

<b>LessonTitle: The Garden Problem</b>	
<b>Utah State Core</b> Geometry Content Standard 2, 3 Process Standards 1-5	
<b>Summary</b>	
Students work together in groups to solve an open-ended problem relating area and perimeter. The problem does not specify the shape of the garden, so students may experiment with various shapes, calculating area and perimeter. The question is framed so that there are multiple answers possible, leading to a rich discussion. The activity is followed by an assessment that involves students with another application of area.	
<b>Enduring Understanding</b>	<b>Essential Questions</b>
Everyone can do what mathematicians do. They ask questions, investigate, generalize, represent ideas, prove conclusions, and move on to new problems or problem variations.	<ul style="list-style-type: none"> <li>• How can you find the shape of a garden with the most area and the least fence? How will you know for sure?</li> <li>• What shape would you predict to have the most and the least surface area?</li> </ul>
<b>Skill Focus</b>	<b>Vocabulary Focus</b>
<ul style="list-style-type: none"> <li>• Problem Solving</li> <li>• Using the scientific process.</li> <li>• Maximum area and constant perimeter</li> </ul>	
<b>Materials</b> Graph paper and string, Calculators, Computers	
<b>Launch</b>	
<b>Explore</b> (Teacher and student roles)	
First give the initial problem and let kids problem solve. Give them graph paper and if they need a place to begin, suggest they try making different rectangles with the same perimeter. The problem does not specify that it is a rectangular garden, so let students deal with the issue of what the shape was to begin with. They don't know so they have to come up with different scenarios. This is part of the thinking.	
After groups have presented and recorded their ideas and other groups' solutions in their logs, direct them to use spreadsheets to study the problem. Lead the students in the process of filling down and entering formulas and then in making graphs	
<b>Discourse Suggestions:</b>	
<ul style="list-style-type: none"> <li>• How can you begin to think about the problem?</li> <li>• How might you justify your thinking?</li> <li>• Are there any other possibilities?</li> <li>• Why do 2 different rectangles with the same perimeter have different areas?</li> <li>• Are there any patterns for various rectangles with the same perimeter?</li> <li>• Try using a string on graph paper. See what happens to the area when you shape the string into different rectangles.</li> <li>• What prediction would you make about the area of a circle with the same circumference as the rectangles you're working with? Again try your string.</li> </ul>	
<b>Summarize</b>	
<ul style="list-style-type: none"> <li>• Groups will present their initial solutions. Students will write their conclusions and learning from other groups and from large group discussion.</li> <li>• Students write a summary of learning. 1) their groups' initial solution, 2) what they learned about the problem from the spread sheet activity , 3) their answers to the essential questions.</li> </ul>	
<b>Apply</b>	
<b>Assess</b>	
"What's the Area" worksheet	

## The Garden Problem

**Bill, Cathy and John were working together to make a garden larger. Bill said, “We have to buy more fencing because if we increase the area of the garden we will need more fencing to go around.”**

**Kathy had a different opinion. “That’s not true,” she said, “We can use the same amount of fencing we have and move it to make the area of the garden larger.”**

**John disagreed with both Kathy and Bill. He said, “I know a way that we can make the garden larger and use less fencing.”**

1) What do you think? Use graph paper and string to help you think about the problem. Come up with a possible answer with your group.

- Explain your group’s ideas.
- Decide if Bill, Cathy or John is right. Justify your conclusion.

2) Compare your group’s solution with other groups. What do you think after hearing the other groups? Would you change your conclusion? Explain.

3) Examine the problem using a spreadsheet. To do this we will consider different rectangles with perimeters of 36 units.

- Name the variables in the columns (perimeter, width, length, area).
- Enter data into the columns. Your teacher will show you how to fill down and enter formulas so you do not have to calculate and enter every number. When you type = the computer recognizes that you are entering a formula.

<b>Column A</b>	<b>Column B</b>	<b>Column C</b>	<b>Column D</b>
1 <i>Perimeter</i>	<i>Width</i>	<i>Length</i>	<i>Area</i>
2 36	1	= (formula)	= (formula)
(highlight cell A2 and drag from lower right corner down to cell A18)	=A2 +1 (formula) (highlight B2 and drag from lower right corner down to B18)	(highlight C2 & drag from lower right corner down to C18)	(highlight D2 and drag from lower right corner down to C18)

3) Make the Graph

- 1) Highlight all the data starting with the cursor in A1 and dragging down and right to D18.
- 2) Go to graph or chart wizard (Above screen, five from the right.) Choose “XY Scatter” under chart type. Then under custom types, choose Colored Lines, Column Area, or Line Column.
- 3) Continue through all of the “next” buttons until you come to TITLES. Type in the following information.
- 4) Title: GARDEN PROBLEM
- 5) x : Width
- 6) y : Length
- 7) Hit finish.
- 8) Highlight your graph and move it below the spreadsheet data.

4) Conclusions: What do you know about the garden problem from looking at the graph? Write your observations about the data and the graph.

Extra for Experts: Make a spreadsheet using a constant area of 36 square units and graph it. Then explain what they tell you about the Garden Problem.

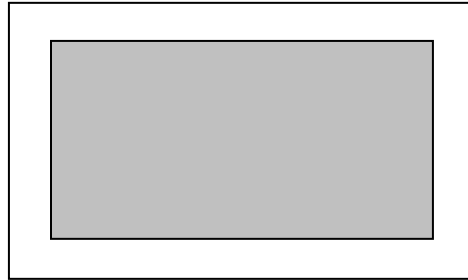
## Assessment

## What's the Area

A subdivision will be built on a piece of land 1000 meters by 1500 meters. In the border of the subdivision, the landscape architects are planning a border of trees and shrubs along with a road. The inner area of houses and parks will cover at least 1.25 million  $m^2$ . How wide can the border be for the landscape and access road?

1) Estimate different widths for the border. Then figure out what's left for the houses and parks.

Width of Border	Area of Houses and Parks



2) Enter the data in the table above in a spreadsheet or a calculator and plot the resulting graph.

3) What widths for the border will allow the required area for houses and parks? Show what you did to figure out your answer. How does the graph from #2 above help you?

4) Write an equation which you could use to help you determine the greatest border width possible.

5) During large group discussion, record other groups' methods and equations.

- Compare your group's work to the results of other groups.
- What can you do to prove whether or not the different expressions are the same? Do it and record your results below.