Duke Farms

Measure for Measure

Exploring your local world through measurement
A lesson in 5 parts

This set of lessons asks a lot of questions but doesn't provide a lot of answers. It challenges you to actively explore and observe your environment using very simple mathematic and scientific techniques.

PART 1: Measuring LENGTH/HEIGHT/WIDTH/DEPTH

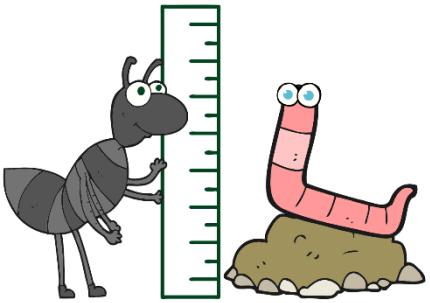
Materials

- Ruler, yard/meter stick, tape measure
- A notebook or clipboard with paper
- A pen or pencil to record findings

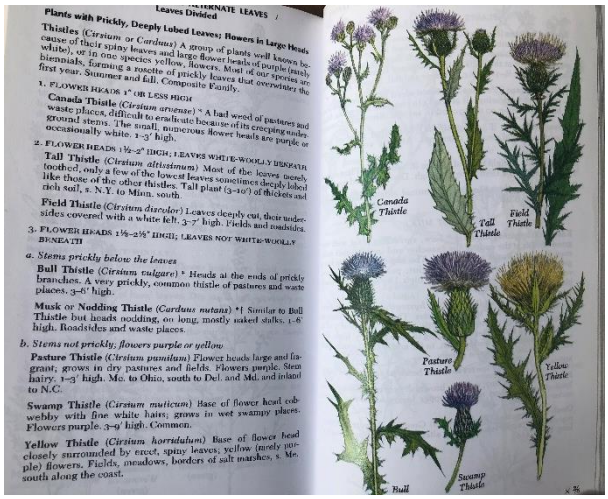
Procedure:

- **Warm-up activity:** Bring a ruler to an area outside and start measuring anything that you see in any way that you wish.
- Sit down in front of a small patch of ground or garden. Measure what you see and don't forget to write down all your observations!
    - What is the tallest? Shortest? Widest? Narrowest? Thickest? Thinnest?
    - Are there shadows in your patch of ground? Measure those too! How do they differ from the actual objects?
    - Is there something that is too tall to be measured with your ruler? Try to measure it with the yard/meter stick or tape measure.
    - Compare units of measure
        - Are the numerals bigger when you measure in centimeters or inches? Meters or yards?
        - Which unit of measure works best for you? Metric or English?

- Look under a rock
    - Do you see any life? Try to measure the length of a worm, pill bug, or ant.
- Find a tree or bush
    - Measure the length of a stick or branch.
    - How high off the ground is the lowest branch?



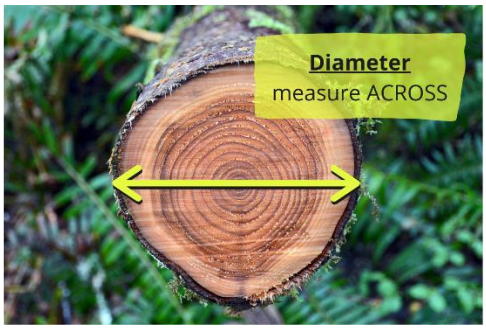
- Measure the length and width of leaves. Are they all the same size?
- Does the tree have flowers? Measure them.
- Look at the bark. Try and measure the length, width, and depth of patches of the bark.
- Stand at the base of the tree trunk with your feet flat on the ground. Reach as far up as you can. Have someone measure that height.
    - Stand on tip toe and reach up again and measure.
    - Subtract the first height from the second. How much higher did you reach?
- Find something outside that has the same measurement as
    - Your foot
    - Your hand
    - Your arm
    - Your height



Don't these flowers all look similar? Well, each one has a specific size! If you measure them, you can identify them! Many plants can be identified by measuring certain parts of them.

CIRCUMFERENCE and DIAMETER

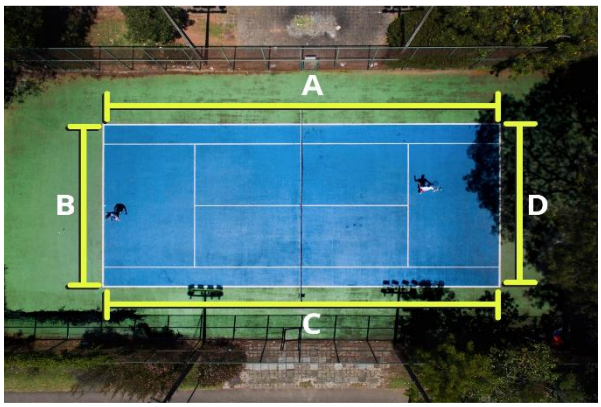
- Measure around the trunk of your tree.
    - This is called ***circumference***: the measurement of the enclosing boundary of a curved geometric figure, usually a circle.
    - Using the circumference, you can find the ***diameter***: the measurement of a straight line passing from side to side through the center of a circle.
        - Diameter = Circumference divided by Pi (3.14)
        - Geometry is that easy!
    - Would you like to measure the ***height*** of your tree? Check this out!



        - https://www.wikihow.com/Measure-the-Height-of-a-Tree
- *Why is this measurement information useful to know?*

- *Write your own word problem and challenge someone!*

PERIMETER and AREA



- Look at a patch of ground. Use your yard/meter stick or tape measure.
  - Measure each of the sides. Add them all together and you have the *perimeter:* the continuous line forming the boundary of a flat shape.
    - Perimeter = A+B+C+D
  - Now you can find the *area* by multiplying the length by the width (the space occupied by a flat shape).
    - Area = A x B or any other combination of the length x width
  - Find the area of other objects in outside: bricks, picnic tables, patio, sidewalk, your entire backyard!
  - Find an object that is not a square or rectangle.
    - How do you measure the area of an irregular object? Check this out!
    - https://www.wikihow.com/Find-the-Area-of-a-Shape
  - *Why could this be useful information to know?*
  - *Write your own Word Problem and challenge someone*!

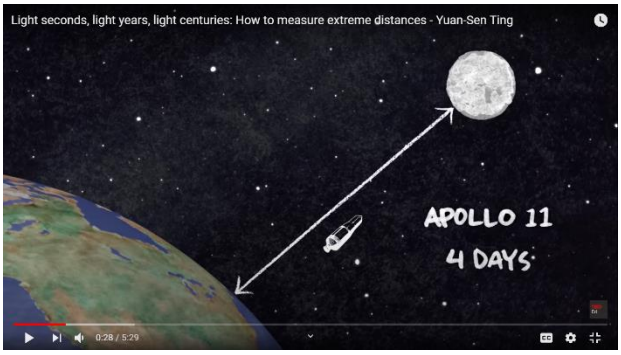
DEPTH

- Dig into a small hole in the ground and measure its depth.
  - Do you see any roots? How far do they go down?
  - Do you see any worms or insects? How far down?
  - What else did you find?
  - Do you see layers in your soil? Measure each one. What does that tell you?
  - *Be sure to fill the hole back in with dirt before you move on*!
- Is there any water in your outdoor space? How deep is the water?
  - Plan to go back another day and measure the depth of that same water again. Did it change? Why?
  - How could you measure the depth of a pool or pond? Would you need a different kind of tool?

DISTANCE

- Distance is just another way of measuring length, only in larger quantities.
- Using your measuring tools, can you measure the length of a backyard or play ground?

- How about the distance from your home to the home next door?
- Do you think that your tools would be efficient in measuring the distance across town? Or across the country?
- What tools do you think would make this easier?
- What units are used in the Metric and English systems to measure distance?
    - How does this relate to your own measuring tools?
- How would you measure the distance between planets and stars? Check out this TED Talk!
    - https://www.youtube.com/watch?v=Op3AYaJc0Xw



Definitions*:

- *Circumference* is the measurement of the enclosing boundary of a curved geometric figure, usually a circle.
- *Depth* is the measurement of the distance from the top or surface to the bottom of something.
- *Diameter* is the measurement of a straight line passing from side to side through the center of a circle.
- *Distance* is the measurement space between two things or people.
- *Height* is the measurement from base to top.
- *Length* is the measurement or extent of something from end to end.
- *Perimeter* is the continuous line forming the boundary of a closed geometric figure.
- *Width* is the measurement of something from side to side.

Conclusions:

- *What measuring tool was the best to use for each measuring task?*
- *What kind of math did you use during these tasks?*
- *Did you prefer to use the Metric or English system of measurement?*
- *If in 2 weeks you went back and measured the same things, how do you think the measurements would change?*
    - *What about in 2 months?*
    - *6 months?*
    - 1 year?
- *Write a word problem that uses length, height, length and/or depth. Challenge your family!*

PART 2: Measuring WEIGHT/ MASS 

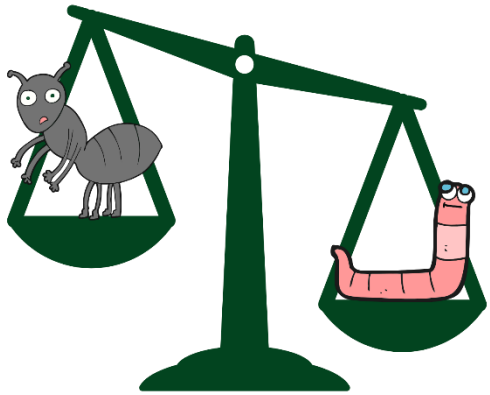
<u>A note to parents and educators</u>: The activities in this section require adult supervision. Scales can be delicate instruments and prone to breakage if not handled properly. You will also want to make sure that no one lifts any object with a weight too heavy for them to handle safely.

Materials:

- A kitchen scale
- A portable bathroom scale
- A bucket
- A notebook or clip board with paper and pen or pencil to record findings

Notes about your weight measuring tools:

- A typical digital kitchen scale can measure units from as small as 1 gram to 4,540 grams OR .001 pound to 10 pounds.
- A bathroom scale can measure as little as to .1 kilogram to 181 kilograms OR .25 pounds to 400 pounds
- Many scales allow you to switch easily between Metric and English systems
- Kitchen scales have a "tare" button that allows you to subtract the weight of whatever container you are using; just press the tare button after you put the empty container on the scale to set it to 0, then add what you want to weigh!
- *Keep in mind that digital scales are sensitive to dirt and water, so be mindful of that as you explore these activities.*



Procedure:

- **Warm-up activity:** Take one or both of your scales outside and start measuring!
    - Take this time to explore how to use the scale
        - Explore the tare button, change the units, and find out which scale is best for measuring what.

LIGHT WEIGHTS

- What do you think is the lightest object from outside that you can measure?
- What measures one gram? One ounce? One pound?
- How many leaves does it take to make one pound?
    - How many stones? Sticks? Bird seed? How much soil? Sand?
- Look for worms or pill bugs in the soil or under rocks. How much do they weigh?
- How much does a flower weigh?
    - Which flower is lightest?

- Which flower is heaviest?
- Put some water in a paper cup. How much does it weigh?
  - Write the weight on the cup. Put the cup in the freezer. A few hours later, measure your cup of ice. Did the weight change or stay the same?
- Fill a paper cup with soil, sand or leaves that are dry and weigh them. If these were wet, would they weigh more or less? Why?
- *Why would this information be useful to know?*
- *How do you think scientists would measure a grain of sand*?

HEAVY WEIGHTS

- What do you think is the heaviest object you see outside?
  - How could that be measured?
- Pick up something that is light enough for you to carry, but too big to put on the kitchen scale. Weigh it on the bathroom scale.
- Weigh yourself on the bathroom scale.
  - Can you and a partner find something outside that has the same weight as you? Or both of you?
- Measure a rock, a brick, a log.
- Fill a bucket with sand, soil or stones. How much does it weigh?
  - Fill that same bucket with sticks or leaves.
  - Why does a bucket filled with the same *volume* weigh different when it contains different objects?
    - We call this *density*, the amount of mass per unit of volume.

- Find a potted plant and put it on the scale.
  - Do you think that most of the weight comes from the plant, the soil or the pot?
    - *Why would this information be useful to know?*
- How could you measure the weight of a tree? Check this out!

  - https://shodor.org/succeedhi/succeedhi/weightree/math1-content.html
- Look up at the moon.

- The pull of gravity on the moon is 83% less than it is on The Earth. If you were visiting the moon, your *mass* would not change, but your *weight* would. How do you think this would change how you walk and play?

Definitions*:

- *Mass* is the amount of matter in a body.
- *Density* is the degree of consistency measured by the quantity of mass per unit volume.
- *Volume* is the amount of space that a substance or object occupies, or that is enclosed within a container.
- *Weight* is a measure of how the force of gravity acts upon the mass of an object.

Conclusions:

- *Which scale was the best for each measuring task?*
- *What is the most accurate unit of measure for small objects? Large objects?*
- *Is there a relationship between size and weight?*
- *What kind of math did you use during these tasks?*
- *Did you prefer to use the Metric or English system of measurement?*
- *If in 2 weeks you went back and measured the same things, how do you think the measurements would change?*
  - *What about in 2 months?*
  - *6 months?*
  - *1 year?*
- *Write a word problem that uses weight! Challenge your family and friends!*

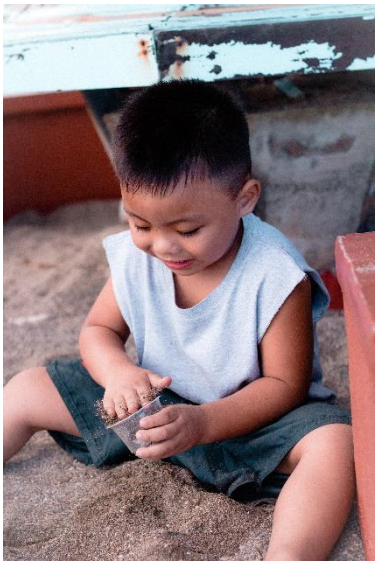
PART 3: Measuring VOLUME

Materials:

- Measuring cups and spoons,
- Gallon or half gallon jug or carton
- Quart and pint cartons
- 1 or 2-liter plastic bottle
- Access to a water source such as outdoor hose or water barrel.
- A notebook or clipboard with paper and pen or pencil to record findings.

Procedure:

- **Warm-Up Activity:** Take your measuring tools outside, fill them with liquids and solids and start measuring!
    - What kinds of solids are you measuring with your tools? Are those solids composed of big or small pieces?
    - What kinds of liquids are you measuring?
- Mix together some dirt and water to make mud.
    - Is mud a liquid or a solid? Or both?
    - What is the best tool to measure mud with?
- Fill the quart carton with water and pour it into the gallon jug
    - How many quarts did it take to fill the gallon?
    - Do the same with the pint carton.
- Fill the gallon jug with water.
    - Pour the water into a 1 or 2-liter bottle.
        - Did it all fit?
- Can you use your bottles to find out how many liters in a gallon?
- Fill a 1 cup measure with water. Pour it into a jug or carton. How many cups did it take?
- Fill a teaspoon with dirt or sand. Pour into the tablespoon. How many teaspoons did it take to fill?
    - Do the same with a tablespoon and your measuring cups.
        - Why is this useful to know?



- Pull up some grass. How much grass can you fit into a 1 cup measure?
    - If you press the grass down into the cup, can you fit more into the cup?
    - Do the same with leaves, flowers, dirt, sand, stones, mulch, shells, or anything you want!
        - Does pressing the objects down (called compacting) make a difference in how much you can fit it into the cup?
        - Why is this helpful to observe?
- Dig a small hole in the soil and pour water from one of your tools into the hole.
    - How much water did you use?
    - Did the water stay in hole, or sink into the ground?
        - Go back and observe the hole in 5 minutes. In 30 minutes. What happened to the water? What does this tell you about the soil? What does this tell you about the recent weather?

- Fill the hole with a solid such as grass clippings, leaves, flowers, dirt, sand, stones, mulch, etc.
  - Do solids act the same in a hole as water?
  - Go back and observe the hole in 30 minutes. In 2 hours. Did anything change?
- What would happen if you did this same activity with sand instead of soil?

- If you have a water barrel, empty some water into a jug or bucket. Watch the level water in the barrel. What do you observe? Why is this happening?

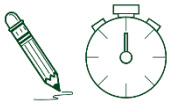
Definitions*:

- *Volume* is the amount of space that a substance or object occupies, or that is enclosed within a container.
- *Mass* is the amount of matter in an object.
- *Matter* is that which occupies space and possesses rest mass, especially as distinct from energy.

Conclusions:

- *Which measuring tools were best for each measuring task?*
- *What kind of math did you use during these tasks?*
- *Did you prefer to use the Metric or English system of measurement?*
- *If in 2 weeks you went back and measured the same things, how do you think the measurements would change?*
  - *What about in 2 months?*
  - *6 months?*
  - *1 year?*
- *Why is measuring volume helpful to know?*
- *Write a word problem that uses volume! Challenge your family and friends!*

PART 4: Measuring TIME



We don't usually think of time as a unit of measurement, but it is! In our outdoor environment, it is an especially interesting tool.

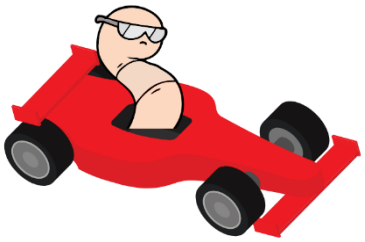
Materials:

- A digital timer, stopwatch or phone that can count up as well as down
- A timepiece such as a watch, clock, or phone
- A camera

- A calendar
- A notebook or clipboard with paper
- A pen or pencil to record findings

Procedure:

- **Warm-up activity:** Take your timer outside and learn how to use it.
    - Does it count in seconds? Minutes? Hours? Milliseconds?
    - How do you set it to count down? Count up?
    - What do you observe that could be measured with time?



- Sit outside and have paper and pencil ready.
    - Set the **count down** timer to one minute. Start. Make a tally mark for each different kind of sound you hear during that one minute. Think about what kinds of sounds they were.
        - Did you hear any wild life? How many different kinds?
        - Did you hear any people?
        - Did you hear any vehicles? What kind?
        - Did you hear the movement of the wind?

OBSERVING BIRDS

- If You have a bird feeder, set yourself up to watch it and set the **count down** timer again for one minute. Start.
    - How many birds do you see at the feeder?
    - How much time does each bird stay there?
    - Does this change at different times of the day?
- Listen to the birds at your feeder, out a window, anywhere! Set the **count up** timer for one minute. Start.
    - Make a tally mark for each bird sound that you hear. How much time elapses between bird calls? Do you think these sounds were made by the same bird? Different birds? Of the same or different species?

    - Do you think that one of the bird calls was in response to the other?
    - Try this activity at different times of the day. Are there more or less bird calls at lunch time? Sunset? Night time?
- What does this tell you about your environment?
- What unit of time is best to measure bird calls?

OBSERVING SQUIRRELS

- When you spot a squirrel start the **count up** timer.
- Look up. How long does it take for a squirrel to go from one tree to another?
    - From the bottom of the tree to the top?
    - Where else does the squirrel go and how long does it take?
    - For how long does the squirrel stand still?
    - Would you consider a squirrel a fast or a slow animal?
- Why is this useful information to know?

OBSERVING WORMS

- Dig a small hole in soil and look for worms. If you find one, GENTLY put the worm on top of the soil and start your **count up** timer.
    - How long it takes for the worm to dig itself back into the soil?
    - Would you consider a worm a fast or a slow animal?
- How can you observe other wildlife using the above techniques? Why is this useful to know?

OBSERVING TREES

- Set your **count down** timer for 5 minutes and lay on your back to look at a tree. Look up, down and all around.
- Take a photo of the tree and mark your calendar with notes about all the observations you made about the tree
    - Do this again in a week, a month, 6 months, and 1 year. Take a photo each time. What changes do you observe? Looking back at your photos might help you to remember.
- What unit of time is best to measure the changes in a tree?

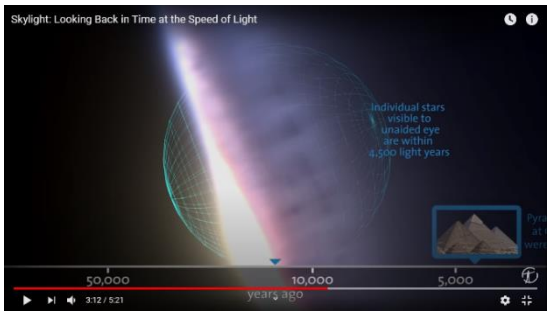
OBSERVING CLOUDS

- Look up at the clouds in the sky. Pick out a cloud and start your **count up** timer.
    - How long does it take that cloud to move across your yard?
    - Did the cloud change at all?
- Do this on another day, maybe in different types of weather.
    - What makes clouds move faster or slower?

OBSERVING THE SUN

- Go to a place where you can see the sun set on the horizon.
    - Look at your clock. What time is it?
    - Start your **count up** timer when the bottom of the sun hits the horizon. Stop it when the sun is completely below the horizon. How long did that take?
    - Does the sun set at the same time every day where you live? Why or why not?

OBSERVING STARS, PLANETS, THE MOON



- Go outside on a clear evening. What do you see?
- Pick out a celestial body. It could be a moon, planet, star or constellation. Set your **count down** timer for one hour and then look for your star again when the timer ends.
- Where did it go? Can you still see it? Why or why not? Is it brighter or dimmer now? Did it change shape?
- Mark your calendar to do this again in one week. And again in one month. How has the sky changed?
- Did you know that the light from the stars that you see has traveled so far that you are looking at the past? Sit back, relax, and learn more in this far out video: https://www.youtube.com/watch?v=wuamuR9p1kM
- Perception of time:
    - Did your own personal time seem to go fast or slow while you did these activities? What does that tell you?

- **Definitions*:**
- Time is not something that is easy to define! Especially since sometimes we perceive time in different ways. In terms of science, here are two definitions.
    - Time is a point of time as measured in hours and minutes past midnight or noon
    - Time is the indefinite continued progress of existence and events in the past, present, and future regarded as a whole.

- **Conclusions:**
- *What measuring tool was the best for each task?*
- *What kinds of math did you use?*
- *Why is measuring time helpful?*
- *Write a Word Problem that uses time. Challenge someone!*

PART 5: Using different types of measurement together

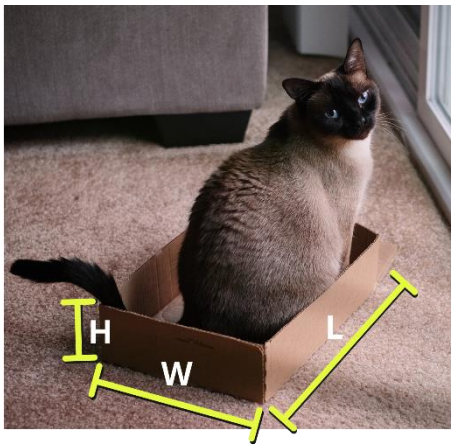
Materials:

- The same measuring tools from Parts 1-4
- Large and small empty Card board or plastic boxes.

Procedure:

VOLUME OF A BOX

- Go outside with a small cardboard box and kitchen scale. The box should easily fit onto your small scale. Using inches or centimeters, measure the length, width and height of the box and write down each number.
    - Find the <u>*volume*</u> of the box by multiplying length x width x height. Write down the answer followed by the words "Cubic" centimeters or inches, depending on which you used.
    - *Why is this useful to know?*



- Now fill the box with something you find outside: grass clippings, stones, sand, shells, flowers, etc. Don't mix different items.
    - Weigh the box and write down the number. Don't forget to switch between weight units to see how they compare! Empty the box.
    - Fill the box again with a different item. Weigh it.
    - Is it heavier or lighter?
    - Try packing down the items to see if you can fit in more. Weigh again.
    - The volume will always be the same, but the weights are different.
    - *Why is this useful information to know?*
    - *What does it tell you about the contents of the box?*
        - Hint: Remember the previous lesson about <u>*density*</u>…?

- Now use your bathroom scale and a large box to repeat the activity.
    - Fill the box with sticks, leaves, rocks, logs, etc.
    - If your box is plastic, fill it with water, mud, or sand. Is there a difference between the amount you put in the box and the weight?

- *What does this tell you about the density of the items?*
- *Why is this useful information to know*?

VOLUME DISPLACEMENT

- Put water in a plastic cup until it is half full. Mark the top of the water line with tape or a marker. Put something into the water such as leaf, stone, shell, or stick. What happens to the water line? Mark it at the new top level.
  - Why did this happen?
  - Does the water rise to different levels with different items?
- Try this with a larger container or bucket
- *Why is this useful to know?*
- This experiment was created over 2,000 years ago by a Greek Mathematician named Archimedes. To find out more check this out! (It also contains a short story about a very smart crow!)

  - https://www.youtube.com/watch?v=X1VazJC8OLY

Unit Conclusions:

- *What was your favorite way to measure?*
- *What did you learn about nature through measurement?*
- *What are ways that measurement can be useful to science? At home? To YOU?*
- *Can you make a chart, graph or poster that shows the results of your exploration?*
- *Do you see the world differently now? How?*

*All Definitions have been taken from https://www.lexico.com/en/definition

NEW JERSEY LEARNING STANDARDS FOR MATHEMATICS

The New Jersey Learning Standards for Mathematics indicate that the topics of Measurement and Data and Geometry be taught on a K-12 basis. Learning Standards from Kindergarten, Grade 1 and from the Secondary Grades are listed as examples of how these outdoor activities align with the teaching of mathematics.

Using natural elements and exploring school grounds, backyards, or even the tiniest of green spaces is a way to make math fun and accessible to learners.

If you are looking for ways to answer your students' question, "Why are we learning this?" take them outside. Math applications abound!

Kindergarten

Measurement and Data K.MD

A. Describe and compare measurable attributes.

1. Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

2. Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter.*

B. Classify objects and count the number of objects in each category.

3. Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.[3]

Grade 1

Measurement and Data 1.MD

A. Measure lengths indirectly and by iterating length units.

1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.

2. Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.*

Secondary

Geometric Measurement and Dimension G-GMD

A. Explain volume formulas and use them to solve problems

1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.*

2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.★

B. Visualize relationships between two-dimensional and three-dimensional objects

4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry G-MG

A. Apply geometric concepts in modeling situations

1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).★

For more information about outdoor activities and the teaching of mathematics or other content areas, contact Kate Reilly, Manager of Education, Duke Farms. kreilly@dukefarms.org