What Does NGSS Look Like in the Classroom?

*How Can We Sense Different Sounds from Across the Room?*

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@ReiserBrianJ
Sound Design Team

Sound Unit Design Team

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## Cycles of Design and Field Trials and Review

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Teachers</th>
<th>Preparation</th>
<th>Students</th>
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<tbody>
<tr>
<td>Draft storyline: authors = NU developers + 2 middle school IL teachers</td>
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<tr>
<td>Alpha pilot (Spring 2016)</td>
<td>2 (IL)</td>
<td>Unit Authors working from storyline with partial lesson plans</td>
<td>50</td>
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<td>Beta pilot (Fall 2016)</td>
<td>4 (IL)</td>
<td>PD and ongoing support from authors</td>
<td>250</td>
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<tr>
<td>Achieve Peer Review Panel Review first 2/3 of unit: “Quality work in progress”</td>
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<td>v1.0 Field trial (Spring 2017)</td>
<td>10 (IL, MI)</td>
<td>PD: 30 hours Intro to 3D Learning (NGSX) + 2 days Unit-specific PD</td>
<td>410</td>
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<tr>
<td>v2.0 Field trials (Fall 2017)</td>
<td>11 (IL, MI, VT, KS, CT)</td>
<td>PD: 5 days Teaching with NGSS + Unit-specific PD</td>
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<tr>
<td>Total</td>
<td>27 Ts</td>
<td></td>
<td>1,660 Ss</td>
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v2.1 Reviewed, Awarded the NGSS Design Badge
Student observe an unusual phenomenon
1. There were different notes – some where higher & some were lower.
2. Volume depended on the distance we were from the sound source.
3. Some people heard screechy sounds, some heard music (someone singing & instruments [violin?])
4. Straws were moving left & right
5. Position of needle changed the sound.
6. Spinning the disc produces the sound; but needle is touching the disc when it makes a sound.
7. Faster spinning = faster sound.
8. Slower spinning sounded clearer.
9. There were lines on the disc
   - (different line = different sounds)
Students model the phenomena

What is happening...
1. At the point where the needle touches the record?
2. At a point in the air between the sound source and your ear?
Connecting to other phenomena

- When I am near any speaker the sound is louder. I’m further they are softer.
- When under a bridge, I can still hear a train passing over.
- How can we hear birds through the window?
- I can hear a police siren from a large distance.
- Airplanes flying through the sky.
- When outside a window I can hear sounds inside.
Students generate questions
Student Questions

How do sounds fade away?

Why are some noises higher pitched than others?

How do we hear underwater?

Is sound a state of matter?

Why do we feel vibrations when we play instruments?

How does a sound go through walls?
Student Questions

- Why can’t some age groups not hear higher sounds with their ear, but some do, like a dog whistle?
- Does vibration cause sound?
- Why do some objects make only 1 sound?
- Can we hear amplified sound even if it is blocked?
- Does something need to touch another to make sound?
- Is sound made of particles?
Ideas for investigations

- Use different objects and observe their sounds; try different volumes.
- Study the structure & function of ear parts.
- Slow motion videos.
- Use our voices as sound sources.
- Zoom in even closer.
- Get in touch with inventors & makers of speakers, megaphones so we can figure out how those work.
- Place people in different areas & set up different tests (distance, volume, different sounds).
- Bring in different instruments.
Anchoring investigations in the sound unit

What do we notice?
How can we explain this?
Where else have we seen something like this?
What do we need to figure out?

Do our explanations agree?
Anchoring investigations in the sound unit

- Explore Anchoring Phenomenon
- Attempt to Make Sense
- Identify Related Phenomena
- Develop Questions & Next Steps

What do we notice?
How can we explain this?
Do our explanations agree?
Where else have we seen something like this?
What do we need to figure out?
Where do the sound classrooms go next?

1. Videos
   - Use different objects to observe different sounds
   - Study the structure and function of ear parts
   - Use your voice as sound source

2. Zoom in even closer to chic

3. Get in touch with inventors or makers of speakers, megaphones
   - So we can figure out how they work

4. Place people in different areas and set up different tests (distance, volume, etc.)

5. Bring in different instruments
What is vibration?

**Ideas for investigations**

- Use different objects → observe their sounds
  - Study the structure & function of ear parts
  - Zoom in even closer to object
- Get in touch with inventors or makers of speakers, megaphones
  - See how they work
- Place people in different areas & set up different tests (distance, volume, different sounds)
- Bring in different instruments
Modeling vibration

Before:
- Fork
  - Side base
- Table

1. Fork strikes and the fork bends
2. When the fork leans the table it bends the opposite way
3. The fork bends again and keeps on going until it stops to vibrate
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.

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.

There are wavy grooves on the record that cause the needle to be pushed back and forth. We thought that different patterns in the grooves might be what makes different sounds.

The instrument appears to be changing shape and moving back and forth after being struck or plucked.

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.
A Question Emerges

Do all objects vibrate back and forth when they make sound?
Amelia: Yes, because um, you might be- not be able to hear a sound but when an object vibrates you can um, it does like make a sound.

Julio: Um I think that not everything vibrates when it makes a sound. ...because mostly things that make sounds are solids and some solids can be really sturdy and not move at all.

Oscar: I would think that there's like- when you hit it it doesn't change a lot but it still has a little vibration

Aaron: It's like kind of, it's like, um if you had a chain saw in the floor it's gonna crack, but if just people stomp on it I don't think it will [vibrate]. Like it could have a little cracks maybe.
Let’s investigate the disagreement
Extending the model

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.

Does every object do this when it makes a sound?

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.

Putting pieces together

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 grooves might be what makes different sounds.

How can we model what is causing these instruments to vibrate?

The instrument appears to be changing shape and moving back and forth after being struck or plucked.

Putting pieces together

Do other things, that make sound, like instruments, also move back & forth?

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.

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.
How can motion help us investigate the differences in sounds we wondered about?

Vibrating object

Motion detector (Initial distance from stick to detector = 0.5 m)

Computer graphs how the distance between the stick and detector changes over time
Let’s compare large vs. small vibration to investigate loud vs. soft sounds
What do students predict these vibrations will look like for loud and soft “sounds”?
What patterns did students find in the graphs of the vibrations for louder vs. softer sounds?

*What students notice*

"It looks like a lot of waves."

"Over time high points decrease (in height) and low points increase (in height)." (…We learn that scientists refer to this distance as amplitude.)

"You can compare how far apart they are this way too....." (…We learn that scientists refer to how far apart they are in time as frequency.)

"It goes up then down, and repeats.”
What does the class conclude about the pattern of displacement over time?

"There is a repeating wave pattern"

"The spacing between the high and low points (amplitude) was less in the graph that we pulled back the stick less"
How do these discoveries students answer the question that motivated this lesson?

“The frequency of the vibrations stays the same for loud and soft sounds for the same sound source.”

“The amplitude of the vibrations decreases as the sound gets quieter.”
Part 2: How does sound travel?

Does sound need air to move from the source to our ears? #NGSX

When you visit Mrs. Ryner’s class of course you submerge your head in a fish tank? S’s studying how sound travels #Refreshing #BeUnited

Wait- sounds can travel through solids, liquids, AND gasses but NOT a vacuum? Sound must need a MEDIUM to travel through!

Today we recalled 5th grade to remember what particles of a medium are like- and then tried to figure out what happens when sound travels!

Gathering evidence: If matter is needed for sound to travel, then it should travel through water too right? #wearelombard @nextgenstory1
Students answer questions they raised weeks earlier

NGSS_tweeps @NGSS_tweeps · Oct 26
How do you track driving questions in your classroom? #NGSS Do you have a DQB- share pictures! Mine is the header for @NGSS_tweeps this week

Wanda Faye Bryant
@wandabryant

Replying to @NGSS_tweeps
Students add stickers to questions that have been answered.

Whitney Smith
@sternwhitney

Today’s an exciting day for some Ss! We’re answering some DQB questions and they can answer THEIR personal questions they posted about sound! #relevance #NGSS

9:24 AM - 10 Nov 2017
(Developing) particle model of sound traveling through a medium

An airplane was so loud it shook my house and the windows were rattling.

Explaination:
The airplane is vibrating. Hitting the air particles, the particles collide passing energy. Sound hit the window making it vibrate.
Particle level model

How does sound travel underwater?

- Sound waves travel through water by transferring energy as water particles collide and vibrate.
- The more dense the water, the more energy is transferred.
- Particles collide with the ones behind it before bouncing back and filling the empty space in front of it.
- Water particles collide with ear drum.
- Ear receiving sound.

Particles collide with more dense water, packed tighter together than air particles.
Extending the science through an engineering design challenge

How can we design a device to gather sound waves and keep them together over a longer distance? #wearelombard @nextgenstoryl1

Today we dove back into sound! Can we create something that allows us to hear quiet sounds further away?

Consensus modeling and developing explanations: Why did our tube shaped devices help us hear sounds over a greater distance than without any device? #wearelombard @nextgenstoryl1

Today we’re testing out our designs! Which one will help sound be heard the furthest away?
Design of NGSS units

1. Coherence from students’ perspective:
   Teachers involve students as partners in identifying questions, problems, and ways to address them

2. Pedagogical supports for science and engineering practices, particularly argument, explanation and scientific modeling

3. Support for classroom discourse essential for engaging in science and engineering practices
How Can We Support Students as Partners in Knowledge-Building?

“We figure out the science ideas.”

“We figure out where we are going each step.”

“We put the pieces of the science ideas together over time.”
Questions?

Download these units and other open-source storylines:
http://www.nextgenstorylines.org

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