Talk Science

Professional Development

Transcript for Grade 4 Scientist Case: The Liquid Materials Investigations

1. The Liquid Materials Investigations, Through the Eyes of a Scientist

Notes

We met Dr. Linda Grisham in her office at Massachusetts Bay Community College and asked her to do some of the very same investigations the students do in the *Liquid Materials* section of the 4th grade curriculum. For example, your students compare and measure volumes of mineral oil and water.

In these videos, Dr. Grisham focuses on the core science concept volume. She also talks about material, density, and weight. You'll see her talk and think about volume as a three dimensional measure. She uses a graduated cylinder to measure liquid volumes in cubic centimeters or milliliters. Cubic centimeters and milliliters are equivalent measures – that is, one cubic centimeter takes up are exactly the same amount of space as one milliliter.

Linda has grappled with the challenges of measuring liquid volumes throughout her professional life as a pharmacologist and science educator. She stresses the need to know exact volumes and she's careful to point out the many ways that error can be introduced into her measurements. Your students have to grapple with volume measures as well. It can take a lot of time and practice to develop this understanding. Knowing how a scientist thinks about these activities will help you support your students as they compare and measure liquid volumes.

2. How Does a Scientist Think about the Comparing Volumes Investigation?

<u>Text on Screen</u>

Watch How

Linda thinks about avoiding sources of error as she uses a standard measure – cubic centimeters – to calibrate a measuring cup.

Sara: I have three odd shapes [containers] and they all have water in them.

Linda: You're going to put me to the test.

Sara: I'm wondering if you could compare the volume of water in those three containers.

Notes

Linda: I guess what I'm trying to do is, I'm trying to imagine this volume of water in the other vessels. That's what my strategy is when I'm thinking about this, because I'm thinking about there's a certain amount of water here; where would that wind up if I put it in the bowl? I'm really trying to visualize the space. It could be very close. What's missing here is, in this one that's very shallow, how to compare it to these ones in cylinders. I'm trying to see how I can visualize it as a cylinder. I think these two [pointing to the two cylinders] are close. I guess I'm going to say this is the smallest. This has the most water, this the next, and the least amount of water.

Linda: Moment of truth here. [Pouring water from the small cylinder into a large glass.] This is your original water. This is the water from the small jar. They're actually the same. And can I use that glass? They're probably all the same. [Pouring water from the large bowl into an identical large glass.] Yep. So I'm wrong.

Text on Screen

Summary

- The liquid volume is the amount of 3-dimensional space the material takes up.
- A standard-sized container makes it easier to compare volumes.

3. How Does a Scientist Think about the Measuring Cup Activity?

Text on Screen

Watch How

Linda thinks about avoiding sources of error as she uses a standard measure – cubic centimeters – to calibrate a measuring cup.

Sara: This is the make your own measuring cup experiment.

Linda: This is my little box. And each one of these is a cubic centimeter, which means it's a milliliter. Let's see how many, how many it takes to fill it up. All right, so there's 1,2,3,4,5 [counting cubes along the length of the box]….1,2,3,4 [counting cubes along the width of the box], so there's 20 [multiplying 5x4] of them here. I filled the box with 20, but not quite to the top, so I need to make a mark on here. It's always interesting to do this. How careful do you want to be? Because, obviously, you're introducing errors if you're not doing this very carefully.

OK, so this is 20. That's 20 cubic centimeters.

Linda: This is where you can have some error [pouring every last drop from the box to the cylinder]. 20 centimeters.

Linda: You can see how you can introduce errors [marking the surface of 20 cubic centimeters]. Depending on how good your eyes are. That's actually the reason I'm doing it [marking the surface] on a couple of sides.

Sara: You're making three measurements. You can use the average.

Linda: This is my own personal one. But if other people were going to use it, I'd have to put some numbers on it. And also tell them the units that I'm using. Because it's not 20 ounces, fluid ounces, it's 20 cubic centimeters, or 20 milliliters.

Linda: 120 milliliters of volume is marked out.

Linda: It's very important to at least be certain about the amount of materials that you're working with. I'm sure it could be done better, a little bit more precise. I'm not quite sure when I look at this that all the....these should all be equal spaces and I can sort of see already that they're not exactly equal marks, so I've introduced error in here. So if I were to do this again, I would try to be a lot more careful.

<u>Text on Screen</u>

Summary

Each 20 cubic centimeters of water takes up the same amount of space as 20 centimeter cubes.

4. How Does a Scientist Think About Volume Measurement?

<u>Text on Screen</u>

Watch How

Linda thinks about how the 1-dimensional scale on the measuring cup can be used to measure 3-dimensional volumes of liquid.

Sara: Which of these two containers has a greater volume of water?

Linda: This one. It's not exactly twice, but it's almost twice as much.

Sara: Now you've made your own measuring cup. So, now, can you find out exactly how much.

Linda: So this one is 40 milliliters. That one has to be 20, 40, 60, and then 70. So this is 70 milliliters.

Notes

Sara: You are using a vertical, one-dimensional scale to make that measurement. You were not actually looking at how much it filled the...

Linda: No, no. They have the same diameter, so the height is going to tell you. I mean it's going to be the measure of the volume.

In a way it's confirming that. [Pouring the water into the measuring cup.] There may have been some hidden spaces in here. Or, maybe this is a little narrower than I thought. So, again, this is 70 milliliters.

Text on Screen

Summary

The measuring cup can be used to compare liquid volumes with accuracy.

5. How Does a Scientist Think About the Relationship Between Weight and Volume?

Text on Screen

Listen to How

Linda explains why chocolate syrup is heavier for its size than water.

Linda: So, this one, it's forty milliliters. Obviously the container has a weight. So…you're twenty-four [weighing the container]. You are sixty-four [weighing the container with 40 cc's of water], so the difference is forty. So it's forty grams.

Sara: It's forty grams and it's forty cubic centimeters, or forty milliliters. So, what's the difference between weight and volume?

Linda: There is a difference between weight and volume. It's just that we're using water as the standard. If I were to use chocolate syrup, if I filled this container to forty milliliters, it would have a different mass. This would weigh a lot more because of the density. There's more material in the same space if I were using chocolate syrup instead of water. It's just that in the metric system, it's set up so that whatever this weighs – a cubic centimeter of water –we're going to call that one gram; one gram mass.

Text on Screen

Summary

- In the metric system, 1 cubic centimeter of water has a mass (or weight) of 1 gram, by definition.
- The relationship between weight and volume is a property of a material; it has the same value, no matter how big the sample.

Notes