

Cumbersome Cubes

Geometry, Volume, & Exponents

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Grade Level	8th – 9th Grade	**Time Frame**	1-2 class period(s)
Subject	Mathematics	**Duration**	75 minutes
Course	Algebra 1		

Essential Question

How does exponential growth relate to geometric properties? What does it meant to defend your thinking?

Summary

Students will explore the properties of a cube and make connections to exponents through a short exploration of volume. Students will also construction and defend a mathematical argument.

Snapshot

Engage

Students will be asked to make quick a conjecture about the volume of a cube with edge length that are exactly half the length of a given cube.

Explore

Students will test their conjectures and build new cubes within specific parameters as well as one that does not meet the same parameters.

Explain

Through a poster and written CER (Claim, Evidence, Reason), students will craft an argument in support of their cubes through both visual and verbal representations. In a gallery walk, students present their work as well as critique the arguments of other groups.

Extend

Students will regroup and defend or change their own reasoning based on the arguments of other groups.

Evaluate

Teacher can evaluate students' understanding on the posters, through the gallery walk presentations, and through observations.

Standards

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

A1.A.3.6: Recognize that geometric sequences are exponential using equations, tables, graphs and verbal descriptions. Given the formula $f(x) = a(r)^x$, find the next term and define the meaning of a and r within the context of the problem.

Materials

- Cardstock or construction paper (enough for each group to have at least 5 sheets)
- Poster Paper or sheets of 11x14 printer paper (one per group)
- Tape (one dispenser for group or every two groups)
- Rulers (one per group)
- Calculators
- Scissors (one pair per group)
- Centimeter cubes (optional)

Engage

Group students into pairs or groups of three. Hand out construction paper, tape, scissors, and a ruler to each group.

Have each group of students build a cube out of construction paper or card stock that has side lengths of 5 inches.

Teacher's Note

An accommodation or differentiation idea might be to give students centimeter cubes to build their cube or to precut 5x5x5 squares.

Ask students in a Think-Pair-Share activity how big the cube is. During the share out, make sure students explain how they arrived at their answer and that they use correct mathematical terminology.

Pose the question: *How can we build a cube that was half of the size of our 5x5x5 cube?* Have students brainstorm ideas in their group.

Explore

Challenge students to create two new cubes

- One cube that represents what they believe to be the correct half-sized cube
- One cube that represents an alternative answer to the question that may be an alternative solution

Teacher's Note

The idea behind the "incorrect" cube is to force students to define "half" of the original. The questions posed are vague on purpose. Some groups may define "half" as 2.5x2.5x2.5, while others will define half as a cube with a volume of 62.5 inches cubed. The importance of the activity is for them to consider both aspects' volume and be able to explain/support their thinking.

Students will use the cardstock/construction paper to create their two additional cubes. Remind them that accuracy matters but that, more importantly, they will have to be able to defend and support their constructions.

Explain

In their groups, students will create a poster. The goal of the poster is to justify the two cubes they built.

Tell students to use images, mathematical sentences (i.e., formulas), and words to justify why their cubes fit the two criteria (one that is exactly half the size of the 5x5x5 cube and one that is an alternative answer).

Students also need to craft a CER Statement for each of their cubes.

- CER Statement 1 should begin with: This cube is exactly half the size of the original because...
- CER Statement 2 should begin with: This cube could be an alternative answer to the problem because...

Teacher's Note

In a CER Statement, students make a claim, provide evidence, and then give a reason why the evidence supports the claim. For example, the students might say: This cube is half the size of the original cube because each side is a 2.5x2.5 inch square. Because each side is a 2.5x2.5 inch square, the length, width, and height of our new cube are all exactly half of the 5x5x5 inch cube.

Using the poster and CER Statements, each group will prepare a 1-2 minute presentation.

Once all groups have created a poster and written their CER Statements, the groups will each choose a docent to represent their group in a Gallery Walk. The docent will remain with the cubes and poster and will be responsible for giving the short presentation to classmates.

The students who are not docents will rotate and listen to each presentation of the poster and CER Statements. Their responsibility is to ask critical questions of each group they visit, asking the presenter to clarify and defend their group's solutions.

Extend

Once students have had a chance to go to each group, have them re-group and share what they have found with their group's docent.

As a group, ask students to decide if their two CER Statements still hold true. Allow them to revise if needed. Students in each group will have to come to a consensus about how to define "exactly half."

As a whole class, have groups share out their CER Statements and why they chose to either keep them or change them after the Gallery Walk.

Evaluate

The two major goals of this lesson are for students to explore exponential growth in geometry and, more importantly, to defend a claim and critique others' claims.

The teacher can assess the students' understanding of exponential growth through an Exit Ticket with the essential question: *How does exponential growth relate to geometric properties?*

The teacher can assess the students' ability to justify their own claim and critique another's claim though the CER Statements as well as observationally through the Gallery Walk and group discussions.

Resources

- K20 Center. (n.d.). Bell ringers and exit tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Claim, evidence, reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/156
- K20 Center. (n.d.). Gallery walk / carousel. Strategies. https://learn.k20center.ou.edu/strategy/118
- K20 Center. (n.d.). Think-pair-share. Strategies. https://learn.k20center.ou.edu/strategy/139