TEACHWITHPORTALS™

# Subject: Math

# Title: Spatial Visualization and Perspectives


**Author:**

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**School / Organization, City and State / Province:**

Shoreline, WA


**Grade Levels:** 6 or 7

**Common Core Standards Met:**

## Solve real-world and mathematical problems involving area, surface area, and volume.

6.G.4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

## Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

7.G.6. Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

**Time needed for lesson:** 2 class periods

## Overarching Question and Objectives:

What do we see when we view objects from different perspectives?

- Students will be able to identify from which perspective they are looking at an object
- Students will be able to articulate how a view from a particular perspective will change when the object's shape is modified
- Explore how these changes affect the surface area of the room

## Summary of lesson:

Building on the ideas of nets from the previous lesson (or not), students will begin by exploring the ideas of perspective when rotating the main room in the Puzzle Maker. Surface area will be introduced and students will explore the concept of surface area by modifying the Puzzle Maker room. They will also experience getting "inside" their figure when they build the game. Finally, Wheatley will give the students directions for constructing rooms with particular surface areas and students will explore the idea that there are a variety of configurations that still result in the same surface area.

## Vocabulary:

Area – the number of square units enclosed in a figure.

Surface Area – the sum of the areas of all of the exposed sides of a figure; the sum of the area of the bases and lateral faces of a space figure.

Net – a 2-D figure that can be folded along its segments to form a 3-D figure.

## Teacher materials needed:

If possible, a computer that will allow you to project the Puzzle Maker for class discussion purposes.

An example of a net/object (perhaps a cube or rectangular prism shape for simplicity)

## Student materials needed:

* The Puzzle Maker

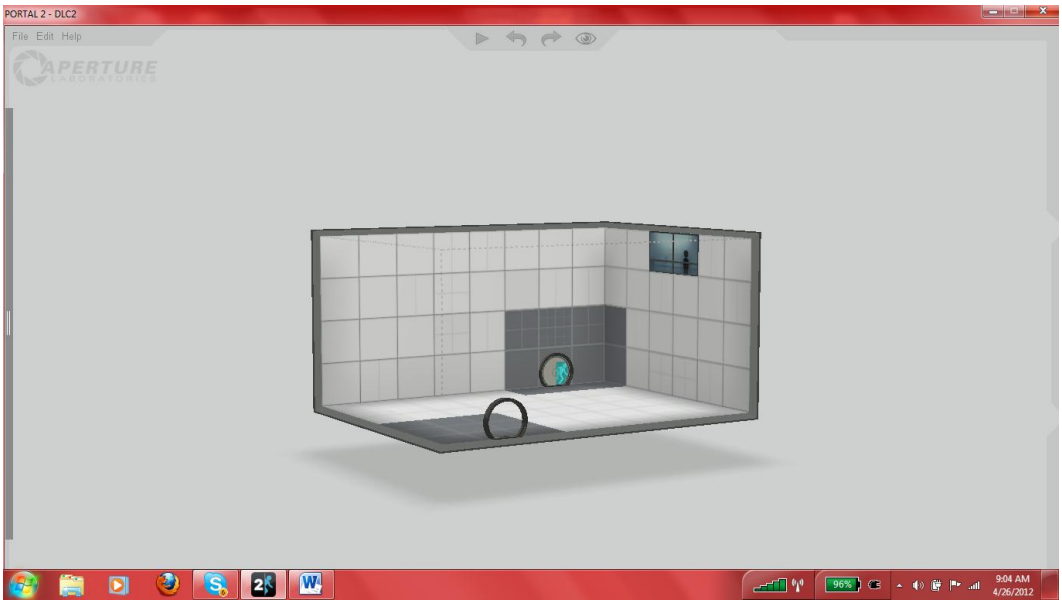
* Rulers

*Graph paper

*Copy of the "Wheatley Room Design Sheet"

## Lesson Plan:

Project the main screen of the Puzzle Maker, the empty room that first comes up when you go into Create Community Test Chambers.




*Ask: What surfaces do you see in this room?*

Hopefully students will respond with floor, walls, etc. They may or may not be able to see the ceiling and the front wall depending on the view. You may need to rotate the room in order for them to see the see-through surfaces. Hopefully some students will point that out.

*Ask: What shapes are those surfaces? What are the walls, ceiling, etc. composed of?*

They should point out they are rectangles. The surfaces are composed of square cubes.

*Instruct students to try to find the area that the all of the cubes comprise in the room.* Do not give them instructions on how to do so. They may simply count all the cubes, some may use the area formula, and they may not agree on what to do with the doors and the observation windows. *Discuss their answers and see if students can come to some agreement. (Depending on count of observation room and doors, 205 square units).*

Using the example of the area formula for rectangles $A = lw$ ask students to explain what we mean when we talk about "area." Make sure they understand that area is the number of square units enclosed in a figure.

*Point out that we did not just find the area of one surface in the room, we found the area of all of the exposed surfaces in the room.*

*Ask: Does anyone know what it is called when we do this?*

Define surface area for them (two possible definitions have been offered above depending on how you like students to think about S.A.

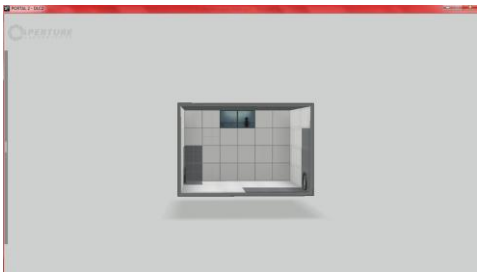
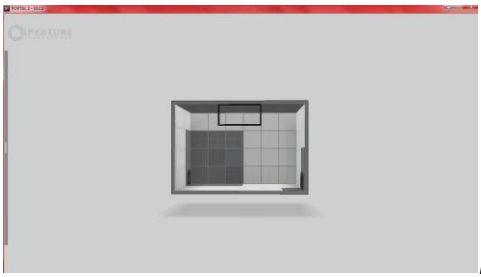
Direct students' attention to a concrete object in your classroom. I find a tissue box often works well for this (you can easily cut it apart). Encourage students to diagram a net for the object you are holding on their paper. As they are drawing, cut your box apart and lay it out so they can see the example of the net.

Have students measure different side lengths for the box and have the class label their net drawings. Point out that they can also find surface area but decomposing the figure into a net and finding the area of each surface that way as well. Make sure the class agrees on the surface area of your object before moving forward.

**Note: When you look at the Puzzle Maker on the building screen, the walls are fairly clearly defined as cubes. However, when you switch to game-view, the squares are split into rectangles. With my groups it was helpful to show this on the demonstration computer at this point so there was no confusion when they were working on their own computers.**


Students should now access the Puzzle Maker on their own computers. Have them rotate the room and look at it from different viewpoints.

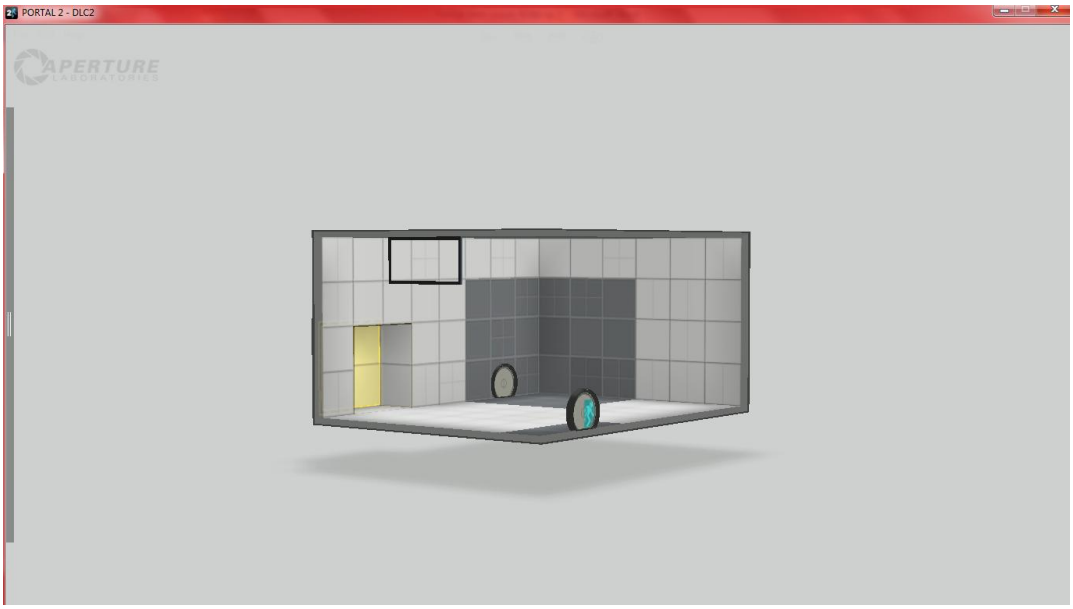
*Explain that the first way we see the Puzzle Maker is from a "Front View." If we rotate the figure so the front is on the right, we now see a "Left View." Ask students what they would see if they were looking at the figure from a "Right View" and "Top View." Describe these various views as different perspectives of the same room. Have students click on the eyeball icon on the top of the screen so they can view the room from the inside. Ask them what they notice.*



*Right and Left Views*

One of the main objectives of this unit is to get students visualizing various figures and perspectives in the room. It is important that they consider various perspectives when designing their rooms.

Point out that right now, in its current form we don't have to think too much about what the room looks like from various viewpoints, but that will change!

*Instruct students to drag a four cube section of the back wall back one space. Ask them to share with a partner how that will change the view from the front, left side, right side and top (without doing it). After they've discussed it, then they can use their mouse to rotate the room.*

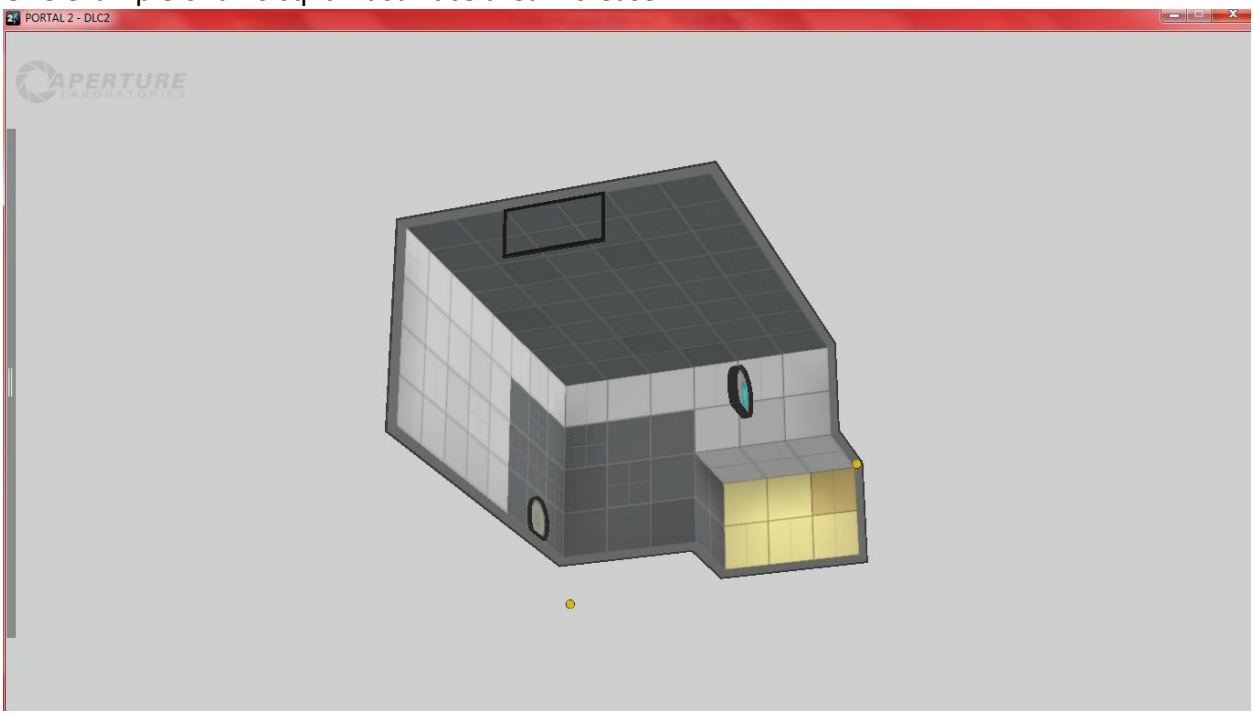



*Ask: Does this impact the surface area of the room? (it does…have students calculate by how much…just counting it is ok).*

*Have students return the wall to its normal position. Ask students to change the room in some way such that the surface area of the room is increased by 20* square *units.* (Make sure they consider the changes in the ceiling cubes, floor cubes and side walls). Have students walk around and look at one another's computers.

*Ask: What did you notice about the change in surface area?* (they might notice that people made different changes to the rooms but the resulting increased SA could be the same, they may have noticed mistakes others made, etc.)

One example of a 20 sq. unit surface area increase.




Explain to students that one of the coolest things about using this tool is our ability to get inside the room virtually and that the following activity will have them make changes to the space, the surface area and then have them explore the virtual environment of the room. We are really going to focus on the structure of the room today more than anything else. Explain that there is a robot character in the game *Portal 2*, known as Wheatley, who is kind of a demanding fellow. And he was kind enough to extend those demands to us! All students will be given a

copy of the “Wheatley Room Design Sheet” and they will need to follow his specific directions to see if they can construct rooms that meet his stringent requirements.

Pass out the design sheet to students and work with them as they design, calculate and analyze the instructions given to them by Wheatley.

There is also a section on the worksheet that includes pattern recognition (and this could easily be extended into a discussion of various patterns when surface area is adjusted) as well as the “Wheatley Challenge” which gives students an opportunity to be more creative with their surface area and designs.

This is a great homework assignment. When students return the following day, ask them (if they haven’t) to “play” their room from the inside. Ask them what they notice being on the inside of the room. Also, ask them from which perspective they think the view of the room is most interesting structurally and why.

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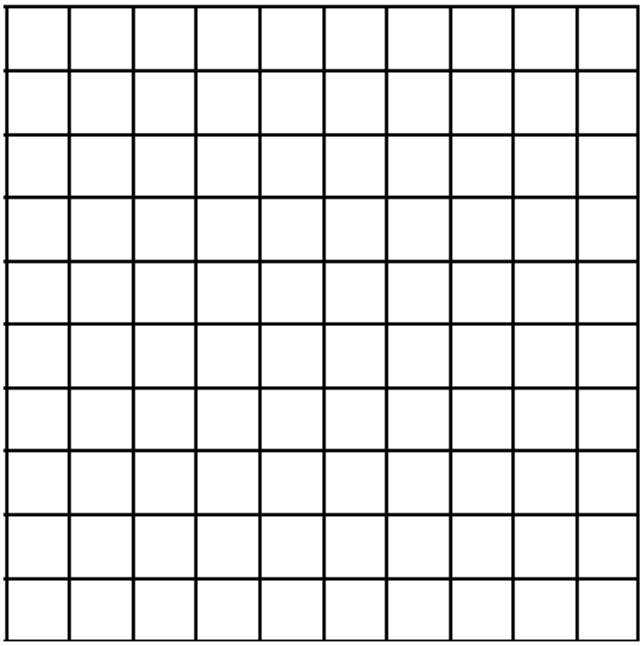
Welcome to the Wheatley Room Design Sheet. Wheatley, the friendly looking fellow pictured to the left is asking your assistance in designing what he believes will be the "perfect" test chamber for subjects at Aperture Science.

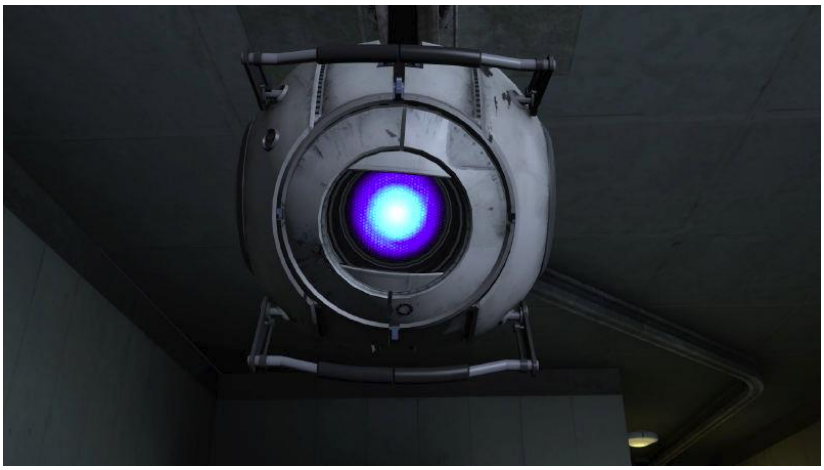
Wheatley feels that the "best" test chambers for subjects are those that have surfaces that are "interesting." He requested that you create a test chamber whose rear surface area is increased by 10 square units and whose right wall's surface area is increased by 16 square units.

Build it.

Make a sketch of the view from the left side.



APERTURE LABORATORIES



Ok, ok. Unfortunately, Wheatley is known for being, um, a *bit* difficult to work with. He realized that what he meant by "increased by 10 and 16 square units" was a room with a total surface area of 144 square units. Totally easy to make that mistake. Can you do it? Use computations and drawings to show that indeed, the surface area of the room really is 144 square units.

Mmmm, ok. Yup, got some bad news. Wheatley decided that that room was too small for a good test chamber. He'd rather expand it. Let's go for a room with a total surface area greater than 300 square units. Using computations and drawings demonstrate that the surface area of the room you create is >300 square units.

Wheatley tells me he recently read in "*Science Test Chamber Today*" magazine that test subjects find the color pink soothing. He figures that painting the walls and ceiling in the original test chambers pink would be a nice touch. Go back to the original dimensions of the test chambers. If a gallon of "soothing" pink paint covers a surface area of 8 square units, how many gallons will he need to paint the test chamber?

If paint costs $16.78 per gallon, how much will Wheatley need to spend to paint the ceiling and walls in the chamber?

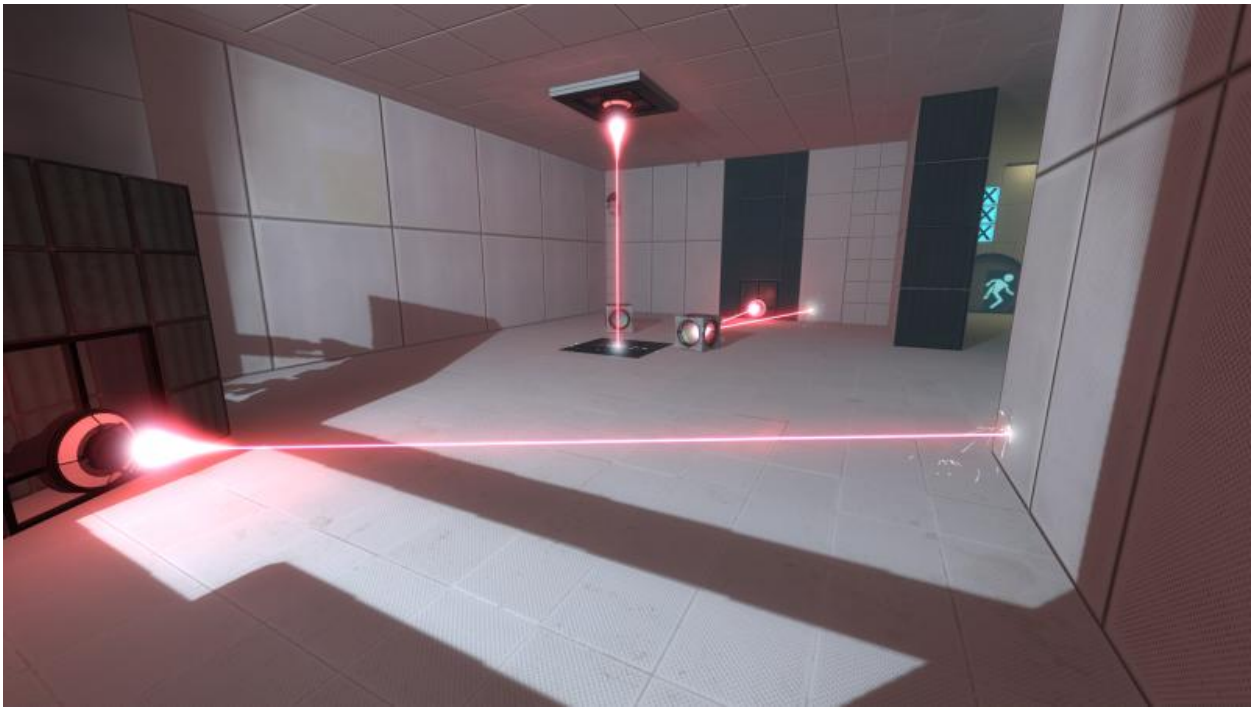
Patterns:

If you pull a 1 x 1 section of the wall back one space, how much more surface area have you created? What happens if you pull it back two spaces?

If you pull a 2 x 2 section of the wall back one space, how much more surface area have you created? What happens if you pull it back two spaces?

If you pull a 3 x 3 section of the wall back one space, how much more surface area have you created? What happens if you pull it back two spaces?

**Challenge:**
What patterns do you notice in the increased surface area? Wheatley has rethought the entire thing and has come to the realization that he doesn't really want the test subjects to feel overly comfortable. In fact, he'd like the room to be extremely complex and interesting in terms of structure. He doesn't want to be a bother to you, but would really, really like it if you could come up with the most interesting physical layout of the room possible. He'd like you play around with surface area and objects that simply add structure to the room. He has high hopes for you (even though you are human). Once you have created your space, save it to share with the class and discuss your thought process.



WHEATLEY LABORATORIES

Wheatley Laboratories would like to thank you for your cooperation!