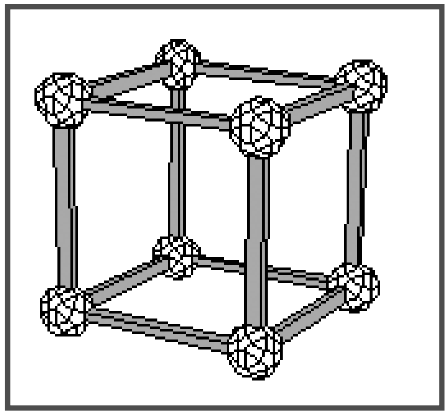
Zome System

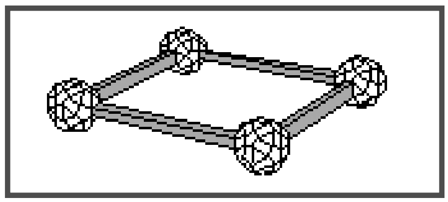
Builds Genius!

Measures of Space - II: Volume

Mathematics / Biology
Intermediate Concept

Lesson Objective:
Students will explore volume and measurement of three dimensional (3-D) space. They will determine that volume increases faster than surface area if one proportionally increases all the linear dimensions of an object.

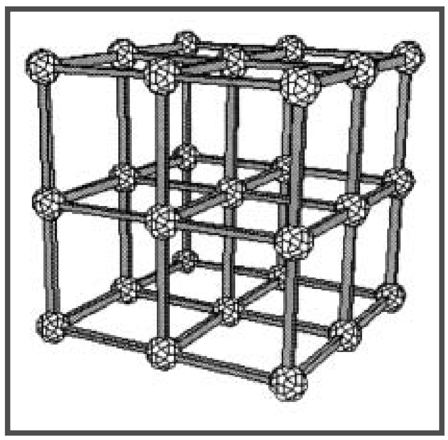


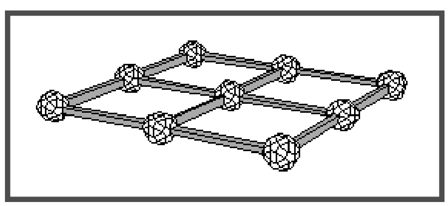


Prerequisite Skills:
Experience working with 2 and 3 dimensions (‘2-D and 3-D shapes,” “Speed Lines!” and “Measures of Space - I: Lengths and Areas”). Some previous exposure to concepts of volume (“Volume for Beginners”).

Time Needed:
One or two class periods of 45-60 minutes.

Materials Needed:
• Two Zome System Creator Kits for 25-30 students



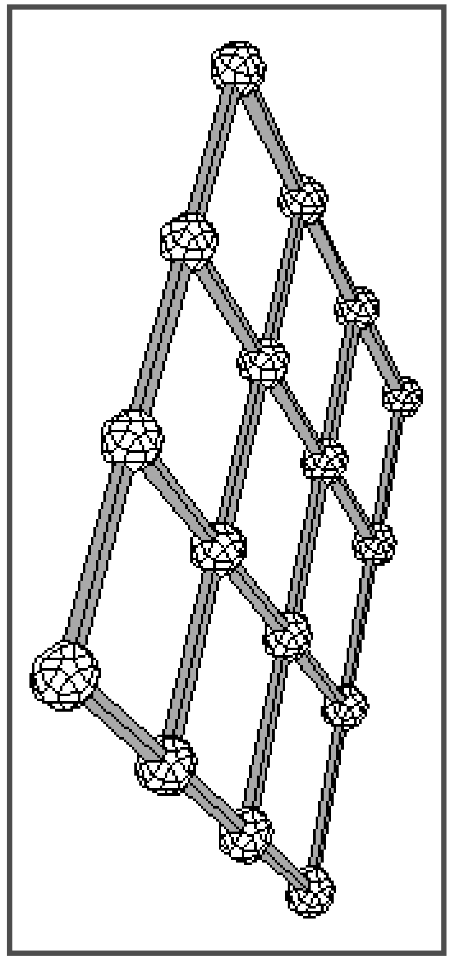


Procedure:
Start the lesson with a brief review of the concepts involved in measuring 1-, and 2-dimensional space. *What is 1-dimensional space? What is length? What unit of measurement represents 1-D space in Zome System? What is 2-dimensional space? What is area? What unit of measurement represents 2-D space in Zome System?*

Volume is a natural extension of length and area, just a dimension higher. In this lesson students are going to explore measurements in 3-dimensional space. Divide the students into the teams from the lesson “Measures of Space - I: Lengths and Areas”, return the grids built in that lesson, along with the remaining Zome System pieces. Their task is to add a third dimension to their grids and determine an appropriate unit of measurement for 3-D space. They must also report the resulting volume of their structure. *What kind of grid will result if we can move* *up and down as well? What is the unit of measurement of such a grid* (a cube)*?* Allow the teams to build, and present configurations of these cubes such as a 2x2x2 cube, a 3x3x3 cube, and a 2x3x5 box. *What is the volume of the structure? What do we mean by volume? How much 3-D space in cube units do they occupy?* A 2x2x2 cube has 2^3, or 8 cubic units, a 3x3x3 cube has 3^3, or 27 cubic units, and a 2x3x5 cube has 30 cubic units.

Next, show how volume increases faster than area. Ask a third of the teams to build a 1x1 square, a third to build a 2x2 square, and a third a 3x3 square. *What is the area of these grids?* Have them calculate the resulting volume when the third dimension is added (1x1x1, 2x2x2, and 3x3x3 cubes). Write down the results in a table on the board. If we compare the rate of growth of the volume to the areas we can see that the volume grows to the 3rd power of the linear dimension whereas the area grows to the square of the linear dimension. *What are some practical implications of these growth patterns?*

An interesting example involves the possible size of animals. Let us suppose that the 1x1x1 cube represents a 200 lb. mountain lion, and the 1x1 square represents the total area of her paws (1 sq. ft.) This means that the gravitational load on her paws equals 200 lb./sq. foot. *What happens if we double her linear dimensions?* The load then is 1600 lb./4 sq. feet = 400 lb./sq. foot. *What happens if we triple her linear dimensions?* The load becomes 5400 lb./9 sq. feet = 600 lb./sq. foot. *How would this affect her ability to hunt?* This type of volume to surface area relationship determines what size different types of animals can be, why an elephant has such large feet and legs in relation to its body, and why an insect can breathe through its skin, whereas a larger animal needs lungs. *Why can a whale become so much larger than a land-based animal? What would human bodies look like if we only were 1 foot tall?*



<u>Assessment</u>:

Give a short problem similar to the mountain lion example, and let students solve with or without the use of

Measures of Space - II: Volume

Zome System. Review their notes in their journals. To meet the standard students must build the cubic grid and be able to calculate its volume. To exceed the standard they must define the comparative growth rates of a square area and a cubic volume.

Standards Addressed:
* Mathematics standards addressing mathematics as a means of communications (NCTM Standard 2).
* Mathematics standards addressing the study of the geometry of one, two, and three dimensions in a variety of situations (NCTM Standard 12).
* Mathematics standards addressing extensive concrete experiences using measurement (NCTM Standard 13).

Transfer Possibilities:
Exploration of volume in non-cubic structures.