SCIENCE CAREER ADVENTURES

Acoustical Engineer: Understanding Sound Waves

NGSS Standard: MS-PS4-2

Adventure Description:

In this adventure, you will think like an acoustical engineer and build a prototype of a sound-proof green room that can be used by musicians who are warming up before they perform.

Activity

Teacher note: You will need two smartphones (we suggest borrowing one from a student). You will also need to download an app ahead of time on your phone. See Handout: Teacher Prep.

Step 1: Background Information on Acoustical Engineers and Sound Waves (5 minutes)

- Show Video: Understanding Sound Waves.
- Show Handout: How Sound Moves. As a class, review how sound moves.
- Next, explain that acoustical engineers have to think about how sound moves when they design a concert hall that has a main stage and a warm up room.
  - Discuss how when you go to a concert, one band usually opens the concert. While the band is opening, the main singer or band is warming up backstage. It is important that the sound from the warm-up room cannot be heard on the main stage. One way that acoustical engineers make sure that the sounds from the warm-up room can't be heard on the main stage is by designing a warm-up room that is sound proof.

Step 2: Teacher Demo (5 minutes)

- Explain to students that you are going to do a quick demonstration to show how loud noise levels are when a room isn't sound proof.
- Show students a shoe box and explain that it will function as a room that isn't sound proof.
- Next, set an alarm on your phone and explain that you will put it in the shoe box. You will then put the lid on the shoe box (as if you were closing the door to the room).
- Next, explain that you will use a noise meter app on your smartphone and read the decibel reading, which will tell us how much sound is transmitted out of the room.

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- Follow these steps to measure noise levels:
  - Make sure class is quiet.
  - Turn the noise meter on and place it on top of the box.
  - Wait for the alarm to go off.
  - Read the decibel reading on the noise meter and record it on the board.

Step 3: Building a Sound-Proof Room (20 minutes)

- Explain to students that they will think like acoustical engineers and design their own sound-proof warm-up room. The goal is to design a room that can get a lower reading than the teacher got when testing a room with no sound proofing.
- Provide students with Handout: Requirements for Building a Sound-Proof Room. Review the steps as a class.
- Divide students into pairs or small groups. Provide groups with the following materials:
  - Small shoe box with lid to represent the room.
  - Materials to line the room such as: Felt, Popsicle sticks, Foam board (Styrofoam), Newspaper, Aluminum foil, Cotton balls, Bubble wrap, Construction paper
  - Glue or tape to hold materials in place
- As students are working, ask the following questions:
  - Why did you choose those materials? (Answers will vary, but students should respond with explanations of why they think each material absorbs sound instead of transmitting it, ideas like the material is thicker or fluffier.)
  - Do you need to line all of the side of the room? (Yes, sound can reflect and bend, so we don't want it coming out of the room from any direction.)

Step 4: Testing Sound-Proof Room (20 Minutes)

- Explain to students that each group will see how sound proof their room is and whether their decibel reading is lower than the reading during the teacher demo.
- Have one group come to the front of the room. All other groups should be silent.
- Turn the phone alarm on and place the phone inside of the shoebox and close lid.
- Turn the noise meter on and place it on top of the sound proof room prototype.
- Read the decibel reading on the noise meter.
- Record the reading on the board with the group's name and repeat process with other groups.

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Step 5: Discussion (5 minutes)

- Discuss the readings that each group received. Have groups compare their prototypes to try to figure out why some prototypes worked better than others.
- As a class, discuss what design and materials differences affected how much sound was absorbed. (Answers will vary but should include which materials absorbed sound the best, the way the materials were arranged in the box, and the way materials were attached to the walls.)
- Extra time? Based on class results, give each group time to improve and retest their prototype, explaining how and why they made changes.

Materials List

Provided online:

- Video: Understanding Sound Waves
- Handout: Teacher Prep
- Handout: How Sound Moves
- Handout: Requirements for Building a Sound-Proof Room

Not Provided online (each student or group needs):

Materials for Class Demo:

- Two smartphones
- Noise meter app downloaded to one smartphone (see Handout: Teacher Prep for suggestions)
- Shoe box with lid

Materials for Student Groups:

- Shoe box with a lid
- Art supplies and building materials (ex: Felt, Popsicle sticks, Foam board (Styrofoam), Newspaper, Aluminum foil, Cotton balls, Bubble wrap, Construction paper)
- Glue or tape to hold materials in place

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