Lesson 3: Voluminous Veggies in the Math Garden

Grade
5

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

Time
approx 1.5 - 2 hours

Supplies
(per pair of students)
- clear shoe box (possibly)
- scissors
- duct tape
- seeds or plants for bonsai (squash, melon, pumpkin, or gourds)
- seeds for giant veggies
- measuring tape or ruler
- cube nets (patterns) or math unit cubes
- glue or tape
- grid or graph paper
- string
- tape or sticky notes
- 3 dowel rods
- graduated cylinder or beaker
- serrated cake server

(per class)
- garden veggies (1 per team: eggplant)

Overview
5th grade students will explore coordinates, area and volume in the garden.

What they will learn
- coordinate pairs, first quad
- calculate area and volume
- calculate volume 4 ways
- care for the earth

How they will learn it
- playing Garden Battleship
- measuring raised beds
- layering with unit-cubes
- find volume of bonsai and giants
- design new garden bed

Essential / Guiding Question
What math do gardeners need to know? How can we calculate the volume of our harvest and the capacity of our garden beds?

Engaging Students
Garden Battleship

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

Exploration
Engineering Challenge: Growing Bonsai and Gigantic Fruit and Veggies

Show students a rectangular fruit / veggie (or picture of square watermelon) and ask if they think it is real. (It is). Invite them to think of ways they could grow veggies in rectangular prism shapes: bonsai fruit! Which veggie? What requirements will a plant need for a container? Challenge pairs of students to concur on a design and implement their plan). For instance, one possibility would be to cut a hole in the end of a clear plastic shoebox and put it vertically over a garden plant, taping the lid (now side) shut and forcing the plant to grow inside. (Months later, after harvest, cut the fruit into unit cubes to measure volume). Also allow students to plant and grow plants from seeds bred to produce gigantic specimens. Eventually, they will be challenged to think of ways to measure the volume of the resulting veggies.

Voluminous Veggies
While waiting for the bonsai and gigantic fruits to grow to maturity so they can be measured, students will practice calculating the volume of other vegetables and fruits.

There's Dirt in my Bed!
Students will calculate a garden bed's capacity for soil. Explain to students the protocol for tiling to determine area, and layering unit cubes inside a larger cube to determine volume. Students will create unit cubes from cube nets (foldable patterns) and measure the inside of various containers (volume); comparing this method to multiplication of area times height; and comparing both methods to multiplication of the length of three edges that meet at any corner.

Explanation
Students will be able to explain the relationship between area and volume, and articulate why volume can be determined four ways: by multiplying area times height, or multiplying the lengths of the three edges that come together in any corner, or by counting the unit cubes that can be stacked in a solid figure, or measuring displacement.

Debriefing
Teacher will provide context for student activities. See Background Information for details.

Environmental Stewardship
Pairs of students will be challenged to develop a method for calculating the total volume of edible plant parts harvested from the garden this year, and defend their method when presenting it to peers. The class will select the soundest method, noting its limitations, and apply it throughout the year to create a cumulative total.

Students will used what they have learned in the lesson to help the Earth by designing a new garden for future development, sketching and labeling its dimensions and area, and calculating its maximum capacity for soil (volume).

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

CONTEXT FOR LESSON ACTIVITIES
Standards
Standards: Common Core Math
MCC5.MD.4, MCC5.MD.5, MCC5G1, MCC5G1
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.
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.
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/
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 Figures

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 materials required for the lesson.
- Provide graph or cross grid paper for Battleship game (1st quad)
- Free online graph paper: http://incompetech.com/graphpaper/
- Divide the class into pairs
- Mark off a garden bed as the first quadrant of a coordinate grid. Choose a corner 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 side 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 twine, or just painter tape looped over the twine and stuck to itself, work well for assigning numbers along the x and y axes.

PROCEDURES FOR LESSON ACTIVITIES

Garden Battleship

- Each student will secretly choose two plants or landmarks in the garden bed to represent the location of his or her battleships and mark these items on graph paper by circling the corresponding coordinate pairs (x,y). A small ship should include one coordinate pair, and a second, larger ship should include two adjacent coordinate pairs.
- Each garden battleships occupies the area of a 2-D solid figure, at a location represented by the x and y coordinates. Ask student to compare area to volume, and imagine how they could play Garden Battleship in 3-D (with the height of each ship represented).
- Students will group up in pairs and play Garden Battleship by calling out coordinate pairs to represent the shots they fire and marking whether they scored a hit or miss, depending on the response from opponent.

Engineering Challenge: Growing Bonsai and Gigantic Fruit

- Show students a rectangular fruit / veggie (or picture of square watermelon) and ask if they think it is real. (It is). Invite them to think of ways they could grow veggies in rectangular prism shapes: bonsai fruit! Ask which vegetables or fruit would work best? What requirements will a plant need for a container? Allow each pair of students to concur on a design and implement their plan. For instance, one possibility would be to cut a hole in the end of a clear plastic shoebox and place the box vertically over a garden plant, taping the lid (now side) shut and forcing the plant to grow inside. Months later, after harvest, cut the fruit into unit cubes to measure volume.
- Show students pictures of giant vegetables. (Google "giant pumpkin boat race") Ask how they think it is possible to grow such big fruit. (Extended growing season and optimal conditions are helpful, but seed that has been bred for bigger and bigger specimens, generation after generation, is necessary to grow giants). Allow students to plant and grow plants from seeds bred to produce gigantic specimens. Some may not mature until time for next year's class to use. Cabbages are a good giant plant to grow in winter and harvest during same school year. Eventually, students should be challenged to think of ways to measure the volume of the resulting veggies, which may be very irregular in shape.

There's Dirt in My Bed!

- Students will gain a conceptual understanding of the distinction between area and volume by tiling the area of a 2-D shape with unit squares, and by layering the volume of a hollow 3-D shape with unit cubes. They can then compare tiling and layering to the use of multiplication, in determining the area and volume of a garden bed. Using this information, students will calculate how much soil the garden can hold. This can be done with a scale model (shoebox) and math cube manipulatives, or students can make their own measuring unit-cubes with cube nets (folding patterns). cube nets http://www.senteacher.org/wk/3dshape.ph

Voluminous Veggies

- While waiting for the bonsai and gigantic fruits to grow to maturity so they can be measured, harvest or buy other garden veggies for students to practice measuring volume. Modify a veggie to have a regular solid shape e.g. cut an eggplant into a cube or rectangular prism. Explain to students that there are four ways to get a correct answer 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; and measuring tape or ruler to each group. After all the groups have explained their result and method, review the four protocols for calculating volume: multiplying area times height, or multiplying the lengths of the three edges that come together in 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 the methods they have not yet explored and compare results.

Environmental Stewardship

- 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. This garden bed should combine different shapes

Assessment for Voluminous Veggies

Student Name(s): _____ **Date:** _____

Level of Mastery → / Benchmark or Performance Measure ↓	 **Mastered task @ 90%+ accuracy: 5 pts**	 **Mastered task @ 85% accuracy: 4 pts**	 **Mastered task @ 80% accuracy: 3 pts**	 **More learning needed**	**TOTAL POINTS**
Garden Battleship	Correctly identified coordinate pairs in the first quadrant, while playing battleship	Played battleship but not always accurate when locating coordinate pairs	n/a	No attempt	
Bonsai and Gigantic Fruit and Veggies	Designed a method for growing a bonasi fruit and planted, tended seeds for giant veggies	Started a bonsai fruit or planted giant seeds	n/a	No attempt	
Voluminous Veggies	Calculated volume of a solid regularly shaped fruit using four different methods	Calculated volume using 2-3 methods	Calculated volume using one method; lacked understanding of concept	No attempt	
Dirt in My (Garden) Bed	Applied math to real world calculating volume of a garden bed to determine amount of soil needed, noted amount correctly	Calculated volume correctly but lacked correct units	n/a	No attempt	
Engineering Challenge: Design a garden with multiple levels and figure volume, or devise a way to calculate total the volume of total garden harvest for year	Used knowledge of volume and creativity to solve a real world problem	Made progress in attempt to solve real world problem without completing it	n/a	No attempt	
TOTAL in LAST BOX →					**_ /25 pts**