How Slime Can Help Students Make Sense of Volume

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Abstract: *In this practioner-based article, the authors discuss the use of slime in a middle school mathematics lesson to teach volume. Lesson questions and sample student work are shared with possible modifications to teach other grade levels. Helpful hints to future use of this activity in the classroom are also discussed.*

Keywords: *geometry, volume, manipulatives, hands-on learning*

Introduction

Background and Context

For decades, kids have enjoyed slime in one form or another. Slime originated in 1976 as a commercially available toy product and has evolved into a popular art project for homes and schools. Slime is a sticky, squishy substance that many teachers shy away from using, but it can be used to add experiential learning to mathematics topics, such as in geometry. Engaging materials can create appealing lessons, which students can easily relate academic knowledge to previous knowledge. Giving students opportunities to use unconventional materials to problem solve can increase their engagement with the material and retention of the concepts. In this article, we discuss the use of slime in a college geometry course for current and future secondary mathematics teachers with extensions for elementary and middle school levels.

Alignment to Common Core Standards

During a summer geometry class designed to teach future and current math teachers, we decided to focus on two content standards to teach volume; specifically, 8.G.9 (CCSSM, 2010)–"Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems" (p. 56); and G-GMD.3 (CCSSM, 2010)–"Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems [using slime]" (p. 78). This was the first time we (i.e., the course instructors) and the 11 students had ever used slime in the course so it was a learning experience for all.

Getting Started

Making Slime

First, we had students create their own slime. Any basic slime recipe from the internet will do (e.g., `https://www.iheartnaptime.net/homemade-slime/`). Pre-made slime can be purchased online and in many stores as can kits for making slime. Specifically, our class utilized a recipe involving white glue, baking soda, and contact lens solution in Styrofoam bowls with plastic spoons.

Although many slime recipes call for borax (i.e., sodium borate, sodium tetraborate, or disodium tetra borate), it is not needed to make slime for this activity. Students may also want to add food coloring to personalize their slime even more but be careful about staining clothes in the process.

Through trial and error, we found that newly made slime does not keep its shape for very long so we let the slime sit out for a few hours before using it for this activity to give it more of a shape. You may want to experiment with various slime recipes and consistencies until you find one that yields slime with the firmness you prefer. If slime seems too messy for you, Play-Doh could also be used. The students in our course really enjoyed being able to easily make the slime (and take it home in plastic bags afterwards) because it provided them with a greater sense of ownership of the activity. Since Play-Doh recipes typically require cooking in an oven for at least 20 minutes, and slime takes only a few minutes to make, we encourage trying out the activity with slime if you feel your class will be responsible enough with it. For our class, we let the slime sit for a few hours until it began to firm up in consistency, then the students utilized plastic GeoModel relational solids to investigate the tasks below.

Prerequisites

Prior to these tasks, students learned the measurement concepts of circumference, surface area, and volume. The slime activity was utilized as a standards-based activity (NCTM, 2000), where students were provoked to extend their knowledge of the idea of volume in a more creative context than through typical calculating volume problems. We gave groups of 2-4 students a set of plastic GeoModel relational solids. GeoModel relational solids include various three-dimensional plastic figures (e.g., cylinder, triangular pyramid) that can be used for geometric explorations. Students specifically used the plastic cube and cylinder for Tasks 1-3 (See Appendix for the full activity).

Activity Details

Task 1: Volume of a Cube

For Task 1, students were instructed to completely fill their cube with slime (See Figure 1).

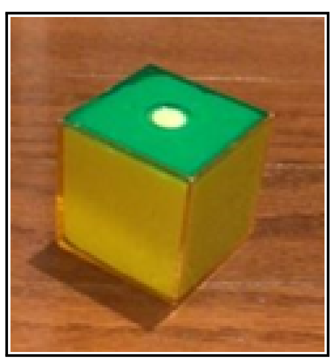

Figure 1: *Cube filled with slime.*

Using the radius measurement in centimeters, students were then asked to predict how big a ball of slime they felt they could make with the slime inside the cube. As can be seen from the full activity, how students were to measure the slime was left up to them. This ambiguity led to students often debating their answers with one another. We encouraged this dialogue because it led to interesting discussions as to what students thought was important when measuring the slime and what answers they could arrive at based on their investigations. All students eventually arrived at successful strategies. When teaching this lesson, instructors could help lead whole class discussions about what students might think will work, and students could discuss as a class before engaging in the activity. The biggest debate in our class involved whether to measure the slime using circumference of a circle or volume of a sphere. After students calculated initial sizes for how big (in cm) a ball of slime they believed they could make, students were instructed to check their answers by creating their very own ball out of the slime from Figure 1 (See Figure 2).

Figure 2: *Slime ball created from slime in Figure 1.*

All students were easily able to calculate the volume of the 5 cm cubes to be 125 cubic centimeters by measuring the dimensions of the cube with a ruler and utilizing their knowledge of the volume formula for a cube. After calculating the volume of the cube, most students then used the volume of a sphere formula to find the radius of the ball of slime they made (See Figure 3). All students calculated answers around 3 cm. There were some minor variations in answers due to rounding differences, as well as technique (using the volume formula for a sphere versus using the circumference formula).

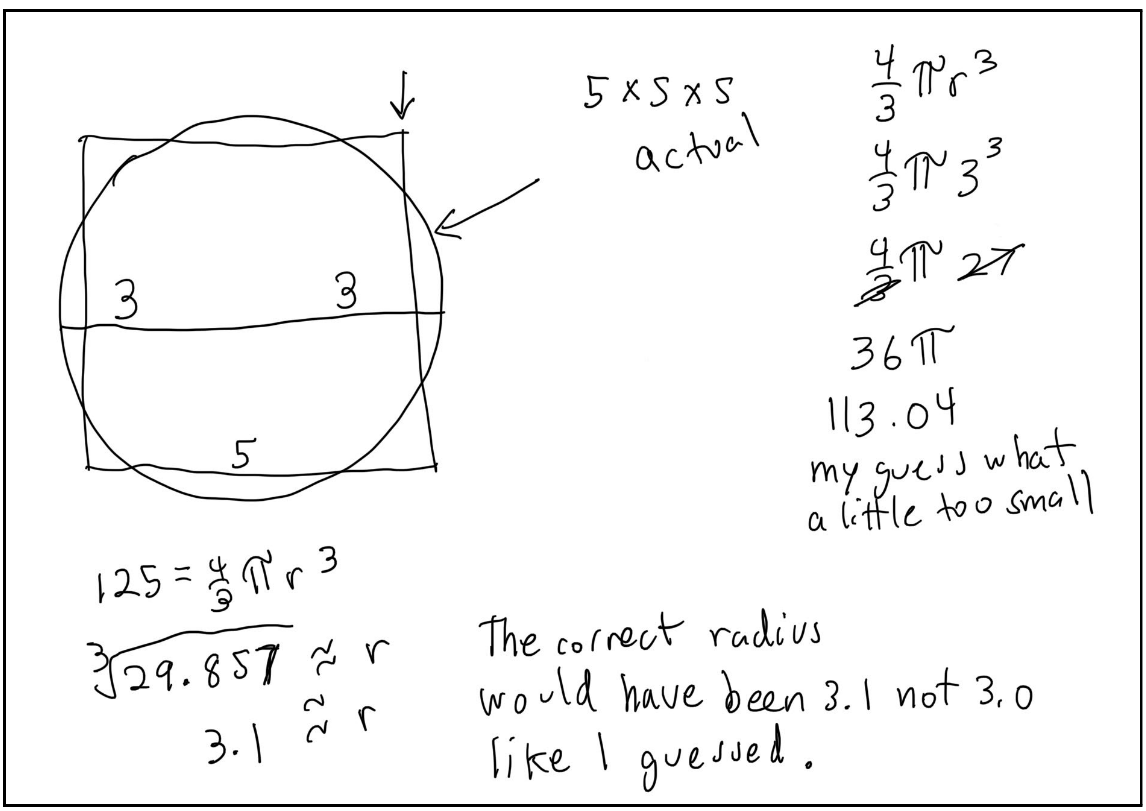

Figure 3: *Sample student work measuring the size of a sphere.*

Unlike most students who used the sphere formula, one student decided to use her knowledge of circumference to determine the radius of the sphere. In class, we had previously discussed the concept of circumference of a circle and its formula by measuring the length of the diameter of a circle using string and then measuring how many times the string went around the circle to derive the formula for circumference of a circle. The student then decided to utilize the concept of circumference and wrapping the sphere with string to substitute into the circumference formula (See Figure 4).

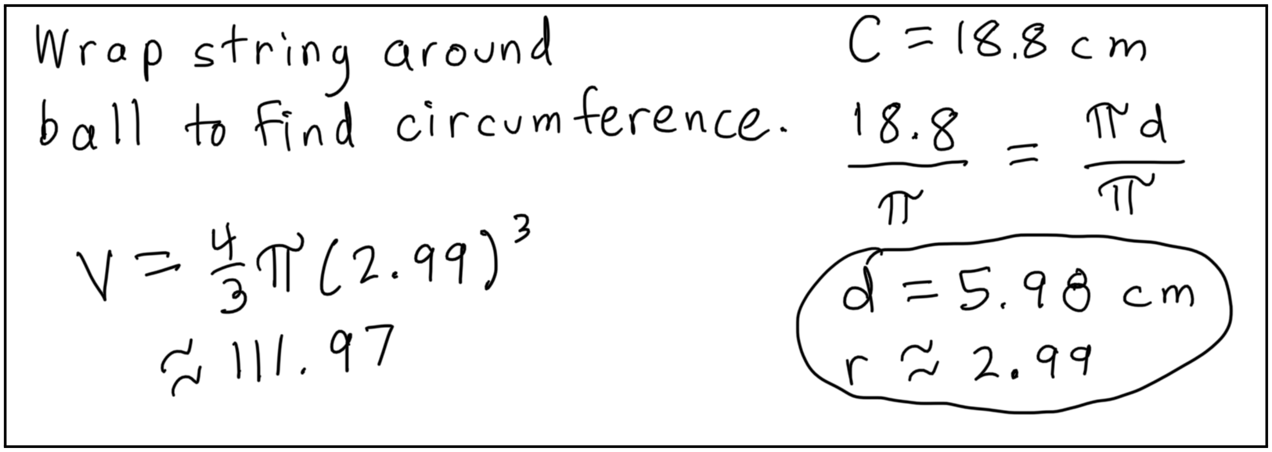

Figure 4: *Sample student work using circumference.*

Task 2: Volume of a Cylinder

For the second activity, we asked students to completely fill a cylinder with slime (See Figure 5).

Figure 5: *Cylinder filled with slime.*

Students again utilized their understanding of volume formulas, specifically the volume of a cylinder, to predict the biggest radius (in cm) and then calculate the size of the sphere they could potentially create with the slime (See Figure 6). Like Task 1, the sphere the students could make had a radius of approximately 3 cm. Most students correctly calculated the ball's radius to be around 3 cm. A few groups incorrectly wrote the cylinder formula by including a $\frac{2}{3}$ instead of $\frac{4}{3}$ as part of their formula, so their resulting answers were incorrect.

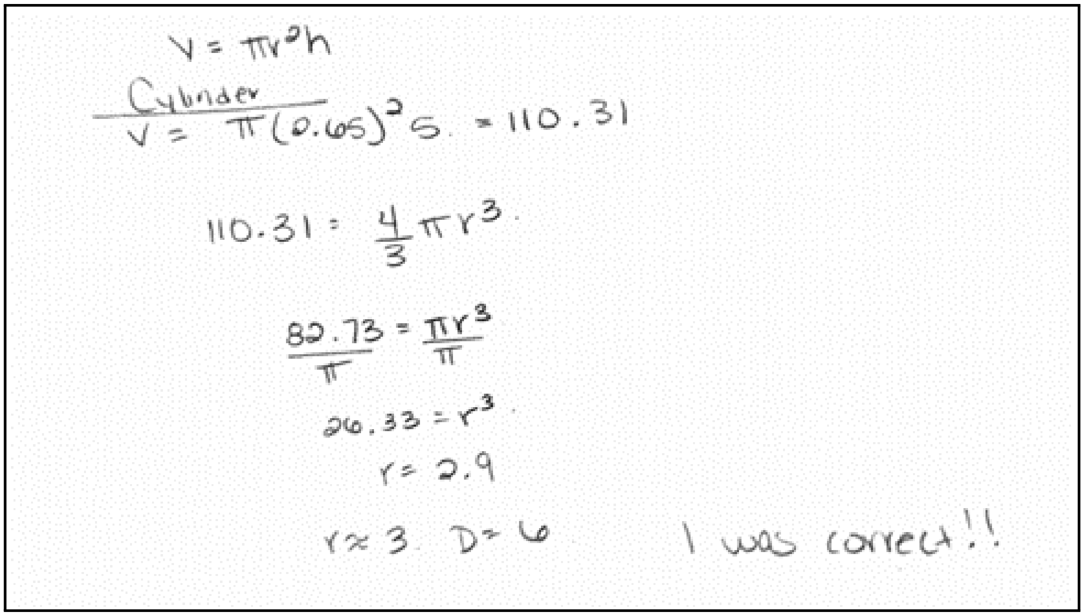

Figure 6: *Sample student work calculating the radius of the slime ball.*

Task 3: Extension Activity

As an extension activity, and in order to increase students' exposure to inquiry based learning, students paired up and shared their slime from each activity. Now, they had double the amount of slime! Students worked together to predict how big a ball of slime they could make from each of the two tasks. This task was difficult for students to complete. Most felt the radius would double, which is inaccurate (See Figure 7 for solution).

$$V = \frac{4}{3}\pi {r_1}^3 \quad (original\ sphere)$$

$$2V = \frac{4}{3}\pi {r_2}^3 \ (new\ sphere\ with\ double\ the\ volume\ as\ the\ original\ sphere)$$

$$2\left(\frac{4}{3}\pi {r_1}^3\right) = \frac{4}{3}\pi {r_2}^3 \ (Substitution)$$

$$2\left(\frac{4}{3}\pi {r_1}^3\right) = \frac{4}{3}\pi {r_2}^3$$

$$2({r_1}^3) = {r_2}^3$$

$$2^{\frac{1}{3}} r_1 = r_2$$

Figure 7: *Solution to Task 3*

If given in class, the teacher could scaffold Task 3 with a discussion about the volume formulas, what variable is doubling, and what impact doubling the volume would have on the radius of the sphere. Once these ideas are understood, this same line of reasoning could be utilized for tripling (or any other scale factor) the volume for more interesting and engaging class discussions. An additional line of reasoning for student discussion could include determining the number of cylinders of slime students would need to double the radius of the resulting sphere.

Conclusion

There are numerous ways to use slime in the mathematics classroom. A basic elementary activity could include measuring the length of slime a student or class created and then comparing similar data among students and classes. An elementary or middle school teacher could have students work in groups to see how much time (in seconds) it takes students to make certain slime creations and use the length of time data for statistical lessons, such as predictions, data representations of the length of time values, and various measures of central tendency (i.e., mean, median, mode) of the data. Middle school teachers could also recreate the classic derivations of volume formulas, comparing the volume of a cone and cylinder, the volume of a cube and square pyramid, and the volume of a sphere and cylinder, using slime.

Having students work through open-ended and inquiry-based learning activities is a great way to get students to think in different ways, assess their knowledge acquisition, increase their engagement with the material, and retain concepts. We feel the following student reflection sums up the activity best in regards to what we were hoping would be achieved through the tasks:

> I had fun making the slime. I think it was an interesting activity . . . I also think it (the activity) would lead to really good discussions about the different problem solving strategies students used. So often in math, it seems that students believe there is only one way to solve a problem and I like doing activities with them where they can be creative and where they are exposed to multiple solving methods.

In mathematics, certain concepts are commonly reduced to procedurally-driven worksheets and formulas. Creating and utilizing activities like this one can produce fun, engaging class discussions. Through these class discussions and inquiry-based learning activities, students will deepen their knowledge and learning.

References

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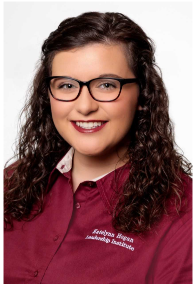

Katelynn Massey is currently teaching 7th grade in Texas. She is an alumna and current graduate student at Texas Woman's University. She likes to focus her passions on helping teachers create meaningful and engaging lesson plans for students. Her past research includes experimental learning for preservice teachers, ESL learners, and the importance of using data to drive instruction.

Appendix

1. Fill the given cube with slime. Use the volume of the cube to approximate the radius (in cm) of the biggest ball you can make with the slime you used. How big a ball could you make from that slime?
2. Check your answer from #1 by creating the ball of slime. Were you correct? Explain. Make sure to create a google account or sign into your existing account
3. Let's try it again! Fill the given cylinder with slime. Use the volume of the cylinder to approximate the radius (in cm) of the biggest ball you can make with the slime you used. How big a ball could you make from that slime?
4. Check your answer from #3 by creating the ball of slime. Were you correct? Explain.
5. Extension: You and a classmate decide to share your slime from the above two activities. Now, you have double the amount of slime! What is the biggest ball of slime (in cm) do you think you can make from the cylinder and then the cube?
6. As you finalize your map, add photos to each point of interest by clicking on the point on the map. If you are unable to take photos yourself, using Google Street View can provide an option to add free images that are part of Google Maps.
7. Check your work by doing the math. Were you correct? Explain.