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MEASUREMENT

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Measurement is a topic that often gives students problems and yet it is one of the most relevant and useful aspects of our curriculum. What makes measurement so difficult and what can we do to help our students master the skills and concepts necessary to become proficient in this area?

First we must understand what measurement is. John A. Van de Walle in "Elementary and Middle School Mathematics: Teaching Developmentally" states that "Measurement is a number that indicates a comparison between the attribute of the object being measured and the same attribute of a given unit of measure." Richard Cherry and Garland John Gates at the 6th Annual State-Wide Math Workshop, decided that measurement is "the application of a mutually agreed upon system (metric, standard, or arbitrary) used to quantify a trait (such as length, area, or volume)." Whatever definition we use, measurement remains a problem area in many adult education classrooms.

John Van de Walle gives us these BIG IDEAS needed to develop measurement concepts:

1. Measurement involves a comparison with a unit that has the same attribute as the item which is being measured (length, volume, weight, etc.) There are many ways to make these comparisons. To measure any thing meaningfully, the attribute to be measured must be understood.
2. Measurement instruments are devices that replace the need for actually measuring units in making comparisons.
3. Area and volume formulas are ways of using length measures to count more easily the area or volume units in an object without actually using area or volume units.

DISCUSSION OF THE TOPIC

Discussion can introduce new topics and help students build on prior knowledge. It is encouraged that the teacher discuss each topic to introduce it to the class. What is known about measurement? What problems do the students have? Students must realize that in order to measure something, they must:

- decide on the attribute to be measured
- select a unit that has that attribute
- compare the units by filling, covering, matching , or some other method with the attribute of the object being measured

Often students are not quite sure what the difference is between linear, square, and cubic measurements. Linear units are one-dimensional and are used for perimeter and circumference. Examples of linear units are inches, feet, yards, meters, or kilometers. Area units are two-dimensional and cover a flat space. Examples of area units are square inches, square feet or square meters. Volume or capacity is measured in three-dimensional units and describe how much can fill a space. Cubic units might be cubic inches, cubic feet or cubic yards. Identifying and writing the correct units is an important part of measuring correctly. It is important to have square inches, cubic inches, etc. for the students to see and hold.

MEASURING LENGTH

Make a ruler

Students are given a strip of paper, and asked to measure it using square inch tiles. How could we measure without the tiles? By marking our paper with the inch marks, of course! In a first

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ruler, the students can count the units. Numbers on the rulers will help students count the inches; numbers are often placed in the center of the units. When the numbers are placed at the *end* of each unit, the ruler becomes more standard and is actually a number line!

After students have made their own rulers, it is important to measure many things with them. A natural progress will be to add half inches and perhaps quarter inches as needed.

Make an enlarged inch

Using a large sheet of paper (8 ½ by 11 inch is a good choice) students can construct an enlarged inch. Fold the paper in half and indicate with a long line that the middle point is ½. By folding in half again, the student can mark off 1/4, 2/4, and 3/4 . (The 2/4 will be written under the ½.) Continue with eighths and sixteenths. Compare the enlarged inch with a standard ruler. Check to see how halves, fourths, eighths, and sixteenths are differentiated on the standard ruler. Are some of the lines longer than others? How many lines are in between each inch mark? Why are there only 15 lines *between* each inch?

Measure items with the enlarged inch. Desks, books, boxes, etc. are all good choices. Students should become accustomed to measuring with this enlarged inch before trying to measure with the standard ruler.

Establish benchmarks

Have students find an inch on their bodies (between two knuckles?) A centimeter (a fingernail?). Find a yard (often from the tip of the nose to the end of the hand). Find a meter. How wide is a hand? (Note: the standard hand measured sideways for horses is 4 inches including the thumb. How close is each student's hand to this standard measure?) How long is each student's foot? (Make sure to take shoes off!) An extension to this activity is to compare length of feet to shoe sizes. How is shoe size determined? Make a graph with the class results. Bring in measurements of family members and/or other students in the building to increase the database.

Estimate measurements

How big is the room? Can the students estimate the length, width, and height of the room? What different ways can be used to estimate these measurements? Are there standard room heights? Standard door heights? Students should be encouraged to *use benchmarks, chunk, use subdivisions, and iterate a unit mentally or physically.* It may be easier to use *chunks* such as windows, cabinets, etc. Or if a wall is completely blank, *subdividing* it mentally in half, then in fourths and even eighths may help the students reach a manageable unit to estimate. A student might *iterate* single units such as bricks or even another student's height. By knowing how long one's foot is, it is possible to pace off one-foot lengths.

It is important to discuss the different ways used to estimate. Students can measure to check their estimates but this should not be the focus.

MEASURING AREA

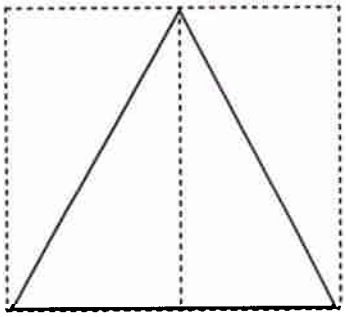
Build a model

Using square tiles, build different sized rectangles to explore. Students can compare perimeter and area; although the same dimensions are used, perimeter and area are not the same. Students can explore the idea that the closer one gets to a square figure, the smaller the perimeter will be for a given area.

Build a square foot with the square inch tiles and then cut one out of cardboard. Since a square *anything* is a square that is *anything* on each side, a square foot, must be one square foot (or twelve inches) on each side. Students can see that it would take 144 square inches to fill in each one square foot. Nine square feet can be put together to model a square yard.

Develop formulas

Using graph and/or grid paper, cut out a rectangle and compare the formula on the formula sheet to the dimensions of the figure as well as the square unit. Do the same for a square (and be sure to discuss the difference in the formulas). Finally take a rectangle and or square and cut it in half. Decide why the formula for a triangle is ½ bh. Make a triangle such as below:



Can the student "see" the rectangles that each side can form? Remember that relying on formulas with no understanding of where those formulas come from is the road to misunderstanding!

MEASURING VOLUME

Build a model

Using a grid or graph paper, build a one-layer structure using cubes. Note that the volume would be length times width times one since there is one layer. Now add a layer. Note that the new volume is length times width times two since there are two layers. Continue to build different rectangular solid structures using the cubes.

Determine volumes

Using a cubic inch, students can estimate and measure volumes of a variety of boxes and/or items in the classroom such as a briefcase or file cabinet.

Establish benchmarks

Have each student hold the cubic inch to feel its size. A cubic inch block is a very useful instrument to help students understand volume. A cubic foot can be built using six of the square feet that were cut from cardboard. Students can see that it would take 1728 cubic inches to equal one cubic foot! Note: A cubic foot is approximately the size of a gallon of milk. A cubic yard can be compared to the size of an average washing machine.

MEASURING TIME

Have students stand with their eyes closed. Have them sit down when one minute has passed. Keep track of the times that each student sits down. Discuss the one thousand one, one thousand two, method.

MEASURING ANGLES

Use a paper plate circle graph
Put two paper plates that are exactly the same except for the colors together, by cutting one radius on each and fitting them together. The plates can be rotated to show angles, fractions, decimals, and percents.

Make a protractor
Cut a basket coffee filter in half. Fold the filter in half and mark the fold with a magic marker and the measure of 90 degrees. Fold in half again to indicate 45 degrees. The filter may have creases. Students can figure out how many degrees each crease indicates. These can be drawn on the filter also. Compare your coffee filter protractor with a standard protractor. Practice measuring various angles with the coffee filter protractor. Paper can be cut out or angles can be drawn on paper to be measured. The "protractor" can be set over the angle to be measured since it is translucent.

Use benchmarks
The 90 degree angle is the easiest to use as a benchmark. Every piece of standard paper has four 90 degree angles that can be fitted into any angle to be measured.

BIBLIOGRAPHY

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