Performance Based Learning and Assessment Task # 2

How Do I Design a Raised Bed Garden to Accommodate My Plants?

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

This task is designed to give students the opportunity to use their knowledge of the formulas for perimeter, area and volume of a rectangular prism to design two raised garden beds, and use ratios, proportions and logical reasoning to minimize the cost in a real life situation. Students will have to graphically represent their design of two raised bed gardens on graph paper or as a print out from a computer program. Students will have to calculate the perimeter, area, and volume of the designs while trying to minimize the cost by using proportions and reasoning. Students will have to solve equations and use proportional reasoning.

II. UNIT AUTHOR:

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III. COURSE:

Math 7; or Geometry; or Algebra 1

IV. CONTENT STRAND:

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

A.4 The student will solve multistep linear and quadratic equations in two variables, including solving real-world problems involving equations and systems of equations.

Computation and Estimation

7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.

Measurement

7.5 The student will

a) describe volume and surface area of cylinders;
b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and
c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.

Patterns, Functions and Algebra

7.14 The student will

a) solve one- and two-step linear equations in one variable; and
b) solve practical problems requiring the solution of one- and two-step linear equations.

V. OBJECTIVES:

- Students will use their knowledge of perimeter, area, volume and proportions to design two raised bed gardens containing a minimum number of plants while minimizing the cost of the materials.
- Students will use graph paper or a computer program to draw their garden.
- Students will calculate perimeter, area, volume and cost.
- Students will use ratios and proportions to calculate the amounts of soil types needed for the soil mixture.

VI. REFERENCE/RESOURCE MATERIALS:

- Students will use the Math 7 text book available in the classroom. Teacher will provide graph paper, rulers, calculators and access to computers for Geogebra, Geometer's Sketch Pad and MS Word.
- Students will also have access to their teacher for guidance.

VII. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed on the designs of their raised bed gardens and if each can hold the minimum number of plants. Students will also be assessed on the accuracy of their work to support their designs and the cost efficiency of their designs. Students will be assessed on the explanation for the final choice of design and what they could do differently or better.

VIII. EVALUATION CRTERIA:

Self assessments and teacher assessments are attached to this document as well as a benchmark of what students are expected to produce.

IX. INSTRUCTIONAL TIME:

This activity should take three to four 45-minute periods.

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VA SOL

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A.4 The student will solve multistep linear and quadratic equations in two variables, including solving real-world problems involving equations and systems of equations.

NCTM Standards

Number and Operations

Students will:

- select appropriate methods and tools for computing with fractions and decimals from among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods.
- develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.

Algebra:

Students will:

- develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.
- recognize and generate equivalent forms for simple algebraic expressions and solve linear equations.

Measurement:

Students will:

- understand relationships among units and convert from one unit to another within the same system.
- understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume.

Connections:

Students will:

- Organize their mathematical thinking through discussion with peers
- Communicate their thinking clearly to teacher and peers
- Analyze and evaluate the mathematical thinking and strategies of their partners

- Use the language of mathematics to express mathematical ideas precisely
- Recognize and apply mathematics in contexts outside of mathematics
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole

Representation:

Students will:

- Create and use representations to record and communicate mathematical ideas.
- Select, apply, and translate among mathematical representations.
- Use representations to model and interpret physical and mathematical phenomena.
- draw reasonable conclusions about a situation being modeled.
- model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Additional Objectives for Student Learning:

Not applicable

Mathematical Objectives

- Students will demonstrate their knowledge of properties of rectangles and rectangular prisms including perimeter, area, and volume to design two raised bed gardens containing a minimum number of plants while minimizing the cost of the materials.
- Students will demonstrate their knowledge of ratios and one-step and two-step equations to perform calculations in a real life problem.
- Students will use graph paper or a computer program to draw their gardens.
- Students will calculate perimeter, area, volume and cost of each garden.
- Students will use ratios and proportions to calculate the amounts of soil types needed for the soil mixture for each garden.

Materials/Resources

- Students will use the Math 7 text book available in the classroom. Teacher will provide graph paper, rulers, calculators and access to computers for Geogebra, Geometer's Sketch Pad and MS Word.
- Students will also have access to their teacher for guidance.

Assumption of Prior Knowledge

Students should know how to use the formulas for perimeter and area, how to set up and solve proportions and ratios, and how to solve one-step and two-step equations.

Students will be operating on Level 3, Abstraction of the van Hiele model hierarchy performance levels. Students will be applying their knowledge of perimeter, area and volume and demonstrating their understanding of how a change in one dimension of a rectangular prism will affect the perimeter, area and volume.

Introduction: Setting up the Mathematical Task

The teacher will ask, "How many of you have ever seen a community garden?" Let the students think and respond. The teacher may ask for the students to describe the garden. The teacher pulls up example images of raised bed gardens.

("DisplayImage.jpg",n.d.)

("raised-garden-beds-design-300x200.jpg", n.d.)

("700_4-foot-cedar-raised-bed.jpg", n.d.)

("IMG_6395.jpg", n.d.)

Students will be placed in groups of three to four by the teacher or by their own choosing. Students will be told that they must design two different cost efficient raised bed gardens for the school. The garden must meet the requirements given on the project sheet. (The requirements can be changed for differentiation.) Students must draw their designs and demonstrate their knowledge of perimeter, area, and volume and the affect that they have on one another through calculations. Students will be asked to be as cost efficient as possible to demonstrate real life situations. Students will decide which of their designs is best and explain or defend their reasons for choosing it.

Student Exploration

Students will work in groups for the entirety of the project, with the help of the teacher when necessary. Students will determine the best way to design the raised beds for themselves, but all must include how they used their calculations to design their gardens.

Student/Teacher Actions

Students will be talking, calculating and drawing their designs. To draw the designs they can use graph paper or a computer. This could be a good use of a program like GeoGebra, Geometer's Sketch Pad or Desmos. The teacher will be circulating and giving help and advice where it is needed. Students might not see the relationship between perimeter, area and volume and how changing one may affect the others. The teacher may go over simple examples for a demonstration.

At the end of the project each group will present their choice for best design to the class, explaining their decisions and calculations. They should include what part of the project was the most difficult, what was something new that they learned, and what they might do differently. Student work should be displayed.

Assessment List and Benchmarks

Students will complete two design drawings along with all calculations and an explanation for their choice for best design and what they may have done differently. Students will self assess their work using the same rubric as the teacher .

Raised Garden Bed

Students work in Groups of three to four students collaborating on the design.

Your group is designing two rectangular raised bed gardens for your school with a budget of $500. Your choice for best design will be the one that is used. A raised bed garden is a small garden that has a boarder as an edge and is filled with soil, so you aren't digging into the actual ground. Your design choice of garden will be growing tomatoes, peppers and beans. You will plant four tomato plants, at least ten pepper plants and at least fifteen

bean plants. The plants are all being donated, so their cost is of no concern. All other hardware nails, brackets and tools are on hand. Items of concern will be area, perimeter, volume and overall cost of the raised bed. You need to design to raised bed gardens and determine your choice for the best design so that it accommodates the minimum number of plants and stays under budget.

Plant spacing requirements:

- Tomatoes must be three feet from other plants and eighteen inches from the edge of the bed.
- Peppers must be at least twelve inches apart and six inches from the edge of the bed.
- Beans must be at least four inches apart and two inches from the edge of the bed.

Lumber:

- All lumber is measured by thickness, width and length. (inches thick *X* inches wide *X* feet long) All boards can be cut to a specific length, but you must still buy the whole board.
- 2 X 10 X 16 cost $25/board
- 2 X 10 X 12 cost $20/board
- 2 X 10 X 10 cost $15/board
- 2 X 10 X 8 cost $13/board

Soil:

- Soil will be a mixture of garden soil, peat moss, and compost in the ratio of 11:4:3. The soil mixture should fill the bed so that it is nine inches deep.
- garden soil is $5/cubic foot
- peat moss is $12/3 cubic feet
- compost is $3/.75 cubic foot

Cost:

- Cost should be calculated for your design using the given prices.
- Remember that you have a maximum budget of $500. Any money left over goes towards a party.

Draw your Raised Bed Designs from a bird's eye view with location of the plants.

Explain the reasoning for choosing your design you thought was the best. Is there anything that you could have done differently or better?

Element	Possible Points	Self	Teacher	Score
Area of	3			

Garden One				
Area of Garden Two	3			
Perimeter of Garden One	3			
Perimeter of Garden Two	3			
Volume of Garden One	3			
Volume of Garden Two	3			
Cost of Garden One	3			
Cost of Garden Two	3			
Overall Design of Garden One	3			
Overall Design of Garden Two	3			
Explanation For Choice	3			
Total	33			

	3 points	2 points	1 point	0 points
Calculation for area of Garden One.	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculation for area of Garden	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not	No Calculations present.

Two.			correct.	
Calculation for perimeter of Garden One..	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculation for perimeter of Garden Two..	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculation for volume of Garden One.	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculation for volume of Garden Two.	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculations for cost of Garden One.	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Calculations for cost of Garden Two.	Calculations are correct.	Calculations are mostly correct.	Calculations are present, but not correct.	No Calculations present.
Overall Design of Garden One.	Design shows all plant locations properly, while staying under budget.	Design shows most plant locations properly, while attempting to stay under budget.	Design shows plant locations that are incorrectly placed and is over budget.	No design is present.
Overall Design of Garden Two.	Design shows all plant locations properly, while staying under budget.	Design shows most plant locations properly, while attempting to stay under budget.	Design shows plant locations that are incorrectly placed and is over budget.	No design is present.
Explanation for choice	Explanation is clear and valid.	Explanation is somewhat clear and valid.	Explanation is not clear nor valid	No Explanation present.

Benchmark

Design 1

Area = 12 * 6 = 72 sq ft

Perimeter = 2(12) + 2(6) = 36 ft - Buy 3 (2 x 10 x 12) boards and cut one in half. $60

Volume = 12 * 6 * .75 = 54 cu ft 11x+ 4x + 3x =54 so 18x = 54 so x = 3

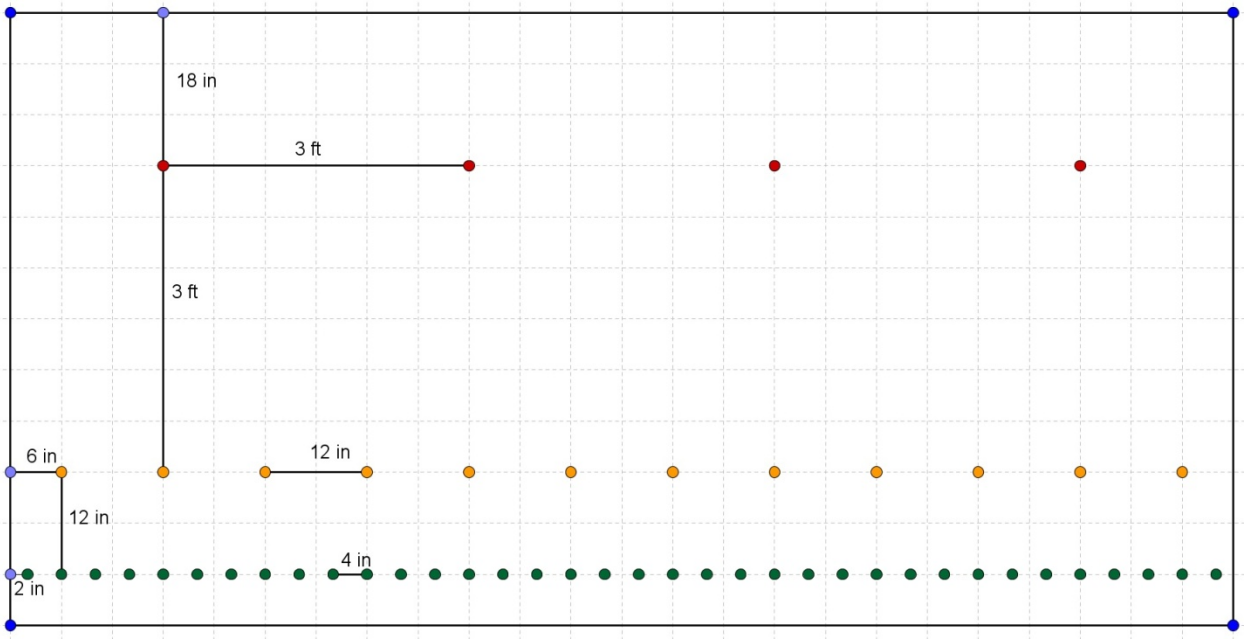
11 x 3 = 33 (each bag has 1 cu ft, so 33 bags@ $5 each)

4 x 3 = 12 (each bag has 3 cu ft, so 4 bags @ $12 each)

3 x 3 = 9 (each bag has .75 cu ft, so 12 bags@ $3 each)

33 bags of soil, 4 bags of peat moss and 12 bags of compost. 5(33) + 12(4) + 3(12) = $249

Total Cost is $309



Design 2

Area = 9 * 6.5 = 58.5 sq ft

Perimeter = 2(9) + 2(6.5) = 31 ft - Buy 2 (2 x 10 x 16) boards and cut each to measurement length and width. $50

Volume = 9 * 6.5 * .75 = 43.875 cu ft 11x+ 4x + 3x =54 so 18x = 43.875 so x = 2.4375

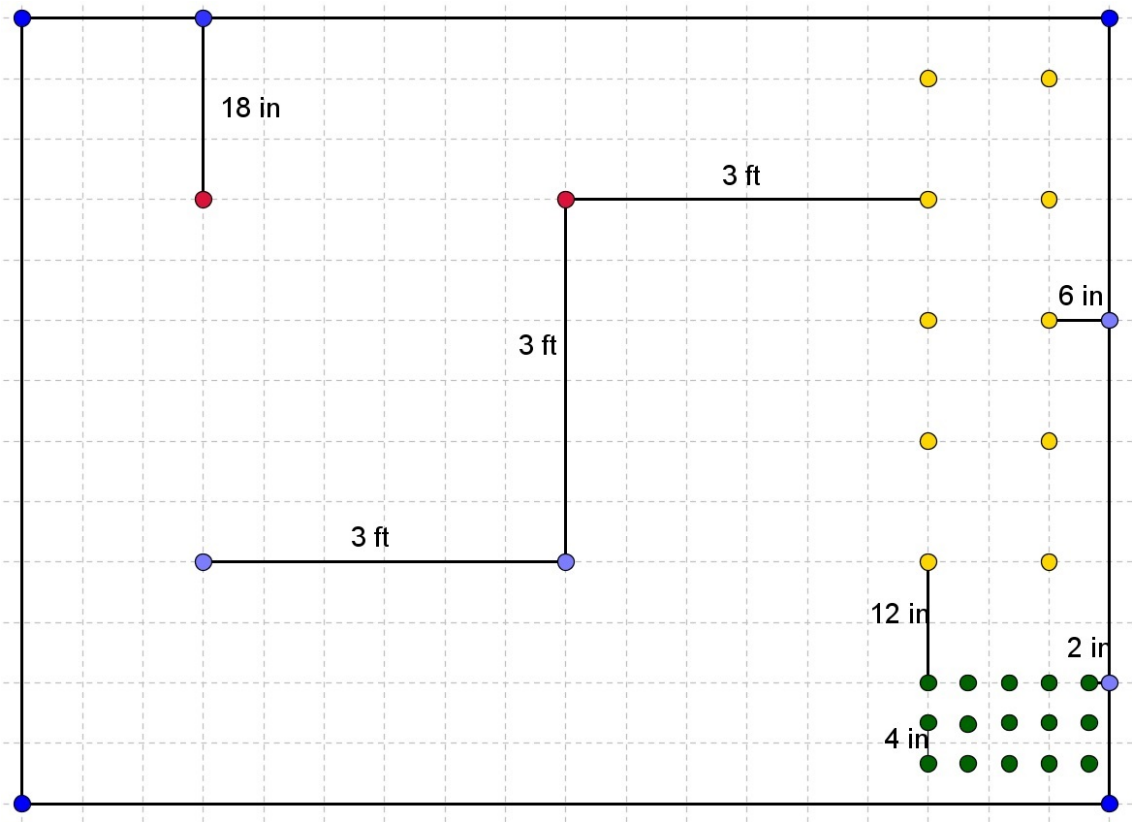
11 x 2.4375 = 26.8125 (each bag has 1 cu ft, so 27 bags@ $5 each)

4 x 2.4375 =9.75 (each bag has 3 cu ft, so 4 bags @ $12 each)

3 x 2.4375 = 7.3125 (each bag has .75 cu ft, so 10 bags@ $3 each)

33 bags of soil, 4 bags of peat moss and 12 bags of compost. 5(27) + 12(4) + 3(10) = $213

Total Cost is $263



Starting at a corner of our bed, we used our graphs to plot the appropriate places for the plants, fitting them as close as we could. We placed the other edges of our beds as close as we could to the plants. We know that given a perimeter, a square will have the largest area, so for the second design we tried to get it as close as possible to a square. We calculated our area, perimeter and volume. We used those calculations to find the cost of our materials. We would spend $309 for the first design and $263 for the second design, so based on the cost we chose design 2 to have more money for a party. We should have tried to get our design to be as close to a square as possible in our first design. We wonder if there is any other configurations of the plants that could accomplish making the design more like a square.

[DisplayImage.jpg]. (n.d.). Retrieved July 15, 2014 from https://store.aces.edu/ItemDetail.aspx?ProductID=13373

[700_4-foot-cedar-raised-bed.jpg]. (n.d.). Retrieved July 15, 2014 from http://www.gardenista.com/posts/raised-garden-bed-round-up

[raised-garden-beds-design-300x200.jpg]. (n.d.). Retrieved July 15, 2014 from http://www.raisedgardenbedshowto.com/

[IMG_6395.jpg]. (n.d.). Retrieved July 15, 2014 from http://365days2simplicity.blogspot.com/2011/04/raised-garden-bed.html