Popcorn Geometry
Lesson Plan

Lesson Overview

Topic	Lesson Information
Lesson Title:	Popcorn Geometry
Lesson Author:	Gayle Willits, Lori Forlizzi, Kim Roush, Ruth Love-Schooley – PSU Career Pathways
Date Created:	October 4, 2020
Lesson Timeframe:	2.5 hours. You can complete the lesson in one class or over a period of two classes, if necessary.
Content Area(s):	Math - Geometry
General Topics/Skills Covered:	Estimation Volume Formulas Calculation
NRS Level(s):	Level 4
Prerequisite Skills:	This lesson is part of the final lessons of our Geometry section. Students will be familiar with cylinders as objects and shapes. They will know the formulas for finding the radius of a circle, the area of a circle, and the diameter of a circle. They will be able to perform calculations using this formula.

Standards and Skills Addressed

Topic	Your Standards and Skills Addressed
College and Career Readiness Standards (CCRS):	• G.GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. • 2.NBT.2 Count within 1000; skip count by fives, tens, and hundreds. • 2.NBT.4 Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons. • 6.EE.2 Write, read, and evaluate expressions in which letters stand for numbers. • A.SSE.1 Interpret expressions that represent a quantity in terms of its context. • K.G.4 Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners"), and other attributes (e.g., having sides of equal length).
English Language Proficiency Standards (ELPS (if applicable):	N/A
Target Grammar/Language Forms (for ESL):	N/A
Standards for Mathematical Practice:	• Make sense of problems and persevere in solving them. • Reason abstractly and quantitatively. • Construct viable arguments and critique the reasoning of others. • Model with mathematics. • Use appropriate tools strategically. • Look for and make use of structure.

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Foundation Skills Framework (Workforce Skills):	Applies mathematical operations, concepts, and reasoning.
Digital Literacy Skills (also see checklist below):	Students will utilize a Zoom environment, including breakout rooms and the chat function, to communicate during the lesson. A video is included for the students to view. Students are also asked to access the Quizizz website and input a code to work on a quiz.
Digital Literacy Skills Checklist:	☐ Are students taught how to find and evaluate online sources? Are they given an opportunity to practice doing so with different topics and for different tasks? ☐ Are sufficient instructions given to students around the use of digital tools, and is sufficient time provided to practice the use of tools? ☐ Do students use digital tools to create and present products (e.g., papers, presentations, graphics)? ☐ Are students provided with an opportunity to select and use appropriate technology to solve problems in class?

Objectives, Materials, Vocabulary, and Culturally Responsive Teaching

Topic	Your Objectives, Materials, Vocabulary, and Culturally Responsive Teaching
Lesson Objective(s):	At the end of this lesson, students will be able to: • Use known measurements to find the volume of different cylinders; • Compare volumes of objects; • Analyze a real-world problem and construct a plan for solving it; • Test the proposed plan and revise if needed; and • Justify their reasoning using data from their formulas/solution plan.
Lesson Objective Tips:	• Check it with SMART. (Is it Specific, Measurable, Achievable, Relevant, and Timely?)
Texts, Materials, Resources (also see checklist below):	• Pencils • Two to four sheets of 8 ½ x 11-inch paper • Tape • Popped popcorn (12-14oz.) • Four paper or other plates of similar size • Volume + formula + chart blank formula (copies in person, can share PDF if remote) • Volume of cylinder worksheet practice (copies in person, can share PDF if remote, or send attached to an email for students to print or copy before class) • Printouts of worksheets (if students have access to a printer at home) or notebook paper/pencil to write formulas and any practice exercises • Calculator to use for practice
Texts, Materials, Resources Checklist:	☐ Are the recommended texts relevant to adult learners, culturally responsive, and useful for building knowledge and achieving the objectives?

Topic	Your Objectives, Materials, Vocabulary, and Culturally Responsive Teaching
Lesson Vocabulary:	Cylinder; volume; circumference; radius; height; two-dimensional shape; three-dimensional shape; sphere; cone; prism; rectangular prism; triangular prism. Have the students get out their notebooks or paper to record any vocabulary they are not familiar with. In my class, I have the students keep a notebook, and I encourage keeping a separate section for vocabulary.
Culturally Responsive Teaching Notes (also see checklist below):	Click or tap here to enter text.
Culturally Responsive Teaching Checklist:	☐ Is it evident that students will connect content to their own lives and to what they already know? ☐ Do the student resources regularly include authors, images, and ideas from a range of racial, cultural, linguistic, gender, and (dis)ability representations and backgrounds, especially those of our students? ☐ Do cultural representations and varied perspectives seem to be fair and accurate? Are stereotypes avoided?

Instructional Activities

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Lesson Introduction: 45 min.	Introduce the lesson objectives and describe how workers in many fields may need to be able to estimate volume and choose containers for liquid or solid matter. For example, laboratory technicians may need to choose a container for experimental materials; chefs may need to plan kitchen equipment to use in preparing recipes for small and large numbers of people; and cleaning and maintenance professionals may need to choose containers to hold liquids or solids needed to complete specific jobs. Note that we have previously discussed area and surface area of two- dimensional shapes. At the end of the previous lesson, we talked about what would happen if we added another dimension. How does that change things? We discussed a basic rectangular box and how we can find how much it holds. Use the above YouTube video to review these concepts and give students a chance to write or rewrite formulas/vocabulary. In this lesson, we have a specific application problem to solve. You need to look at two cylinders and determine which will hold a larger quantity. You have spent the day volunteering to put up flyers for a local park's "drive-in movie night." Since you have helped put up the flyers, you get free admission to the movie and one free container of popcorn. You are very excited because this park is known to sell the best popcorn in town. However, when you get in line at the concession stand, you learn that the vendor is all out of popcorn bags but does have some paper plates. No worries; you have some flyers and tape left. You can use your flyers, tape, and a paper plate to create a container for your popcorn. Show students how two containers for popcorn can be created; in one case using an 8 ½ x 11 sheet to wrap and join at the 8 ½-inch sides and using a second sheet to wrap and join at the 11-inch sides. Cylinders can be taped to plates to finish the popcorn containers. Show students each container.

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	Ask students to discuss and predict (with partners in breakout room) which cylinder will hold more popcorn – short or tall. Everyone should justify their answer. Release students to breakout rooms. Return students to main room and ask each student to state and justify their prediction. Record predictions and justifications. Discuss why they made their choices; try to spark a discussion on the whys, encouraging students to come to a possible conclusion.
Lesson Introduction Tips:	• Explain how the lesson objectives will be shared with learners. • Make connections to learners' goals and prior and future lessons. • After the video, reiterate the differences between 2D and 3D figures; the units in which they are measured; the differences in labeling figures and being flexible; and GED® vs HiSET® formula sheets.
Lesson Body, **Direct Instruction: 15 min.**	Assist students in creating both cylinders on their own at home. Once the cylinders are completed, ask them to fill both containers with popcorn. Then, have them dump out the contents of each cylinder onto two fresh paper plates, keeping the piles separate. Students count and record the number of kernels from each of their containers. Students see the "short" container holds more kernels.
Lesson Body, **Guided Practice: 15 min.**	Ask students to discuss the factors that might determine volume and why the volume of the "short" container was larger. Ensure that all students recognize that the radius drives the size of the volume. Have students calculate the volume of the two cylinders using the formula. Students will write about what changes they could make to the

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	cylinder dimensions to increase the amount of popcorn it could hold. They should prove their prediction by drawing a model and completing a calculation.
Lesson Body, Independent Practice: 30 min.	Have students practice calculating volume of cylinders, specifically with different heights, radii, and diameters, with the attached worksheet. Remind students that they must convert diameter to radius, in the questions that only provide the diameter, by dividing it by 2 because the formula calls for the radius. Allow the students about 10 to 15 minutes to work individually. I use the chat feature when teaching remotely. Have students share answers privately or ask questions and then go over each question individually or only ones that students answered in correctly or had difficulties with. If in- person, I may have students volunteer to share questions on the board or have the answers available for students to check and go over only the ones they answered incorrectly or had difficulties with. After we are done with this practice, we may discuss again any observations they have about the volume of a cylinder.
Lesson Body Tips:	• Provide enough detail that another instructor could teach this lesson based on the information in this lesson plan. • Include how the students will be grouped, approximate timeframes for each activity, and how technology will be integrated. • Describe where in the lesson sequence, and how, the instructor will model the target skills and/or tasks for the learners.
Differentiation (also see checklist below):	Click or tap here to enter text.
Differentiation Checklist:	☐ Are teachers cued to adapt instruction for their specific learners?

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	☐ Are there adequate supports to help teachers differentiate instruction to meet the needs of individual learners, including English learners and those with learning disabilities (e.g., texts at different levels, broad topics or compelling tasks that allow teacher/student flexibility)? ☐ What kinds of choices are students able to make within the lesson plan (e.g., text selection, project topics or products)?
Assessment: 20 min.	Have students do the following Quizizz to assess their knowledge. I prefer to do the guided quiz in class, but you can also assign it for homework if you run out of time. You could also create your own quiz, if you prefer to do that, and use it here to assess the students' knowledge. I like the Quizizz website because it allows me to be more flexible with students while working remotely, and it is easy to use. https://quizizz.com/admin/quiz/5e9e23a6aa0448001c5a7b81/volume-of-a-cylinder-practice
Assessment Tips:	• Describe the ongoing assessments that will be used to check learners' progress toward the lesson objectives. • Describe the cumulative assessments that will measure the extent to which learners met the lesson objectives.
Lesson Conclusion: 20 min.	Instructor closes the lesson by reviewing the objectives, again discussing the different dimensions of the cylinder and how they affect how much the cylinder can hold. How does this connect to other three-dimensional shapes like a sphere or cone? Do you have predictions about what the volume formulas for these shapes would be? Could they be related to any of the formulas we learned about today? Have the students share any ideas about those shapes in the chat.

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Lesson Conclusion Tips:	• Review lesson objectives. • Provide an opportunity for student reflection. • Connect to prior and future learning.
Lesson Extension, Homework:	Provide a sheet of problems in three workplace contexts where a worker must decide between two containers by ascertaining which container has the correct volume to solve a problem. The problems should require students to find the surface area and volume of three-dimensional shapes and the cost of making specific three-dimensional objects with real-life applications. This assignment is attached in a separate document.
Lesson Extension, Additional Enrichment/Practice Opportunities:	Option 1: Find two gallon-size containers that have different shapes/dimensions but hold the same volume. Option 2: Draw two shapes that have different dimensions with the same volume. Label the figure with realistic dimensions. Option 3: Trace a circle using an object with a round base, like a jar. Cut string the length of the circumference of the circle. Straighten the string out and measure it. Measure the diameter of the circle and do the calculation (divide the circumference by the diameter) to see how close to π you get.
Key Shifts:	• Check to ensure that your lesson addresses the Key Shifts in the CCRS.
ELA Key Shifts (check all that apply):	☐ Text Complexity ☐ Evidence

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	☐ Building Knowledge
Math Key Shifts (check all that apply):	☒ Focus ☒ Coherence ☒ Rigor

Instructor Reflection Before the Lesson

Instructor Reflection Questions (to be completed before teaching the lesson):

- Are there opportunities to position students as experts on topics?
- What implicit bias might be reflected in the lesson or instructional design of the lesson?
- Were sufficient instructions on the use of digital tools provided and do students have an opportunity to practice?
- Were students provided with the opportunity to make choices regarding the lesson topic, project, etc.?

Instructor Reflection After the Lesson

Instructor Reflection Questions (to be completed after teaching the lesson):

- What went well in the lesson?
- What did not go well in the lesson?
- Did the learners meet the lesson objectives? If not, why?
- What changes should be made for next time the lesson is taught?