Mathematics: The Language of STEM
Experimenting with Volume and Mass
Crystal Kreider

CONTENT AND TASK DECISIONS

Grade Level(s): 5th

Description of the Task: Students will use Unifix cubes to build a shape that is the widest, then one that is the tallest and finally a shape that is the heaviest. Students will draw and label the shape, volume and mass of each then draw conclusions about similarities and differences. They will then experiment with their own amount of cubes and, as time allows, explore other extensions with volume and mass.

Indiana Mathematics Content Standards: 5.M.5: Apply the formulas $V = l \times w \times h$ and $V = B \times h$ for right rectangular prisms to find volumes of right rectangular prisms with whole number edge lengths to solve real-world problems and other mathematical problems.

Indiana Science Content Standards: 5.PS.1 Describe and measure the volume and mass of a sample of a given material.

Indiana Mathematics Process Standards: PS.4: Model with mathematics.

Mathematics Content Goals: Students will represent their understanding of volume by building several structures to represent the same given volume.

Language Objectives: Articulate the representation of volume by using academic vocabulary. Students will be given the words volume and mass at the beginning of the lesson and these words will also be written on the board in the objective. Higher-level EL students will be expected to talk about the volume and mass of their shape using the words greater than, less than and equal to. Lower-level EL students may need the support of the sentence frame: "My shape had a volume of _____ (___cm^3) which was _____ (greater than/less than/equal to) the mass of _____ (___ grams)."

Materials: NASA video, Unifix cubes (1 cube = 1 cubic centimeter = 1 gram), experiment sheets, exit tickets, liquid measuring tools for possible extension on experiment sheet as time allows

THE LESSON

Before (10 minutes)
- **Activate prior knowledge**
  - NASA Space station video: https://www.youtube.com/watch?v=lohpORgOKVU
  - What did the video tell you about volume and mass/what did you already know? (Make a list on the board.)
  - How do you calculate volume?
  - What is volume? (Volume is the amount of space something takes up. The formula we use is LxWxH)
  - What is mass? (Mass is a measurement of the matter in an object. It can be measured on earth using a scale.)
  - Turn and talk – What, if anything, do mass and volume have in common?
- **Be sure the problem is understood**

- o   Today we will experiment with mass and volume. Your goal is to model volume and measure the mass of the shapes that you build. You will then draw conclusions and ask questions based on this information.
  - o   Show and describe recording sheet. (See the bottom of the page.)
  - o   Demonstrate how to use and tare the scale.
- **Establish clear expectations**
  - o   You will work with a partner
  - o   Remember our math expectations (established at the beginning of the year)
  - o   You will have x amount of minutes to complete this experiment
  - o   Take your time! I'm more concerned about your understandings and what inferences you can make from your data than that you are the first one finished. If you are the first to finish, it tells me that you probably did not give your brain a nerdy math and science workout today. How sad!
  - o   Record your thinking and any I wonders that you have. If you have extra time, you may experiment with some of your wonders.

During (20 minutes) This phase of the lesson should be designed for students to explore the focus task. Describe specifically what the students will be doing in this phase. Include a description of how the students will record their mathematical thinking in writing or drawing throughout the investigation. Describe how you will accomplish each of the following in this phase of the lesson:
- **Let go**
  - o   Allow students to struggle through the process and work to solve their own problems with their partner
  - o   Walk around and make sure they are at least on the right track and focused on their experiment
- **Listen actively**
  - o   Walk around and monitor conversations. Listen for and ask questions/lead students to correct misunderstandings
  - o   Provide scaffolding for ELs and students with misconceptions as needed. (Walk around with a small whiteboard, marker and my own Unifix cubes to help as needed.)
- **Provide appropriate support**
  - o   Prove to me that your shape is the tallest/widest/heaviest
  - o   How did you come up with a mass that was different than your volume?
  - o   Why is your mass the same as your volume on each of these tasks?
- **Provide worthwhile extensions**.
  - o   Allow students to explore their "I wonder" questions
  - o   Provide liquid measurement tools to allow students to explore the volume and mass relationships with liquid measurements
  - o   Ask students to build 2 different shapes and describe the mass and volume of each. Have them put them together in a different way then predict and check if the mass and volume have changed.

After (15 minutes)
- **Promote a mathematical community of learners**
  - o   Partner groups together to describe and share thinking. Have them discuss their findings and wonderings.
  - o   Listen for groups who have good thinking but may have incorrect understandings and have them share out with the class.
- **Listen actively without evaluation**
  - o   Let the group(s) share and have students listen to their findings and then comment. They will share what they agree with and disagree with and ask questions.
  - o   Facilitate the conversation if needed but allow the students to feed off of each other's ideas.
- **Make connections**

- o Do you think that mass and volume will always be the same?
  - o Why were they the same this time?
  - o What if you had different manipulatives? How would the experiment change?
  - o How is what we discovered today the same and different from what the crew aboard the ISS told us in the video?
- **Summarize main ideas**
  - o Volume is the amount of space something takes up. The formula we use is LxWxH
  - o Mass is a measurement of the amount of matter in an object. It can be measured on earth using a scale.
  - o Volume and mass can be related to each other, especially when using the same objects to create different shapes. Our Unifix cubes each weighed 1 gram. and were 1 cm^3 so the volume and mass were the same!
  - o No matter the shape, if you use the same amount of cubes to make it, the volume will be the same.

ASSESSMENT (10 minutes)

Observe: As students are working I will formatively assess their progress, asking leading questions as needed to help them arrive at the understanding that the volume and mass of their shape stays the same even though the shape itself may differ because they are using the same tools for each task. At the end of class, I will give the students an exit tickets to complete.

Ask:

- Based on the experiments you completed today, what do you know about the relationship between volume and mass?

- Mrs. Kreider wants to buy a fridge for the classroom. She looks at several options and decides that the fridge with the dimensions of 24" by 24" by 36" will be large enough but will also weigh less than the fridge with the dimensions of 20" by 20" by 18". Is Mrs. Kreider's conclusion reasonable? How do you know?

Mathematician: Date:

Volume and Mass Experiments

Using the Unifix cubes you were given, build shapes that have the following volume. Record your thinking in the boxes below. Remember that good mathematicians and scientists are always asking questions! If you come across something that you wonder about, ask a question on the bottom.

Important information! Make sure your scale reads "0" before setting your shape on it!

Amount of cubes: 24	What did it look like? (Make sure to add labels with dimensions)	Volume	Mass
Build the tallest shape you can using 24 cubes			
Build the heaviest shape you can with 24 cubes			
Build the widest shape you can using 24 cubes			

What did you notice about the mass and volume of the shapes?

_____

_____

_____

_____

_____

What did you wonder?
I wonder..._____

_____

Now try your own!

Amount of cubes: __	What did it look like? (Make sure to add labels with dimensions)	Volume	Mass
Build the _____ _____ _____			
Build the _____ _____ _____			
Build the _____ _____ _____			

What did you notice about the mass and volume of the shapes?

_____

_____

_____

_____

_____

Did you notice any similarities or differences between the first experiment and the second experiment?

_____

_____

_____

What did you wonder?
I wonder..._____

_____

_____

Mathematician: Date:

Exit Ticket

Based on the experiments you completed today, what do you know about the relationship between volume and mass?

_____

_____

_____

_____

Mrs. Kreider wants to buy a fridge for the classroom. She looks at several options and decides that the fridge with the dimensions of 24" by 24" by 36" will be large enough but will also weigh less than the fridge with the dimensions of 20" by 20" by 18". Is Mrs. Kreider's conclusion reasonable? How do you know?

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