Measuring Volume

CONTENT STANDARD: Measurement

CONTENT TOPIC: Physical Science

CONCEPT: Quantitative attributes of matter such as mass, weight, volume, and length can be described.

CONTENT OBJECTIVE: To understand the concept of volume measurements.

INSTRUCTIONAL OBJECTIVES: The learner will:

- Define and measure volume
- Define and measure length and area
- Calculate volume (for 4^{th} and 5^{th} grades).

OUTLINE OF CONTENT:

I. All matter has volume
II. Measuring length
III. Calculating volume

GOAL: To enable students to acquire scientific knowledge by applying concepts, theories, principles and laws from science.

STANDARD(S): The learner will understand that:
Everything is constantly changing; rates of change vary over a wide scale with a great variety in patterns of change.

BENCHMARK: Some things may stay constant while others change.

Cycles of change can be extended in scales of time, space, and material.

BENCHMARK: Changes occur in various ways and may be altered by controlling some variables.

INFORMATION:

For K and 1^{st} grade emphasize **Volume is the measure of "stuff" that fills a space.**

Length: This concept is so basic that it is really impossible to define. However, people use other words like: "distance", "width", "height" etc. to express the same basic concept. Length can be

measured in feet, inches, miles, furlongs, light-years, etc. We will usually try to use meters and centimeters in the discussions that follow.

Area: Now that we know what "length" means (even through we couldn't really define it) it's easy to define "area". **Area is the number of square length units it takes to cover a surface.** Lots of people will say that "area is length times width." However this doesn't really give you the concept, rather, it tells you how to find it if you know something else (length and width) and it only works if the surface is rectangular. What if you want to find the area of the bottom of your shoe? The bold definition given above should force you to see a surface (perhaps the bottom of your shoe) covered with squares. When you are asked to find the area, you should think in terms of counting these squares.

Area can be measured in square meters, square centimeters, square kilometers, etc. Area could also be measured in square feet, square inches or square miles. We plan to stick to metric units in these discussions.

FYI: An **acre** is a unit of area and there are 640 acres in a square mile. A **hectare** is a metric unit of area and it is 100 meters by 100 meters. If you think about it you will discover that there are 100 hectares per square kilometer. Should you ever want to convert, there are about 2.47 acres per hectare. We plan to avoid all conversions in our discussions--we will just use metric units as though everyone liked them the best.

Volume: Again, once you know what length is, volume is easy. **Volume is the number of cubic length units it takes to fill a space.** The space can be any shape you want and if it happens to be a rectangular solid, you can find its volume *by multiplying length by width by height*. However if the space you are interested in happens to be inside of a football, then computing it might be difficult but the concept of volume is still the number of cubes it takes to fill the space. Volume can be measured in cubic meters, cubic centimeters, cubic inches, etc.

FYI: The **liter** is essentially the volume of a cube 0.1 meters on a side. If you think about it, you will see that it will take 1000 liters to fill a cubic meter. One thousandth of a liter is called a milliliter or "ml" and a milliliter is essentially the same thing as a cubic centimeter. For quick conversion purposes, a liter is about the same thing as a quart (which is a "quart"er of a gallon.)

The purpose of this activity is to learn about the basic concepts of length, area and volume. To understand what makes each of them different but also to see how they are related.

Remember that measurement is an important skill that students begin developing in the earliest years. It begins with non-standard units of length, volume, and mass. An important concept is that any *measurement is an estimation* to the nearest unit being used (inches, centimeters, pounds, grams, etc). The measurement tool and the unit will be determined by the attribute being measured and the purpose of the measurement. Students must be able to select and use a balance to measure mass and measuring cups or graduated cylinders for volume. When measuring

matter, *students should understand that all measurements have error* because one must always estimate the last reported digit. All instruments have limitations on their ability to measure.

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CLASSROOM CONNECTORS

TIME REQUIRED: 30 minutes

MATERIALS: Graduated cylinder, water, ruler and clay.

SET: Raise your hand if you know how tall you are. We live in three dimensional space which is often called "3D". Almost everything has three dimensions but some things, like a piece of string, have more of one dimension than than the other two. Something like a piece of paper or a picture has more of just two dimensions and most other things like people, houses and cars seem to be important in all three dimensions.

SUPERVISED PRACTICE:

1. Hand out one stick of clay to each sudent
2. Using the ruler measure the clay (length, height and width). Write down the answer
3. Using the graduated cylinder:
    a. Fill the cylinder with enough water to cover the clay. Write down the beginning amount of water in Liters
    b. Put the clay entirely under water and measure the amount of water
    c. Subtract the two amounts to find the volume
4. Using the clay allow the students to make any shape they desire with the clay:
    a. They must use ALL the clay
    b. The new object they create must fit in the cylinder to measure
5. Using the graduated cylinder:
    a. Fill the cylinder with enough water to cover the clay. Write down the beginning amount of water in Liters
    b. Put the clay entirely under water and measure the amount of water
    c. Subtract the two amounts to find the volume

CLOSURE:

1. Does the volume change when you change the shape of the clay? Why or why not?
2. How would you measure the length around the outside of a circle (called the circumference)? For example, how would you measure the circumference of a coin?
3. How would you measure the area of something with a strange shape like the bottom of your shoe or the surface of your hand?
4. How would you measure the volume of something like a bottle or a soft drink can?