**MATH 486**

**LESSON OBJECTIVES, PLAN & ASSESSMENT**

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| **Lesson Title:***Pump Up the Volume!**(8th Grade)* | **Lesson Focus:**Mathematical concept: Volume of a cylinder. Essential questions: * “Which cylinder is larger?”
* “How can the volume of a cylinder be maximized?”

Skill to be mastered: Finding: volume. circumference, problem solving, and identifying definitions of key terms (e.g. volume, cylinder, circumference, radius, and pi) through an inquiry investigation.  | **Lesson Benefits:**Provides students with a conceptual understanding of volume.Also provides students with an understanding of the practical application of volume. Continue to develop problem solving skills.  |
| **Instructional Materials, Equipment, Technology, and Resources** |
| **Instructional Materials:**Worksheet | **Necessary Equipment:**PaperScissorsTapeCalculators | **Technology:**Access to YouTube.Projector and screen.  | **Lesson Resources:**<http://betterlesson.com/lesson/635909/cylinder-volumes-part-1> |
| **Learning Targets** |
| **Learning Objective:**Students will be able to:~Determine how to maximize volume of a cylinder. ~Explain their reasoning in writing.  | **Student Friendly Language Learning Objective:**I can:~Figure out how to create a cylinder with the largest volume.~Explain my thought process in writing.  |
| **Language Support** |
| **Key Vocabulary:**Volume PiCylinder Radius Circumference DiameterHeight | **Language-Sensitive Modifications:*** Definitions for related mathematical concepts will be posted and reviewed in another lesson.
* Sentence stems are utilized on the worksheets to guide student thinking
* Visual representations on the worksheet help identify each size/shape in question.
* Students will discuss and work in pairs to scaffold learning.
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| **Language Functions**Explain | **Language Target**Students will be able to explain their reasoning in writing and orally in class discussions. |
| **Assessment of Language Target**The language target will be formatively assessed throughout classroom discussions and from student responses on the activity worksheet. | **Precision, Syntax and Discourse****Mathematical Precision:** Students need to understand and use the definitions of*circumference* and *area* in order to develop a conceptual understanding of volume in this lesson. These definitions will be established in the pre-assessment lesson beforehand. They will also need to accurately use the terms: *height, radius,* and *diameter***.** For this lesson, students will process the information using inches. They will need to accurately confirm and use the paper’s dimensions using this measurement. **Syntax:** Students will need to accurately write about and discuss the mathematical concept of volume and it’s surrounding terms. Students will need to accurately state the measurements (inches) in both speech and writing (worksheet).**Discourse:** Students will explain their methods and reasoning in both writing and orally. They will be asked to record predictions and reflect on them while using accurately terminology and measurements. Students will also create a hypothesis using the same expectations. |
| **Placement of the Lesson in Sequence** |
| This is the second lesson in the unit on Volume. In the previous lesson, students will have taken a pre-assessment to determine their current understanding of area and circumference of a circle. These concepts may need to be retaught if many students score below 80% on the pre-assessment. In the previous lesson, students developed a conceptual understanding of calculating the volume of a cylinder by discussing how the area of a circle and the height of the cylinder are used to calculate the volume. An explanation of a circle being pushed through space to create hundreds of copies could help students understand the concept of multiplying the height of the cylinder by the area of the circular base. (A similar activity could be conducted using the familiar concept of a cube and a deck of cards. Each card individually does not have volume per se, but when they are stacked together in a deck, they now take up space three dimensionally).The succeeding lessons would then cover the volume of a cone and sphere.  |
| **Instructional Plan** |
| **Teaching Activities/Student Learning Activities:***List the syntax by identifying the steps that you will perform to reach the stated goal of the lesson. This needs to be clearly stated in a manner that would allow any teacher to be able to understand the steps and strategies in order to successfully facilitate the lesson. (Do it or talk it out to see if you have missed any steps or listed extraneous or confusing steps.***Hook:** Play the video **(5 minutes)*** The video shows a pot of soup. The soup is poured into a cylindrical container and spills over the edge of the container.
	+ Use the following YouTube link to access the video: <https://youtu.be/s5SvOqaGcJk>
* Question: How could we prevent this?
	+ Students brainstorm ideas on how this could be avoided.

Read learning targets orally as a class. **(5 minutes)**Have students think about what the learning objectives are. Then students will share the learning target with an elbow partner in their own words. A few students will be randomly asked to share the learning target using their own words (Student Voice). A few students will also be asked to explain why this is important to learn. Students will then be asked to rate their current understanding of the concept (volume of a cylinder) on a scale of 1-3 (1-I don’t know anything about volume of a cylinder; 2-I know a little; 3-I could teach about volume). They will do this by holding up the correct number of fingers to indicate where they are. Students will be asked to record this number in the corner of their worksheet for later reference. **Learning Activity: (15 minutes)**Pairs of students will be given two pieces of paper measuring 8 ½” x 11”. Students will make two cylinders: one with h= 8 ½”, the second cylinder has h= 11”. They will make a prediction on their worksheet regarding which cylinder has the largest volume. Have students vote on which one they think has the largest volume. Record on the board. Students will work with their partner to determine the volume of the two different cylinders.Once students have an answer, the class will discuss the methods they used to determine the volume of the cylinders and which cylinder has the largest volume. Bring the discussion back to the video. **(5 minutes)*** Review the brainstorm. Keep/modify ideas. Add any new ones.
* New brainstorm: Could we change the dimensions of this container to increase the volume so that the soup will fit?

**Performance task: (15 minutes)**Question: *How can you maximize the volume of a cylinder by using only one piece of 8.5” X by 11” paper?*  Have students *think-pair-share* to come up with ideas on how we can test this question as well as come up with a hypothesis. (Note: Students are allowed to use scissors to cut the paper.)Students will explain how they can maximize the volume of a cylinder both in writing and orally in a class discussion. Students will answer the sentence stem: “In order to maximize the volume of a cylinder…”. They should include the some of the following vocabulary words: height, radius/diameter, circumference. **Conclusion discussion:** **(10 minutes)***Toss the Ball* to groups to share their results and compare it to their hypotheses. Were they wrong or right? Help students identify errors in their thinking and make any changes to their worksheets.On a half sheet of paper, students will write their initial understanding of the concept and they will re-rate themselves on their current understanding and explain why they gave themselves that rating. Students will also write about whether or not they met the learning target for this lesson. They will cite specific evidence from the lesson plan to show where this was accomplished. These will be collected before students leave. (Exit Ticket) | **Student Voice Strategies:***Explain the strategies that you will use throughout your lesson to give the students an opportunity to express their understanding of the learning objective, their feeling of success and how they see this lesson as positively impacting their learning in the future. Utilize the edTPA Rubric questions for Student Voice.*The learning targets will be written on the board and students will chorally read the learning targets. Students will have the opportunity to explain the learning targets in their own words to an elbow partner. They will also be asked to explain why they need to learn this concept. Students will be asked to rate their current understanding of the concept (volume of a cylinder) on a scale of 1-3 (1-I don’t know anything about volume of a cylinder; 2-I know a little; 3-I could teach about volume). They will do this by holding up the correct number of fingers to indicate where they are. Having students make predictions that they will either confirm or modify is another way of capturing student voice. It demonstrates their increased understanding of the concept. At the end of the lesson, students will fill out an Exit Ticket where they will write what the learning target was and will evaluate their current understanding. They will also be encouraged to add comments about why they gave themselves that rating. This will be used to modify the next day’s instruction in terms of re-teaching and pacing. |
| **Student Feedback and Re-Teaching:*** *Students will have to deduce the measurements that they need in order to solve this problem. If a student is having trouble determining the measurements of the paper that they are using, the student will be encouraged to check with a partner on the measurements they are using to help solve the problem.*
* *Students will also have to know how to find the area of a circle. If there student doesn’t know the formula for area of a circle, they are encouraged to check with a partner, or will be given the area of a circle formula;* $πr^{2}^{}$*.*
* *Students will have to know the volume of a cylinder formula. If there student doesn’t know the formula for volume of a cylinder, they are encouraged to check with a partner, or will be given the volume of a cylinder formula;* $πr^{2}^{}h$*.*
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| **Differentiation, Cultural Responsiveness and/or Accommodation for Individual Differences**Students with with IEPs may not have the motor skills to manipulate the paper due to their disability. In lieu of this, students will be able to work in small groups to allow discussion and manipulation of materials.In order to appeal to students of diverse cultures, popcorn could be brought in to allow students to support their hypothesis of whether a taller or shorter object would have more volume. This tangible evidence further supports the abstract reasoning of calculating the volume and it serves to deepen students’ conceptual understanding of volume.English language learners will also benefit from working with an elbow partner for the first activity. They will receive more individualized attention and immediate feedback regarding their verbal explanation. This activity also has a high level of engagement built in to the structure through the use of manipulatives and the inquiry-based learning. When students are engaged, they exhibit more on-task behavior.  |
| **Standards & Assessment** |
| **Common Core Standards**[CCSS.MATH.CONTENT.8.G.C.9](http://www.corestandards.org/Math/Content/8/G/C/9/)Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.[*CCSS.ELA-LITERACY.SL.8.1*](http://www.corestandards.org/ELA-Literacy/SL/8/1/)*Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.* | **Prior Content Knowledge and Pre-Assessment**This lesson builds upon 7th grade Common Core State Standards for math, which requires students to know the formulas for area and circumference of a circle ([CCSS.MATH.CONTENT.7.G.B.4](http://www.corestandards.org/Math/Content/7/G/B/4/)). Students will be given an assessment to determine their ability to calculate the area and circumference. Students will need to know the formulas for area and circumference and be able to calculate the area and circumference when they are given either the diameter or the radius. Students will also need to be able to solve for the radius when they given the circumference or the area. Students will need to be able to understand how to calculate the volume of a right rectangular prism ([CCSS.MATH.CONTENT.6.G.A.2](http://www.corestandards.org/Math/Content/6/G/A/2/)). This foundational knowledge will aid students in their understanding of the volume of a cylinder.  |  |
| **Assessment Strategies**WorksheetPerformance Task: Maximizing Volume. Exit Ticket | **Expected Evidence**Students will successfully complete the worksheet, achieving an 80% or better.Students provide a model of what they thought would make a cylindrical shape with the greatest volume. They should be able to determine that increasing the height decreases the circumference of the cylinder. This leads to a smaller volume. However, decreasing the height subsequently increases the circumference and therefore creates a larger volume. Students need to arrive at the correct conclusion and be able to explain their conclusion using the key vocabulary terms. Students will give themselves a numerical rating on how well they understand the concept. They will also be expected to explain their reasoning behind the rating. | **Assessment Commentary**The worksheet provides quantifiable data regarding conceptual understanding.This performance task will demonstrate students’ understanding of volume. It also builds on the concept of conservation: that taller containers do not necessarily have larger volumes than wider, shallower containers. Students gain this understanding through physical modeling as well as mathematical modeling using the correct methods and formulas to determine the volume of a cylinder. Using an Exit Ticket will be a way to collect qualitative data regarding how confident the students are in their ability to problem solve and calculating the volume of a cylinder. The results will be used to guide future instruction and lesson pacing.  |