Sound and Waves: An Integrated K–8 Hands-On Approach Supporting the NGSS and CCSS ELA

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**Presenters**

Chih-Che Tai (Asst. Director/Asst. Prof. of Science Education)
Renee Rice Moran (Asst. Prof. of English Language Arts)
Laura Robertson (Asst. Prof. of Science Education)
Karin Keith (Chair/Asst. Prof. of English Language Arts)

**Assistants**

Alvin Tai (6th Grade, University School)
Emily Tai (3rd Grade, University School)
Overview of the Presentation

1. **Background**: Integration of Science and Literacy
2. **Excitement in Learning/Teaching Sound & Waves**:
   - for students
   - for instructors
   - for both
3. An instructional **Plan** to integrate
   Science content + Hands-on activities + Literacy strategies
## Why Science and Literacy Integration?

<table>
<thead>
<tr>
<th>NGSS Practices</th>
<th>CCSS ELA Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1. Ask questions and define problems</td>
<td><strong>E1. Demonstrate independence in reading complex texts, and writing and speaking about them.</strong></td>
</tr>
<tr>
<td>S2. Develop and use models.</td>
<td>E2. Build a strong base of knowledge through content rich texts.</td>
</tr>
<tr>
<td>S3. Plan and carry out investigations.</td>
<td>E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose.</td>
</tr>
<tr>
<td>S4. Analyze and interpret data.</td>
<td><strong>E4. Construct viable arguments and critique reasoning of others.</strong></td>
</tr>
<tr>
<td>S5. Use mathematics and computational thinking.</td>
<td>E5. <strong>Read, write, and speak grounded in evidence.</strong></td>
</tr>
<tr>
<td>S7. Engage in argument from evidence.</td>
<td>E7. Come to understand other perspectives and cultures through reading, listening, and collaborating</td>
</tr>
<tr>
<td>S8. Obtain, evaluate and communicate evidence.</td>
<td></td>
</tr>
</tbody>
</table>
Preparing College/Career Readiness through Integrating Science Learning with Literacy in Grades 4-12 (6-12)
A LEA-IHE-Business Partnership Initiative Supported by TN DOE MSP and THEC ITQ Grants (2015-18)

Local Education Agents

Institute of Higher Ed

Business Partners

EAST TENNESSEE STATE UNIVERSITY
Picture of College Readiness

Percent of 2016 ACT-Tested High School Graduates Meeting ACT College Readiness Benchmarks by Subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>Tennessee</th>
<th>Nation</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>58</td>
<td>61</td>
</tr>
<tr>
<td>Reading</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>Mathematics</td>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>Science</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>All Four Subjects</td>
<td>20</td>
<td>26</td>
</tr>
</tbody>
</table>
• **RQ1**: How does cross-discipline instruction benefit and enrich each subject discipline?
• **RQ2**: How does integration of science learning with literacy in G4-12 impact students’ learning in schools?
Excitement in Learning Sound & Waves (learners)

What do you feel excited about sound?

• Celebrations (5th grader)
• Pretty (2nd grade)

What do you feel excited about waves?

It is cool when you see it change because it is like it is a show in front of you and it is also like something you never seen before and never did before and also the first person to do it and it is also like the coolest thing ever. I think it is really cool to do the light’s and really cool to do sound and waves.

A second grader
Interviewed in 2016
**K-2 (1)**

- **Sound** can make matter **vibrate**, and vibrating matter can make sound

**G3-5 (4)**

- **Waves** are regular **patterns** of motion, which can be made in water by disturbing the surface. Waves of the same type can differ in **amplitude** and **wavelength**. Waves can make objects move.

**G6-8**

- A simple wave model has a **repeating pattern** with a specific **wavelength**, **frequency**, and **amplitude**, and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena including **sound** and **light**. Waves can transmit **energy**.
A Concept Map of Sound and Waves in K-12

Sound/ Light

Pitch/Color

mutually related

Frequency: \( f \) (Hz, cycles/sec)

Wave/ Vibration/ Oscillation

Period (seconds/cycle)

Speed = freq. \( \times \) wavelength (cm/sec)

Volume/ Intensity of Sound/Light

mutually related

Amplitude

Wavelength (cm/cycle)
## An Integration Plan for A Cognition Architect

<table>
<thead>
<tr>
<th>Science Content</th>
<th>Hands-on activities</th>
<th>ELA Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. What is sound?</strong></td>
<td>• Kazoo straws</td>
<td>1. Graphic novels</td>
</tr>
<tr>
<td><strong>How is sound made?</strong></td>
<td>• Wine glasses</td>
<td>2. Text evidence</td>
</tr>
<tr>
<td></td>
<td>• Ukuleles</td>
<td>3. Cite and justify evidence</td>
</tr>
<tr>
<td><strong>II. How does sound travel?</strong></td>
<td>• Pulse of air</td>
<td>4. Use evidence in writing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Use technology to support literacy and content knowledge</td>
</tr>
<tr>
<td><strong>III. Types of waves: transverse vs. longitudinal</strong></td>
<td>• Ropes/ slinkies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Group of people</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Wave gadgets</td>
<td></td>
</tr>
<tr>
<td><strong>IV. From noises to music</strong></td>
<td>• Kazoo straws</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Straw flute</td>
<td></td>
</tr>
</tbody>
</table>
A. Kazoo Straws (videos)
1. Let’s do it. First play one straw then make another one according to your sitting area (see right).
2. Q: How to make a kazoo straw with a higher pitch? Why?

<table>
<thead>
<tr>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>16cm</td>
</tr>
<tr>
<td>8cm</td>
</tr>
<tr>
<td>12cm</td>
</tr>
<tr>
<td>14 cm</td>
</tr>
</tbody>
</table>

B. Two wine glasses w/ different amount of water
1. Which one has a higher pitch? Why? (Use feedback detector)
2. How is sound made?

C. A ukulele with frequency detector app
1. Does a bigger sound have a higher pitch?
Using Graphic Novels to Understand Science

• How is the use of text changing in the science classroom?
Why Graphic Novels?

- Globalization has led to an emergence of greater reliability on visual modes of communication.
- New technologies make interactive, nonlinear, and hypertextual forms of communication possible.
- Graphic novels increase motivation.
- Graphic novels may help students connect with content that they struggle comprehending from their textbook. (Hassett & Schieble, 2007; Jimenez & Meyer, 2016)
Sound involves more than just volume. This bird’s song gets louder and softer, but it is also full of notes, some higher than others.

The frequency of a sound determines its pitch.

Something with lots of Hz sounds higher than something with fewer Hz.

But people can’t hear everything. In fact, we can only hear frequencies between 20 and 20,000 Hz.

Sounds below 20 Hz are called infrasound. Sounds above 20,000 Hz are called ultrasound.

Frequency equals the number of sound waves that pass a point during a certain amount of time.

For instance, right now only one sound wave passes by me each second. Therefore, the sound has a frequency of 1 hertz (Hz).

But if 50 waves pass by me in one second, the sound has 50 Hz. Faster vibrations create sounds with higher frequencies.
How Does Sound Travel/ How Does Waves Move

A. A pulse of air
   1. Hypotheses about how sound travels.

B. Types of waves

<table>
<thead>
<tr>
<th>Transverse</th>
<th>Longitudinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ropes</td>
<td>• Slinkies</td>
</tr>
</tbody>
</table>

• Q: How to use a group of people/kids to simulate two types of waves?

C. Wave gadgets (also next page)
• Standing waves to visualize wave movement
How Does Waves Move

A. Components of a wave movement
   1. Frequency
   2. Wavelength
   3. Amplitude

B. Wave movement demonstration (transverse type)
   • Frequency (Hz) activity using flash strobes
   • Identify/ describe a wave movement
   • Find wavelength and amplitude of a wave
1. Read the pages of the graphic novel provided.
2. As a group, fill in the empty speech bubble with text that illustrates concepts of wave movement.
3. Discuss why you choose the particular piece of text you inserted.
4. Compare your text to that of the original author’s text.
A. Kazoo Straws (videos)
Let’s resume our Kazoo activities and cheer up!

B. Make a straw flute instrument (see bags, handouts)

<table>
<thead>
<tr>
<th>Stage</th>
<th>16cm</th>
<th>8cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12cm</td>
<td>14 cm</td>
</tr>
</tbody>
</table>

**Step 1**

**Step 2**

**Step 3**
# Math in Straw Flute (optional)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0 cm</td>
<td>16.9 cm</td>
<td>15.0 cm</td>
<td>14.1 cm</td>
<td>12.7 cm</td>
<td>11.3 cm</td>
<td>10.0 cm</td>
<td>9.5 cm</td>
</tr>
<tr>
<td>Do</td>
<td>Re</td>
<td>Mi</td>
<td>Fa</td>
<td>So</td>
<td>La</td>
<td>Si</td>
<td>Do</td>
</tr>
</tbody>
</table>

**Ration of Lengths**

<table>
<thead>
<tr>
<th>#1/#5</th>
<th>#2/#6</th>
<th>#3/#7</th>
<th>#1/#8</th>
<th>#1/#4</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/2</td>
<td>3/2</td>
<td>3/2</td>
<td>2/1</td>
<td>1.347</td>
</tr>
</tbody>
</table>

Two combinations
- Do + So (Harmonic)
- Do + Fa (Dissonant)
Twinkle, Twinkle Little Star

11 55 66 5 44 33 22 1
55 44 33 2 55 44 33 2
11 55 66 5 44 33 22 1
Connecting graphic novels to writing and technology- Story Visualizer

Tasks that provide opportunities for students to use spatial skills to imagine, visualize, and create lead us towards multimodal and multidimensional literacy (Spellman, Jones, & Katsio-Loudis, 2014).
The Secrets of Sound and Waves

Producers

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Questions and Comments

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