Square Patios

Reporting Category	Functions
Topic	Connecting different representations of functions
Primary SOL	A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including a) determining whether a relation is a function; e) finding the values of a function for elements in its domain; and f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic
Related SOL	A.1, A.4f

Materials

- Building Square Patios activity sheet (attached)
- Construction paper
- Colored toothpicks
- Wooden toothpicks
- Miniature marshmallows

Vocabulary

independent variable, dependent variable

domain, range, function, relation (A.7)

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. Distribute copies of the Building Square Patios activity sheet. Divide the class into groups, and give each group the materials listed on the activity sheet.
2. Have student groups complete the activity. (Note: Students are to build only the first five patios, looking for patterns. They do not have enough materials to build larger patios. If a group is unsure and would like to check its rule by building a larger patio, allow two groups to combine materials in order to build a 6 x 6 or a 7 x 7 patio.)
3. As students are working, make sure they are making the connections between the different representations—concrete (patio model), numeric (chart), verbal (#2 and #6), algebraic (#3 and #7), and graphic (#4 and #8). If students are having difficulty coming up with a verbal sentence, prompt them to look at what is changing in the patios or in the chart. If students are having difficulty coming up with an algebraic representation, encourage them to look back at their verbal representation.
4. As students make their graphs, note whether or not they are connecting the points. This is a good time to question whether the data are continuous or discrete. It is also a good time to bring up ideas of domain and range.

5. As students work on finding a relationship between the patio dimensions and the number of frames and corners, you may need to suggest they look for hints in the patterns already completed. You may also suggest that they look at a graph to see if it is more like the border stabilizers or the tiles.
6. Lead a whole-class summary in which students summarize or share ideas on how to go from one representation to another, especially on how they arrived at their algebraic representations. Then, discuss questions 5, 9, 10, 11, and 12, which made connections between representations and ideas of functions and included more difficult relationships.

Assessment

- **Questions**
  - How did you take each pattern in the patio problem and turn it into an algebraic equation?
  - What is another situation that would have a pattern or graph like the relationship between the patio dimensions and the number of tiles?
  - What is another situation that would have a pattern or graph like the relationship between the patio dimensions and the number of border stabilizers?
- **Journal/Writing Prompts**
  - Explain what information someone can gain from looking at each kind of representation (concrete, verbal, numeric, graphic, and algebraic) explored in this task.
  - Given one representation of a function, how might you represent it in another way? (Note: You may leave this prompt open ended or name a specific representation(s) for your students to relate.)
- **Other**
  - Give students a variety of representations of several different situations. Have students match up the picture, verbal explanation, data table, graph, or equation that goes with each situation.

Extensions and Connections (for all students)

- Have students rewrite their algebraic expressions/equations into function notation. Then have students use them to solve for various domain values.
- Explore the domain and range values for each of the situations.
- Give other concrete patterns that will allow students to see the changes in each step and then transfer those ideas to other representations.

Strategies for Differentiation

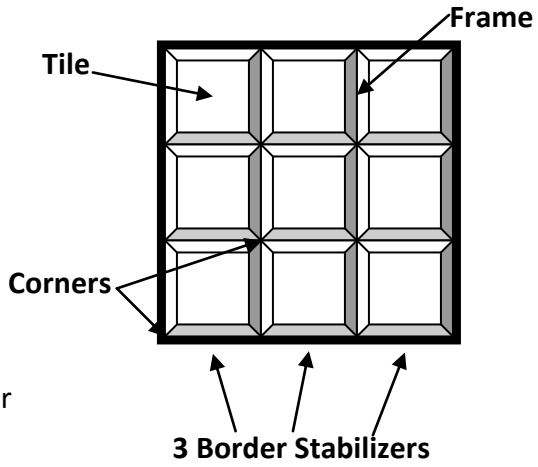
- Have students divide a sheet of paper into five sections and label the sections “Concrete,” “Verbal,” “Numeric,” “Graphic,” and “Algebraic.” In each section, have students represent the same function in the specified representation.
- Depending on the needs of individual students, square patio questions can be reduced.

Building Square Patios

Name _____ **Date**_____

Materials

- 30 construction paper squares, each cut to the length of a wooden toothpick, to use as tiles
- 45 wooden toothpicks to use as frames
- 40 miniature marshmallows to use as corners
- 30 colored toothpicks to use as border stabilizers



Directions

1. Using the materials above, build models of the first *five* square patios listed in the chart below. Record your data in the chart.
2. Looking at the number of tiles in each of your patios, predict and write in the chart how many tiles would be in a 6 x 6 patio, a 7 x 7 patio, and a 10 x 10 patio. Explain how you arrived at your answers.
3. Now, fill in the number of tiles needed for an *n* x *n* patio, and explain how you arrived at your answer.

Patio Dimensions	No. of Tiles	No. of Border Stabilizers	No. of Frames	No. of Corners
1 x 1				
2 x 2				
3 x 3				
4 x 4				
5 x 5				
6 x 6				
7 x 7				
10 x 10				
n* x *n				

4. Create a graph showing the different patio dimensions and the number of tiles in each patio. Which variable is independent, and which is dependent?

5. You have made algebraic and graphic representations of this relationship. Is this relationship a function? How do you know?

6. Next, fill in the number of border stabilizers needed for each of the five patios you built. Do you see a pattern? If so, use this pattern to predict the number of border stabilizers needed for a 6 x 6 patio, a 7 x 7 patio, and a 10 x 10 patio. Explain how you arrived at your answers.

7. Now, fill in the number of border stabilizers needed for an n x n patio, and explain how you arrived at your answer.

8. Create a graph showing the different patio dimensions and the number of border stabilizers needed for each patio. Which variable is independent, and which is dependent?

9. You have made algebraic and graphical representations of this relationship. How could you use each of these representations to predict the number of border stabilizers needed for a 16 x 16 patio?

10. Compare the two different graphical representations you have made. What do you notice?

11. Can you find a relationship between the patio size and the number of frames? If so, what is it in algebraic form?

12. Can you find a relationship between the patio size and the number of corners? If so, what it is in algebraic form?