"Sounds" Like Science

By Kathryn Arnone and Bethany Morris

It seems each new school year brings its own opportunities to grow as an educator. As teachers in a STEM-focused school that serves primarily at-risk students, we face a new challenge in rethinking our instruction to align with the *Next Generation Science Standards*. This involves changing the focus of units previously taught or replacing them with new objectives altogether. When we first noticed the term *waves* in the *NGSS*, we felt panic—it conjured up images of diagrams from college physics classes and terms like *frequency* and *amplitude*. Were we really expected to teach these to primary students? After some investigation of our own, we have a much clearer idea of what teaching sound waves might look like in the primary classroom. Using the 5E learning cycle (Bybee et al. 2006), a bit of technology, and the energetic creativity of first and second graders, we've found that it is possible to tackle teaching sound in a manner that engages our students and implements scientific practices emphasized in the *NGSS*.

Doing Our Homework

We had both attended a workshop on sound (Hanuscin et al. 2011) in order to strengthen our content knowledge. For teachers who don't have a strong background, we suggest that as a beneficial first step. We began with the *NGSS* and developing our understanding of what our students should know and be able to do as a result of our instruction. *NGSS* Appendix E (NGSS Lead States 2013), which shows the disciplinary core idea progressions across grade levels, helped dispel our notion that we'd be teaching wavelength, frequency, and amplitude. Though these are addressed in the upper grade levels, in grades K–2 we realized we are laying the groundwork for these concepts by helping students understand that sound can make matter vibrate, and vibrating matter can make sound (disciplinary core idea PS4.A). Building on what we learned in the workshop, we developed a 5E lesson that focused on how we make and represent sound. ■

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Students draw pictures representing sounds humans make.

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Exploring Human Sounds

Objective:

To help students understand that sounds can make matter vibrate and that vibrating matter can make sound.

Grade Level: K–2

Engage

To get students thinking about their ideas on sound, we began the lesson by having small groups of students create graffiti boards. Each group of students was given a large piece of butcher paper and a variety of colored markers. We asked students to draw pictures representing sounds people could make and required them to label their drawings. Students discussed how they could make sounds and then began to excitedly draw their pictures. In order to assess students' prior knowledge and possible misconceptions, we prompted them to consider how these sounds were made. A few of the students mentioned vibration at this point, but others did not. We noted that as a teaching point for our next learning cycle. We engaged in a whole-class discussion during which students shared their drawings and explained how they believed these sounds were produced. As students shared, we recorded their thoughts on chart paper in order to reference their initial thoughts later in the lesson. Students commonly shared sounds created with their mouth (such as whistling or yelling), while a few others chimed in with sounds created by their bodies (e.g., clapping or snapping).

Explore

This discussion led us right to our investigation question: Why would humans make these sounds? We allowed students to discuss in their groups and then share with the rest of the class. We hung chart paper with the categories listing ways people use sound at the top of each chart (e.g., express feelings, warn for danger, get needs met, for entertainment, and so on). We had students write their sounds on sticky notes and took volunteers to share and demonstrate their sounds until all students had a turn. In order to assess their understanding of why humans make the sounds that we do, we asked them to place their sticky note on the chart that was labeled with the purpose for making their sound. For example, one student demonstrated singing so he placed his sticky note on the chart labeled Entertainment.

Explain

After students explored the reasons for human sounds with their peers, we posed the following questions: What are some of the properties that these sounds have in common? Is there a reason for these similarities? We had each student record their group's ideas in their science notebook. As a way to formatively assess our students' understanding, we gave the students the following prompt: "Write about a time you made a sound and why you decided to do so. What did the sound 'sound' like? How did you make that sound? Be sure to use your sound words!" Students individually wrote in their science notebooks and included words they had heard during our previous discussions such as *loud*, *soft*, *long*, and *short*. Some students even wrote about making sounds by causing something to vibrate. In this assessment we were looking for complete sentences using correct capitalization and punctuation as well as learned spelling patterns and word wall words. Descriptive language and onomatopoeias were also characteristics we were hoping to see based on prior instruction in writing. On the science side, we were assessing the level of prior knowledge about sound our students brought to the lesson. If they were able to use the word *vibration* accurately or explain the concept, we knew they were ready to extend their knowledge. We were excited to see the vocabulary from the lesson appearing naturally in the students' writing. They took science concepts and words and used them seamlessly in a narrative story. Many of the stories included the reason for making a certain sound, which helped us assess their understanding. After students shared their narrative sound stories, we discussed that people make lots of different sounds in many different ways for a variety of reasons.

Elaborate

We decided to ask the students questions that seemed very peculiar to them: How can sound be shown in your science notebook? How could you show another scientist if a sound was loud or soft, high or low, or long or short?" We recognize that the use of visual representation of sound is not emphasized in *NGSS* for first-grade students; however, we found it important to have a simple way to represent the sounds during discussion. This visual representation allowed us to quickly and efficiently discuss the properties of specific sounds and provided background knowledge necessary for using the technology used in this phase of the learning sequence.

In this phase, students tested their explanations for sound in a new context and gathered more information. We passed an iPad to each group and instructed them to pick and record a sound using the free Pocket Soundwave app, which demonstrates what a sound wave looks like. We told the students to push the record button and for one student in the group to make a clear sound. Once they recorded their sound, they played it back and described what they saw on the screen. Students got excited when the sound wave appeared. "Look at the little squiggly lines!" and "Why is that

An app demonstrates what sound waves look like.

squiggly line bigger than that one?" were some reactions we heard. As students continued to engage in this experience, they began to make the connection that if they made their sound louder, the "little squigglies" were taller and if they made their noises softer, the "little squigglies" were shorter. Students were instructed to record in their science notebooks the sound that they made and sketch what the sound looked like when it was played back. For those who do not have access to iPads, there are a variety of sound apps available on Google Chrome and Android that will work well. You could also use a digital sound level meter to measure loud and soft sounds using decibels. These tools are inexpensive and are available in models that have few buttons so they are easy to use.

We challenged the students to figure out how they could change the look of the sound they selected. They recorded their sounds again and discovered they could get their initial sound to look different by varying the sound in volume (louder or softer) and/or duration (long or short). Students discussed in their groups why they thought it was possible to change the "look" of the same sound. After a few minutes of investigation, we assessed their understanding by having each student draw a picture of their sound (clarified as a sound wave via small group conferences during the investigation) on a sticky note. Students passed their note to the student on their right, and that student decided if the sound wave showed a loud/soft and/or long/short sound. The students made that determination based on the sound waves' shape. Sounds longer in duration have a longer unbroken sound wave, while shorter sounds have a shorter sound wave. If the sound is loud, it looks taller top to bottom. If it is quiet, it is shorter from top to bottom. Based on the sound wave represented on the sticky note, the students could be looking at a short, quiet sound, a loud sound, or any combination of the characteristics.

Evaluate

Throughout this learning sequence, we evaluated student understanding of (a) How humans make sound, (b) Why humans make sound, and (c) How sound can be represented. In order to evaluate students formally, we implemented a card-sort to see how students were able to interpret these representations of sound. We asked students to match the picture of the sound wave to the words that described it best (see NSTA Connection for a template). As each match was created, students glued them into their science notebook. This page not only served as an assessment for us but will be a resource for students in the next learning cycles as they record and describe sounds.

Delving Deeper

We come back to the science notebook page in the days ahead as we continue our exploration of the properties of sound. We use the Pocket Soundwave app to record sounds we make using various materials and instruments and discuss the sound wave shape it produces. We touch on the concept that a sound wave is a representation of a particular sound that we can use as a form of measurement, but that sound itself does not have a physical appearance. Students investigate how vibration and sound are related and continue to read and write about sound and tie together their experiences to form a cohesive and more comprehensive schema for sound. Along the way, as teachers, we grab hold of this new opportunity to become better teachers; to help our students stretch further, explore more deeply, and truly view themselves as scientists at work.

Connecting to the Standards

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

Performance Expectation:
1-PS4-1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Science and Engineering Practice:
Planning and Carrying Out Investigations

Disciplinary Core Idea:
PS4.A Wave Properties

NGSS Table: Waves and Their Applications in Technologies for Information Transfer
www.nextgenscience.org/1-ps4-1-waves-and-their-applications-technologies-information-transfer

NSTA Connection

Visit *www.nsta.org/SC1402* for the activity template.