Title:	**Grade:** 5	**BIG Idea:**
Fish Aquarium Math *a multi-day lesson	**Author(s)**: Hope Phillips	Volume

Real-World Connection:

Designing and building aquariums includes mathematical concepts including, but not limited to, the following: multiple calculations; measurement; work with a variety of shapes, solids, and angles; and volume. The size of an aquarium tank is identified by the number of gallons of water it will hold. For example, the tank size for a 12" x 6" x 8" vessel is 2 ½ gallons. For a given a volume, there are multiple tank shapes that could exist. Tanks can take the form of cylinders and prisms. Prism types include rectangular, triangular, pentagonal, and hexagonal. The dimensions and shape of the tank depend on the amount of space available for the aquarium and the client's preferences.

Using the video *Aquarium Makers* from the Futures Channel series *Algebra in the Real World,* students will experience large-scale, custom-made aquariums and see the connections to mathematics.

How Students will Experience the Connection: highlight in yellow all that apply

Video Clip	Photo	Podcast
Print Media (article, ad, etc.)	Vodcast	Other

GPS Standards:	**Objectives:**
M5M4. Students will understand and compute the volume of a simple geometric solid. a. Understand a cubic unit (u^3) is represented by a cube in which each edge has the length of 1 unit. c. Derive the formula for finding the volume of a cube and a rectangular prism using manipulatives. d. Compute the volume of a cube and a rectangular prism using formulae. **M5P1.** Students will solve problems using appropriate technology.	1. Students will discover the formula for the volume of a rectangular prism using the general equation, B x h. 2. Students will discover the unit for volume by forming cubes using manipulatives. 3. Given a fixed volume, students will use their knowledge of multiplication and/or divisibility rules to determine possible dimensions of a rectangular prism.

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

M5P3. Students will communicate mathematically**.** **M5P4.** Students will make connections among mathematical ideas and to other disciplines. **M5P5.** Students will represent mathematics in multiple ways.	

Materials:

Calculators – one per student
Handout – *Fish Aquarium Math*
Cubes – linking or not linking; preferably centimeter or inch cubes (*inch cubes are preferable due to their larger size for ease of handling); 30 per student pair
Yard sticks or meter sticks (depending on unit of cubes) – one per student pair
Video clip – from Futures Channel or one of your choosing
Volume Applet - http://illuminations.nctm.org/ActivityDetail.aspx?ID=6

*Directions for using applet are on the site.

Related Task:

After showing the video clip, ask students what mathematical ideas they heard presented. Have a brief class discussion about their ideas. Tell students they will be working with rectangular prisms today – one of the most commonly-recognized aquarium shapes. (An assumption is made here that students are familiar with prisms and their characteristics.)

Tell students they will need to know an important mathematical concept in order to work with fish aquariums. Ask if they can think of the name of the concept that refers to how much space a tank takes up. If they are hesitant, ask students whether tanks are two dimensional or three dimensional. Compare and contrast a two-dimensional figure with a three-dimensional figure. Focus on the vertical and horizontal lengths of a 2-D figure – that it lacks height; it is flat; that it lacks thickness. Ask students what mathematical concept we associate with covering 2-D figures? Answer: Area. Students will build on the general formula for the volume of prisms from the area formula.

Let students know that volume is measured in cubic units. Write on the board units such as cm^3, in^3, ft^3, etc. Ask students what they think the word “cubic” means and why there is a superscript “3” after each unit of measurement. Ask

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

students to what the *three* dimensions refer – i.e. length, width, and height.

To help avoid confusion, because length and width are arbitrary terms and may be interchanged, consider labeling the dimensions as follows: vertical length; horizontal length; and height. Tell students that, sometimes, the word *depth* is used as a synonym for *vertical length*. The concept of *depth* will have to be explained. Consider classroom objects that are rectangular prisms and discuss their varied depths (i.e. tissue box; eraser; plastic containers)

Tell students they you will use an applet to help them learn more about volume. Open the applet and display for students. Set the dimensions so that the squares on the prism are not too small (i.e. 2 x 3 x 4). Remember, the sides of the prism may be flipped up.

**Repeat steps 1-3 with new prism dimensions until you are comfortable that students understand.

1. Show students that using the top button, the single blocks, fills the bottom layer of the prism, also called the *base*. Ask a question like, "Using this button how could we determine the total number of blocks that would make up this prism?"

   Students should recognize that you can continue to press the individual-block button until the prism is full (24 units^3). This requires counting along with the pressing of the button. Complete this process with several prisms, making their size larger each time. At some point, ask students if it is efficient to fill a large prism with individual blocks? Help them see the need to try another method for determining volume.

2. Introduce students to the second button, or the row block. Cover the bottom layer, or base, with these blocks. Ask a question like, "How would you describe each of these row block? Are they a quicker way to fill the prism?"

   Ask students to predict how many cubes are in a row on the bottom layer, or base (answer: 2). Now ask students to tell you the number of rows on the base (answer: 3). Ask how many cubes it takes to cover the base. Students should see the horizontal and vertical lengths as 2 x 3, or 6 blocks on the first layer. Remind students that by *covering* the bottom layer, they have found the area of the rectangle that forms the base of the prism.

   Focus students' attention on the use of the row block for greater efficiency in their quest to determine the prism's volume.

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

3. With the bottom layer completely covered, ask students to predict how many total layers are in the prism. Flipping up the sides may help students visualize this more easily. Now click on the layer block to fill every layer. (Answer: 4) Help students determine another word for the total number of layers – i.e. the height of the prism. Count the layers again and ask which of the three dimensions "4" gives them.

   Summarize what information the students now know -- the total number of blocks that cover the bottom layer/base and the total number of layers. Ask students, "How I we use this information to determine the volume of the prism?" (Answer: multiply the number of blocks it took to cover the base times the total number of layers).

Volume = number of blocks it took to cover the base x number of layers

Remind students that they have given a verbal rule for determining volume, but mathematicians use symbols in place of words because this is a more efficient way to communicate. Guide students through the steps below.

Volume = number of blocks it took to cover the base x number of total layers

- Substitute "**V**" for volume
- Substitute "**Area of the base**" for *number of blocks it took to cover the base*

(The symbol for area of the base of a prism is a capital *B,* as opposed to a lowercase *b* that signifies the length of the base of a triangle when calculating its area)

- Substitute "**height**" for *number of total layers*

So, **V = B x h** Show students that for the 2 x 3 x 4 prism, 2 x 3 is the area of the base and 4 is the height.

V = B x h
V = (2 x 3) x 4
V = 6 x 4
V = 24

The focus should be on <u>*first*</u> calculating the area of the base first and <u>*then*</u> multiplying by the height. By placing parentheses around the 2 x 3, we are grouping those dimensions together as the area. Parentheses are not actually needed according to rules for order of operations, however.

Now it is students turn to work with prisms. Tell student they will be using manipulatives to assemble rectangular prisms. Remind students that we name

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

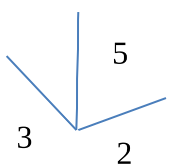
prisms by their three dimensions. Ask them to build a prism that is 2 units x 3 units x 5 units. (This rectangular prism also happens to be a cube). Utilize a unit in your discussion, whether it be centimeters or inches (depends on your manipulative). After they have been working for a short time, ask that students share their results.

If some students have formed an actual cube, ask how they knew to make it. If students struggle, focus their attention on the rule for determining volume, **V = B x h.** Group the dimensions 2 x 3 x 5 to help students visualize the formula.

(2 x 3) x 5
B x h

So the number of blocks on the bottom layer/base is 6. There are five total layers of 6 blocks each. The total number of blocks will be 30.

Some students may understand the 2 x 3 x 5 dimensions by assembling only a corner of the prism (see illustration below) and may not need to complete the entire prism. This representation emphasizes the individual dimensions of vertical length, horizontal length, and height.



Pass out the handout and calculators to students. Tell them they are to determine different sizes of rectangular prisms that would be possible with the given volume (576 in^3). If inch cubes are available, it is helpful for students to visualize having 576 blocks to equal the given volume of the aquarium.

1. Students are to determine the area of the base and height for each aquarium having 576 in^3 of volume.
2. Students are to multiply to ensure that **B x h** is 576.
3. Students are to write express each volume as three dimensions.

Ask students what kind of strategies they might use in determining the dimensions using their calculators. Sample answers may include: guess and check and divisibility rules.

Sample answers appear in the table below. There are multiple answers; these represent only a few.

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

Area of the Base	Height	Volume	Three Dimensions
24”	24”	576 in^3	3” x 8” x 24”
64”	9”	576 in^3	8” x 8” x 9”
36”	16”	576 in^3	6” x 6” x 16”

Students may give dimensions like 576 x 1 x 1. While this is not an incorrect answer, ask them to think about the likelihood of a tank with these dimensions being built. It would be extremely long, very narrow, and very short. Encourage students to use their yard sticks/meter sticks to envision more realistic dimensions. This part of the lesson is intended to show the connection between the mathematics and the *real world*.

During class discussion, encourage students to share their answers and strategies. The two questions at the bottom of the handout offer real-world connections using basic math skills.

How many gallons of water would you need to fill your tank?

This is a division problem to determine how many 231 in^3 of space are in 576 in^3 of space.

$\frac{576\ in^3}{\frac{231\ in^3}{1\ gallon}}$ = 2.5 gallons of water to fill the 576 in^3 tank

How much would the water in your tank weigh?

This is a multiplication problem, or repeated addition.

$\frac{8\ lbs.}{gallon}$ x 2.5 gallons = 20 lbs. OR 8 + 8 + ½(8) =

16 + 4 =
20

Learn More:

http://www.thefutureschannel.com/ Selected free videos connecting mathematics to the real world

http://freshaquarium.about.com/od/aquariumsandstands/a/tanksizesweights.htm information about aquarium sizes

Created as part of *Making Real-World Connections in Mathematics*, a project of the Columbus Regional Mathematics Collaborative at Columbus State University through IMPROVING TEACHER QUALITY Higher Education funds administered by the University of Georgia.

Fish Aquarium Math

You have a volume of 576 in^3 for your fish aquarium. What are its possible dimensions? Record your dimensions in the chart below.

Area of the Base length x width (in^2)	**Height (in)**	**Volume (in^3)**	**length x width x height (in^3)**

Select an aquarium you would like to build. If there are $\frac{231\ in^3}{1\ gallon\ water}$ how many gallons of water would you need to fill your tank? Show your work.

One gallon of water weighs 8 pounds. How much would the water in your tank weigh? Show your work.