Voluminous Veggies in the Math Garden

Grade 5

Standards
MCC5.MD.3, MCC5.MD.4, MCC5.MD.5, MCC5G1, MCC5G2

Time
(3) 45 – 60 minutes sessions

Supplies
(per team of 4 students)
- containers for forcing bonsai fruit
- scissors, duct tape, etc. for building
- seeds or plants for bonsai (watermelon, for example)
- seeds for gigantic veggies (spring)
- seeds for regular veggies (spring veggies such as eggplant, zucchini)
- measuring tape or ruler
- cube nets (patterns), large dice, or math manipulables
- graph paper
- string
- blue tape or sticky notes
- 3 dowel rods per garden bed
- large graduated cylinder or beaker
- serrated cake server (free from bakery)

Garden Connections
Students will grow, harvest, and measure bonsai and gigantic fruits and vegetables in the school garden.

Overview
5th grade students will explore coordinates, area and volume in the garden by growing and measuring bonsai and giant vegetable specimens, playing Battleship in the gardens, and designing a new garden bed.

Engaging Students
Garden Battleship
With a garden bed marked off as the first quadrant of a coordinate (x,y) grid, students will graph the location of plants or landmarks to represent their vessels and play a version of the classic children's game: Battleship.

Exploration
Engineering Design Challenge
Students will plant seeds to grow bonsai and gigantic varieties of fruits and veggies; harvest them; and devise ways to calculate their area and volume.
Voluminous Veggies
While waiting for bonsai and gigantic fruits to grow to maturity, students will practice calculating volume of other vegetables and fruits.
There's Dirt in my Bed!
Students will calculate a garden bed's capacity for soil using several different techniques and comparing the results obtained each way.

Environmental Stewardship
Teams of students grow a row for the hungry and donate veggies to a local food pantry. Students will also develop methods for calculating the total volume of edible plant parts harvested from the garden this year, and justify their methodology when presenting it to peers. The class will select the soundest method, noting its limitations, and apply it to a cumulative total.

Explanation
Students will be able to explain the relationship between area and volume, articulate why volume can be determined four ways (by multiplying area times height, or multiplying the lengths of three rays that come together in any corner, or by counting the unit cubes that can be stacked inside a solid figure, or measuring water displacement), and show how x and y axes are part of a coordinate grid.

Evaluation
A rubric is available to assess student performance in lesson activities.

Standards

Standards: Common Core Math

MCC5.MD.3, MCC5.MD.4, MCC5.MD.5, MCC5G1, MCC5G2

MCC5.MD.3 understand concept of volume measurement

a. A unit cube can be used to measure volume.

b. A solid figure packed with n unit cubes has volume of n c. u.

MCC5.MD.4 Measure volume by counting unit cubes in a solid

MCC5.MD.5 Relate volume to addition and multiplication in solving real-life math problems about volume

a. Show that packing a rectangular prism with unit cubes = multiplying edge lengths = height x area

b. Volume is additive.

MCC5G1 Use axes to define a coordinate system. Understand (x,y) convention

MCC5G2 Represent real world and math problems by graphing points in a coordinate plane and interpreting coordinate values of points

Background Information

Growing a Square Watermelon http://www.instructables.com/id/Grow-a-square-watermelon/

Square watermelon video: https://www.youtube.com/watch?v=2JNSpMhJLvg

Common Core Frameworks: 5th grade Volume and Measurement

https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit7FrameworkSE.pdf

Common Core Frameworks: 5th grade 2-D Figure

https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit6FrameworkSE.pdf

Common Core Frameworks: 5th grade Geometry and Coordinates

https://www.georgiastandards.org/Common-Core/Common Core Frameworks/CCGPS_Math_5_Unit5FrameworkSE.pdf

Teacher Preparation

- Assemble supplies and materials required for the lesson. Request free serrated cake servers from grocery bakeries.
- Free online graph paper may be printed for Garden Battleship. http://incompetech.com/graphpaper/
- Set up the garden battlefield in advance. Mark off a section of the garden as the first quadrant of a coordinate grid. Choose the bottom left corner of a raised bed to serve as the intersection of x and y axes. Insert a dowel to serve as the 0, 0 point at that corner. Tie string or twine to the dowel, run the string down the length of the garden bed to the right, tie it to a dowel inserted at the end of the bed, and mark it with numbers at regular intervals. Do the same for the y axis, along the perpendicular side of the garden bed starting at the 0, 0 point. Sticky notes taped to the twine, or just painter tape looped over twine and stuck to itself, works well for assigning numbers along the x and y axes. Numbers should be close enough together that plants in the garden are easily located by coordinates and do not fall completely between the (imaginary) grid lines. Prepare several beds this way, so pairs of students can play at various locations in the garden.
- (Optional) In advance of volume measurement activity, modify each veggie to have a regular solid shape e.g. trim an eggplant into a cube or a zucchini into a rectangular prism. Trim enough veggies in advance for each pair of students to have one. Measure the sides of each and keep a record, for future comparison to student calculations of volume.
- Print cubenet patterns for students to fold and tape into cubes. Each group of students will need multiple cubenets, if math manipulables are not available, at a scale that would fit inside the veggie for which volume is being calculated: http://printables.atozteacherstuff.com/435/cube-pattern/
- Identify available garden space for growing bonsai and gigantic veggies, keeping in mind that prize-winning giants such as pumpkins may need to be planted where they will be easy to harvest.

PROCEDURES FOR LESSON ACTIVITIES

Engaging Students

Day 1 / any season, in the garden

Garden Battleship

- Be sure coordinate grids are marked on garden beds in advance, as described in the Teacher Preparation section. Take the class outside and divide students into groups of four to play Garden Battleship, assigning two groups to each garden bed, if necessary. (A group of students will not interact with other groups, so reduce overlap, if possible).

- Pass out graph paper, pencils and clipboards and tell each students to draw four quadrants with x and y axes labeled. Note: numbers start at the 0, 0 point (lower left corner of each quadrant) and increase along the x axis to the right and along the y axis going up. Lines (not spaces) on the graph paper are to be labeled with numbers.
- One quadrant will serve as a record of the student's own battleship placements, and the other three quadrants with be used to record whether shots the student fires at the three opponents are hits or misses.
- Garden ships –which can be imaginary or secretly represented by plants - occupy the area of 2-D figures.
- Each student's navy consists of:
    - One cruiser, drawn as a 2 square x 2 square shape and sunk if hit on the x, y coordinate in the middle
    - One destroyer, drawn as a 2 square x 3 square shape and sunk it hit on both of the two x, y coordinates
    - One battleship, drawn as a 2 square x 4 square shape and sunk if all three "x, y" coordinate pairs are hit.
- Important for assessment: Student must list own battleships by x, y coordinates, below corresponding coordinate grid
- Tell students to play a round of Garden Battleship by taking turns calling out a "salvo" of 5 shots fired, after which each opponent has to report back whether he was hit (or sunk) based on where the x and y coordinates landed.
- Play additional rounds until only one player in each group has a ship still floating.
- After the game, ask students to compare area to volume, and imagine how they could play Garden Battleship in 3-D (with the height of each ship represented).

Exploration

Day 2, in Fall if harvesting veggies planted last spring OR anytime with using veggies from market or another classes' planting.

Voluminous Veggies

Harvest or obtain garden veggies so that students can practice measuring volume. Modify each veggie to have a regular solid shape for easier measurement e.g. trim an eggplant into a cube or a zucchini into a rectangular prism. Let students know that there are four ways to find the volume of but do not provide formulas or methods. Allows small groups of students to explore, problem-solve, calculate, and share their answers and techniques. Provide a serrated plastic cake server for cutting (free from grocery bakery department); a graduated cylinder, beaker or measuring cup; cubenet patterns with scissors and tape, and a ruler to each group. After all the groups have made sense of how to calculate volume and explained their method, review the four protocols for calculating volume: multiplying area times height, or multiplying the lengths of the three edges that come together at any corner (actually: l x l x h), or by counting the unit cubes that can be stacked in a solid figure, or by placing an object in water and measuring displacement. Then allow students time to try all the methods they have not yet explored and compare the results.

There's Dirt in My Bed!

Given what students have learned about measuring the volume of veggies, challenge them to calculate the area and the volume of a raised bed, and to figure out which number is relevant when deciding how much soil to purchase to fill a raised bed (volume). Students can distinguish between area and volume by laying square tiles to determine area and counting them all (or multiplying number of squares along length x number of squares along width). They can explore calculating volume by layering a hollowed out 3-D shape with unit cubes (folded from templates). Using this information, students will be able to calculate how much soil a raised bed can hold by counting the cubes stacked inside or by the number of cubes in a layer (area) time the height of the raised bed. Encourage students to make a scale model (using a shoebox) and cube nets (folding patterns: http://www.senteacher.org/wk/3dshape.ph) to estimate volume.

Day 3, in Spring

Engineering Design Challenge: Growing Bonsai Fruit and Gigantic Veggies

- Explain that bonsai is a way of growing plants to keep them smaller than they would naturally be. Show students a picture or video of a traditional bonsai and a square watermelon: https://www.youtube.com/watch?v=2JNSpMhJLvg
- Invite students to brainstorm ways they could grow veggies in cubes or rectangular prism shapes. (To press up against the sides of a container and be shaped by it, the fruit or veggie will have to be somewhat smaller than it usually is). Which fruits or veggies would be easiest to grow this way? Could you also grow square-shaped radishes underground? What sort of containers would work? Would you wait until a fruit started to form and put that part of the plant in the container, or start the entire plant in a container? Challenge each team of students to agree on a bonsai fruit or veggie design; then plant and tend it. When harvested, these plants will be measured to calculate their volume. With a few fast-growing exceptions, most plants planted in spring will be harvested in fall by next year's class.

- Show students this video about giant pumpkins: https://www.youtube.com/watch?v=RtZeeUg5baA
- Ask the class to brainstorm how pumpkins could grow that large. (Compost or fertilizer and sufficient water can contribute to plant growth, especially with the right combination of nutrients, but gigantic specimens are grown from special seed that is genetically capable of large sizes. This seed comes from mutant, randomly large plants, pollinated by other randomly large plants. Gardeners also often remove all but three or four fruits from a plant so all its energy can go into making the remaining fruits especially large. Hand-pollinating flowers early can add growing time).
- Allow students to plant special seeds that produce gigantic specimens and challenge them to think of ways they could measure the volume of the resulting gigantic veggies. Most giant fruits and veggies planted in spring will be harvested the following fall, by next year's class, because one secret to producing giants is to extend the growing season as long as possible. Plants that come in "monster-sized" varieties include pumpkins, gourds, cabbages, cucumbers, tomatoes, carrots, and broccoli.
- While planting giant veggies, also plant regular veggies so that next fall's class can harvest them and calculate volume.

Environmental Stewardship

Ask students to discuss whether giant fruits and veggies could help reduce world hunger. (Maybe not: they take a lot of soil nutrients to produce and the taste is not as good as regular-sized veggies). Consider options for growing as much produce as possible when planting a row for the hungry and harvesting it to give to the local food pantry (Vertical or tower garden design? Composting to boost sizes? Structures to extend growing season?). Let each team of students choose a plan for growing food to reduce hunger in your neighborhood and follow it through. Challenge the teams to develop methods for calculating the total volume of edible plant parts they will harvest from the garden this year, and justify their methodology when presenting it to peers. The class will select the soundest method, noting its limitations, and apply it to get a cumulative total (or estimate).

Evaluation

A rubric is provided to assist in assessing student proficiency.

Extensions

- Challenge students to devise a way to total the volume of all edible plants raised in the school garden this year.
- Encourage students to be creative in designing, sketching, and labeling measurements (including volume) on a plan for a new garden bed, to include different shapes.

Assessment for Voluminous Veggies

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**
Student accurately identified points on a coordinate grid using x,y convention, in <u>Garden Battleship</u>	Student plays Garden Battleship but does not always identify locations accurately and drawing of coordinate grids is inaccurate or incomplete	Student plays Garden Battleship and draws coordinate grad accurately but some axis labels or numbers are missing, some ships are not accurately located	Student uses x, y convention to identify points accurately, can pinpoint own ships when asked, draws first quadrant coordinate grid with 0, 0 at left bottom corner, x axis labeled horizontally, y axis labeled vertically, and numbers assigned to lines (not spaces)	
Student can calculate volume of <u>voluminous veggies</u> or fruit AND can calculate the volume of a <u>garden bed</u> to determine the maximum amount of soil it can hold.	Student can demonstrate one method for calculating the volume of a vegetable, fruit, or garden bed.	Student can demonstrate two methods for calculating the volume of a vegetable, fruit or garden bed.	Student can demonstrate 3 or 4 methods for calculating the volume of a vegetable, fruit or garden bed (area x height, multiply lengths of all sides that meet in one corner, place cubes in layers inside hollowed out shape, displaced water).	
Students will design a method for growing a <u>bonsai vegetable</u> or fruit and a <u>giant vegetable</u> or fruit.	Student can identify one strategy for enhancing the size of vegetables OR design a method for shaping a bonsai fruit or vegetable.	Student can identify more than one strategy for enhancing the size of vegetables and design a method for shaping a bonsai fruit or vegetable.	Student can identify several strategies for enhancing the size of vegetables and design a method for shaping a bonsai fruit or vegetable.	
Student grows food for hungry and devises system for measuring or estimating total volume of produce grown.	Student grows fruits and veggies.	Student grows fruits and veggies and has at least one strategy for directly measuring volume of part of harvest and extrapolating total.	Student grows fruits and veggies and has at least one strategy for directly measuring volume of part of harvest and extrapolating total.	