Can You Walk a Mile With My Foot?

By ***Lori Hypes*** for Blue Ridge Public Television (WBRA, WMSY, WSBN)
Tazewell Middle School, Tazewell, VA

.

GRADE LEVELS:
4^{th} – 8^{th} grades

TIME ALLOTMENT:
4 – 45 minute blocks

SUBJECT MATTER:
Math/Science

OVERVIEW:
In this lesson students will discover how our current standard of measurement was developed. They will have fun making and decorating their own metric ruler that they will use all year. Students never have to leave the classroom to have fun looking for the identity of mystery items on a measurement scavenger hunt. Through the use of an exciting website, students will be amazed as they are able to convert length into, Metric, British and American, Thai, Chinese Imperial, Old Russian, Nautical, Astronomical, Ancient Roman and even Biblical Units. They will even be able to measure the flag pole in the school yard without a ladder!

LEARNING OBJECTIVES:

Students will be able to:

- Measure and compare the length of their foot to the foot of other classmates.
- Construct a metric ruler and use it.
- Discover and identify 10 unknown items in the classroom using clues and completing a scavenger hunt.
- Compute their body shape according to their height and arm span in U.S. Customary Units and Metric Units.
- Convert Centimeters into U.S. Customary Units and two other units of their choice.
- Measure the flag pole without a ladder.

STANDARDS:
State Standards:
The objectives listed may be used in part to address the Virginia Standards of Learning at
http://www.pen.k12.va.us

Math 4.11 a, b, c
Science 5.11 a, b; 4.1 a, b; 5.1 c, d; 6.1, c, d, f; 7.1 c; 8.1 b, c

MEDIA COMPONENTS:
Computer
TV
United Streaming Video: *Measurement and Scale* (Start video at the beginning.)

Web Sites:

- http://www.convert-me.com
  At this web site students will be able to convert the measurements they obtained in class.

- http://micro.magnet.fsu.edu/primer/java/scienceopticsu/shadows/
  At this web site students will be able to figure out how they can measure the length of an object that they cannot literally measure.

MATERIALS :

Materials needed for Introductory Activity:

- Paper – enough for each student to trace his or her foot
- Rulers with U.S. Customary Units and Metric Units

Materials needed for Learning Activity:

- Computer(s)
- Television
- VCR
- Adding machine tape (enough for each student to have 39 cm)
- Scissors to cut the tape
- Laminator or (clear tape or clear contact paper if you do not have a laminator)
- Measurement Scavenger Hunt worksheet
- AIMS worksheet: *Are You A Square?* (Or teacher can make up one. Directions are in the Culminating Activity section.)
- Graph paper for every student
- Clothes pins for scavenger hunt

Materials needed for Culminating Activity:

- Web directions (Hand out *Distance and Length Conversion* sheet)
- 4 (100 ft) ropes
- Black or blue markers (4)
- 4 meter sticks

PREPARATION FOR TEACHERS:

- ✓ Prior to teaching the unit, bookmark the Web sites. (Follow the acceptable internet use policy for your school.) Download the United Streaming video to desktop or cd.
- ✓ Cue the video clip to the place to start the lesson.
- ✓ Make sure you go through the instructions from the student materials handouts to make certain that you understand and are familiar with the lesson format and what the students need to do or understand for the lesson.
- ✓ You will have to modify the *Measurement Scavenger Hunt* to fit your particular room situation. Please refer to the example and the blank template.
- ✓ When using media, always provide the students with a ***Focus for Media Interaction***, which is a specific task to complete during or after viewing video segments, web sites, or other media material.

- ✓ Prior to this lesson, students should have been introduced to U. S Customary Units and the Metric Units. Students should also know:
  The distance from one end to the other of the longest side of an object is its length.
  The distance from one end to the other of the shortest side of an object is its width.
  The linear measurement of an object is its length.
  Distance is the space between two points.

INTRODUCTORY ACTIVITY: SETTING THE STAGE

Day One

When class starts, **Ask: "**Whose foot is really a foot? I want you to estimate the distance in U.S. Customary units and then in metric units of your own foot. Record your estimate on a piece of paper." Give each student a ruler to record the actual distance. (Decide before class if you want to do this activity with shoes on or off.) Have students mark the distance from the heel of their shoe/foot to the tip. After all students have successfully completed this activity lead students into a discussion about why we call a foot of measurement a foot. (Accept all student responses.)

LEARNING ACTIVITIES (video)

1. **Provide a Focus for Media Interaction**: **Say**, "We are now going to watch a video about how our present day standard of measurement evolved. After watching this first clip, I want you to answer this question: How has measuring things helped us?" **Start** United Streaming Video *Measurement and Scale* at the beginning. **Pause** after the narrator says the words "Measuring things has helped us give a kind of order and logic to our vast universe and our everyday lives." Stop streaming at (40). **Ask**:: "How has measuring things helped us?" (Measuring things has helped us give a kind of order and logic to our vast universe and our everyday lives.

2. **Focus for Media Interaction**: **Say**, "During this next clip, I want you to listen for the question that the narrator asks at the end of this clip and also be prepared to offer a suggestion. **Resume** the video and **Pause** after the narrator asks: "But how did we first come up with rulers, miles, feet and all the rest? (1:15) **Ask: "**How do you think we first came up with rulers, miles, feet and all the rest?" (Answers will vary.)

3. **Focus for Media Interaction:** Say, "In this next clip I want you to listen for the answer and see if you were correct. **Resume** and **Pause** when the narrator says "And the distance around the waist of a man, was a girth or 3 feet. (1:34) **Ask**, **"**How did we first come up with rulers, miles, feet and all the rest?" (In the beginning, man was his own measure. Two steps made one pace. A thousand paces made a mile. Finger tip to finger tip made a fathom, that is 6 feet. And the distance around the waist of a man, was a girth or 3 feet.

4. **Focus for Media Interaction**: Say, "In this next clip I want you to be able to tell me what exactly was their unit of measurement based on; and what is a cubit?" **Resume** and **Pause** when narrator says "The sides of the Great Pyramid of Geza are more than 750 ft. long and they are only off by this much." (2:12) **Ask,** what exactly was their unit of measurement based on?" (The foot was a foot, the hand was a hand, the finger was a finger, a span was the distance from pinkie to thumb.) "What was a cubit?" (The cubit was the distance between the elbow and fingertip.)"

5. **Focus for Media Interaction**: Say, "I want you to watch this next segment and be able to explain what *UNCIAE* is. **Resume** and **Pause** when you hear "…*UNCIAE* as a unit of both weight and length, it was the source of the modern terms *ounce* and *inch*." (2:51) **Ask**, "What is an *UNCIAE*? (*UNCIAE* is a unit of both weight and length, it was the source of the modern terms *ounce* and *inch*.)"

6. **Focus for Media Interaction:** Say, "In this next clip, be able to explain the problem that arose with this type of measurement and how it was solved." **Resume** and P**ause** when you hear "…adding her initial *E* made the official yard stick almost exactly 36 inches long." (3:48) **Ask**, "What was the problem that arose with this type of measurement and how was it was solved?"(Units varied from place to place. Traders needed an absolute standard. Henry I said a standard yard was the distance from his nose to his finger tips. Then Queen Elizabeth added her initial and made the yard stick almost 36 inches long.) "

7. **Focus for Media Interaction**: Say, "In this next clip be prepared to tell me what happened to the bar in 1864 and what did the British scientist try to base the *Standard Yard* on?" **Resume** and **Pause** when you hear, "The British had failed in their attempts to create an absolute standard of length." (5:19) **Ask**, "What happened to the bar in 1864 and what did the British scientist try to base the *Standard Yard* on?" (A fire ravaged England's House of Parliament and the bar was destroyed. The British tried to base the yard on a pendulum swing of one second but gravity would not allow this to happen.)

8. **Focus for Media Interaction**: Say, "In this next clip, how did the French tackle the measurement problem and were they successful?" **Resume** and **Pause** when narrator says "Once again we were a long way off from a standard unit of length." (6:38) **Ask**, "How did the French tackle the measurement problem and were they successful?" (They wanted to use a scientific constant: circumference of the earth. One ten millionths of the distance between the north pole and the equator was to be one meter. Unfortunately explorers later discovered that the earth was not a regular shape."

9. **Focus for Media Interaction**: Say, "In this last clip, what is our present day meter based on?" **Resume** and **Stop** when narrator says "It's a distance you can count on." (7:15) **Ask**, "What is our present day meter based on?" (Speed of Light! The meter is the distance traveled by a beam of light in a tiny fraction of a second-*3 billionths of a second*.)

Day Two

Materials needed for this activity:
Enough adding machine tape for every student to make his/her own ruler
Meter sticks or 12 inch rulers with U.S Customary Units and SI Units
Each student should have a sharp pencil
Permanent marking pens (optional)
Template: (Suggested art work for the back of the meter tape. See end of this lesson.)

Students will make a metric tape to be used to complete another activity in this lesson.

Directions:
1. Measure and cut 120 cm of adding machine tape.

2. Mark off the starting point of the metric tape about 8 cm on the tape. (This leaves room for students to tape the paper down on a work surface if the choose. Some students will not measure accurately and will need the extra tape to complete the measuring device.)
3. Use a meter stick or ruler that has both U.S. Customary Units and SI Units to mark off their tape. Both units will go on the same side of the tape: inches on the top and centimeters across the bottom. (At the beginning, I had my students mark only the inch and ½ inch tick marks first and then later go back and put in the additional tick marks. Do the same with the centimeters.)
4. Have students decorate the other side of the measuring tool with a timeline of the evolution of the meter stick (see template). Make sure students put their name on the measuring tool. Laminate for lasting durability.

Day Three

1. Scavenger Hunt for Lengths. Pass out *Measurement Scavenger Hunt* worksheet to each student. Have students follow the directions on sheet. Students will record the correct object and measurement on the worksheet.
   *(**Note:** A blank template has been included for you to use in your classroom. I have also included the one I use in my classroom for you to see how I have used it. You may want to give the team with the most accurate measurements some type of reward.)

2. AIMS activity 1986. Have students compare their height to their arm span in U.S. Customary Units or Metric Units. Use the chart provided in the AIMS book or make your own. Students should follow the following steps:
   - Make a prediction how many centimeters tall do you think you are?
   - How many centimeters wide is your arm span? Measure to find out.
   - Have students use graphing paper to record data. Each block will represent 10 centimeters. The X axis will represent the height and the Y axis will represent the arm span.
   - Have students color in the graph paper where the two points intersect.
   - Students should be able to see clearly if they are a square, a tall rectangle or a wide rectangle.

CULMINATING ACTIVITY

Web Site # 1 Instructions

- The teacher will assist the students as they work their way through the interactive web site. Bookmark the web site: http://www.convert-me.com/en/ **Media Interaction**: Tell the students: "You are now going to go to the computers where you will work on a site dealing with distance and length conversion. This site is an interactive unit's converter. You will need to take with you your height and arm span, and the worksheet entitled *Measurement Scavenger Hunt* that you completed ." At this point, pass out the worksheet, "Distance and Length Conversion". Read the instructions to the students as they follow along. Complete numbers 1-6.

Web Site # 2 Instructions

- The teacher will assist the students as they work their way through the interactive web site. Bookmark the web site: http://micro.magnet.fsu.edu/primer/java/scienceopticsu/shadows/ At this site students will discover that they can use shadows and a meter stick to measure very tall objects on the ground. Also the

students will even be able to measure the height of a Tyrannosaurus Rex. Continue the worksheet "Distance and Length Conversion" picking up at question 7.

CROSS-CURRICULAR EXTENSIONS

Science

- Have students gather specific data in both U.S. Customary Units and Metric Units and discuss why the metric system is the universal language of scientists.

Art

- Students can make a study of geometric art.

Career Education

- Hands On Activity: Divide the students into four groups. Give each group a rope and a marker. (The ancient Egyptians used string for surveying. It was knotted and stretched to do their measuring. They called their surveyors "rope-stretchers.) Have students mark the rope off in metric feet with a permanent marker or tie knots in the rope. Have each group make a basic floor plan of your school. Then have each group map out a different route from your room (or some other designated place) to the office. Then send students out into the hallways to measure. Students can then determine which is the most efficient route. (Students could also make meter markers to be posted within your school that informs the student body how far they have walked in meters from one place to another.)

Math

- Students can estimate how many unsharpened pencils would be needed to equal the length of a yard and meter.
- Students can estimate how many pennies would be needed to equal the length of a yard or meter stick.
- Propose a contest. Post a question about a length that you know but that students can only estimate. Ex: What is the length of the rope hanging from the ceiling of the gym? Recognize the first-, second-, and third-closest estimates.
- Graph the dinosaur as the shadow moves.

Social Studies

- Estimate the distance on a map and then use the scale on map to calculate the actual distance.
- Look at other cultures around the world and examine their system of measuring.
- Have students work in groups and develop a map that leads to a secret location. Include landmarks such as door of classroom, a certain tree in the schoolyard, etc. Students must show measurements, in either U.S. Customary Units or Metric Units to the final destination. Have groups trade maps and see whether the other group can find their way to the secret location.

COMMUNITY CONNECTIONS

- Ask a surveyor to address your class and bring his instruments.
- Invite the Department of Highways to explain the mapping of the highway system. Where do roads start and end?

Measurement Scavenger Hunt

Team: _____

Period: _____

Date: _____

Beginning Time: _____ Ending Time: _____

Rules: In your classroom, there are items you and your partner need to measure. Your job is to identify as many of the objects as possible in the given time and measure them. You are to use the metric tape you made. You may work in groups of two. As you identify the items and measure them, pick up a clothespin from your assigned cache and attach it to the outside of your clothing. At the end of this activity you will have to give up a clothespin for each incorrect answer. The team with the most items correctly identified will receive a homework pass for the next regular assignment in class. When your teacher gives you the signal you may begin.

			Measurements	
Number	Clue	Object	Estimate	Exact
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Measurement Scavenger Hunt

Team: _____

Period: _____

Date: _____

Beginning Time: _____ Ending Time: _____

(Example of the one I use in my classroom.)

Rules: In your classroom, there are items you and your partner need to measure. Your job is to identify as many of the objects as possible in the given time and measure them. You are to use the metric tape you made. You may work in groups of two. As you identify the items and measure them, pick up a clothespin and attach it to the outside of your clothing. At the end of this activity you will have to give up a clothespin for each incorrect answer. The team with the most items correctly identified will receive a homework pass for the next regular assignment in class. When your teacher gives you the signal you may begin.

(**Note to teacher**: Assign each group a number. Make a card and put 10 clothespins on each card. You can monitor how far along each team is and what place they finish in the event there is a tie.)

			Measurements	
Number	Clue	Object	Estimate	Exact
1	There are four of me from bar to tip, but you need to only measure one.	One of the student chair legs		
2	From door to door	Counter top from door to door		
3	More than 20 gallons and empty (length and width of largest surface)	Empty fish tank		
4	Don't look down	One floor tile		
5	How far is the top of your book from the floor	From top of book on table to the floor		
6	I don't feel very sharp. (Include the floor.)	Pencil sharpener to floor		
7	There's a whole bunch of me (75), but you only need to measure one. (L & W)	One lab drawer in my science room		
8	Don't stick me (Length and Width)	Bulletin Board		
9	I hold the teacher's book (from the highest point)	Lectern height		
10	I have a large vocabulary (L & W)	Dictionary		

Distance and Length Conversion

Interactive Units Converter.

Student Instruction Sheet

1. At this site you will convert the data you have collected in class: height and arm span; and the "Measurement Scavenger Hunt" data.

2. Access web site: http://www.convert-me.com and click on **Distance and Length Conversion** and set the significant figure to 2. (The rule is: when you need easy rounded off numbers, switch significant figures to 2 or 3. When you need precision, go for 5 to 7 significant figures.)

3. To convert 20 meters into feet, choose **meter**. Type your value in the box against the unit you've chosen and click the nearest **Convert** button. To convert 20 meters into feet, type 20 and click **Convert.** The value you've entered gets converted into all available units. Find the unit you needed to convert to and read the value in the box against it. To convert 20 meters into feet, find the value in the box marked foot.

4. Using the data previously collected (mentioned in # 1), convert the lengths into metric, U.S. Customary and two of your own choosing. From the list of available units choose the one, that you want to convert from. Record this information on your own paper.

5. If time allows, experiment with other known measurements. Examples: Height of Empire State Building, length of football field, height of basketball goal, etc.

6. When the entire class is finished, pose this question. How can we calculate the length of the flagpole in the school yard without someone literally measuring the pole? (Offer a possible to the teacher.)

7. In order to solve the problem raised in question # 6, access the following website: http://micro.magnet.fsu.edu/primer/java/scienceopticsu/shadows/ when the teacher directs. "Read the directions at this site and follow them. (Click and drag the slider to change the time of the day. Notice how the relative position of the sun and the length of the shadows change during the day. Also, notice the change in the division formula. Dividing the length of the T-Rex's shadow by the length of shadow of the meter stick gives us the height of the T-Rex. All you have to do is to stand the meter stick upright. Look at the shadow that it casts

on the ground. Mark the length of the shadow then measure its length. Now comes the tricky part. Very carefully approach the T-Rex. Remember a T-Rex is carnivorous, and would love to have you for a snack. Measure the length of the shadow of the T-Rex. The lengths of shadows cast by the same light source are always proportional. For example, if the shadow of the meter stick is twice as long as its height, then the shadow of the T-Rex will also be twice as long as the T-Rex's height. Notice that this is true at 6:10 a.m. At this time, the shadow of the meter stick is 2 meters long. The shadow of the T-Rex is 12 meters long. If we divide the length of T-Rex's shadow by the length of the shadow of the meter stick, we get the height of the T-Rex: 6 meters! Try it at different times. Be careful. You may be making the T-Rex nervous.)

Distance and Length Conversion

Interactive Units Converter.

Teacher Instruction Sheet

1. At this site you will convert the data you have collected in class: height and arm span; and "Measurement Scavenger Hunt" data.

2. Access web site: http://www.convert-me.com and click on **Distance and Length Conversion** and set the significant figure to 2. (The rule is: when you need easy rounded off numbers, switch significant figures to 2 or 3. When you need precision, go for 5 to 7 significant figures.)

3. To convert 20 meters into feet, choose **meter**. Type your value in the box against the unit you've chosen and click the nearest **Convert** button. To convert 20 meters into feet, type 20 and click **Convert.** The value you've entered gets converted into all available units. Find the unit you needed to convert to and read the value in the box against it. To convert 20 meters into feet, find the value in the box marked foot.

4. Using the data previously collected (in #1 above), convert the lengths into metric, U.S. Customary and two of your own choosing. From the list of available units choose the one, that you want to convert from.

5. If time allows, experiment with other known measurements. Examples: Height of Empire State Building, length of football field, height of basketball goal, etc.

6. When the entire class is finished, pose this question. How can we calculate the length of the flagpole in the schoolyard without someone literally measuring the pole? Allow students time to brain storm. (Accept all reasonable answers.) If students are unable to figure out a way, proceed to the next web site.

7. Have students access the following web site and see if they can figure out a way to measure the flagpole without climbing the pole." http://micro.magnet.fsu.edu/primer/java/scienceopticsu/shadows/ At this site students will discover that you can use shadows and a meter stick to measure very tall objects on the ground. Students will measure the height of a Tyrannosaurus Rex. **Say**, "Read the directions at this site and follow them." (Click and drag the slider to change the time of the

day. Notice how the relative position of the sun and the length of the shadows change during the day. Also, notice the change in the division formula. Dividing the length of the T-Rex's shadow by the length of shadow of the meter stick gives us the height of the T-Rex. All you have to do is to stand the meter stick upright. Look at the shadow that it casts on the ground. Mark the length of the shadow then measure its length. Now comes the tricky part. Very carefully approach the T-Rex. Remember a T-Rex is carnivorous, and would love to have you for a snack. Measure the length of the shadow of the T-Rex. The lengths of shadows cast by the same light source are always proportional. For example, if the shadow of the meter stick is twice as long as its height, then the shadow of the T-Rex will also be twice as long as the T-Rex's height. Notice that this is true at 6:10 a.m. At this time, the shadow of the meter stick is 2 meters long. The shadow of the T-Rex is 12 meters long. If we divide the length of T-Rex's shadow by the length of the shadow of the meter stick, we get the height of the T-Rex: 6 meters! Try it at different times. Be careful. You may be making the T-Rex nervous.)

8. Have students read the directions at this site and follow the directions. (Click and drag the slider to change the time of the day. Notice how the relative position of the sun and the length of the shadows change during the day. Also, notice the change in the division formula. Dividing the length of the T-Rex's shadow by the length of shadow of the meter stick gives us the height of the T-Rex. All you have to do is to stand the meter stick upright. Look at the shadow that it casts on the ground. Mark the length of the shadow then measure its length. Now comes the tricky part. Very carefully approach the T-Rex. Remember a T-Rex is carnivorous, and would love to have you for a snack. Measure the length of the shadow of the T-Rex. The lengths of shadows cast by the same light source are always proportional. For example, if the shadow of the meter stick is twice as long as its height, then the shadow of the T-Rex will also be twice as long as the T-Rex's height. Notice that this is true at 6:10 a.m. At this time, the shadow of the meter stick is 2 meters long. The shadow of the T-Rex is 12 meters long. If we divide the length of T-Rex's shadow by the length of the shadow of the meter stick, we get the height of the T-Rex: 6 meters! Try it at different times. Be careful. You may be making the T-Rex nervous.)

9. Have students use the same strategy to measure the flagpole. Have fun!

$$\frac{\text{Height of known object}}{\text{Length of shadow of known object}} \qquad \frac{\text{X (height of object)}}{\text{Length of shadow of object}}$$

Distance and Length Conversion

Student Worksheet

Name: _____ Date: _____ Class: _____

Item measured	U.S. Customary Units	Metric Units	Choice 1	Choice 2