Lesson Plans for the Waves and Sound Module

1. Making Waves

Objective:

Students will be able to investigate the differences between transverse and longitudinal wave pulses through guided inquiry

Engage

Explain to students that his module will lead up to them inventing and building musical instruments.

Exploration

1. Demonstrate wave pulses for students and how to measure the amplitude
    a. Transverse
    b. Longitudinal
2. The Essential Question for this inquiry
    a. "Does the amplitude of a wave affect wave speed?"
        i. Students design and experiment to answer this question
        ii. Use telephone cord or slinky (we prefer phone cords)
3. Students use the scientific method to respond to the question
    a. State the purpose and make a hypothesis
    b. Think about the measurement tools + controls and variables
    c. Students record data
    d. Students analyze their data
        i. Look for trends or patterns
        ii. Draw conclusions based on their data.

** Facilitator should always differentiate instruction by providing the necessary blend of guidance and exploration for each student group and their specific needs.

*Common experimental error – a lack of control in length and/or tension of phone cord.

4. Introduce and Demonstrate Standing Waves.
    a. Frequency

i. "Does frequency have an affect on the speed of a wave?"

b. Students shake the telephone cords
   i. Model of standing wave in the fundamental frequency
   ii. "This is a standing wave with half of one wave."

c. Teacher continues to wiggle the cord – making standing waves
   i. Point out the nodes and the antinodes
   ii. Count how many half-waves there are.

d. Questioning of students
   i. Can they figure out how to make a standing wave with different numbers of half-waves (loops)
   ii. Students or facilitator forms cooperative groups for investigation
   iii. Facilitator solicits responses from students

1. What causes the change in the number of standing waves?
2. Inform them that what they changed is called frequency
3. Model how to measure frequency and wavelength when they make standing waves
4. Students design and run an experiment
5. **"**Does the frequency of the standing waves affect the wave speed?"

Explanation, Elaboration and Evaluation

5. Analysis of experimental data
   a. Students should answer the questions on the handout.
   b. Synthesizing and analyzing their findings from their lab
6. Students discover that wave speed does not change with frequency or wavelength
   a. Wavelength is constant (within experimental error) if tension remains constant
7. Facilitator reinforcement concepts and building of knowledge
   a. Standing waves
   b. Frequency and Wavelength and their measurement
   c. Experimental error and pattern development in data sets
   d. Interactions between matter and energy

*Student Handout is meant to support this process and guide students through the exploration phase. Teacher is responsible for the scaffolding of content within the Explain Phase.

2. Sounds on Strings

Objective:

Students will be able to change the pitch in vibrating strings. Calculate wavelength and draw conclusions from experimentation.

Engage and Explore

1. Setting up the experiment and initial investigation
   a. Have a model of the set up in front of class.
      i. Fishing line or string is ran the length of a table

ii. Clamp one end with a C-clamp
iii. The other end should hand over the table edge by a pulley (with mass attached
b. Challenge students to explore and discover
i. Find two methods for making the sound of vibrating fishing line change pitch
ii. These two methods include
1. Changing mass – tension in the line
2. Pushing down on the string – length of the line

Explanation, Elaboration and Evaluation

2. Students data collection
a. Students draw the waveforms they find
b. Calculate wavelength
3. Students analyze data and draw conclusions
a. Students explain how they would use this knowledge & skill to make an instrument.
b. What does each method that they discovered do for the sound that it makes?

4. Sounds from Vibrating Air

Objective:

Students learn that sound waves are another example of energy interacting with matter and that they are modeled with transverse waves. Students will be able to calculate and analyze wavelength and frequency using 340 m/s as the velocity. Student will be able to control pitch in vibrating columns of air.

Engage and Explore

1. Students explore and investigate
a. "What are two methods for controlling the pitch by blowing on the straws?"
b. Give students two straws
i. How can they make sound by blowing into one of the straws?
ii. Find two different ways to make different pitches
1. Students should take qualitative data
2. Make a qualitative data table
iii. Facilitator goes over results with the class
iv. Give quick notes on waves in air.
1. Compression wave
a. Modeling of waves the same as transverse waves
2. Showing sound waves in air via computer simulation
a. "Sound" application from PHET (phet.colorado.edu)
b. Give quick notes on the wavelength
i. Speed of sound in air is approx. 340 m/s
ii. Demonstrate how to calculate frequency of the vibrations in the column of air.

Explanation, Elaboration and Evaluation

1. Students draw conclusions based on data
    a. Students are asked to explain how they would use this knowledge and skill to make an instrument and analyze the sound it makes.
    b. Students answer questions from the handout.

*Student Handout is meant to support this process and guide students through the exploration phase. Teacher is responsible for the scaffolding of content within the Explain Phase.

Culminating Activity: The Instrument Invention Challenge – Making the Band edition

Objective:

Students will be able to bring together knowledge and skills of sound in strings and vibrating columns of air to create an instrument.

Students will be able to explain interactions between matter and energy and analyze frequency, wavelength and wave speed of their instruments.

Engage and Explore

1. Student Create a musical instrument
    a. Instrument must produce at least 3 pitches
    b. Instrument is constructed out of recycled materials.
        i. Recycling and repurposing is brought into the creative/inventive process.
    c. Students involve engineering concepts
        i. Draw and sketch prior to building
        ii. Critically think and problem solve
        iii. Use technology to solve novel problems
            1. Drills, saws, clamps, pliers, laptops and screwdrivers
            2. Using computer software to analyze data
    d. Students use scientific knowledge to analyze instruments
        i. A great free-ware that is available for down load is Overtone Analyzer by Sygyt (http://www.sygyt.com/en/overtone-analyzer-editions)
    e. Students develop team skills
        i. Optional- they can work in groups of 2 or 3 (band)
            1. Each person creates a musical instrument
            2. No multiple instruments per band (i.e. no two string instruments)
2. Students analyze their instruments
    a. Using laptops and frequency generating software
        i. Students match 3 frequencies that their instrument made

ii. Take measurements
    1. Calculate wavelength
    2. Wave speed
        a. Instruments with vibrating columns of air can assume 340 m/s
        b. They also can calculate it if they would like

Evaluation

3. Students produce poster boards or PowerPoint
    a. Students explain how their instrument works
    b. Data and calculations as described on handout
    c. Sketches of their instrument and waveform
    d. Students present and play their instrument in front of the class.

*During all activities teacher serves as a facilitator of student learning (i.e. student centered instruction). Most tasks should be completed by students after simple directions, or facilitated questions to enhance student learning.

**Use of student handouts serves as guidelines for students.

Accommodations

All individual accommodations for students should be met with respect to your particular students and classroom dynamics and will vary from class to class and group to group. Facilitator should always differentiate instruction by providing the necessary blend of guidance and exploration for each student group and their specific needs.