March 12-14, 1998

Let's Measure!

Grade Level: Third **Presented By:** Heather Arabie

Length of Unit: 10 lessons and 1 culminating activity

I. ABSTRACT

Through this extensive study of measurement students will gain a better understanding of linear measurement, weight(mass), and capacity.

The activities in this unit are designed to encourage all learning styles. Hands-on activities, use of manipulatives, and cooperative grouping easily lend themselves to modifications in the general education classroom. Through peer-tutoring and teacher-led small group instruction, all students will feel successful as their understanding of measurement expands.

The lessons also enable the teacher to teach standardized test objectives in real-life applications. Concepts, such as reasonableness and understanding measurements in metric and standard units, are found throughout the unit.

II. OVERVIEW

A. Linear measure

1. make linear measurements in feet and inches, and in centimeters

2. know that one foot = 12 inches

3. know abbreviations: ft, in.

4. measure and draw line segments in inches (to inch), and in centimeters

5. estimate linear measurements, then measure to check estimates

B. Weight (mass)

1. compare weights of objects using a balance scale

2. estimate and measure weight in pounds, and know abbreviation: lb.

C. Capacity (volume)

1. estimate and measure capacity in cups

2. measure liquid volumes: cups, pints, quarts, gallons

3. compare U.S. and metric liquid volumes: quart and liter (one liter is a little more than one quart)

III. BACKGROUND KNOWLEDGE

A. Burns, Marilyn. About Teaching Mathematics; Drean, Tamara J. and Souviney, Randall J. Measurement Investigations; Sonnenberg, Victoria. Metric and Standard Measurement

B. Students should be familiar with measuring in inches and centimeters from second grade.

IV. LITERATURE RESOURCES

Adler, David A.,3D, 2D,1D

Anno, Mitsumasa, Anno's Math Games

Ault, Roz, Kids are Natural Cooks

Branley, Franklyn M., How Little and How Much

Briggs, Raymond, Jim and the Beanstalk

Carle, Eric, The Grouchy Ladybug

Douglass, Barbara., The Chocolate Chip Cookie Contest

Gerstein, Mordicai, The Sun's Day

Hoban, Tana, Is It Larger? Is It Smaller?

Of Colors and Things

Hutchins, Pat, Clocks and More Clocks

Johnston, Tony, Farmer Mack Measures His Pig

Kalan, Robert, Blue Sea

Krauss, Ruth, Big and Little

Krementz, Jill, The Fun of Cooking

Kroll, Steven, The Biggest Pumpkin Ever

Leaf, Munro, Metric Can Be Fun

Lexeu, Joan, Archimaedes Takes a Bath

Lionni, Leo, Inch by Inch

Lopshire, Robert, The Biggest, Smallest, Fastest, Tallest Things You Ever Heard Of

MacGregor, Carol, The Fairy Tale Cookbook

Marshall, James, Yummers

McCloskey, Robert, Journey Cake, Ho

Myller, Rolf, How Big is a Foot?

Neasi, Barbara, A Minute Is a Minute

Olney, Ross and Patricia, How Long? To Go, To Grow, To Know

Parker, Nancy Winslow, Love From Aunt Betty

Polacco, Patricia, Thundercake

Thompson, Brenda, The Winds that Blow

Titherington, Jeanne, Big World, Small World

Tresselt, Alvin R., How Far is Far?

(Resource list from "Linking Mathematics and Literature" by Lori Downey)

V. LESSONS

A. Lesson 1: How Big is a Foot?

1. Objectives: The students will:

a. think about ratio and proportion and compare non-standard forms of measurement

b. write about their mathematical solutions for non-standard measurement

2. Materials:

a. How Big Is a Foot? by Rolf Myller

b. writing paper

3. Prior Knowledge for Students: Because this is an introductory lesson for measurement, very little prior knowledge is required. The students should be familiar from second grade with measuring in feet, inches and centimeters.

4. Key Vocabulary:

a. apprentice

b. feet

c. long

d. wide

5. Procedures/Activities: This lesson, which will take approximately two days, was

adapted from Math and Literature by Marilyn Burns pp. 49-53.

a. Summary of How Big Is a Foot?: This story takes place "Once Upon a Time" when beds had not been invented. A king wants to give the queen something to sleep on for her birthday. He tells the queen to lie down on the floor. Then, using his own feet as a measure, he paces around the queen to find the length and width of the "bed" he wants built. The king tells his apprentice the bed should be 6 feet long and 3 feet wide. The apprentice measures the wood with his own feet (which are much smaller than the king's feet) and creates the queen's bed. When the bed is finished, it is too small, and the angry king throws the apprentice into jail. After the apprentice thinks for a long time about the problem of the bed, he figures out a solution and makes a new bed. This bed is the right size for the queen and is ready just in time for her birthday. The king is so happy he frees the apprentice and makes him a royal prince.

b. Begin to read How Big Is a Foot? to the students, stopping on the page where the apprentice goes to jail.

c. Have the class offer solutions for the apprentice's problem.

d. Then have the students write a letter to the apprentice expressing concern and advising his how to solve his problem.

6. Evaluation/Assessment: Day Two

The students may need to spend more time writing their letters on the second day. Share letters as a class. Base evaluation on the understanding each student has expressed in his/her letter: They understand the problem if they suggest that the apprentice should use his feet to measure the queen first and then make the bed, or that he should use the length of the king's foot to measure the materials for the bed and then make the bed.

Modification: Using cooperative groups, have the students brainstorm a solution to the apprentice's problem and have one person in each group record the letter. At sharing time, another student from the group can share the group letter.

7. Extension Activities:

a. The king used his feet to measure the queen's length. What else could the king have used to measure the queen?

b. Have the students trace around their feet or shoes on a piece of paper. Have them cut out the foot and use it to measure various items in their classroom. Have them estimate the measurement first.

B. Lesson 2: Nonstandard Measuring

1. Objectives: The students will:

a. estimate nonstandard measurements

b. measure various objects using nonstandard forms of measuring

c. understand why we need a standard form of measurement

d. understand why we need various forms of linear measurement (inch, foot, yard, etc.)

2. Materials:

a. Popsicle sticks

b. Unifix cubes or Multilink cubes

c. Record sheet (Appendix A)

d. Book shelf

e. Table

f. Coat

3. Prior Knowledge for Students: how to work in pairs or cooperative groups.

4. Key Vocabulary:

a. height

b. length

c. width

5. Procedures/Activities: This lesson, which should take one day, was adapted from Box It or Bag It Mathematics.

a. Remind students of the problem with measurement in the How Big Is a Foot?. (The king and the apprentice both used their feet to measure, but they had different sizes of feet.)

b. Explain that today students will be estimating and the using popsicles sticks and cubes to measure various objects around the room.

c. Pass out the record sheet and explain the objects that the students will estimate and then measure (the length of a bookshelf, the width of a door, the height of their partners, the length of a table, and the height of a coat).

d. Divide the class into groups of two. Have the students estimate and measure the objects listed on the activity sheet.

6. Evaluation/Assessment: Discuss the measurements the students came up with using popsicle sticks and Unifix cubes. Talk about how their estimations compared with the actual measurements. Ask the students about difficulties in measuring large objects with small forms of measurement, e.g. using Unifix cubes to measure the length of a table. rainstorm measuring tools that would make it easier to measure large objects. This will lead into the next lesson of measuring objects using inches, feet, yards, centimeters, and meters.)

Base evaluation on the accuracy of the measurements on the record sheet.

C. Lesson 3: Fall Colors by the Yard (Standard Measurement)

1. Objectives: The students will:

a. estimate linear measurements

b. measure to the inch and half-inch following written directions

c. know that 1 foot = 12 inches; 1 yard = 36 inches; 3 feet = 1 yard

2. Materials:

a. Rulers marked with the inch and half-inch

b. Yard stick

c. 3" x 36" strips of white paper (one for each student)

d. Crayons or markers

3. Prior Knowledge for Students: Review what the students learned in the second grade about measuring in feet and inches; 1 foot = 12 inches; and measuring to the inch.

4. Key Vocabulary:

a. inch

b. half-inch

c. foot/feet

d. yard

5. Procedures/Activities: This lesson, adapted from Bright Ideas for Teachers should take one day to complete.

a. Give each student a 3" x 36" strip of white paper.

b. Review yesterday's discovery of needing different sizes of standard measurement. Display the yardstick and ruler. Explain that the paper strip is the length of the yardstick. Discuss objects that you might measure using a yardstick (football field, buildings, playground, etc.) and with a ruler (tabletops, people, etc.). Display a ruler and discuss how many inches are in a ruler. Compare the ruler to the yardstick and show how many feet are in a yard. Continue discussing which measuring tool would be appropriate for various objects. (Inches could measure pencils, chalk, desk tops; rulers/feet could measure room length, swing sets, tabletops, etc.)

c. Write the following directions in a chart on the chalkboard or overhead projector for decorating the paper strips with crayons or markers. (If teaching this unit a season other than fall, modify accordingly.)

2 inches Write you name in your favorite color.

5 inches Draw a colorful fall leaf.

8 inches Write "FALL IS HERE!" in fall colors.

4 inches Make a brown, gold and orange design using circles.

5 inches Make a red, yellow, and gold design using triangles.

6 inches Make a design using circles, squares, and triangles in three different colors.

5 inches Draw a pumpkin patch.

d. After students complete their "Fall Yards" display them with their corresponding segments lined up.

6. Evaluation/Assessment: If the students measure the segments accurately, their "Fall Yards" should be completely filled and all the segments should match up as a class when displayed.

D. Lesson 4: Jim and the Beanstalk

1. Objectives: The students will:

a. estimate linear measurements in inches and centimeters

b. make linear measurements in inches and centimeters

c. know that 1 meter = 100 centimeters and 1 meter is a little more than a yard

2. Materials:

a. Jim and the Beanstalk by Raymond Briggs

b. String

c. Rulers with centimeters and inches markings

d. Meter stick

e. Record sheet (Appendix B)

3. Prior Knowledge for Students: The students should be familiar with measuring in centimeters from the second grade.

4. Key Vocabulary:

a. Metric System

b. Standard or Customary System

c. centimeter

d. circumference

5. Procedures/Activities: This lesson, which should take one day to complete,

was adapted from Math through Children's Literature.

a. Summary of Jim and the Beanstalk: One morning Jim discovers a huge beanstalk outside his window. He decides see where goes. When he reaches the top, he finds a great castle. Since he was hungry, he goes to the castle for food. When he knocks on the door, a very old giant answers. Since the giant doesn't have any more teeth, he doesn't feel like eating Jim and shares his breakfast with him instead. The giant seems very sad and Jim asks him why. The giant explains can't see very well and can't read his favorite poems. Jim decides to help the giant. He measures the giant's head and has special, giant glasses made for him. The giant is very grateful, but is still sad because he can't eat much because he had no teeth. Jim measures the Giant's mouth and has false teeth made for him. The Giant loves his new teeth, but is still sad because he is quite bald. So Jim measures the Giant's head for a wig. The Giant is so happy and grateful to Jim he give him a giant gold coin and tells him to go home quickly and chop down the beanstalk just in case the Giant felt like eating his favorite dish, fried boy!

b. Read Jim and the Beanstalk to the class.

c. Have the students experiment measuring body parts of various sizes.. Demonstrate with a student using string to measure the circumference of his/her head. Wrap the string around the student's head, cut the string, estimate and measure that string using centimeters and inches, and record their head measurement on the record sheet. Discuss the similarities and differences between inches and centimeters and standard form of measurement and the metric system. Be sure the students understand that the standard and metric systems are NOT the same, but they have similar measurement units.

d. Using partners, have the students use string to estimate and measure in the same manner the circumference of their heads, waists, wrists, ankles, head to toe, and fingertip to fingertip (stretching out arms on either side). Record data on the record sheet.

6. Evaluation/Assessment: Monitor the peer work as they measure, checking the students understanding of the various linear measurements of the string. Make sure if they are measuring inaccurately, they check the reasonableness of their answers ("Does that number of inches/centimeters makes sense for the size of your ankle?").

7. Extension Activity: After the students record their data, create two graphs as a class (one in inches and one in centimeters), showing one of the above measured body part's various sizes among the class.

E. Lesson 5: Magnified Inch

1. Objectives: The students will:

a. estimate linear measurement

b. measure and draw line segments in inches (to 1/4 inch)

2. Materials:

a. 81/2" x 14" white paper

b. Rulers with inch and centimeter markings

3. Prior Knowledge for Students: The students should be familiar with measuring to the inch from the second grade.

4. Key Vocabulary:

a. fractions

b. millimeters

5. Procedures/Activities: This lesson, adapted from Family Math, should take one day to complete.

a. Pass out the 81/2" x 14" paper to the students.

b. Have them look at the small markings in between the inch markings on their rulers. Compare these markings to millimeters and centimeters. Discuss why these small measuring marks are needed in real life. (A Lego piece may need to be 3 inches long to fit in a fort you're building and a piece just 3 inches long wouldn't fit.)

c. Explain to the class that the length of 1 inch has been magnified to the length of their piece of paper. Have the students follow these directions:

(1) Fold the paper in half end to end. (How many sections does your paper have?)

(2) Draw a line along the fold about 3 inches long.

(3) Write under your line to show that it is of the way along the paper. (Compare your paper to your ruler.)

(4) Fold your paper in half again.

(5) Draw a line about 2 inches long on each new fold.

(6) The first line is 1/4 of the way along the paper. Write 1/4 under it.

(7) The next line is 2/4 or of the way along.

(8) The third line is 3/4 of the way along. Write 3/4 under this line.

(Compare your paper with ruler's markings.)

d. After discussing the markings on the ruler as a class, have the students measure using their ruler and draw line segments and form various shapes of the following lengths on a piece of paper (they may use the "Magnified Inch" to practice measuring on a larger scale):

(1) a square with sides the length of 2 inches each

(2) a triangle with sides the length of 3 1/4 inches each

(3) a five-sided shape (pentagon) with sides the length of 1 3/4 inches each

(4) a square with sides the length of 4 inches each

(5) a triangle with sides the length of 6 1/4 inches each

(Continue to have the students measure and draw as many shapes and line segment lengths as needed to master measuring to the 1/4 inch.)

6. Evaluation/Assessment: Decide on exact measurements of line segments and shape sizes for the students to construct. Create an answer key by constructing the line segments and shapes on tag board and cutting them out. Place the cut out shapes over their drawn shapes to check for accuracy.

7. Extension Activity: Continue this activity by folding the paper in 1/8, 1/16, 1/32, etc. sections and measuring line segments and shapes accordingly.

F. Lesson 6: What is Weight?

1. Objectives: The students will:

a. define weight and mass and recognize the difference between the two

b. become familiar with the Law of Conservation of Mass

2. Materials:

a. Various pictures of astronauts, space, and earth

b. Heavy aluminum foil

c. Small basin

d. Water

e. Scissors

f. Balance scale (optional)

g. Appendix C

3. Prior Knowledge for Students: The students should have a basic understanding of the concept weight: they should know, for example, that a book is heavier than a pencil.

4. Background Knowledge for the Teacher: All objects have gravity pulling them towards the center of the Earth. Weight is the measurement of that force on an object. Mass is the actual quantity of matter or material in that object. Weight and mass are often used interchangeably. In most cases, there will be little difference between weight and mass. However, because weight is the measurement of gravitational force on an object, the farther one is away from the center of the Earth the less one weighs. This is why astronauts appear "weightless" in outer space. Therefore, the mass of an object remains constant regardless of the object's location.

The Law of Conservation of Mass states that an object's mass will remain constant if nothing is created or destroyed. Therefore, changing the shape or size will not change the mass. Students will need this law when they are estimating the mass of the same object in different shapes.

5. Key Vocabulary:

a. mass

b. weight

c. Law of Conservation of Mass

6. Procedures: This lesson will take one day to complete.

a. Display pictures of astronauts in space (be sure to have some pictures that show the astronauts floating and some pictures that don't).

b. Put the students in cooperative groups to generate a list of all the differences between space and Earth.

c. After the students have had enough time, come together as a class for discussion.

d. Have one member from each group use a self-adhesive paper note to share at least one of their ideas on a class diagram.

e. Continue until it is suggested that a person will "float" in space and not on Earth

f. When the students recognize this concept and agree that it is true, begin discussing the difference between weight and mass.

g. Be sure that students understand that the mass of an object will always stay the same no matter where it is and that the weight can change.

h. Introduce the concept of the Law of Conservation of Mass. Use the demonstration of a whole piece of paper and then tear it in two. Because only the shape changed and nothing was destroyed the mass of the paper stays constant.

7. Activity:

a. Give each student a piece of heavy aluminum foil.

b. Have the students fold the foil in half evenly.

c. Once in half, have the students use the fold to cut out a pair of identical rectangles.

d. Ask the students if they will agree that these two pieces are equal in weight. Be sure that the rectangles are a perfect match to create the understanding that the weight is equal. If necessary for better understanding, use a balance scale to weigh one pair of rectangles as a demonstration.

e. The student should fold one rectangle into a small ball. It is very important that the ball be as tight as possible with no air pockets. Fold the other rectangle into a small boat.

f. Have the students use their Record Sheet (Appendix C) to record predictions of what will happen when each piece is placed in water.

g. Students should place the boat and the ball in a small basin of water.

h. If the ball is folded correctly it should sink and the boat should float.

i. Remove the boat and ball from the water and ask the students if their mass is the

same. Ask the class to generate solutions for why the ball sank and the boat floated if the mass of the two is the same.

j. Have the students unfold the foil and place them on top of one another to show that nothing was created or destroyed.

k. Review the concept of the Law of Conservation of Mass and how it applies to the experiment.

(This activity was adapted from Measurement Investigations by Tamara J. Drean and Randall J. Souviney.)

7. Evaluation/Assessment: Students will complete the Record sheet.

G. Lesson 7: Why Do We Need the Balance Scale?

1. Objectives: The students will:

a. recognize the need for a balance scale

b. understand the need for a consistent form of measurement

c. compare weights of objects using a hand-made balance scale in nonstandard measurements

2. Materials:

a. Various rocks students bring from home

b. Candy of choice

c. Balance scale

d. Appendix D

3. Prior Knowledge for Students: The students should be familiar with the balance scale.

4. Background Knowledge for the Teacher: In ancient times if people wanted to trade items, there had to be a way to determine if the trade was "fair." Probably, the first type of measurement was handfuls. Weight was a very difficult thing for ancient civilizations to measure. The first system of weighing probably developed from how much a person or container could carry. However, this system made consistency difficult because the size of the object being measured could change. The people often confused size and amount with weight.

People began comparing objects in their hands. They would guess which was heavier or lighter by taking the objects in each hand and estimating. About 7,000 years ago the Egyptians came up with a very simple balance scale. A stick would hang by a cord tied in the middle. There would also be cords tied at each where the objects to be weighed were hung. If the weights were about equal the stick would be parallel to the ground. If one object was heavier, the stick dipped at that end. Many civilizations, including the Romans, adopted and improved this scale, .

Once there was a device that could measure weight, there needed to be a standard

weight to use. People knew that any object used as a standard could not change in basic size or shape from place to place. The first known standard weight object was a grain of wheat. By using the grain, tradesmen were sure that wherever they journeyed to trade, the amount would be about the same as it was in their homeland. The grain is still used today when measuring medicines! Ancient Romans, had standard weights throughout the empire. The weights were used in all lands conquered by the Roman Army, which caused the spread of Roman weights and measures in Europe, Western Asia, England, and Africa.

The Roman scale was similar to the Egyptian scale. Both had a center rod with two trays hanging from either end. The Roman Scale also had a pointer that showed when the trays were balanced.

5. Key Vocabulary:

a. balance

b. heavy

c. light

d. parallel

6. Activities/Procedures: This lesson will take 1-2 days to complete.

a. Have each student bring rocks in a variety of sizes to class from home, playground, etc.

b. Have children get into small groups to choose the best rock from their group. Tell them to look at all of the features: color, shape, smoothness, and size. Create an atmosphere that encourages a variety of sizes that could be "best."

c. Label each group's rock so that you know which rock belongs with which group.

d. Tell the groups that you are going to use their rocks as the standard unit equaling 1. Without telling the students what you ding, use the stone as 1 and balance the scales with candies of your choice. Separate the candies so that the students begin to realize that their rock is going to determine the amount of candy their group will receive. Exaggerate the differences to ensure that the children feel the "unfairness."

e. Discuss with the students why this is so unfair. Have the groups resume work to discover a way to make a fair measurement.

f. Come back together and discuss their ideas. The main point that you want to get across to the students is that a fair measurement must be consistent from place to place.

g. Introduce the grain of wheat as the first known standard. If you can find a real grain of wheat, it would be a great addition!

h. Tell the students that today they will be making a standard balance scale. They will also be measuring various items using the toothpick as their standard unit of measurement.

TO BUILD THE ROMAN BALANCE:

Each child will need: 2 identical plastic cups, 1 ft. ruler, hole punch, string, scissors,

bendable coat hanger, 2-3 heavy books, desk or table.

(1) Make a string loop.

(2) Slide it onto the ruler, and tape the loop at the 6-inch mark.

(3) Punch 3 equally spaced holes around the rim of each cup.

(4) Cut 6, 16-in. string segments.

(5) Thread a piece of string through each hole in both cups, tying a knot just below the rim. Be sure the knot is big enough that it won't slip through the hole!

(6) Bring the three strings for the first cup together.

(7) Form a knot that leaves 3 inches of excess string.

(8) Tie a knot using the free ends to form a loop.

(9) Slide the loop onto the ruler and tape it down at the 1-inch mark.

(10) Repeat above process with the second cup, taping it down at the eleven-inch mark.

(11) Take the coat hanger and bend the hook to make a 90-degree angle with the rest of the hanger.

(12) Lay the hanger flat on the table with the bent hook hanging over the edge.

(13) Place the heavy books on top of the hanger to hold it in place.

(14) Place the center loop (6-in. loop) onto the hanger's hook.

It is very important that after the cups stop swaying that the cups are level and the ruler is parallel to the floor. If the cups aren't level: adjust the length of the string. If the ruler isn't level: adjust the string loop or the hanger's hook.

i. Explain to the students that they will now use their balance scales to measure various objects.

j. Just as the people of ancient times used grain or other weights, today they will use toothpicks as the "fair" unit of measurement. Stress that no matter where you buy your toothpicks, they will be about the same size!

k. Be sure to caution students to use light objects that will not break the scale.

7. Evaluation/Assessment:

Record sheet (Appendix D) of estimates and actual toothpick weight.

Suggested Journal Questions:

a. Why is it important to have one unit that all people know?

b. Why was weight a difficult concept to understand and measure?

c. What device did people invent to accurately measure weight?

d. Who invented it?

This activity was adapted from Measuring Up! by Sandra Markle.

H. Lesson 8: Pounds, Ounces, Kilograms, Grams

1.Objectives: The students will identify:

a. pounds, ounces, kilograms, and grams and their abbreviations as the units to measure weight and mass

b. estimate and measure weight in these units

c. identify reasonable measurements to use with various objects

2. Materials:

a. Balance scales

b. Custom and metric standard weights

c. Various objects to use in weighing

d. Appendix E-1

e. Appendix E-2

3. Prior Knowledge for Students: The students should be familiar with the units used to measure weight.

4. Background Knowledge for the Teacher:

Names for units of measure have an interesting history. Our standard unit for weight is the avoirdupois pound, which by definition contains 16 ounces. But the abbreviation for pound, lb., and the word "ounce" come from Latin, from the standard Roman system of weights. The Roman pound was called a libra, hence the abbreviation lb. The libra was divided into 12 parts. These parts were called ounces, the word ounce meaning " a twelfth part." Today although our pound is divided into 16 equal parts, we still call these parts ounces. Also we still have a pound, called the "troy pound," that contains 12 ounces. We use Troy pounds and Troy ounces when measuring precious metals.

The kilogram is the standard unit for weight in the metric system. Antoine Lavoisier first discovered the kilogram by filling a 1,000 cubic centimeter with water. The prefix "kilo" means 1,000. The word "kilogram" means 1,000 grams. Recall that the first standard weight was the wheat grain. 15.432 grains equal 1 gram. There are 2.2 pounds, avoirdupois, in 1 kilogram.

The abbreviations for this lesson are: pound = lb.; ounce = oz.; kilogram = kg; gram = g.

Here are some helpful rules to remember when making METRIC abbreviations.

- Do not capitalize except when using Celsius (Liter can be L or l. Gram is g not G).

- Do not use plural forms (8 kg not 8 kgs).

- Do not put a period at the end of the abbreviation unless it is the end of a sentence.

5.Key Vocabulary:

a. pound

b. ounce

c. gram

d. kilogram

6. Procedures/Activities: This lesson should take one day to complete.

a. Discuss where we got the terms pound, ounce, kilogram, and gram. Tell the various amounts in each: 1 lb. =16 oz., 1000 g=1 kg, about 2.2 lbs. =1 kg.

b. Display these terms, amounts, and their abbreviations in the room where they can easily be seen throughout the entire unit.

c. Have a balance scale at the front of the room to provide a brief demonstration to the students.

d. Review with the students that when the arrow is on the zero, the items are balanced. Tell them that instead of using stones, toothpicks, etc. today you will be using customary weights that are sold all over the world to ensure accuracy and "fairness."

*NOTE: If your school does not have commercial customary weights, try calling a high school or middle school science department in your district. Or try to make standard weights. Find an object that weighs one pound. Place it in one of the trays. Use a small container and fill it with rice until it equals one pound. Repeat this process with kilogram. An ounce equals 437.5 grains and a nickel weighs about 5 grams.

e. As a teacher demonstration, weigh several example objects using the various units . Make predictions as a class and then compare your predictions with the measurements. After the objects have been weighed, allow the students to hold the items to get the "feel" of an object that weighs 1 pound, etc. Be sure to monitor for understanding during this time. Let students know that they will be using these measurements also.

*NOTE: By using all four standards in the same lesson, the students will have a better understanding of the similarity between pounds, kilograms, ounces, and grams. One of the goals of this lesson is for students to identify which measurement would be more reasonable to use in different situations. Another goal is for the students to understand relationships between standard measurements, for example, that if something weighs 4 kg it is about 8 lbs.

f. Display several items for the students to look at but not touch. Be sure that the objects vary in size and shape. Some should be small but heavy, others large but light: Styrofoam, balls, small bags with heavy stones, large bag with cotton filling.

g. Have the children work in cooperative groups to estimate the weight of 3 objects. Be sure you have enough objects that each group will receive about 6 objects. If possible use the same items in each group. Have the students record their estimates on the

Record Sheet (Appendix E-1). When estimates are done, pass out the balance scales and allow the students to weigh their items.

*NOTE: There are two ways that this can be done, depending on the advancement of your students. One way is to be sure that most of the objects are near a whole number measurement to avoid the confusion ascertaining pounds and ounces. Another way is to allow the children to use only ounces when measuring and then work together as a class to convert something that is 20 oz. to 1 lb. 4 oz.

h. Students measure three objects using pounds and ounces. Record these measurements on the Record Sheet.

i. Have students estimate the mass of the remaining three objects using kilograms and grams. Record results on the second Record Sheet (Appendix E-2). Remember to use at least one heavy item because it takes about 2 lbs. to equal 1 kg.

j. Come back together and discuss differences. Review by selecting various items in the class and guessing which unit would be reasonable to use to weigh it and about what the weight would be.

(This activity was adapted from Measurement Investigations by Tamara J. Drean and Randall J. Souviney.)

7. Evaluation/Assessment: Evaluation is based on the accuracy of the record sheets (Appendix E-1 and E-2) of estimates and weights.

Suggested Journal Questions:

a. What are the standard measurements for weight and mass that we use in the world?

b. What are their abbreviations?

c. Estimate how much each of the following would weigh: dog, penny, desk, pencil.

8. Extension Activity: To show a relationship between customary and metric units, have the students re-measure items using the unit of measure they did not use earlier. For, example, if they used pounds earlier to measure a book, they should now use kilograms. This could be done cooperatively or as a class.

I. Lesson 9: The Volume in Your Mouth!

1. Objectives: The students will:

a. identify the meaning of capacity/volume

b. estimate and measure items and their capacity using nonstandard units

2. Materials:

a. Variety of familiar, plastic containers that range in size

b. Water

c. Rice

d. Mini-marshmallows

e. Appendix F

3. Prior Knowledge for Students: The students should be familiar with the concept of capacity.

4. Background Knowledge for the Teacher:

Volume and capacity are the measurements used to describe the inside of a container. The definition of volume is the measurement of space occupied by anything. The definition of capacity is the amount a container holds. An object such as a brick has volume but no capacity. People began measuring volume, as they did with weight and mass, using natural objects like eggshells. But, because eggshells could differ in size, it became necessary for people to develop a standard unit.

The Babylonians were the first to develop a standard unit for measuring capacity. They used a hollow cube with specific linear measurements and filled it with water. This gave them the first unit of capacity. A cube filled with water is still used today as a standard unit of capacity.

The study of volume corresponds well with a unit on matter because all matter takes up space. The amount of space occupied is the volume.

5. Key Vocabulary:

a. capacity

b. volume

c. full

d. empty

6. Procedures/Activities: This lesson should take one day to complete.

a. Have several containers at the front of the room that vary in capacity. Try to use bottles that are short and fat, long and slender, as well as bottles that are familiar to the students.

b. Work as a class to order the bottles by capacity. Be sure that labels are removed so that the students can not see the capacity listed on the label.

c. Once the bottles have been put in order, fill the bottle that is predicted to hold the largest amount to the top with rice. Use a black marker to show the full capacity.

d. Use the rice from the largest bottle to fill the next largest bottle. Using a different color marker, make a mark to show the point at which the container is filled with rice. Talk with the students to determine if this container is filled to capacity. Repeat with the remaining bottles. Be sure always to use rice from the first (largest) bottle. The main point for the children is that if the rice from one container overflows when poured into a new container, the first container has a larger capacity. If the rice does not come to the rim or top of the container then the first container has a smaller capacity.

e. Rearrange the bottles, if necessary, in the correct order from largest to smallest. It is important that the order does change from the original order so that the students

understand that looks can be deceiving.

f. Relate to the students that they have just determined the capacity of the bottles. Discuss the difference between capacity and volume. Use the vocabulary terms throughout the lesson so that the students become familiar with their meanings.

g. Students will work to find out who has the biggest mouth in the room!

Put the students with partners. Have each student estimate how many mini-marshmallows it will take to fill their own mouths to capacity. Students record this observation on Appendix F. Partners should also estimate each other's mouth capacity by looking into their partner's open mouth. Record this observation also.

h. When all estimates are done, pass out a generous handful of mini- marshmallows to each student. Tell them that their mouths are filled when their lips can barely close and no eating until all of the work is done. Have students begin filling their mouths with the marshmallows. Make a large class chart that shows each child's name and the capacity of marshmallows his or her mouth can contain.

(These activities were adapted from Measurement Investigations by Tamara J. Drean and Randall J. Souviney.)

7. Evaluation/Assessment: Use the class graph and Record Sheet (Appendix F) as a discussion/assessment tool. Review what capacity and volume mean. Also discuss how various containers may have capacities larger or smaller than expected.

J. Lesson 10: Cups, Pints, Quarts, and Liters

1. Objectives: The students will:

a. define and describe cups, pints, quarts, gallons, and liters

b. know that 1 quart = 2 pints; 1 gallon = 4 quarts

c. identify the liter as the metric form of liquid measure

d. compare metric and customary liquid amounts

2. Materials:

a. Cup, pint, quart, gallon, and liter containers

b. quart milk cartons for each student

c. rice or water

d. various containers used for measuring

e. Appendix G

3. Prior Knowledge for Students: The student should have a general v understanding of the terms used to describe amount of capacity.

4. Background Knowledge for the Teacher:

The gallon is the oldest standard used in measuring liquid. The word "gallon" comes from an Old Gallic word for "bowl." A gallon has eight parts called pints. When gallon was first defined, it was defined as the volume of eight pounds of wheat.

When we learned about mass and weight, one of the terms we discussed was ounce. A fluid ounce is the capacity that will hold the amount of water weighing one ounce. There are twenty fluid ounces in one pint. There are two cups in a pint.

The word quart is short for " a quarter part." When measuring in liquids, a quart is one fourth of a gallon. One quart is equal to two pints. There are four cups in a quart.

The liter is the metric standard used to measure volume. A cubic meter is the standard used to make one liter. One liter is equal to 1.76 pints. The volume of one kilogram of water is equal to one liter.

5. Key Vocabulary:

a. cup

b. pint

c. quart

d. gallon

e. liter

6. Procedures/Activities: This lesson should take one day to complete.

a. Place before the students the following labeled containers: 1 gallon, 1 quart, 1 pint, 1 cup, and 1 liter.

b. Discuss where they have seen these objects before.

c. Review the need for a standard form of measurement discussed in previous lessons. Discuss that the need is the same with liquid measurements.

d. Display a large chart that contains all of the measurements and their amounts.

e. Using water (or rice if your container is not waterproof) show several examples of the relationships between the different containers.

f. Distribute one-quart milk cartons to each student. If there is time, it might be fun to decorate the cartons.

g. Have three or four containers that involve various measurements using the quart container to fill a cup, pint, gallon, liter etc. It may be easier to use rice instead of liquid to save spills, but try to allow the students to use liquid at least once.

h. Ask the students to estimate the amount of liquid each container can hold. Be sure that their estimations use the appropriate units. Have students use the Record Sheet (Appendix G) to record their estimations.

i. Have the students measure and record their findings using the quart measure on the Record Sheet.

j. After students have completed the activity, come back together to discuss their findings. Which container had the greatest capacity? What was its measurement?

k. Set aside a special time to examine the similarity and differences between the liter (metric) and the customary standard measurements, i.e. a liter is a little more that a quart, a liter is less than a gallon, etc.

7. Evaluation/Assessment: Use the record sheet to check for full understanding of the units and their equivalencies. The students may have a better understanding of the bottom portion of the record sheet if it is done as a class.

8. Extension Activity:

Use various glass soda bottles or wineglasses filled with the above measurements and make music with varied pitched. Show the students that when the capacity changes, the pitch will also change!

There are a variety of children's cookbooks available. How about doing some measuring in the classroom while baking a class treat!

VI. CULMINATING ACTIVITY

The students will participate in a variety of measurement activities. The assessment tools used will consist of several record sheets, as well as, a final independent sheet on reasonableness.

It is a good idea to designate separate areas of the room for each center. This will ensure that all of the students are being assessed on the measurements of the same objects. It will also help the teacher maintain an accurate record for judging the assessment.

#1 Linear Measurement

Materials: 5 books, (ranging in length, width, height) labeled A-E, 12-in. rulers with centimeters, balance scale, and student record sheets (Appendix H and I)

Procedures:

Students arrive at this station and estimate the dimensions of the book in inches. and record observations on Appendix J Record Sheet. Next, students use rulers to measure length, height, width, etc. of each book, and record observations. Students estimate the same books in centimeters, recording observations. Next,

Students use rulers to measure dimensions in centimeters and record observations.

After students estimate and measure each book, they should record the order the books come in under the specific categories listed on Record Sheet (Appendix I).

(adapted from Marilyn Burns' Math Solutions)

#2 Weight and Mass

Materials: balance scale made in previous lesson, toothpicks, cotton, pennies, dimes, nickels (be sure to use real coins), toothbrush, marker, pen, pencil, eraser, and student record sheet (Appendix J)

Procedures: Students prepare balance scale for weighing. Remind them to make sure their cups are equal and that their ruler is parallel to the ground. Students use record sheet as a guide to find which item has a greater mass/weight.

(adapted from Sandra Markle's Measuring Up!)

#3 Capacity

Materials: 5 plastic/glass labeled containers that vary in size and shape, rice or water, small basin, and student record sheet (Appendix K)

Procedures: Students predict which container will have the greatest capacity and fill this container (Container A) to capacity. Students use the rice collected in container A to determine if what they select as the next largest container (container B) has a greater or lesser capacity. Students repeat procedure with remaining containers and record observations on student record sheet.

(adapted from Tamara J. Drean and Randall J. Souviney's Measurement Investigations)

VIII. BIBLIOGRAPHY

Abrohms, Alison. Literature Based Math Activities. New York, NY: Scholastic, Inc., 1992

ISBN: 0-590-49201-2

Bendick, Jeanne. How Much & How Many. New York: Franklin Watts, 1989. ISBN: 0-531-10679-9

Braddon, Kathryn L. Hall, Nancy J., and Taylor, Dale. Math through Children's Literature. Englewood, CO: Teacher Ideas Press, 1993. ISBN: 0-87287-932-1

Briggs, Raymond. Jim and the Beanstalk. New York: Coward-McCann, Inc., 1970. ISBN: 0-698-30758-5

Bright Ideas for Teachers. Frank Schaffer Publications, Inc.

Burns, Marilyn. Math and Literature. Sausalito, CA: Math Solutions Publications.

Cossey, Ruth, Stenmark, Jean, and Thompson, Virginia. Family Math. Berkeley, CA: Lawrence Hall of Science.

Downey, Lori. "Linking Mathematics and Literature."

Markle, Sandra. Measuring Up! New York: Atheneum Books for Young Readers, 1995.

ISBN: 0-689-31904-5

Myller, Rolf. How Big Is a Foot? New York: Antheneum, 1962.

Nugent, Glenda. Hands On Math. Cypress, CA: Creative Teaching Press, 1995.

Osborne, Victor. How Do We Know How To Measure? Austin: Steck-Vaughn

Company, 1995. ISBN: 0-8114-3883-X