Mathematics: The Language of STEM
Harry's Cupboard I
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CONTENT AND TASK DECISIONS

Grade Level(s): 5

Description of the Task:

Indiana Mathematics Content Standards: 5.M.4 Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths or multiplying the height by the area of the base.

Indiana Mathematics Process Standards: PS.4 Model with Mathematics. Students will use grids to model area(s) and compare areas. PS. 8 Look for and express regularity in repeated reasoning. Students will derive formula for volume of rectangular prism.

Mathematics Content Goals: Students will understand that the volume of a rectangular prism can be found by packing the prism with unit cubes. Further, students will derive a formula for calculating the volume of a prism based on its dimensions.

Language Objectives: Students will verbally define volume using cubes to represent cubic feet. Students will verbally defend their use of the formula for volume.

Materials:
Centimeter grid paper
Centimeter grid paper on card stock
String/material tapes for creating yard tapes
Copy of text: Harry Potter and the Sorcerer's Stone
Centimeter cubes
Rulers

THE LESSON

This lesson is the first of 2 (or 3) to be taught as a unit in which students connect their knowledge/skills of finding area to the concept of finding volumes of complex rectangular prisms (5.M.6). The hook consists of the situation *Harry Potter* finds himself in with the Dursleys. Harry lives in a cupboard (closet) under the stairs in the Dursley's home. Its space is inappropriately small. Dudley (Harry's cousin) by contrast has two bedrooms upstairs. In these lessons, students will revive their understanding of area, compare the areas of Harry's, Dudley's and their own bedrooms. Having evaluated the concept of appropriate space, students will add the height dimension to their rooms and consider volume. After exploring volume of simple rectangular prisms (this lesson) students will consider the volume of Harry's "room." This room, built under the stairs, could be considered as the sum of the volumes of multiple rectangular prisms (next lesson).

Before:

The "before" is review of the 3rd and 4th grade standards related to finding the area of simple and complex rectangles.
Create a conversation concerning the size of Harry Potter's "bedroom" with the Dursley's. Use *Harry Potter and the Sorcerer's Stone* and/or video from the movie.
What would living here be like?
How much space does a person need?
How small is too small?
Can you Justify/quantify?

- **Activate prior knowledge**

  Students draw on centimeter grid paper: Harry's "room" is (may be assumed to be) 4'x 12'. Dudley's room (invented size) is 20'x24'.
  The ensuing conversation:
  "How big is Harry's 'room'?"
  "How big is Dudley's room?"
  "How do the sizes compare?"

  If students don't recall, remind them that area is space in a plane. Rectangular areas can be computed with the formula Area = length x width. Units are "squared."

  To reinforce the concept of area and to further provoke a conversation concerning living space (area, at this point), invite students to create a measuring string to find the area of *their* bedrooms. Use one yard of string per student. Taped ends might prevent unraveling. Students mark one foot increments. Teacher might invite students to use their strings to measure the classroom and create a scale drawing on centimeter grid paper where one foot = one centimeter. It will allow comparison with Harry's and Dudley's rooms.
  As students measure their bedrooms they should also create a scale drawing on centimeter grid paper.
  Students' area drawings can then be compared, sorted, ordered with regard to other students, Harry's or Dudley's room or the classroom.

  As rooms will not necessarily measure to the exact foot, students, for now, will have to round their measurements to the nearest foot.

  As a challenging extension, students could add bedroom furniture and the like to scale in their drawings.

  *****At this point you may launch into the primary lesson, volume, or step aside to teach areas of other shapes: 5.M.3; finding areas of triangles, parallelograms and trapezoids.***

  "We've been considering "space" to be the area of bedrooms. How else might we interpret 'space?' (volume, capacity, considering the height of the rooms…)"

  Invite consideration of the classroom. "How much space is there in here when we consider the

height? How would measure or describe the space?"

Use rulers taped together to build a cube. "How might we use this to measure our room?" Define and explain one cubic foot.

Introduce the centimeter cube. Invite students to consider the centimeter cube as a scale model of a foot cube just as had been done with centimeter grid paper.

- **Be sure the problem is understood**
  Students, working in pairs if number of blocks allow, are to begin stacking centimeter cubes on their classroom drawings to find the volume (number of cubes) of the classroom in cubic feet.

- **Establish clear expectations**

Pairs should stay on task and focus on finding the number of centimeter cubes necessary to construct a model of the classroom.

- "That's a lot of cubes. How are you keeping track?"

- Invite class discussion of classroom volume. Disagreements?

- After groups reach completion/conclusion: invite the building of "walls" with centimeter grids on tag board. These walls can be cut out and taped together with the "floor" to construct a model "3D" room.

- Listen for insights and "shortcuts." A goal will be for students to add height dimension to their Area formula to model mathematically the cube stacking being done. If it's apparent at this point have that discussion and ask for justification.

- Assign students to measure the heights of their bedrooms. During the next day students can find their bedroom's volume by stacking cubes in. Additionally, they should build some scale walls and construct a "3d model to compare with others and the classroom.

Discuss methodology involved. Are there patterns? How can our use of the formula for area lead to greater efficiency? Is there a formula that can lead us to volume based on the three dimensions measured? Test it on other rooms. Verify.

Extend the use of this formula to Dudley's room. Formula first, cubes second. Does formula work?

How does your room compare in volume to the classroom? To others' rooms?

Discuss the merits of the formula V=L x W x H.
Does this always work?
Are there cases where the formula will not work? Explain.

ASSESSMENT

Observe: Students should display with model and formula the volume of their classroom and their bedroom. The student will defend their answer with model and use of formula.

Ask:
How did you find the area of your bedroom?
What problems did you encounter? How did you overcome them?