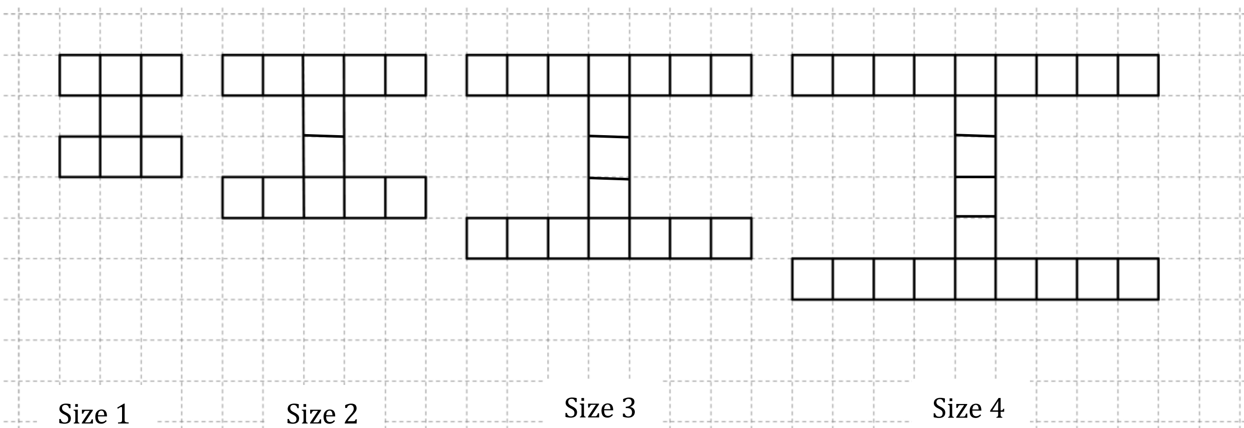
1.2 I Rule!

A Solidify Understanding Task

Marco has started a new blog about sports at Imagination High School (mascot: the fighting unicorns) that he has decided to call “I Site”. He created a logo for the web site that looks like this:

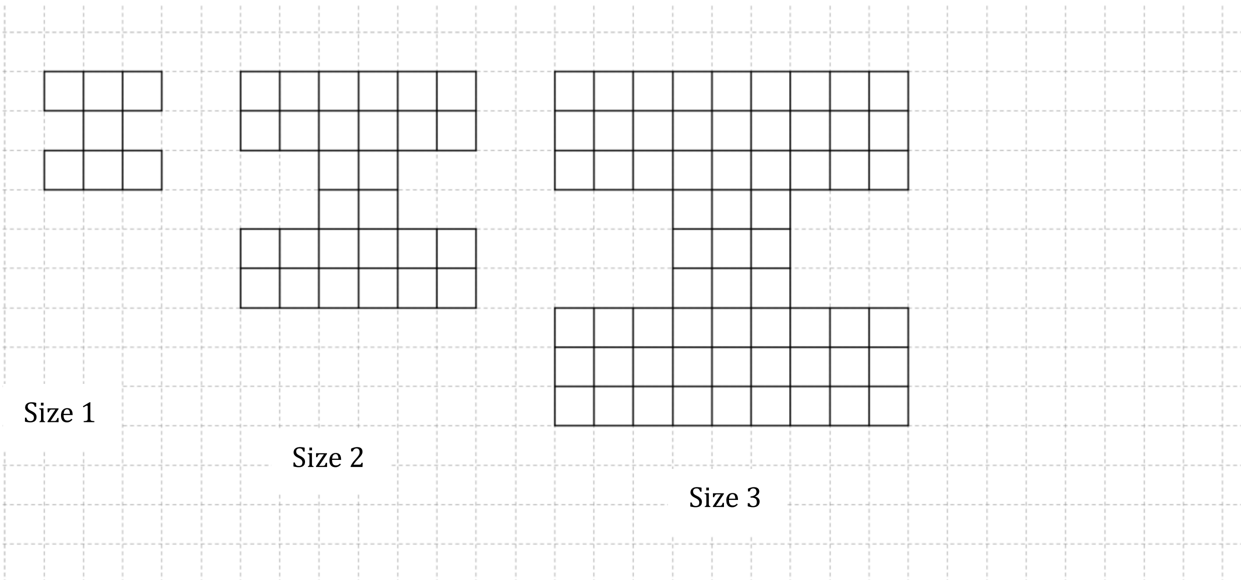
He is working on creating the logo in various sizes to be placed on different pages on the website. Marco developed the following designs:



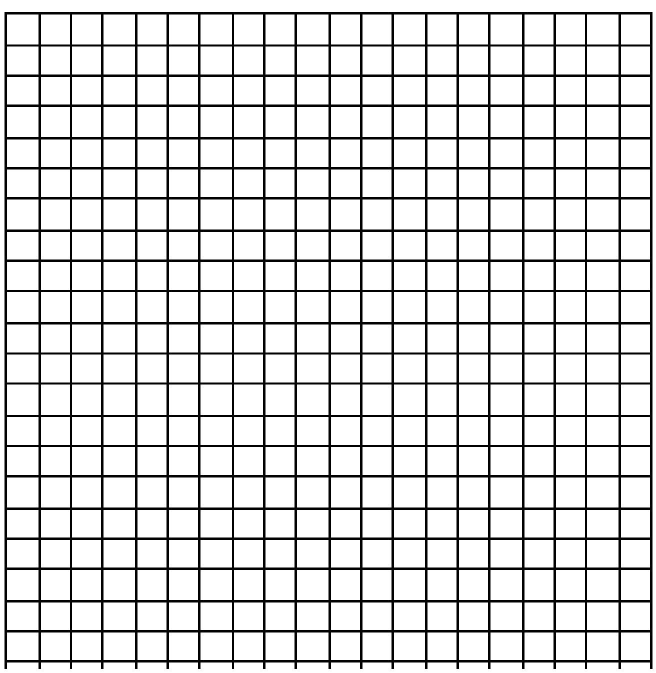
1. How many squares will be needed to create the size 100 logo?

2. Develop a mathematical model for the number of squares in the logo for size *n*.

Marco decides to experiment with making his logo "blockier" so that it looks stronger. Here's what he came up with:



3. Assuming that Marco continues with the pattern as it has begun, draw the next figure, size 4, and find the number of blocks in the figure.



4. Develop a mathematical model for the number of blocks in a logo of size n.

5. Compare the models that you developed for the first set of logos to the second set of logos. In what ways are they similar? In what ways are they different?

I Rule! – Teacher Notes
A Solidify Understanding Task

Purpose: The purpose of this task is to solidify students' understanding of quadratic functions and their representations, by providing both an example and a non-example of a quadratic function. The task provides an opportunity for students to compare the growth of linear functions to the growth of quadratic functions. Equations, both recursive and explicit, graphs, and tables are used to describe the relationship between the number of blocks and the figure number in this task.

Core Standards Focus:

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.*

A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

F.BF.1 Write a function that describes a relationship between two quantities. *

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

Analyze functions using different representations.

F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

*Focus on situations that exhibit a quadratic or exponential relationship.

Construct and compare linear, quadratic, and exponential models and solve problems.

Compare linear and exponential growth studied in Secondary Mathematics I to quadratic growth.

Related Standards:

Launch (Whole Class):
Begin by having students read the task and understanding the context. Ask them to compare the two sets of logos in the first and second parts of the task and share what they notice about the mathematical/geometric attributes of the figures. Have students get started on questions 1 and 2.

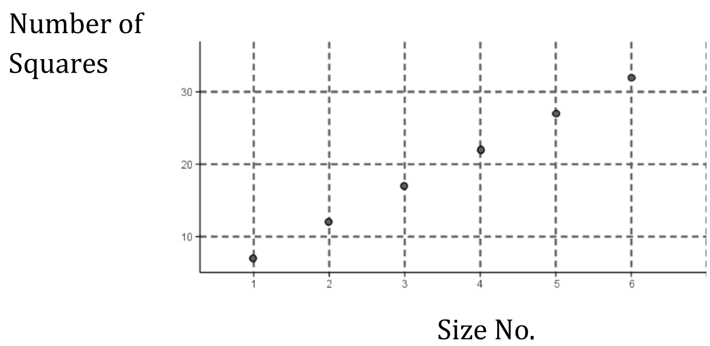
Explore (Small Group):
Part 1: Monitor students as they work, looking for their use of tables, graphs, and equations. If students are stuck, ask how they see the figures changing. It may be useful to provide colored pencils to help them keep track of what changes and what stays the same in each figure. Encourage students to use as many representations as possible for their mathematical model.

Discuss (Whole Class):

Part 1:

Start the discussion with students presenting a table and a graph. Ask students what type of function this is and how they know. Using the first difference, highlight the ideas that the rate of change is always 5.

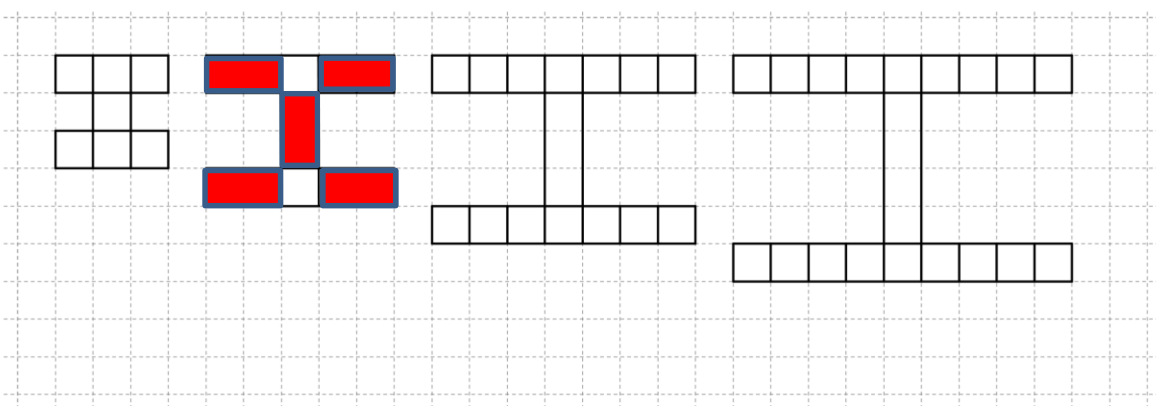
Size No.	Number of Squares
1	7
2	12
3	17
4	22
5	27
n	



Ask students to show how they see the change of 5 in each of figures. Then, ask a student to present a recursive equation and connect it to the figures. The recursive formula is:

$$f(1) = 7, f(n) = f(n-1) + 5$$

Ask a student to show how they used the diagram to find an explicit formula. A possible explanation is, "I noticed that for n =2 there were 5 groups of 2 blocks (shown in red) and then 2 more blocks left over. When I tried it on the other sizes it worked the same way so I decided the equation is: $f(n) = 5n + 2$."



At this point, ask students to work on the second part of the task with the "blockier" logos.

Explore (Small Group):
As you monitor student work, ensure that students are able to correctly draw the next figure. Listen for how they are using the diagram to think about how the figures are changing. Encourage students to use all the representations including getting both an explicit and recursive equation if time permits.

Discuss (Whole Group):
Part 2. Begin the discussion much like Part 1. Have students show a table and graph, making connections to the figures. Direct students to look at the first differences in the table and how they see the growing differences on the graph. Much as in the discussion in “Something to Talk About”, help students to see that the first differences are linear, making this a quadratic function.

Size No.	Number of Squares
1	7
2	28
3	63
4	112
5	175
6	252
n	

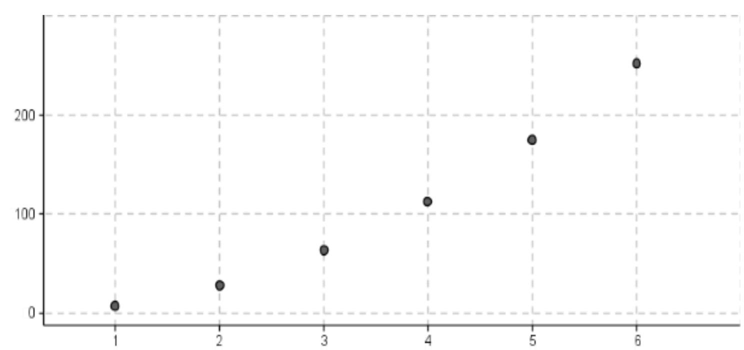
First Difference

21
35
49
63
77

Second Difference

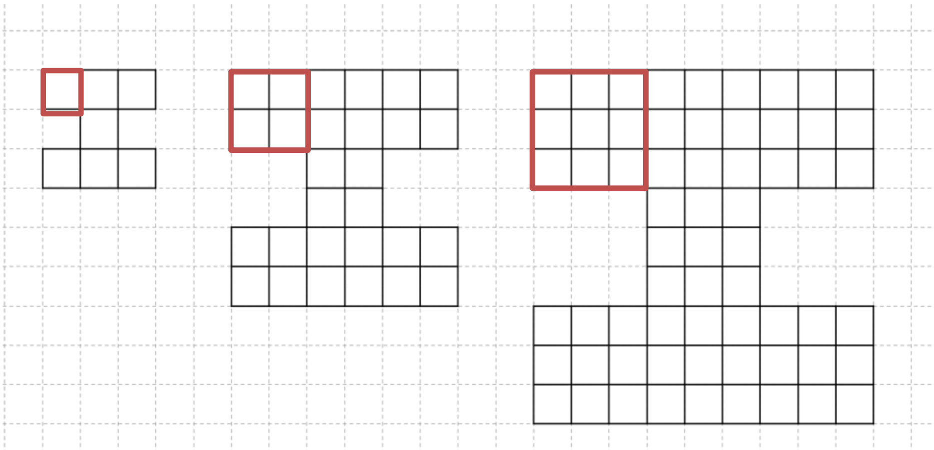
14
14
14
14

Number of squares

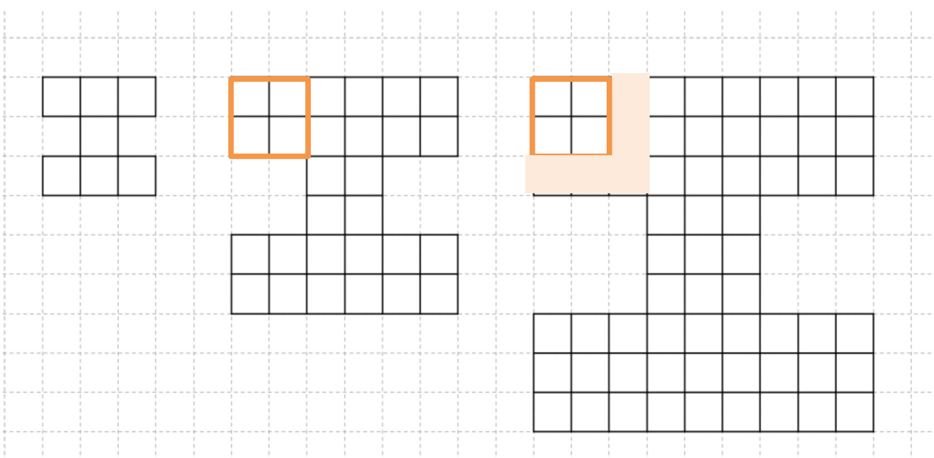


Size number

Ask students to present an explicit equation and to show how they used the diagram to get the equation. One possible way to think about it is show below, with a student saying, “I noticed that each time there are seven large squares. For n = 2, the squares are made up of 4 smaller squares, for n = 3, the squares are made up of 9 smaller squares, and so on, giving the equation: $f(n) = 7n^2$.



Ask students to share their thinking about a recursive equation. They have used the diagram a similar way, noticing that each time the big squares are wrapped with an "L" shape that adds $2n-1$ squares each time as shown below:



This thinking yields the equation:

$$f(1)=7, f(n)=f(n-1)+7(2n-1)$$

Ask students how they see the rate of change in the table showing up in the recursive equation. They may notice that the part added on to the previous term is the change, which for a quadratic function will be a linear expression.

End the discussion with a comparison of linear and quadratic functions. Lead the class in a discussion to complete a table such as:

	Linear	**Exponential**
Rate of change	Constant	Linear
Graph	Line	Parabola
Equation	Highest powered term is x	Highest powered term is x^2 term

Aligned Ready, Set, Go: ***Quadratic Functions 1.3***