# Talk Science

Professional Development

## Transcript for Grade 4 Scientist Case: The Mineral Materials Investigations

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### *1. The Mineral Materials Investigations, Through the Eyes of a Scientist*

We met Professor Roger Tobin in his laboratory at Tufts University and asked him to do some of the very same investigations the students do in the *Mineral Materials* section of the 4th grade Inquiry Project curriculum.

Your students estimate, measure, and compare the volume of irregularly shaped rocks. It's hard to estimate how much three-dimensional space something takes up and it's not always easy to measure or calculate it. What does it take to develop an understanding of volume and its measurement?

In this scientist case, Roger focuses on volume, a core science concept. He talks and thinks out loud about volume as a three-dimensional measure. You'll also hear him talk about material, density, and weight. In everyday life, we think about the amount of 3-dimensional space things take up all the time, e.g., when we decide which suitcase we need to pack our clothes or how big a canister we need to store some flour. Scientists also think about the volume of things. Those things may be as large as the polar ice cap, or as small as nanofibers. Scientists need to know the volume of an object to find important material properties, such as density.

A challenge for both students and scientists is to devise strategies to estimate and measure volume, and to understand how accurate estimates and measurements are. Like your students, Roger uses the method of water displacement to compare the volume of irregularly shaped rocks. You'll hear how he thinks about what happens to the water during displacement, and how he talks about liquid displacement and solid volume. The better you understand how a scientist thinks about volume and volume measurement, the better you'll be able to support your students as they learn about volume.

### *2. How Does a Scientist Estimate Relative Volume?*

Text on Screen

**Notice**

The strategy Roger uses to estimate which volume is greatest.

Sara: Say that you wanted to compare the volume of these three candles [short, medium, and tall], how would you go about doing that? Which do you think is biggest?

**Notes**

Roger: I have poor intuitive judgment of volume as volume, so what I'm doing in my mind is I'm breaking it down into the dimensions of the object. So I'm looking at these two [compares medium and tall candles] at their ends to remove thinking about the length for the moment and just see how do the areas relate. And they look to me like they're not too terribly different. But the white one [the tall candle] is almost twice as long. More than twice as long. So, of these two, I'm going to go with this one [the tall candle].

Sara: So even though this one [the medium candle] takes up more space on the table, you think this one [the tall candle] has a larger volume.

Roger: That's what I think.

Sara: What about this one? [the short candle]

Roger: Now this one gets tough, because it's a lot shorter – a whole lot shorter – but it's also quite a lot larger in diameter. I think we tend to underestimate how important the diameter effect is. It's not just bigger across, it's also bigger the other way so the area's quite a lot bigger.

Looking at this I guess it would say, [counting how many lengths of the short candle equal the length of the long candle] 1,2,3,4,5,6 …so this [the long candle] is maybe six times bigger in height than this [the short candle] is. Then I would ask myself the question, is it six times smaller in area? So I'm holding this one here [puts the base of the long candle on the wider base of the short candle] to try to say, how many of these do I think I could fit? And I guess I feel like maybe only about four. So, I'm still going to go with this one [the long candle] though I'm not that sure about it.

Sara: Could you use their weights to compare their volumes?

Roger: Yes. But it only works if I can assume that these are made of more or less the same material so that they have the same density: the same amount of weight for every unit of volume.

[Weighing the short candle] About 36 grams.

[Weighing the long candle] Let's put this one on. I was wrong.

Sara: How much does that weigh?

Roger: 29 grams.

Text on Screen

**Summary**

When Roger estimates an object's volume, he thinks about the amount of 3-dimensional space it takes up. He thinks about both the 2-dimensional area of the base and the 3rd dimension: height.

## *3. How Does a Scientist Explain What Causes the Water Level to Rise?*

Text on Screen

**Watch**

How Roger explains why volume, not weight, causes the water level to rise.

Sara: Presumably a larger rock, that has a greater volume, also weighs more. Is it weight or volume that's pushing the water out?

Roger: Almost all rocks have the same density, except for a few. So it's tough to do the experiment with rocks. You can't really tell. But we have these handy dandy cubes. I know they have the same volume, because they have the same dimensions, they take up the same amount of space. But they have quite different weights. This one [the copper cube] weighs four times as much as this [the aluminum cube]. So if it were the weight that made the water get out of the way, then this one should displace a whole lot more water than this one.

And they're the same.

So that's an experiment. Then the theoretical question is why should that be true? And to me the answer is that the reason the water rises is because you've got space there that's occupied by the rock or the cube. And if it's occupied by the cube, it's not occupied by the water so the water has to go somewhere else. But that just depends on the space.

Text on Screen

**Summary**

- If a solid is submerged in a liquid, the liquid cannot occupy the same space as the solid.
- Equal volume cubes cause the water level to rise the same amount, no matter how much they weigh.

**Notes**

## *4. How Does a Scientist Think About The Method of Water Displacement to Compare Volumes?*

Text on Screen

**Watch**

How Roger explains why water level rise is a measure of volume.

Sara: Which of those do you think is bigger --- or has a greater volume?

[Roger is holding a pink piece of granite and a black piece of basalt.]

Roger: Right. The black one has a bigger area, looking at it sideways, face on, and the granite – the pink one, whatever it is—is thicker. So which one of these is going to win? I always guess wrong, so my guess was going to be this would win because it is thicker [holding up the pink granite], but I'm almost always wrong about that, so I'm going to go with the black one this time.

Sara: OK

Roger: I'll probably be wrong again. [He places the rocks in containers with equal amounts of water, and then compares the water levels.] Wrong again! This time the granite wins.

Sara: And how can you tell?

Roger: Because the water level is higher. So, it has displaced more water, pushed more water out of the way. That means it must be taking up more space.

Sara: Could you explain why that's a way to compare volume?

Roger: The rocks don't soak up water, so when I put the rock into the water, the water has to go somewhere. If the rock is in there, the water has to be somewhere else. A certain amount of space in there is taken up by rock, and it's not taken up by water. And since the water hasn't been destroyed, all it could have done is move somewhere else. So the amount that the water has risen is a measure of how much water has been pushed out of the way by the rock. And the bigger the rock, the more water is pushed out of the way.

Sara: This is often called the method of water displacement to determine volume. What does displacement mean in this case?

Roger: To me, displacement means pushing the water out of the way. Displaced water is water that has been pushed out of the way and has to find a new place to be. So when I put the clay or the copper into the container, it takes up space that is no longer available to the water, so the water is displaced – has to move some place else.

**Notes**

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Text on Screen

**Summary**

- The total volume occupied by the submerged solid and liquid together is exactly equal to the volume of the solid plus the volume of the liquid.

- When immersed, a solid displaces a liquid volume equal to the solid volume.

## *5. How Does a Scientist Think About Volume Measurement?*

Text on Screen

**Listen to How**

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

Sara: You compared these two stones and found that this one is a little bit bigger than this. But could you find out exactly how much bigger?

Roger: I'm always leery of the word exactly. You can't determine anything exactly. You may be able to determine things to some level of accuracy. So, using these things [centimeter cubes] I can probably determine within a cubic centimeter what the difference is.

We can try to figure out how much more space by adding cubic centimeter blocks to this one until they're equal. With each one, the water level is rising a little bit. I just added three, and it's pretty close. I think now the black one is a little bit higher. I'm going to say three and a half.

Text on Screen

**Summary**

- *Volumes can be measured in cubic centimeters.*

- *Using 1 cc cubes, you can only determine the volume to within 1 cubic centimeter.*