GEO GARDENS

- Fractions
- Area
- Congruence
- Spatial Visualization

Getting Ready

What You'll Need

Geoboards, 1 per student

Rubber bands

Geodot paper, page 116

Activity Master, page 99

Overview

Students search for different ways to partition the Geoboard into congruent and noncongruent fourths and then eighths. In this activity, students have the opportunity to:

- divide a whole into fractional parts
- represent fractions spatially
- find the area of a variety of shapes
- recognize that shapes with equal areas may not be congruent

Other *Super Source* activities that explore these and related concepts are:

Peanut Brittle, page 9

Pedro's Patio Plans, page 18

Food Pyramid, Square, Circle, page 23

The Activity

On Their Own (Part 1)

Susan wants to make a garden so that she can grow some of her own vegetables: tomatoes, lettuce, cucumbers, and green peppers. How many ways can Susan lay out her garden?

- Work with a partner. First enclose all 25 pegs on the Geoboard with one rubber band to represent the shape and size of Susan's garden.
- Then divide the Geoboard garden into fourths in as many ways possible. Represent the areas allotted to the 4 crops according to the following rules:
  - The garden must be partitioned into fourths that are all congruent to each other.
  - Be sure that your solutions are all different, not just reflections or rotations of one another. Changing the location of crops does not create a different solution.
- Record each solution on Geodot paper.
- Be prepared to explain how you know your solutions illustrate fourths.

Thinking and Sharing

Invite a volunteer from each group to share one of the solutions and explain how it illustrates fourths. Continue until all possible solutions have been posted. Discuss any examples for which duplicate solutions are already posted.

Use prompts like these to promote class discussion:

- What does it mean to divide the Geoboard garden into fourths?
- How would you describe congruent shapes?
- What are some ways to prove that shapes are congruent?
- How did you go about finding new solutions?
- What do all the fourths have in common?
- What did you notice about the area of each of the fourths?
- How many different shapes can be used to divide the Geoboard into congruent fourths? How do you know these are the only possibilities?

On Their Own (Part 2)

What if... ***in addition to the four original crops, Susan decides to grow four new crops: radishes, onions, red peppers, and carrots? How should Susan lay out the 8 crops she will plant in her garden?***

- Work with a partner. Enclose all 25 pegs on the Geoboard with one rubber band to represent the shape and size of Susan's garden.
- Try to find several different ways to divide the Geoboard garden into *congruent* eighths to represent the areas allotted for the 8 crops.
- Record each of your solutions on Geodot paper.
- Now try to find several different ways to partition the Geoboard into 8 different *noncongruent* sections that have equal areas.
- Again, record each of your solutions on Geodot paper.
- Be prepared to justify your solutions and explain how you know that the shapes are either congruent or noncongruent.

Thinking and Sharing

Invite students to share their congruent garden layouts. Discuss their solutions and then have them share their layouts for noncongruent eighths.

Use prompts like these to promote class discussion:

- How did you go about finding solutions?
- How many different shapes can be used to divide the Geoboard into congruent eighths? How do you know these are the only possibilities?
- What was your strategy for filling the Geoboard with noncongruent eighths?
- What are some ways to prove that shapes are congruent or noncongruent?

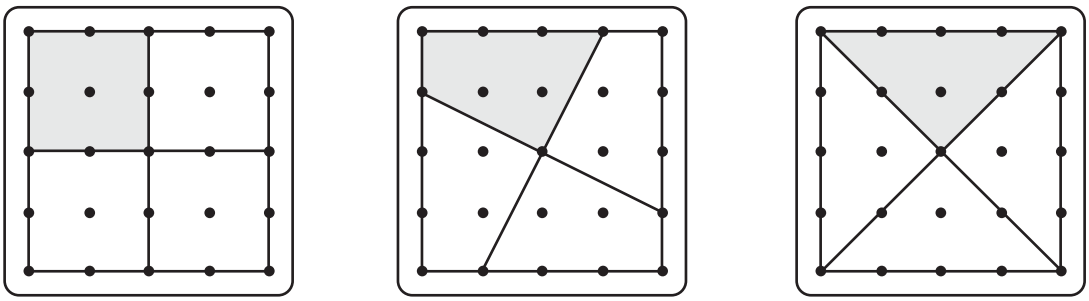
What do you notice about the perimeter of the garden layouts? Suppose Susan wanted to build a fence around each type of crop. Using one of your layouts from Part 2, write a note to Susan explaining anything that she may need to know before she builds the fence.

Teacher Talk

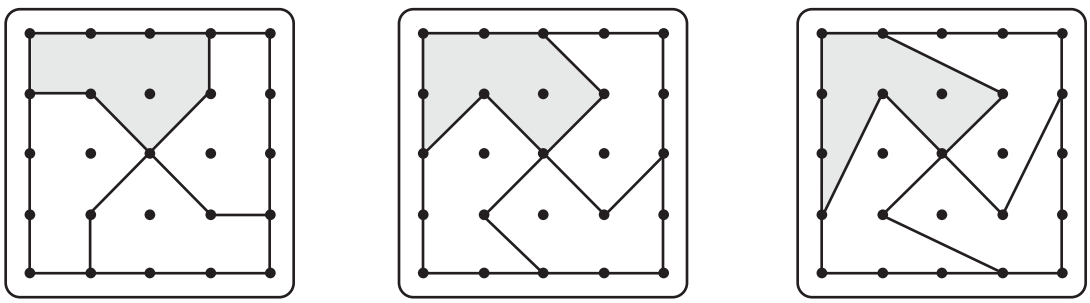
Where's the Mathematics?

As students investigate the various ways to divide the Geoboard into fourths or eighths, they work with the concepts of fractional parts of a whole, congruence, and area. The layouts for Susan's garden prompt students to think of fractions in spatial terms. There are many solutions to the problems, and students may not have time to find and check them all. Before they start thinking about fourths or eighths, students need to know that the area of the entire Geoboard garden is 16 square units. By posting a variety of layouts, students will recognize that all solutions consisting of fourths have equal areas of 4 square units and solutions consisting of eighths have equal areas of 2 square units.

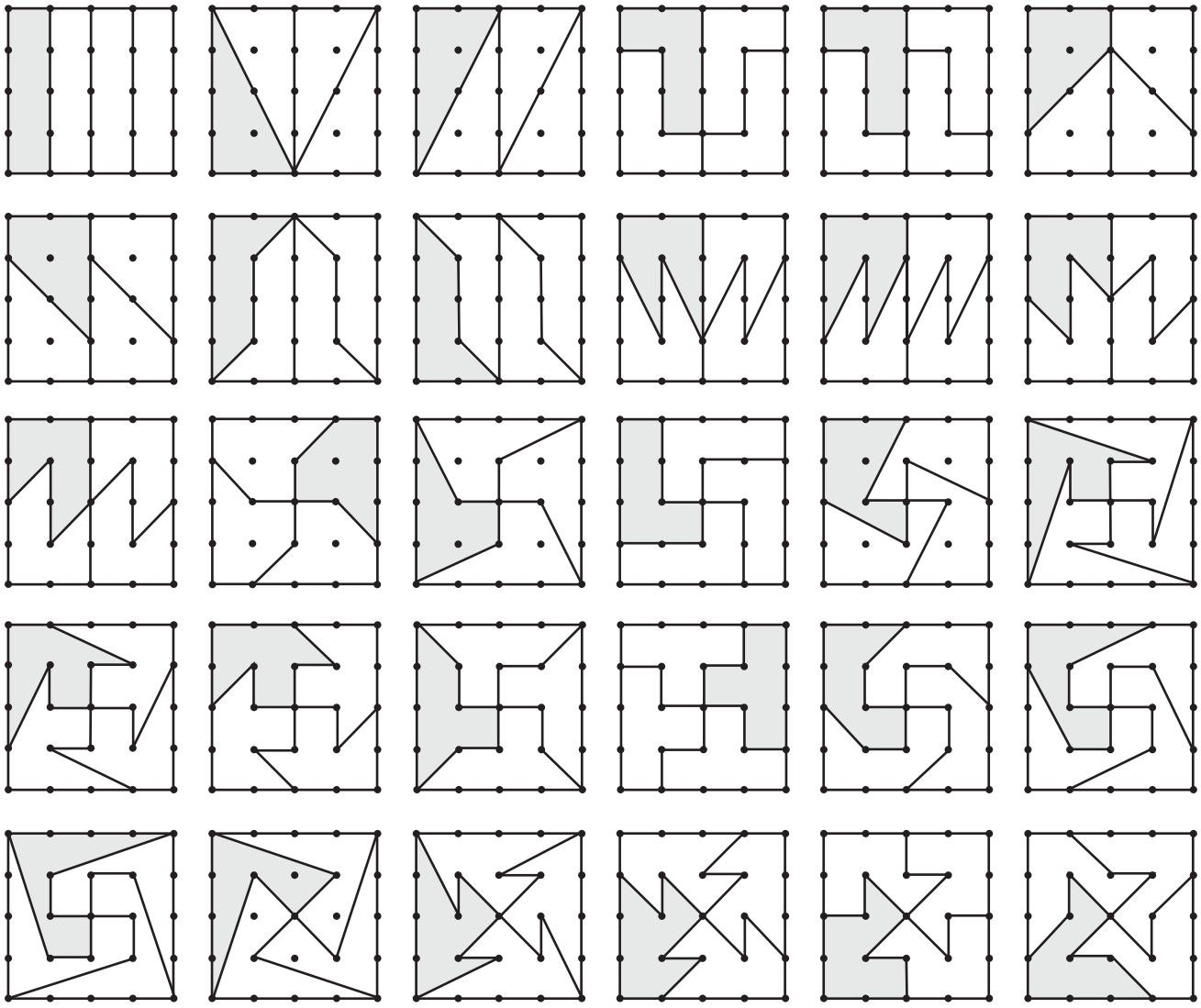
In Part 1, students may begin dividing the Geoboard into fourths with two segments passing through the center peg that are each parallel to a pair of the board's sides. They may then try to "rotate" these segments using the center peg as the pivotal point to generate other solutions.



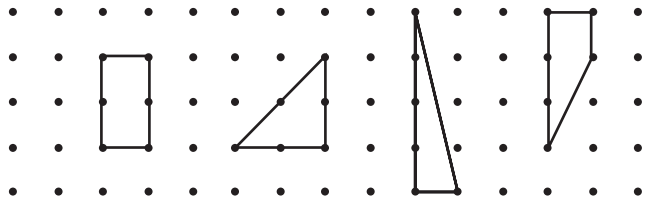
To find more solutions, students may observe that the dividing "lines" do not have to be straight. One strategy is first to partition the Geoboard diagonally and then to move opposite ends of the rubber bands one peg at a time, either all clockwise or all counter-clockwise, into new positions.



The following designs demonstrate the wide range and variety of possible solutions:



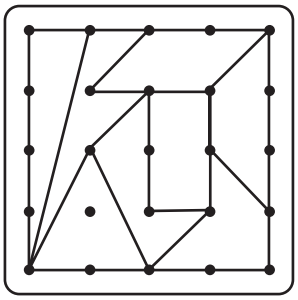
In Part 2, there are four basic shapes students can use to divide the Geoboard garden into congruent eighths; these shapes can be arranged in different ways.

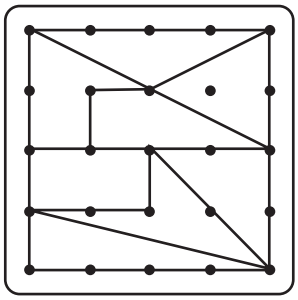


The same methods used to generate congruent fourths can be used to generate new layouts for congruent eighths. Moving the rubber bands peg by peg is one strategy that can be applied on the Geoboard, regardless of the number of fractional parts required.

Finding noncongruent eighths challenges students to find shapes that have areas of 2 square units that fit together to cover the Geoboard surface. Students may construct their solutions one figure at a time. They may make one shape, determine if its area is 2 square units, and then check to see that it is not congruent to any of the previously made shapes. Using this one-shape-at-a-time strategy may lead students to partition the Geoboard in ways that leave spaces that are not eighths of the Geoboard. To avoid this problem, suggest that students work along the outer edges of the Geoboard and then inward so they do not cut off space along the border.

Other students may draw a series of shapes on the Geodot paper, each having an area of 2 square units. After cutting out these shapes, they may experiment with the cutouts to look for eight noncongruent eighths that fit together to form a 4-by-4 square. Two examples of Geoboards partitioned into noncongruent eighths are shown below.





Once students learn that eighths must all have the same area, they may assume that they must also have the same perimeter. Further exploration will prove that this is not the case, and students will discover that shapes with the same area may have different perimeters.