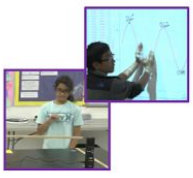
How Can We Sense Different Sounds from Across the Room?

Middle School
PS4 Waves
Storyline Skeleton
[1.0 field trial version -Feb. 2017]

Lesson Routine	Questions	Phenomena / Problems	What we figured out
L1 Anchoring phenomena		 and students' prior experiences	In order to sense a sound it needs to travel from a sound source to our senses. We had a lot of questions about related phenomena and some ideas for investigations to pursue.
L2 Investigation	What does the needle and record look like up close?		There are wavy grooves on the record that cause the needle to be pushed back and forth. We thought that different patterns in the groves might be what makes different sounds.
L3 Investigation	Do other things, that make sound, like instruments, also move back & forth?		The instrument appears to be changing shape and moving back and forth after being struck or plucked.
Putting pieces together	How can we model what is causing these instruments to vibrate?	Previous phenomena from L2	We developed a model for why instruments vibrate for a while after they are struck or plucked. They deform, spring back, overshoot their original position, and then repeatedly change shape back and forth for a bit.
L4 Problematizing / Putting pieces together	Does every object do this when it makes a sound?		All matter is springy up to a point. It deforms when we push or pull on it and will vibrate back and forth for a bit after the outside force that originally deformed it is removed. The resulting vibration of that matter makes sound.
L5 Investigation	How do vibrations at the sound source compare for louder vs. softer sounds?		The amplitude of the vibrations of the sound source increases for louder sounds, but the frequency of those vibrations stays the same.

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L6 Investigation	How do vibrations at the sound source compare for higher vs. lower pitch sounds?		Sound sources that produce higher pitch notes vibrate more frequently.
Investigation	How does the motion detector make these graphs anyway?		The detector samples the position of the stick 25 times / sec. and stores this information as coordinates (number values) in a digital file.
L7 Putting pieces together	How can a single object (like a needle or a speaker) be forced to produce so many different sounds?	Previous phenomena from L1 and L2, and.... 	Changing the pattern in how you push on an object over time can cause it vibrate at different frequencies and different amplitudes.
L8 Investigation	What is inside a speaker that makes it vibrate?		Different amounts of electricity sent through a wire coil produces different amounts of force on a magnet and the surface attached to it.
Investigation	How is the music stored and played back in an electronic music player?		Electronic music players use information stored in the form of numbers (digital format) that specify how much electricity to send to the speaker and when to send it.
L9 Problematizing	How does a vibration at the sound source make something move that is far away?		We had competing models for what's happening between the sound source and the window.
L10 Investigation	Is air being moved all the way from the sound source to my ear?		The air around the source source isn't traveling all the way to my ear when we hear a sound coming from the sound source.

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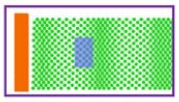
L11 Investigation	Do we even need air to hear sound?		Matter is needed for sound to travel across. Sound can travel through any state of matter (a medium).
L12 Putting pieces together	How can we model sound traveling through a solid, liquid, or gas?	Previous phenomena from L8 and L9	Solids, liquids, and gases are made of particles moving through empty space. Particles can bounce off of each other in a gas and can push into each other in a solid or a liquid.
L13 Investigation	What exactly is traveling across the medium?		Sound is a pressure wave that travels longitudinally through any medium. The waves have a constant distance between peaks in particle density (wavelength). Arrows can help us represent the direction of energy transfer.
L14 Putting pieces together	How does sound make matter move?	Previous phenomena from L9 through L11	When a sounds source vibrates, it causes pressure waves in surrounding medium. These transfer energy through collisions to neighboring particles across the medium, which can make any object it reaches vibrate.
L15 Investigation	What is going on inside the ear, that can explain why some people can (or cannot) hear certain sounds?		Sound causes the ear drum to vibrate, which transfers vibrations into other structures behind it. Cells with hair-like structures in the cochlea move in response to different frequency vibrations that reach them and send signals to the brain. Hearing loss is often due to damage to any of these structures
Investigation	What solutions can help counter hearing loss?		Hearing aids and cochlear implants use the same structures as in a electronic speaker, but work in reverse, converting vibrations into electrical energy. This can be used to produce louder sounds in a small speaker or to send signals to nerve cells directly to the brain.

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