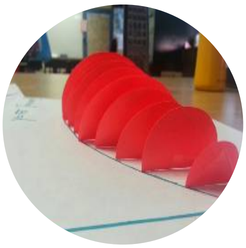
K20 LEARN



What Does That Look Like?

Volumes With Known Cross Sections

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Grade Level	11th – 12th Grade	**Time Frame**	2-3 class period(s)
Subject	Mathematics	**Duration**	120 minutes
Course	AP Calculus		

Essential Question

How can I model a volume with a known cross section?

Summary

Students will create three-dimensional representations of volumes with known cross sections in order to better understand what the solids look like and to better calculate volume.

Snapshot

Engage

Students use the Think-Pair-Share strategy to answer the question, "If a definite integral measures the area underneath a curve, how could you use a definite integral to measure volume?"

Explore

Students draw the bases of the solids that they want to create on a sheet of paper. After drawing, students measure and embed vertical cross-sections perpendicular to the base of the solid in order to create 3-D models.

Explain

Students work with one another to verify their work and to check for understanding.

Extend

Students create their own problems and exchange with a neighbor.

Evaluate

Students reflect on learning and provide feedback on their learning using the 3-2-1 strategy.

Standards

Oklahoma Academic Standards for Mathematics (Grades 9, 10, 11, 12)

G.3D.1.1: Solve real-world and mathematical problems using the surface area and volume of prisms, cylinders, pyramids, cones, spheres, and composites of these figures. Use nets, measuring devices, or formulas as appropriate.
G.3D.1.2: Use ratios derived from similar three-dimensional figures to make conjectures, generalize, and to solve for unknown values such as angles, side lengths, perimeter or circumference of a face, area of a face, and volume.

Attachments

- Extend Activity - Spanish.docx
- Extend Activity - Spanish.pdf
- Extend Activity.docx
- Extend Activity.pdf
- Volumes with Known Cross Sections Handout - Spanish.docx
- Volumes with Known Cross Sections Handout - Spanish.pdf
- Volumes with Known Cross Sections Handout.docx
- Volumes with Known Cross Sections Handout.pdf
- Volumes with Known Cross Sections Notes - Spanish.docx
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Materials

- Volumes With Known Cross Sections handout (attached)
- Extend Activity handout (attached)
- Protractor and compass
- Pencil
- Paper
- Colored card stock
- Tape or glue

Engage

Display the question, "If a definite integral measures the area under a curve over a closed interval, how could you use a definite integral to measure volume?" Have students use the Think-Pair-Share strategy to begin thinking, collaborating, and discussing the possibilities of how to use definite integrals to measure volume.

Think: Have students respond to the question by thinking about it and then writing their response.

Pair: Have students pair with an elbow partner and each share their responses. They can either choose the “best” response or collaborate to create a “shared” response.

Share: Ask pairs to share their thoughts with the entire class

After hearing students' ideas, show one of the short animations of volumes with known cross sections.

Teacher's Note

As you might recall, the basis of the definite integral is to find the area of an infinite number of infinitesimally small rectangles under a curve over a closed interval. Remind students of this information as you transition into teaching about finding volumes with known cross sections.

Teacher's Note

Initially, this concept can be challenging for students to visualize and comprehend. If you feel like students are having a difficult time, it might be helpful to have students jot down a few notes on the topic that is attached so that they can get a better idea of the mathematics behind the concept. This activity can help students recall prior knowledge of definite integrals in order to construct new knowledge.

Explore

Have students pair up with the person sitting next to them. Explain to students that they are going to work on building 3-D representations of volumes with known cross sections through an exploration.

Distribute copies of the **Volumes with Known Cross Sections** handout.

Ask students to work through the handout. Move around the room to assist students who might be struggling with the concept.

Teacher's Note

As you are moving throughout the room, gauge how you think students are understanding the concept. Focus on students who are struggling and encourage peers to share with each other how they are setting up their models. This can be a great way for students to teach other students the concept.

After students have finished their constructions at the end of the handout, check their work to ensure that it looks correct.

Explain

After two pairs of students are finished with the handout, have them form a group of four.

Within the group of four, have one partner from each pair work together to explain the work they did. If there are misconceptions or incorrect answers, ask students to explain how they arrived at the answer, allowing them to catch their mistakes.

Teacher's Note

If there are common misconceptions among the groups or other components of the concept that need to be clarified, this would be the time to make sure that students are on the same page. Ask students to share some of the solutions they found and how they found them.

Extend

In this section, students will create their own problem for their peers to solve.

Working individually, have students fill out the template in the **Extend Activity** handout.

Students will be asked to create a region out of equations, select a cross section, and solve the problem. After solving, have them exchange problems with a neighbor.

Teacher's Note

As an example, students might use something like y=vx , x=0, x=4 and the x-axis. This creates a bounded region that cross-sections can then be embedded into. As students create their own bounded region to serve as the base of their solid, make sure to check student work to ensure that: 1) The region is bounded and 2) The function can be integrated based upon the integration rules that you have discussed in your class. Encourage students to be creative, but warn that too much creativity could lead to integrals that are too challenging.

Students will solve their neighbor's problem.

Evaluate

Ask students to submit their work from the 3-D models they created and from the Extend problem.

As an exit ticket, give each student a sticky note and have them answer the questions below using the 3-2-1 instructional strategy.

1. What are 3 things you learned?
2. What are 2 questions you still have?
3. What is 1 thing you found interesting?

Ask students to place their sticky notes on the board as they leave the class.

Resources

- Hill, D. R. & Roberts, L. F. (2002). Volumes by section demo gallery. Retrieved from http://mathdemos.org/mathdemos/sectionmethod/sectiongallery.html
- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5059a7b
- K20 Center. (n.d.). Think-Pair-Share. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5064b49