recorded on a piece of paper. Repeat this with the roles reversed.

After the roles are reversed we will discuss the following question as a group: Did you have any trouble telling where the sounds were coming from? We will then record what we learned today on our KWL chart.

Lesson Eight: Echoes

This lesson will begin by asking the students if they have ever heard an echo. Time will be allowed for students to share their experiences. In order to demonstrate this concept of echoes we will use a tub of water to see how the waves bounce off of the sides and return to the starting point. A large tub will be filled with water then make a wave in the center of the tub with your finger. Students will observe how the wave travels towards the edge of the tub and then bounces back. Students will also have the opportunity to try this themselves.

After we have observed how waves travel, we will go out side to experiment with this concept. Students will stand near the middle of the large, flat wall of our school. Then take about 50 steps back, away from the wall. They will take turns shouting and observing the length of time it took to hear the echo. A stopwatch could be used for accuracy. Then this experiment may have many trials, varying the distance from the wall.

When finished we will return to the classroom to discuss our observations, and the reasons for the differences in the length of time for us to hear the echo. We will also add what we learned today to our KWL chart.

Culminating Activity

As a culminating activity for this unit, students will work in pairs to make their own musical instrument. Students will be required to produce the instrument based on the principles of sound they have learned throughout the unit, using various materials such as, milk cartons, rubber bands, paper cups, strings, tin cans, bowls, water, pencils. They will also be expected to know which type of instrument (percussion, stringed, or wind) they made, and how it works. When completed, the students will share their instrument with the class.

Endnotes

1 "Science Curriculum Framework." *New Haven Public Schools: Curriculum Framework* . http://www.nhps.net/curriculum/html/Science-PK-4.asp>. (6/29/03).

2 "Science Curriculum Framework."

3 "Science Curriculum Framework."

4 "Language Arts Curriculum Framework." *New Haven Public Schools: Curriculum Framework* . http://www.nhps.net/curriculum/html/LangArts-PK-4.asp> (6/29/03).

5 Herbert, Don. *Mr. Wizard's 400 Experiments in Science.* (Book Lab: North Bergen, NJ, 1968) 69.

6 Herbert 72

7 "Production of Sound." Think Quest. 2003. http://www.thinkquest.org/websitena.html> (6/28/03).

8 "Production of Sound."

9 Herbert 70

10 "Production of Sound."

11 Herbert 70

12 "Nature of a Sound Wave." *The Physics Classroom and Mathsoft Engineering & Education Inc* . 2003. http://www.physicsclassroom.com/Class/sound/U11L1a.html> (6/30/03).

13 "Sound Waves." February 2003. http://www.fi.edu/fellows/fellow2/apr99/soundvib.html> (6/29/03).

14 "Sound Waves."

15 "Speed of Sound." *The Physics Classroom and Mathsoft Engineering & Education Inc* . 2003. http://www.physicsclassroom.com/Class/sound/U11L2c.html> (6/30/03).

16 "Speed of Sound."

17 Herbert 71

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19 "Waves." 2003. http://gcsephysics.com/pwav11.htm> (6/30/03).

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