Shape Shifters in the Math Garden

Grade 3

Standards
MCC3-MD2; MD4; MD6, MD8

Time
90 minutes over 1 or 2 days

Supplies
For Worm Safari
- metric measuring tape
- bug catchers
- magnifiers
- forceps
- journal
- Earthworm Anatomy handout
- Earthworm Groups I.D. (optional)
- 1-4 4-liter (1 gal) jugs
- ground yellow mustard
- 4 spray bottles to keep worms wet

For Food Critic
- Food Critic Review Sheet
- tasting plate
- 5 harvested veggies to taste

For RainGauge
- rain gauge
- beaker /measuring cup

For Massive Measurements
- tiles (2-d squares)
- scale

For Shape Shifting Garden Design
- 254+ cm (100+") string per student
- metric measuring tape
- dowels or skewers (1 per student)

Garden Connection
Students will harvest and taste-test food from the garden, measure organisms and objects in the garden, and design a future garden bed.

Overview
Third grade students will explore measurement in the garden by finding the longest worm in centimeters; estimating the mass of vegetables and weighing them; graphing taste-test results; guessing and measuring water in a rain gauge; designing gardens of different shapes and same perimeter; and possibly build a garden that is the best shape given the design constraints.

Engaging Students
Worm Safari: MCC3MD4
Take students to the garden for a Worm Safari. Declare a contest to find the longest worm and have students measure them to the nearest 1/4" (1 cm).

Exploration
Food Critic: MCC3MD3
Students will taste-test five edible items from the school garden, describe and rate the taste of each, prepare a picture graph of their personal ratings, and create a bar graph that collects the entire class' data regarding a food.
Rain Gauge: MCC3MD2
Students will note the amount of rain in the rain gauge, and predict the volume of water collected in milliliters, pour it into a beaker and record.
Massive Measurements: MCC3MD2
Students will estimate the mass of garden veggies before weighing them, and hold objects of various masses to practice guessing weight.
Engineering Challenge: MCC3MD8
Students will predict the relationship between perimeter and area. Given a string representing the length of garden edging, students will design two gardens with the same perimeter and calculate the area and the amount of soil needed to fill each garden bed.

Explanation
Students will explain their data, showing their measurements and charts.

Environmental Stewardship
Students will design a garden bed and may also build it. Students may also remove any invasive, non-native worms they find during the lesson.

Evaluation
Students will demonstrate ability to measure length to the nearest cm or 1/4 inch; estimate mass in g, kg, and l; measure liquid volume; display data in a bar graph; and explain the relationship of perimeter to area.

Standards

Georgia Performance Standards in Common Core Math

MCC3MD2 Measure and estimate liquid volumes and masses of objects using standard units of g, kg, and l.
MCC3MD3 Draw scaled picture graph and scaled bar graph to represent a data set
MCC3MD4 Measure lengths using rulers marked with 1/2 and 1/4 in and show data by making a line plot
MCC3MD8 Exhibit rectangles with same perimeter and different areas or v.v.

Background Information

Earthworm sampling methods: http://www.nrri.umn.edu/worms/research/methods_worms.html
Calculating different areas with same perimeter, and vice versa:
http://investigations.terc.edu/library/common_core/3U4_Session.pdf

Teacher Preparation

1. Assemble supplies and materials needed for lesson; ask students to bring in empty gallon jugs, cleaned and rinsed.
2. Divide class into pairs of students.
3. Make copies of the following hand-outs for students (or provide online access during measurement activities)
   a. Earthworm Anatomy https://www.naturewatch.ca/english/wormwatch/about/key/images/diagram_2.pdf
   b. Food Critic Review Sheet (included below)
   c. Rain Gauge and Massive Measurement Data Chart (included below)
   d. Bar Graph
   e. Picture Graph
   f. Engineering Design Challenge

   Additional, optional handouts on worms:
   Earthworm Species http://www.nrri.umn.edu/worms/identification/ecology_groups.html (optional)
   Earthworm I.D. http://www.nrri.umn.edu/worms/downloads/identification/ecological_groups.pdf
4. Arrange for students to have computer and Internet access, if bar graphs are to be made online using an interactive web site such as CreateAGraph: http://nces.ed.gov/nceskids/createagraph/default.aspx

PROCEDURES FOR LESSON ACTIVITIES

Worm Safari

- Divide students into pairs and assign each pair a part of the garden for the Worm Safari.
- Provide each pair with this handout:
  Earthworm Anatomy https://www.naturewatch.ca/english/wormwatch/about/key/images/diagram_2.pdf
- Explain this protocol for bringing worms to the surface without harming them:
  - Mark a one square foot section of the garden.
  - Estimate the number of liters that will fit in a half gallon jug, and pour water in the jug to measure.
  - Mix 40 g (1/3 cup) of dry ground yellow mustard in 4 liters (1 gal) of water.
  - Pour the solution, 1/4 gallon (or 1 liter) at a time, pausing and pouring again, over a 1 ft^2 area of the garden.
  - Use forceps or hand sort, to gently remove only those worms that fully surface between pourings.
  - Collect worms in a bug catcher or paper plate and spritz with water to keep skin moist, allowing them to breathe.
- Distinguish among worm species, identify adult specimens only, and measure specimens to find longest for each species represented. Adults have a clitellum (wide part nearer mouth than tail). If two worms have a different number of segments between the head and clitellum, or a different number of segments in the clitellum, they are different species.
- Encourage students to show and compare their worms, identifying the longest adult for each species.
- Return earthworms to the soil after measuring (unless they are non-native, invasive species, which can be harmful). Refer to the Debriefing section of this lesson or the Worm Watch web site for information on non-native species.

Food Critic

- Allow students to harvest and taste-test 5 foods from the garden (or prepare a food different ways and taste-test).
- Students will rate the food on the Critic worksheet and transfer data to bar graph and pictograph.

Rain Gauge: MCC3MD2

- Students will note the inches of rain in the rain gauge, and predict the volume of water collected in milliliters.
- Pour the water into a beaker (or measuring cup) with metric measurements, record the amount, and compare to inches.

Massive Measurements: MCC3MD2

- Students will estimate the mass of garden veggies and fruit before weighing them.
- Students will hold objects of various masses and volumes and estimate before weighing or measuring.

Engineering Challenge: MCC3MD8

- Students will predict the relationship between perimeter and area. Given a string representing an amount of garden edging, students will design two gardens with the same perimeter and calculate the area of each as well as the amount of soil needed to fill the beds.
- See included handout for procedures

Debriefing

After the lesson, check to see that students have these understandings:

- Sub-unit marks on a ruler allow measurement with greater precision.
- Masses of solids and volumes of liquids can be estimated in grams, kilograms and liter units.
- Data can be more quickly and easily interpreted when presented in picture graphs and bar charts.
- Two shapes that have equal perimeter measurements do not necessarily have the same area. A square is the largest four-sided area for any given perimeter. (Example: The same 12 ft string can enclose an area that is 5 ft x 1 ft (5 square feet) or an area that is 3 ft x 3 ft (9 square feet).
- Two shapes that have the same area do not necessarily have the same perimeter measurement. (Example: Four 1 ft x 1 ft squares in a row have a perimeter of 10 feet and an area of 4 square feet. Four 1 ft x 1 ft squares arranged in a square have a perimeter of 8 feet and an area of 4 square feet).
- Earthworm Misconceptions
    - Contrary to popular wisdom, earthworms do not form two living creatures if cut in half. An earthworm that is cut near its tail may regrow a tail but the severed portion of its body will not live.
    - Earthworms do not have heads on both ends of their body. Students can determine the head end by watching a worm move or by looking for the clitellum, a band around mature worms with cocoon material inside, located closer to the head.
    - Earthworms can be good for soil, aerating it (creating air spaces) as they move and contributing their “castings” (excrement) which improve soil fertility and reduce the need for artificial fertilizers. Earthworms that are native to an area are helpful in the garden.
    - However, not all earthworms are natives. Non-native species imported from Europe, including night crawlers introduced by fishers throwing excess bait on the ground, can be destructive. For instance, in places where night crawlers do not have natural enemies, they may multiply in large numbers and damage plant roots or eat all the leaf bits that provide shelter for other creatures

Garden Food Critic's Review

Name of Critic: _____

Date: _____

Directions:

- ☐ Taste-test foods from the garden
- ☐ Describe the flavors (sweet, sour, bitter, spicy, bland, etc.)
- ☐ Rate the food on a scale from 1 to 5 by coloring in stars
- ☐ Tell what the stars mean: ★ = _____ ★★ = _____
  ★★★ = _____ ★★★★ = _____ ★★★★★ = _____
- ☐ Create a bar graph, listing foods along the x axis, and stacking stars (see graph page)

1. _____(name of food) ☆☆☆☆☆

   Describe flavors: _____

2. _____(name of food) ☆☆☆☆☆

   Describe flavors: _____

3. _____(name of food) ☆☆☆☆☆

   Describe flavors: _____

4. _____(name of food) ☆☆☆☆☆

   Describe flavors: _____

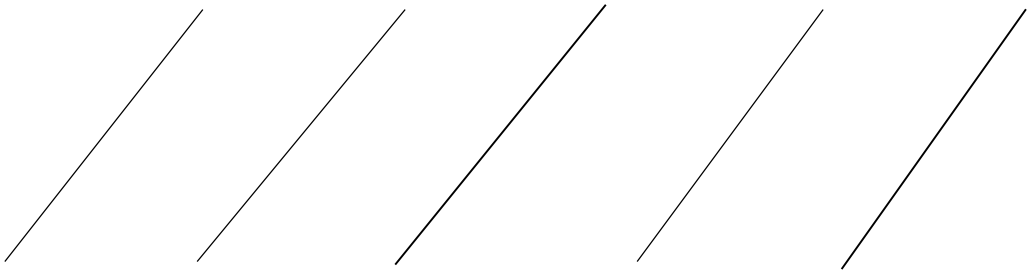
5. _____(name of food) ☆☆☆☆☆

   Describe flavors: _____

Title of Picture Graph

Name:_____

Number of Stars Awarded



Foods Tasted

(write name of each food you tasted on a diagonal line)

Title of Bar Graph (class rating of one food)

x: Number of Students who Rated this Food (in increments of ____)

y: Star Rating Given by Students

Name(s): _____

Create your own bar graph here, or go to the Create a Graph web site to make one online:
http://nces.ed.gov/nceskids/createagraph/default.aspx

Rain Gauge Measurements and Massive Measurement of Various Veggies

Name: _____

Rain Gauge

- Estimate the volume and record your guess below before taking the actual measurement.
- When measuring the volume of a liquid, get at eye level with the measuring device and look for the meniscus at the surface of the water: it is a curve or dip. Read the measurement mark at the low point of that curved surface.

- Estimated volume: _____ Actual volume: _____
- Pour water from rain gauge to beaker or measuring cup and measure its volume there: _____

Massive Measurements of Veggies

- **Harvest five fruits or veggies from the garden to estimate and weigh. <u>Include units in your measurements!</u>**

⇩ Types of Veggie	Estimated Mass	Actual Mass

Engineering Design Challenge: Shape a Garden

Make a Prediction:
If you had two pieces of garden edging that were identical in length, and used each piece to make a different shaped garden, would the area inside the edging be the same for both gardens?

Circle one: Yes No

1. Design two different garden shapes that have the same perimeter measurement (length of edging).

Garden Design #1: Given a length of string representing the perimeter of a garden (the total length of edging available to outline the garden) how would you arrange the string to shape a four-sided garden that will provide the largest area for planting?

- Lay out the string to make a model of your garden, holding the string tight by using dowels or bamboo skewers at corners if working on soft ground. Otherwise you can tape string to paper or a table.
- Measure the length of each side, and add the length of all 4 sides together to get the perimeter.
- Multiply the length of two sides that share a corner to get the area measurement.
- Remember to include units in your answers.

Perimeter (length of string): _____ Area of garden (length x width):_____
Sketch your garden design below.

Garden Design #2: Given the same perimeter (same length of string) how would you make another four-sided garden so that it would be a good shape for young children to be able to reach all the plants from the edge of the garden?

Perimeter (length of string): _____ Area of garden (length x width):_____
Sketch your garden design below.

Did your designs confirm your prediction? _____ Or were the results unexpected? _____

Engineering Design Challenge Page 2

2. Design two gardens of any size but <u>exactly the same area</u>: the first one a square shape and the second one a rectangle.
Measure and compare the garden perimeters.
Hint: Make or draw nine 1" x 1" square tiles and arrange them to make a square garden. Measure the perimeter. Then rearrange the nine square tiles to make a rectangular garden. Measure the perimeter.

Garden Design #1: Square
Perimeter (length of all sides added together: _____ Area of garden (# of squares) _____
Sketch your garden design below.

Garden Design #2: Rectangle
Perimeter (length of all sides added together: _____ Area of garden (# of squares) _____
Sketch your garden design below.

3. Design, sketch and label a garden with best combination of maximum space and accessibility for short arms. Incorporate creative space-saving ideas such as vertical planting or stacked beds.

Assessment for Shape Shifters in the Math Garden

Student Name: Date:

Level of Mastery → / Benchmark or Performance Measure	 **EMERGING** **Not yet proficient** **1 point**	 **COMPETENT** **Partially proficient** **4 points**	 **PROFICIENT** **Mastered task** **5 points**	**TOTAL POINTS**
Garden Food Critic Review	Student described and rated half or fewer of the foods offered.	Student taste-tested most foods and rated each.	Student taste-tested all available foods and described and rated each.	
Picture and Bar Graphs of Review Ratings	Student attempted both the pictograph and bar graph but only one or neither one accurately reflects the data.	Student created a pictograph and bar graph that accurately reflect data but did not include all labels and units of measurement.	Student used the Food Critic data to create a pictograph and bar graph reflecting data accurately, and included labels and units of measurement.	
Rain Gauge	Student was unable to accurately measure water in rain gauge or measuring cup	Student accurately read measurement of water in rain gauge but did not transfer water to cup and measure	Student accurately measured water in rain gauge and also measured that volume of rain in measuring cup	
Massive Measurement of Vegetables	Students measured weight of vegetables without estimating first.	Student guessed and measured weight of vegetables once.	Student predicted and measured the weight of vegetables and practiced to increase accuracy of estimates.	
Engineering Challenge	Student designed garden beds but did not follow criteria of engineering challenge or did not include all measurements	Student met the engineering design challenge criteria for two of the three parts.	Student designed garden beds with the same perimeter but different area; the same area but different perimeter; and the most useful shape.	