

Mathematics: The Language of STEM

Lesson #2 - Year 3: The Pythagocaster

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CONTENT AND TASK DECISIONS

Grade Level(s): 5th

Description of the Task: Explore pitch by plucking a string with a finger placed at different intervals along a board. Think of it like playing a guitar. The length of the part of the string that vibrates will change depending where the finger is placed, thus affecting the pitch. Students will use math to determine where specific pitches will be found on the board based on the length of string that is vibrating.

Indiana Mathematics Content Standards: 5.DS.1: Formulate questions that can be addressed with data and make predictions about the data. Use observations, surveys, and experiments to collect, represent, and interpret the data using tables (including frequency tables), line plots, bar graphs, and line graphs. Recognize the differences in representing categorical and numerical data.

Indiana Mathematics Process Standards: PS.6: They calculate accurately and efficiently and check the validity of their results in the context of the problem. They express numerical answers with a degree of precision appropriate for the problem context.

Mathematics Content Goals: Use division of whole numbers and multiplication of fractions to discover the solution various problems

Language Objectives: Students will be able to use the mathematical terms half, divide, and measure Along with the musical terms octave, pitch, frequency, interval

Materials: meter stick, fishing line, round stickers,

THE LESSON

Before: This phase of the lesson should be designed to get students ready for problem solving. It also provides an opportunity for you to find out what they already know about the topic. Describe how you will accomplish each of the following in this phase of the lesson:

- **Activate prior knowledge** Ask students about pitch
 - What is pitch?
 - How many times per second does a string vibrate if it produces the tone A3?
 - What happens when a string vibrates faster and faster?
 - What happens when a string vibrates slower and slower?
 - Play various “A’s” on a piano. Have students note the sound of each octave
- **Be sure the problem is understood**
 - We are going to determine where octaves are located on a meter stick when pushing a finger down on a string (think of a finger pushing down on a guitar string)
- **Establish clear expectations**
 - Students will be able to calculate where octaves will occur on a meter stick when pushing down a string that is attached to it (think of a finger pushing down on a guitar string)

During:

- **Let go,** Students will work in small group to determine where the octaves are by plucking the string and then placing fingers in various locations on the board to try to listen to when the octaves are. Have students place stickers on the board where they think the octaves are located. Stop at 4 stickers.
- **Listen actively** Listen to and take notes of student interactions. Note the different strategies used to solve the problem
- **Provide appropriate support** After students have explored pitch, have them go back to their seats. Explain the concept of division with respect to sound. Explain that in music, an octave is created when a string length is cut in half. If a student presses their finger at the 40 centimeter mark of an 80 centimeter length of string, then the string will create a pitch that is one octave higher, when plucked, then the string with no finger pushing on it. Where will the next octave sound? Cut the 40 cm section in half (the 20 cm. point on the board). Where will the next octave be? (Halfway between 20 cm. and the end; 10 cm.). How close were your predictions?
- **Provide worthwhile extensions.** Go back to the board and place the stickers where an octave should be. Have the students play their instrument again and listen.
- Have the students calculate where the intervals of a fifth are located on the board (Half way between the octaves). Have them place stickers of another color at those locations. Add stickers to the fourths, thirds, and other relevant intervals along the meter stick. Use math to determine the locations of the different intervals along the meter stick.

After:

- **Promote a mathematical community of learners** Students will work together to discover the physics of instruments and sound
- **Listen actively without evaluation** take pictures of student learning
- **Make connections**
 - How do you think this idea of string length and ratio is used on a guitar?
 - What are frets on a guitar used for?
 - Is it the same for violin, cello, or bass?

- How do you think music was invented?
- **Summarize main ideas** Music was invented by Pythagoras. He discovered the ratio of the octave in sound is 2:1. Using fractions, he was able to create the music scale which is what is used to make music to this day. Think of the song Do, Re, Mi from the Sound of Music if you're not sure what a scale is. In honor of Pythagoras, we will name our instrument the "Pythagocaster".



ASSESSMENT

Observe: Students will take pictures of their Pythagocaster and post them on their personal page of the music classroom webpage

Ask:

How can you use the idea of ratio to create other kinds of instruments?

How do brass instruments use to concept of ratio to create sound?