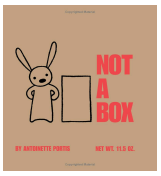
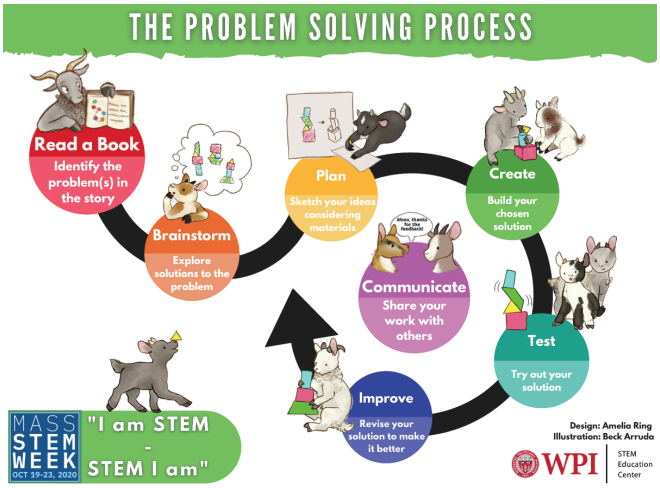
I am STEM: STEM Week Lesson

Written by: Lee Burgess

Selected Book	**Title: Not A Box** **Written & Illustrated by: Antoinette Portis** 		
Grade	6th Grade	Read-Aloud Link	*Not A Box - YouTube*
Challenge Overview:	In our story "Not A Box," our protagonist adamantly believes their box is NOT a box. That level of imagination is necessary to be a successful innovator! Using a box, create a device/method to amplify a song being played from a cell phone and describe the physical effects of amplification.		



	Monday	Tuesday	Wednesday	Thursday	Friday
STEM/ Problem Solving	Read the book. **Identify the problem(s)** in the story. Define criteria and constraints.	**Plan** your solution: Sketch your ideas. Gather and explore materials.	**Create** your chosen solution. **Share** your work.	**Test** your solution. **Share** and obtain feedback. **Improve** your solution.	**Communicate** your revised solution to an audience.

	Brainstorm possible solutions.	**Share** your work.			

STE, Math, and ELA Practices

STE	Math	ELA
✓ Asking questions and defining problems ✓ **Developing and using models** ✓ Planning and carrying out investigations ✓ Analyzing and interpreting data ✓ Using mathematics and computational thinking ✓ Constructing explanations and designing solutions ✓ Engaging in argument from evidence ✓ Obtaining, evaluating, and communicating information	✓ Make sense of problems and persevere in solving them ✓ Reason abstractly and quantitatively ✓ Construct viable arguments and critique the reasoning of others Model with mathematics ✓ Use appropriate tools strategically ✓ **Attend to precision** ✓ Look for and make use of structure ✓ Look for and express regularity in repeated reasoning	✓ Demonstrate independence ✓ Build strong content knowledge ✓ **Respond to the varying demands of the audience, task, purpose and discipline** ✓ Comprehend as well as critique ✓ Value evidence ✓ Use technology and digital media strategically and capably ✓ Come to understanding other perspective and cultures

Culturally & Linguistically Sustaining Practices (CLSP)

- ❏ Connect the content of the book to your students' cultural and linguistic backgrounds.
- ❏ Ask relevant and inclusive questions that connect to all students from various backgrounds (i.e. Asking what kind of instruments and music they like or hear in their homes, rather than what instruments they play).
- ❏ Ask students to make connections to the problems in the stories by relating them to their home and community experiences.
- ❏ Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities (i.e. writing, drawing, speaking, etc…), including students' home language.
- ❏ Select materials and tools that are developmentally appropriate, culturally accepted and easily available for all students.
- ❏ Give students plenty of opportunities to discuss and share various stages and possibilities of the design.
- ❏ When possible, assist students in group work by providing them clear and fluid roles.
- ❏ Scaffold students' learning using their family and home funds of knowledge (i.e. connect the students' family/community expertise to inform the problem solving process).

MA STE, Math or DLCS Standards

6.MS-PS4-1; Use diagrams of a simple wave to explain that (a) a wave has a repeating pattern with a specific amplitude, frequency, and wavelength, and (b) the amplitude of a wave is related to the energy of the wave.

6.MS-PS4-2; Use diagrams and other models to show that both light rays and mechanical waves are reflected, absorbed, or transmitted through various materials.

Learning Targets:	Students will be able to… ● Design, develop, and produce an acoustic amplification device using a box. ● Develop a diagram that displays how mechanical waves can be amplified. ● Present the development process and resulting device/method to an audience. ● Collaborate with a design team to create an amplification device.

MA ELA Standards

1. Write arguments (e.g., essays, letters to the editor, advocacy speeches) to support claims with clear reasons and relevant evidence.

a. Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically in paragraphs and sections.
b. Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
d. Establish and maintain a style appropriate to audience and purpose (e.g., formal for academic writing).
e. Provide a concluding statement or section that follows from and supports the argument presented.

ELA Learning Targets:	● Develop an oral presentation about your group's chosen solution. ● Develop a written rationale for the chosen solution. ● Develop a rationale for the chosen solution ● Discuss cultural responses to the human desire to consume music. ● Define music as organized sound.

Key Vocabulary Words

<u>Tier 1</u>

- Volume
- Acoustic
- Digital
- Sound

<u>Tier 2</u>

Sound Wave Characteristics

Loudness

- The phenomenon of sound depends on the amplitude of the sound wave. If the amplitude of the sound wave is large, then the sound is said to be loud.
- It is expressed in decibel (dB).
- Sounds above 80 dB is noise to human ears.

Normal Breathing	10 dB
Soft Whisper (at 5 m)	30 dB
Normal Conversation	60 dB
Busy Traffic	70 dB
Average Factory	80 dB

- Frequency can also be referred to as pitch.
- This depends on the frequency of vibration of the waves.
- If the frequency of vibration is higher, we say that the sound is shrill and has a high pitch. On the other hand, if the sound is said to have a lower pitch then it has a lower frequency of vibration.
- A bird produces a high-pitched sound whereas the roaring of a lion is a low-pitched sound.

<u>Tier 3</u>

- Mechanical Waves
- Decibel - A measure for the degree of loudness
- Efficacy- the ability to create and refine a tool to achieve an intended result.
- Organology- The study of musical instrument making.
- Amplification - Sound whose volume is increased by any means.
- Resonance - The prolongation of sound by reflection from a surface or by the synchronous vibration of a neighboring object

CLSP Strategies

- Connect the content of the book to your students' cultural and linguistic backgrounds.
- Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities (i.e. writing, drawing, speaking, etc…), including students' home language.

Materials

- Cardboard boxes
- Variety of materials for building including but not limited to…
  - Craft materials
    - Rubber bands, popsicle sticks, string, etc)
  - Household materials
    - Spoons, paper towels, tissues, paper, foil, etc…
  - Recycled materials
    - Boxes, plastic containers, paper towel rolls, plastic bottles, bags, etc…)
  - Materials for amplitude manipulation including but not limited to…
    - Aluminum foil
    - Cotton Balls
    - Copper foil (if available)
    - Rubber or mylar balloons (could be filled with various gasses)
    - Rubber or mylar balloon filled with water
    - Rubber or mylar balloon filled with high salinity content
    - Large stone
    - Wood plate
    - Steel wool

- Glue or Tape
- Scissors
- Browser-Based Decibel Reader:
  - Sound Meter :: WebBrowserTools
  - Bouncy Balls
- Cell phone
  - Song of choice

CLSP Strategies	• Select materials and tools developmentally and culturally appropriate/available for all students.

Monday	

Teacher Preparation:	• Read the book
	• Post the Engineering Design/Problem Solving Process visual.
	• Create a place to display the lesson vocabulary
	  ○ Volume
	  ○ Acoustic
	  ○ Digital
	  ○ Sound

Student Preparation:	Read “Not a Box” Pencil and paper to draw/record your prediction of the visual representation of various sound examples.
Problem Solving:	• Read the book. • **Identify the problem(s)** in the story. • Define criteria and constraints. • **Brainstorm** possible solutions
CLSP Strategies	• Connect the content of the book to your students’ cultural and linguistic backgrounds. • Ask relevant and inclusive questions that connect to all students from various backgrounds (e.g. Asking what kind of instruments and music they like or hear in their homes, rather than what instruments they play). • Connect the problems in the stories to all students’ home and community experiences. • Scaffold students’ learning using their family and home funds of knowledge (e.g. connect the problem to the students’ family/community expertise).

Duration	Activity	Instructions	Product
13 mins	Hook	Read with the students the book “Not a Box”	*Not A Box - YouTube*
20 mins	Brainstorm	Explore and capture possible uses of a box! Encourage drawing or manipulating boxes to facilitate creative thoughts. Present the Engineering Design / Problem Solving Process visual and review the steps. Discuss: where are we in the process? Mark with an arrow.	Engineer Design Process visual, with arrow List of student-generated ideas

		Have the students turn, pair, and share their ideas for box uses. Offer honing prompts such as “what about for communication?” or “what about for transportation” Connect their ideas of boxes to a problem they have or they are presented. Have students turn, pair, and share around the question “have you ever been somewhere, like a hotel, and wanted to amplify your music?”	scribed by the teacher.
7 mins	Introduction to the problem	Tomorrow in class we are going to begin solving a problem! We will be tackling how to acoustically amplify the sound being produced from a cell phone. Tonight, think about what song you would want to hear being amplified; be sure to provide a reason for your song choice!	Statement of challenge!

Tuesday	
Teacher Preparation:	• Retrieve yesterday’s vocabulary chart. • Create a place to display the lesson vocabulary • Teacher Resource page
Student Preparation:	Paper & Pencil for Sketching
Problem Solving:	**Plan** your solution: • Sketch your ideas • Gather and explore materials. • Share your work
CLSP Strategies	• Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities, including students’ home language. • Give students plenty of opportunities to discuss and share various stages and possibilities of the design.

	• Assist students in group work by providing them clear and fluid roles, whenever possible.

Duration	Activity	Instructions	Product
5 mins	Inquire	Ask students to draw what they think sound **looks** like AND explain why they think it looks this way. Have students share with their neighbors their hypothesis. Present the Engineering Design / Problem Solving Process visual and review the steps. Discuss: where are we in the process? Mark with an arrow.	Student drawings with annotation of their visual perception of sound. EDP visual, with arrow
20 mins	Explore/ Demonstrate	With students, explore video demonstrations of wave format. Based on today's findings would you change your original hypothesis as to a visual representation of sound? As the class is exploring the videos about resonance, have the students turn, pair, and share their thoughts on • Why did the sand of the Chladni experiments behave this way? • What pattern does sound move in? (waves) • Does sound need a medium to be heard? Could sound travel through a vacuum? • How are vibrations and pitched frequency related? • How does the human ear work?	Documented record of student conversation. (e.g., worksheet, note catcher, etc.)
15 mins	Brainstorm	Based on the demonstrations, do you believe that amplification is possible? If so, discuss and record with your partner how this could be	Schematic of prototype

		done with a box? How could we use a box and everyday materials to amplify a sound?	

Wednesday	
Teacher Preparation:	Materials Rating Chart
Student Preparation:	Brainstormed list from yesterday
Problem Solving:	• **Create** your chosen solution. • Share your work.
CLSP Strategies	• Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities, including students' home language. • Give students plenty of opportunities to discuss and share various stages and possibilities of the design. • Assist students in group work by providing them clear and fluid roles, whenever possible.

Duration	Activity	Instructions	Product
5 mins	EDP Check-in	Present the Engineering Design / Problem Solving Process visual and review the steps. Discuss: where are we in the process? Mark with an arrow. • Where are we in the process? • What is the design challenge?	EDP Visual with an arrow indicating current position in process.
15 mins	Gather & Rate	Groups are to begin rating materials for their use in loudening and softening the volume of their device.	Materials gathered, rated and labeled for use.

			Materials Rating Chart
15 mins	Develop	Groups begin developing their prototype amplification device.	Updated schematic and prototype

Thursday	
Teacher Preparation:	Stations for peers to travel, test, and peer-review. Some way to record critique between groups (e.g., Jamboard).
Student Preparation:	Sound Amplification Manipulator Prototype ready for peer-review.
Problem Solving:	• **Test** your solution. • Share and obtain feedback. • **Improve** your solution.
CLSP Strategies	• Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities, including students' home language. • Give students plenty of opportunities to discuss and share various stages and possibilities of the design. • Assist students in group work by providing them clear and fluid roles, whenever possible.

Duration	Activity	Instructions	Product
5 mins	EDP Check-in	Present the Engineering Design / Problem Solving Process visual and review the steps. **Discuss**: where are we in the process? Mark with an arrow.	EDP Visual with an arrow indicating

		• Where are we in the process? • What is the design challenge?	current position in process.
10 mins	Prototype/ Experiment	Student groups travel to different stations and offer peer-reviews of their sound amplification manipulator.	Peer-review critiques. Peer review rubric.
10 mins	Review & Revise	Groups are to review the peer-critiques provided and determine what changes to their design will be made. Record said changes.	
15 mins	Device v.1	Develop the final version of the sound amplification manipulator for show.	Final device product

Friday	
Teacher Preparation:	- Invite a special guest to join the class
Student Preparation:	- Draw a picture or write “I am STEM because…”
Problem Solving:	• **Communicate** your revised solution to an audience.
CLSP Strategies	• Ask relevant and inclusive questions that connect to all students from various backgrounds. • Encourage students to express and communicate their knowledge and ideas using multiple modes and modalities, including students’ home language. • Give students plenty of opportunities to discuss and share various stages and possibilities of the design.

Duration	Activity	Instructions	Product
45 mins	**Share** their solutions with a special guest	Introduce the special guest to the class Show their solution to the special guest. Use evidence from the development process to support your final design. ● Using a wave diagram, explain how their design will amplify their music. ● Use information from their rating charts and the demonstration note catchers to explain why their design is the best solution to their problem. Draw or write about themselves in STEM. "I am STEM because…" (if completed ahead of time, students can share with special guest) Celebrate how they solved a problem like engineers!	The final loudening device
	Family connection	*Optional:* Put together a digital class book or slideshow and share it with all students and families after the lesson	Optional: Book or Slideshow

Final STEM Week Activity:

Ask your students to complete the statement, "**I am STEM because…**"
Students can create a video, poster, essay, skit, etc…

Extensions

- Explore instrument making from the original box
  - How could this box be crafted into a tuneable (able to manipulate the pitch)instrument?

- What materials would need to be added to help with the general resonance of the instrument to be audible to an audience?
- What classification of instruments could this box be turned into? By what means would you create this?
    - Classifications:
        - Aerophone (Blown instruments)
        - Chordophone (bowed or plucked instruments)
        - Membranophones (vibrates by striking, rubbing, or singing into a stretched membrane)
        - Idiophones (vibrates when struck, shaken, or scraped)
        - Electrophones (pitch/vibrations produced by electrical/electronic/digital means)