The Sounds of Science

By Christine Anne Royce

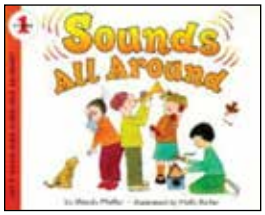
Energy's abstract nature makes it a challenging topic to teach in the elementary classroom. Making this topic concrete helps students conceptualize what energy is and where energy transfer occurs in everyday life. *Sound* is a form of energy associated with vibrations that occur when a mechanical wave travels through matter. Young children are familiar with creating sounds: loud ones, soft ones, scary ones, and fun ones are part of their normal play and work. However, they are probably not familiar with how sound is produced or the fact that it is a form of energy. This month's feature activities engage students in qualitative investigations as they make observations about sound and how it travels.

This Month's Trade Books

What Makes Different Sounds?
Lawrence F. Lowery
ISBN: 978-1-936959-44-0
NSTA Kids
40 pages
Grades K–4

Synopsis

As twins walk home from school, they are confronted with different sounds. As they ask questions about what makes specific sounds and how sounds are generally made, they explore a variety of sounds and learn about vibrations, volume, and pitch.



Sounds All Around
By Wendy Pfeffer
Illustrated by Holly Keller
ISBN: 978-0-06-445177-2
HarperCollins
32 pages
Grades 1–4

Synopsis

This book examines sources of familiar sounds and provides simple explanations that children can understand. The author delves into how sounds waves vibrate through the air, ground, and water and provides additional examples of how animals can hear sounds through these different mediums. The illustrations help students visualize the abstract concepts being discussed. ■

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References

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards*. Washington, DC: NGAC and CCSSO.

NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards*.

Grades K–2: Sounds Abound

Purpose

To investigate the characteristics of sound, how vibrating materials make different sounds, and how sounds can make different materials vibrate.

Materials

- *What Makes Different Sounds?*
- cards for sorting
- objects for creating sounds: bell, pencil sharpener, whistle, toy horn, toy drum and drumsticks, marbles and cotton balls in metal cans, musical triangle, recorded sounds (see Internet Resource), toy xylophone with mallet, toy guitar or other stringed instrument
- tuning fork, plastic beaker of water, and rice
- student station sheets (see NSTA Connection)

Engage

Before implementing the activity, collect objects that will create a variety of sounds and place them in a box or bag so that the objects are not visible to students. Have students sit silently in a circle. If possible, all sounds in the room should also be minimized. Two of the characteristics of sound that are mentioned in the book are loudness and pitch. Therefore, as part of the initial engagement, quietly tell students that they will hear and be asked to identify sounds, as well as whether they are loud or soft and high or low. Explain that they will be asked to close their eyes as they listen, and emphasize that the sounds are either being made in the classroom or are recorded, so students should not be afraid of any of them. Then, one at a time, share familiar sounds, such as a whistle (high or loud), an animal growling (low), or a whisper (soft). After you have put the object away, ask students to open their eyes and answer two questions with a thumbs-up or a thumbs-down: "If you think this sound is loud, give me a thumbs-up; if you think it is soft, give me a thumbs-down. Now, if you think this sound has a high pitch, show me a thumbs-up; if you think it has a low pitch, show me a thumbs-down. Who can tell me what they think the sound was?" After repeating this process with several items, ask students to describe in their own words some of the characteristics of sound.

Explore

Set up the stations in Table 1 (p. 20) to allow students to explore the different characteristics of sound. Coteachers or parent volunteers can lead each station, or students can use the stations one at a time as a whole-class activity. At each station, students should complete the information on their student station card sheet (see NSTA Connection).

Explain

Ask students to come together and listen to *What Makes Different Sounds?* as you read it aloud. Stop at the following points to lead a discussion, and ask students to use examples from their station activities to support their answers.

- Page 4 (with the musical staffs): In the story, a teacher uses a drum to show that sounds can be loud. What did you notice about the loudness or softness of sound when you used the drum at the station? The story also says, "the drum head vibrated when it made a sound." At which station did you notice that sound can also cause vibrations? How do you know the object vibrated?
- Page 8 (with the musical triangle): Compared to the drum, did the triangle sound loud or soft? Was it a high sound or a low sound?
- Page 14 (has "beep beep" on it): The story describes the fire engine's siren as being high and loud. How would you describe the following sounds as from your explorations: the toy drum, the short bars on the xylophone, the long bars on the xylophone, the thin string on the guitar, the thick string on the

guitar, the triangle, and the tuning fork? Which sounds could you make louder or softer and how?

Ask students to list their new vocabulary terms related to sound, including *loud*, *soft*, *high*, *low*, and *vibrate*. You may also want to introduce the term *pitch*, associated with high and low. Ask students to explain each term in their own words.

Elaborate

One of the activities at the end of the book asks students to look back at the different objects that make sound and place them in order from loudest to softest produced sound. Provide each student with one set of sorting cards (see NSTA Connection) and ask students to rearrange the cards in order from loudest to softest. Then ask them to choose five to seven of the objects that they have heard in real life and put

Table 1.

Sound stations.

Station (Characteristic)	**Activity**	**Questions**
Loudness	*Materials: toy drum and drumsticks* Have students bang the drum with some force and notice how loud the sound is. Then have students tap the drum lightly and notice how much sound is produced. After students have tried the drum, ask them to make the loudest sound and then the softest sound they can by clapping their hands.	What do you notice about the sound when you bang the drum with force? When you tap it lightly? What about when you clap your hands? Does it take more energy (force) to make a loud sound or a soft sound?
Pitch	*Materials: toy xylophone with mallet, toy guitar, or other stringed instrument* Ask students to hit the different bars on the xylophone with the mallet and make observations about the sounds produced. After students have tried the different bars on the xylophone, ask them to pluck the thinnest and then the thickest string on a guitar.	What type of sound do you get when you strike the shorter bars or pluck the thinnest string? What happens to the sound as you increase the size of the bar you strike or pluck the thickest string?
Sound Is Caused by Vibrations	*Materials: musical triangle and tuning fork* First ask students to make observations about the musical triangle while holding it still, before striking it. Is it vibrating? Then have students make observations after striking it. Repeat with the tuning fork.	Before striking either object, is the object vibrating? What happens to the object after you strike it? Describe the movement in your own words, as well as what you hear.
Sound Can Cause Vibrations	*Materials: plastic beaker of water, tuning fork, drum with rice grains* Strike the tuning fork, similar to what students did at the previous station, so they hear a sound. Then, carefully touch the tuning fork to the surface of the water in the beaker and observe what happens. Next, place the rice grains on the drum and lightly tap it, observing the grains. Tap it harder; now what happens?	What allows the tuning fork to make sound? When you placed the tuning fork in the water, what did you observe? What did you notice about the rice grains on the drum when you tapped it?

those objects in order from highest to lowest pitch. Answers may be subjective but should be explainable by students.

Evaluate

Students are evaluated throughout the lesson, beginning with the initial determination of their understanding of high and low and soft and loud during the Engage phase. Students are also asked to record their own understandings as they explore different stations and discuss those understandings during the Explain phase as they use their observations to support their claims. They are then asked to apply their understanding of high and low and soft and loud in a new setting by ordering a series of objects.

Internet Resource

Free Downloadable Sound Clips
www.freesoundeffects.com/free-sounds/household-1003

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013):

K–2: Sounds Abound

1-PS4-1 Waves and Their Applications in Technologies for Information Transfer

www.nextgenscience.org/pe/1-ps4-1-waves-and-their-applications-technologies-information-transfer

The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities. The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

Performance Expectation	**Connections to Classroom Activity** *Students:*
1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	• participate in stations that examine different characteristics of sound such as high, low, soft, and loud, and that sound is caused by vibrations and can cause vibrations.
Science and Engineering Practice	
Planning and Carrying Out Investigations	• engage in two different types of investigations at each station, which ask them to use evidence to explain their understanding about a sound's loudness and pitch and how a sound is produced.
Disciplinary Core Idea	
PS4.A: Wave Properties • Sound can make matter vibrate, and vibrating matter can make sound.	• investigate how sound creates vibrations in one exploration station and how sound is created by vibrations in a separate exploration station.
Crosscutting Concept	
Cause and Effect	• engage in two different types of investigations at each station, which ask them to use evidence to explain their understanding about a sound's loudness and pitch and how a sound is produced.

Grades 3–5: Sound Signals

Purpose

To explore how clearly we can hear words through air, a solid, and a liquid as sound travels through each medium.

Materials

- *Sounds All Around*
- chart paper
- student data sheet and station cards showing various objects (see NSTA Connection)
- 1 gallon resealable bag
- earmuffs
- 2 metal spoons and a funnel for each station
- aquarium with water
- plastic and paper cups of varying sizes
- 60 cm of string per pair
- different types of string
- candles
- rosin

Engage

Begin by asking students to describe ideas they have about sound and record these on a piece of chart paper. Depending on students' initial understanding and developmental level, it may be worthwhile to have them participate in the K–2 activity stations to build some prior knowledge about basic sound concepts. Then read *Sounds All Around* to the class and stop at the following pages for discussion:

- Page 8: After reading this page, ask students to place their hand on their throat and talk normally so they can feel the vibrations from their vocal cords. Then ask them to hum, sing, and, finally, yell to make observations as to how the vibrations change. Ask students to explain in their own words what is happening with their vocal cords to cause the sound they hear.
- Page 10: Although students cannot feel or see what is happening in their ears, ask them to carefully look at the picture on this page and describe what they think is happening.
- Page 19: Sound waves can travel through the solid ground and the air. Ask students if they can name an example, aside from the one in the text, of sound traveling through a solid.
- Page 21: Sound waves can also travel through water. Ask students, "Have you ever been underwater and heard someone talking? Was it clear enough to hear? What happened as you got closer or farther away?"

Explore

By either using three individual stations or by conducting these activities over three class periods, ask student pairs to explore how sound energy can be transferred through different types of materials. Ask them to make observations as to what happens to sound with each type of material and record those observations on the sound signals student data sheet (see NSTA Connection).

Station 1: Sound Traveling Through Air

Blow up a gallon-size resealable bag and seal it so that it is filled with air. Have students hold it up to one of their ears while at the same time blocking their other ear with either their hand or a pair of earmuffs. With only one ear available to listen, ask students' partners to tap two metal spoons together near the bag. Instruct students that a light tap is sufficient. The listener observes what is heard through the bag of air, then listens to how words sound through the bag. Ask partners to hold up and speak into the opening of a funnel and say the name of one of the objects on the word cards (see NSTA Connection) in a normal voice. The listeners must determine how well they can decipher what was said.

Station 2: Sound Traveling Through Water

Place a 5- or 10-gallon aquarium on a table and fill it with water. Ask the first students in each pair to put their ear to the aquarium, so that it is touching the short side of the tank, and at the same time use the earmuffs to cover the other ear. The partners should stand on the other side of the aquarium and tap two metal spoons together outside of the tank. Listeners should observe whether they hear any sound with their ear against the tank. Then, partners should tap the spoons together under the water. Listeners should record their observations for both trials on their data sheet and compare and contrast their findings. Students can then switch roles and repeat. Ask students, "Does the sound travel through the air better than the water, or the water better than the air?" Repeat the process with the funnel and a different random word from a Station 1 card.

Station 3: Sound Traveling Through a Solid

Repeat the Station 2 activity with a slight adaptation. Rather than placing an ear against an aquarium of water, listeners should place their ear against the flat top of a

wooden table. Partners should then tap the top of the table lightly with the metal spoon for the listener to observe. Ask students, "Does the sound travel through the air better than the solid, or the solid better than the air?" Repeat the process, placing the funnel against the table and using a different random word from a Station 1 card.

Explain

Ask students to explain in which medium (air, water, or solid) sound was easiest to hear. Students should explain their answer and use examples from their observations to support their claims. After students have discussed the transfer of sound, ask them to discuss the clarity of sound through the different mediums, based on how well they heard the different words.

By the end of this phase, students should be able to explain that sound is caused by vibrations and that different mediums help sound travel differently, with different levels of clarity. Ask students to use the data sheet to write two or three sentences summarizing their understanding of how sound energy can be transferred.

Elaborate

Page 31 of the book has directions for creating a traditional cup-and-string telephone. This telephone works because sound that is spoken into one cup creates vibrations that travel through the solid string to the other cup, which another person can use to listen. Because we know that sound travels better through solid objects than through air, the person speaking can whisper and the sound will reach the listener. However, because the string vibrates and some of the energy is lost to the surrounding air, ask students to consider alternatives that would improve this particular type of communication device. They can change the type

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013):

3–5: Sound Signals

4-PS3-2 Energy

www.nextgenscience.org/pe/4-ps3-2-energy

The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities. The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

Performance Expectation	**Connections to Classroom Activity** *Students:*
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	• investigate whether sound energy can travel through air, liquids, or solids and how well they can hear a sound transmitted through each of the mediums.
Science and Engineering Practice	
Planning and Carrying Out Investigations	• make observations about sound energy travelling through different mediums and use those observations to support their conclusions related to which medium sound travels through best and which medium sound travels through with the most clarity.
Disciplinary Core Idea	
PS3.A: Definitions of Energy • Energy can be moved from place to place by moving objects or through sound, light, or electric currents.	• investigate whether sound energy can travel through air, liquids, or solids and how well they can hear a sound transmitted through each of the mediums. • develop a cup-and-string telephone to test the transfer of sound energy and then modify it to improve the transfer of a message.
Crosscutting Concepts	
Energy and Matter	• investigate whether sound energy can travel through air, liquids, or solids and how well they can hear a sound transmitted through each of the mediums.

of cup, the type of string, or the string's coating by running a candle along it or using rosin. Ask them to select one change they want to try to improve the transfer of sound energy in this device and record their findings on the data sheet.

Evaluate

In a lesson such as this, initial understandings are assessed through a discussion and, if necessary, activities that build the developmentally necessary knowledge. Once students have basic knowledge of sound, they engage in discussion throughout the text, as well as exploration during station activities and the recording of their findings. They are asked to explain their understanding through a written statement before applying and transferring their knowledge in a new task.

Additional Texts

Johnson, R. 2014. *What are sound waves?* New York: Crabtree Publishing.

Lowery, L.F. 2014. *Sounds are high, sounds are low*. Arlington, VA: NSTA Kids.

Mahaney, I.F. 2007. *Sound waves*. New York: Rosen Classroom.

Rosinsky, N.M. 2003. *Loud, soft, high, and low sound*. Minneapolis: Picture Window Books.

Showers, P. 1991. *The listening walk*. New York: HarperCollins.

Waring, G. 2006. *Oscar and the bat: A book about sound*. Sommerville, MA: Candlewick Press.

NSTA Connection

Download student data sheets, sorting cards, and station cards at *www.nsta.org/sc1612*.

Connecting to the *Common Core State Standards* (NGAC and CCSSO 2010):

This section provides the *Common Core for English Language Arts and/or Mathematics* standards addressed in this column to allow for cross-curricular planning and integration. The Standards state that students should be able to do the following at grade level.

English/Language Arts

Reading Standards for Informational Texts K–5 – Key Ideas and Details

- Grade 4: "refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text."

Language Standards

Writing Standards Research to Build and Present Knowledge

- Grade K: "With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question."
- Grade 4: "recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources."

Writing Standards K–5 – Text Types and Purposes

- Grade K: "use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic."
- Grade 2: "write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.
- Grade 4: "write informative/explanatory texts to examine a topic and convey ideas and information clearly."

Vocabulary Acquisition and Use is one of the standards for language. This particular standard is across grade levels. "Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade [appropriate] reading and content."

Speaking and Listening – Comprehension and Collaboration

Grade 1: "participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups."

Speaking and Listening Standards K–5 – Presentation of Knowledge and Ideas

- Kindergarten: "add drawings or other visual displays to descriptions as desired to provide additional details."
- Grade 1: "add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings."