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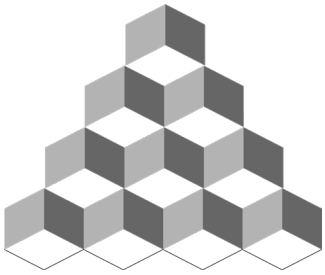

Seeing and Describing Linear Functions
Week 1 - Days 3,4,5

Introduction

We have created this activity with the goal that students will see the visual nature of algebra and make connections between written descriptions, coordinate graphs, tables of values, visual patterns and algebraic expressions. There are different ways of seeing these functions so there are different answers. We love that!

Connection to CCSS

MP 1 MP 6
MP 2 MP 7
MP 3 MP 8

Agenda

Activity	Time	Description/Prompt	Materials
Exolore Part 1	40 min	• Give out the task cards • Ask students to prepare a page that visually shows how each pattern increases and decreases. • Ask how they see the pattern growing and how they see the pattern getting smaller. • Where do they see the extra squares as the pattern grows or shrinks? • Ask students to show their thinking on a poster?	• One page of task cards per group • Colored pens or pencils • Poster paper
Discuss	15 min	• Display all of the work and ask students to do a gallery walk. Choose a few to compare and contrast as a class. The goal is to see the many different ways we see a pattern. • Students may have decided that some patterns decrease and the tiles flip or move around, or they may decide that the pattern just ends. This is a time to discuss domain. The goal is to discuss domain visually and make sure students understand you will be coming back to it throughout the year. • Later in this activity you may want to discuss range.	• Space to display student work
Discuss	10 min	• Ask students what would be between the case numbers? • Does the pattern continue between the case numbers? If it does what does it look like? • Ask students to discuss in their groups and come up with some ideas • Note that this is a time for thinking about patterns and what it means for a function to be continuous with different domains.	

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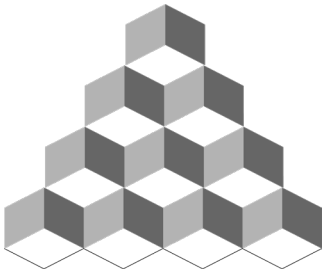


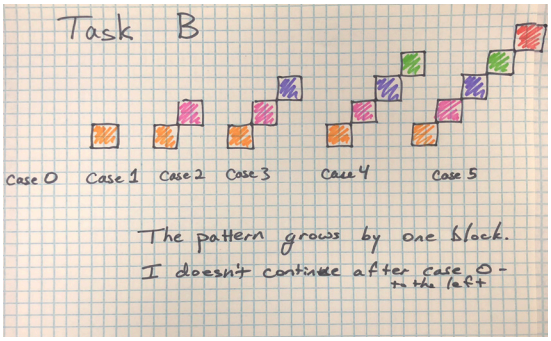
Explore Part 2	30 min	Introduce students to the algebra representation handout. In each of the 4 areas ask students to complete the following... • Make a table using numbers • Make a coordinate graph to illustrate the pattern • Describe the way the pattern is increasing or decreasing • Describe your function using an algebraic expression that shows the number of blocks in any case number.	• Copies of the Algebra Representation handout, A,B,C,D, for each group or student • Colored pens or pencils
Discuss	10 min	• As a class discuss the different representations shown in student work.	
Explore Part 3	20 min	In groups students make their own patterns to fit two different functions • Make a pattern that grows as the case numbers increase • Make a pattern that gets smaller as the case number increases	• Copies of the Make your own function handout 1 and 2 for each group or student • Colored pens or pencils
Discuss	20 min	• Discuss the patterns and representations students produced	
Reflect	5 min	What representations of linear functions did you find most helpful?	• Journals • Colored pens or pencils

To the Teacher:
This activity begins with students recognizing and extending visual patterns. It is important for students to spend time without assigning numbers and quantifying the number of squares in each case. The goal is to work visually, thinking about how the shape grows and where you see the extra squares. Seeing the different ways to visualize and explain how patterns change is an exciting and motivating activity for algebra learners.

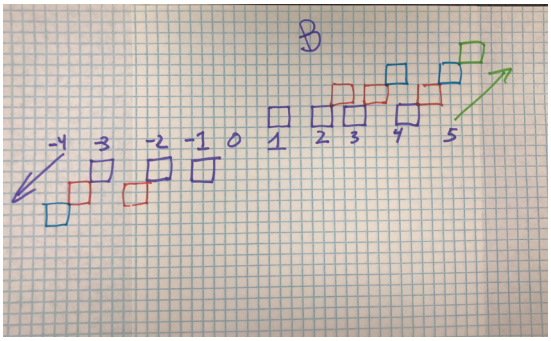
The second part of the lesson asks students to find different representations for the visual patterns they have extended. For each pattern students will make a table, plot points on a coordinate graph, describe how the pattern extends in words and make a generalized expression using symbols and numbers for the pattern.

As their learning facilitator you will be able to make choices as you introduce upcoming content for later in the year. For example, Are there any shapes between the integer case numbers? If so, what would they look like? Is this a continuous function over the set of real numbers? Does it have a domain which only includes the integers? Is the domain infinite over the set of integers or are there case numbers for only

some of the integers? These are questions that have different answers depending on how the students see the pattern change. If students see the pattern ending when there are no more squares then the pattern has a different domain than if the students see the pattern going on to infinity in both directions. By introducing these topics informally you will have concrete experiences to reference later as you progress through your year of algebra.



In this example the domain is zero and the positive integers. (0, 1, 2, 3, 4, ...)

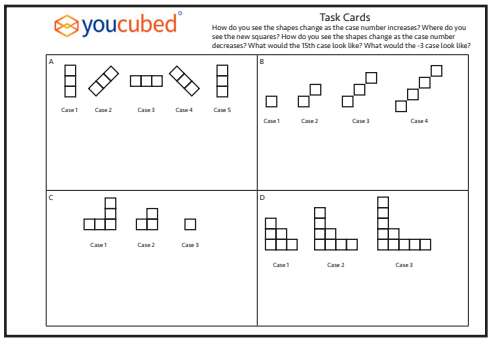


In this example the domain is all integers. (..., -4, -3, -2, -1, 0, 1, 2, 3, 4, 5,...)

Explore Part 1

Give students the Visual Pattern page and ask them to prepare a visual for each of the patterns. In their visual they will think about and answer the following questions that are listed on the student handout:

- How do you see the shapes change as the case number increases?
- Where do you see the new squares?
- How do you see the shapes change as the case number decreases?
- What would the 105th case look like?
- What would the -3 (the negative third) case look like?



Ask students to prepare a poster that visually shows how each pattern increases and decreases. As they answer the questions on their handout, they should make their work clear and detailed so another student can understand their thinking. Color coding their work to show how the drawing is connected to the table, the graph, the writing and the expression is very helpful for learners and readers of mathematics.

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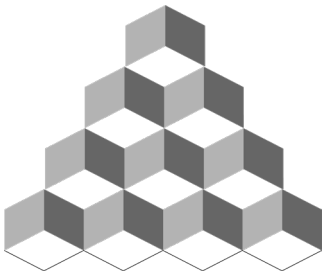


Discuss

Now is an important time to discuss some important ideas that will come up later in the year. Some students may have ended a pattern while others may have shifted squares to show how it is still changing. In this case you may want to share that one has a different domain than the other.

Another good topic to introduce is functions and whether or not they are continuous. We like to ask students if there are images that fit the pattern and are between the case numbers. What would that look like? Are they continuous enough that there is an image for every different case number? What are the different case numbers that are between two integers?

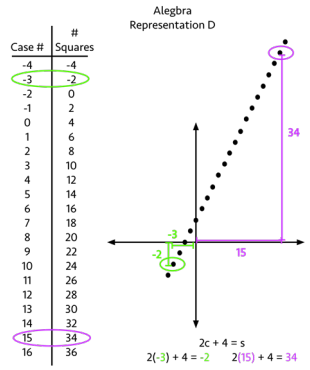
Some students may not agree and will believe that there are only images for the integer case numbers. Some may think that the case numbers are not infinite. In this case you can discuss whether or not the domain is over the set of real numbers (http://www.wolframalpha.com/input/?i=real+numbers) or over the set of integers (http://www.wolframalpha.com/input/?i=Math+integers). What is the domain of the function? If the domain is finite then you can discuss the notation to communicate that information about the function.

Explore Part 2

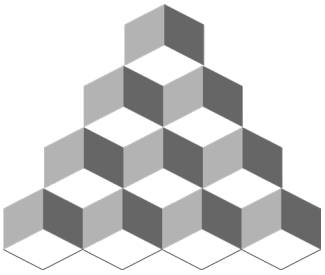
Now that students have completed the patterns and seen the different ways others have recorded their thinking ask students to complete the algebra representations paper. We have included a sheet for each of the four patterns in part 1. On this sheet students will complete 4 very important representations for each function, a table of values, a line on a coordinate graph, a written description and an algebraic expression. This is a time for students to embrace struggle and challenge. Students should work together in groups and complete the different representations in any order. This is not a time to direct teach how to do this. Encourage students to color code their work and to look for connections across the different representations. This is a very good time for learning and mistakes should be celebrated.

Discuss

When students have completed their representations of the 4 functions facilitate another class discussion about what they found. In our work with students we have found the progression of recognizing a pattern, extending the pattern using visuals and numbers, writing to describe it and then working toward an algebraic representation is a process well worth the time spent getting through it. Taking the time now for this will help students since they will have a full understanding of the different meanings of the function.



In part 1 we asked the following questions, What would the 15th case look like? What would the -3 case look like. After students have generalized the functions you can have a discussion about how you might answer these questions using the table, graph and expressions from the work done in Part 2.



Explore Part 3

We have included more representation sheets with a new task. Now we ask that students make up their own pattern to fit the two given constraints. For the first one we ask students to make a pattern that grows as the case number increases. For the second function we ask that they make a pattern that gets smaller as the case number increases. On the representation paper they will draw their pattern, make a table of values, graph it on a coordinate graph and generalize their function.

Discuss

When students have completed their patterns and representations facilitate a discussion about their work. Are they all functions? How do you know? Are all of the functions linear? How do you know if they are linear or not? In our future lessons students will see patterns of growth that are not linear. If you see some non-linear patterns now might be a great time to discuss the difference.

Reflect

What representations of linear functions did you find most helpful?

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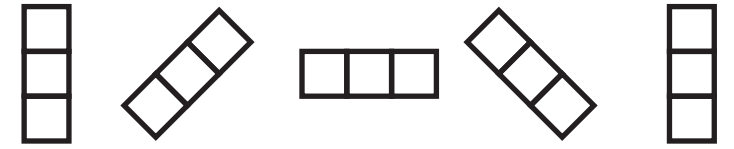
Task Cards

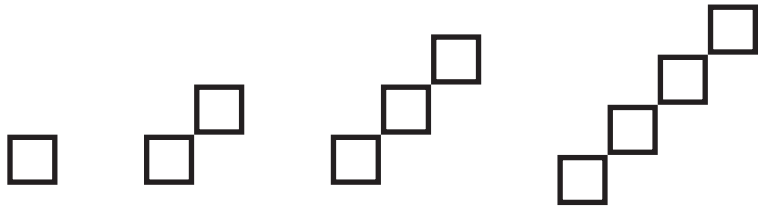
How do you see the shapes change as the case number increases? Where do you see the new squares? How do you see the shapes change as the case number decreases? What would the 15th case look like? What would the -3 case look like?

A



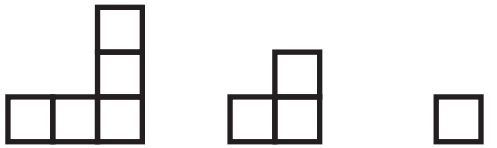
Case 1 Case 2 Case 3 Case 4 Case 5

B



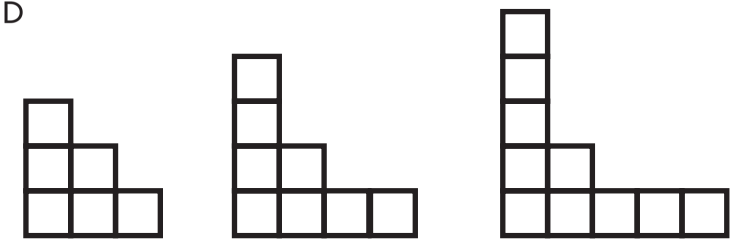
Case 1 Case 2 Case 3 Case 4

C



Case 1 Case 2 Case 3

D



Case 1 Case 2 Case 3

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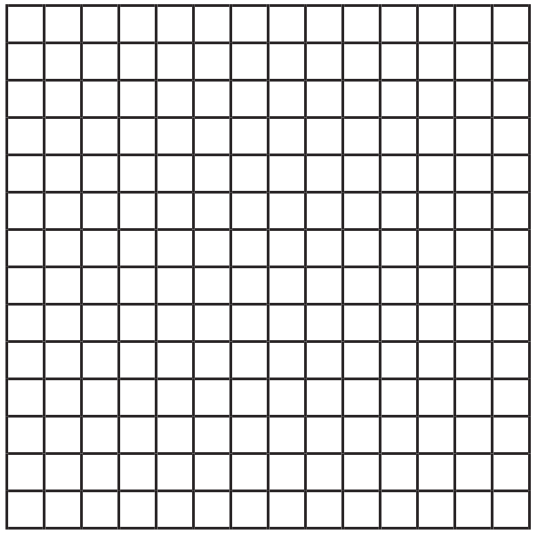
Algebra Representation A

Case 1 Case 2 Case 3 Case 4 Case 5

Make a table using numbers.	Make a coordinate graph to illustrate the pattern. 
Describe the way the pattern is increasing or decreasing.	Describe your function using an algebraic expression that shows the number of blocks in any case number.

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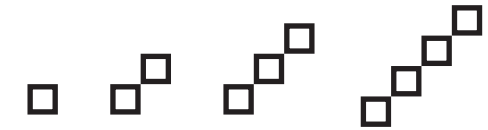
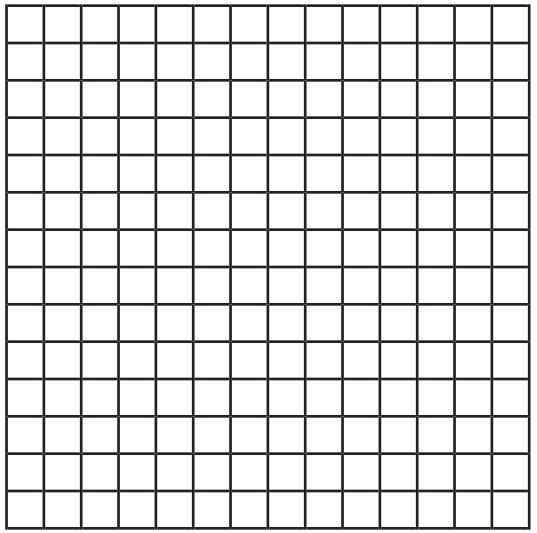
Algebra Representation
B



Make a table using numbers.	Make a coordinate graph to illustrate the pattern. 
Describe the way the pattern is increasing or decreasing.	Describe your function using an algebraic expression that shows the number of blocks in any case number.

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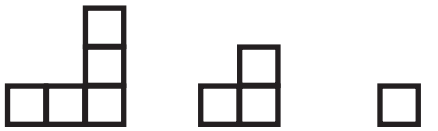
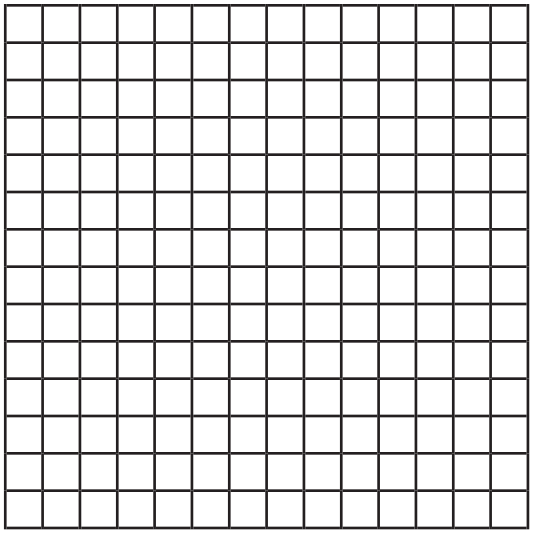
Algebra Representation
C



Make a table using numbers.	Make a coordinate graph to illustrate the pattern. 
Describe the way the pattern is increasing or decreasing.	Describe your function using an algebraic expression that shows the nuber of blocks in any case number.

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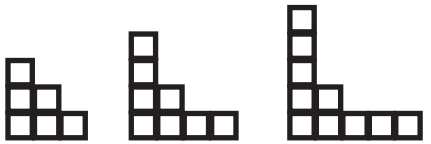
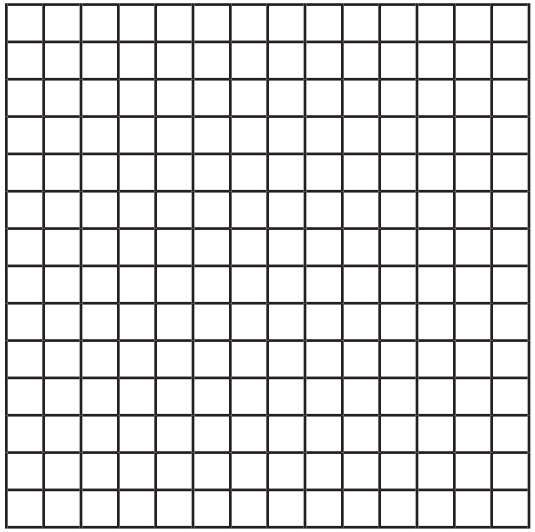
Algebra Representation
D



Make a table using numbers.	Make a coordinate graph to illustrate the pattern. 
Describe the way the pattern is increasing or decreasing.	Describe your function using an algebraic expression that shows the number of blocks in any case number.

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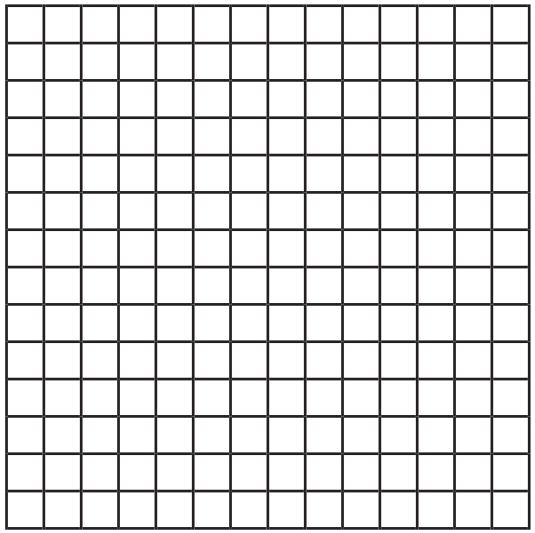
Make your own #1

Make a pattern that grows as the case numbers increase.

Draw your pattern. Include at least 3 representations and label them by case number.	Make a table using numbers.
Make a coordinate graph to illustrate the pattern. 	Describe your function using an algebraic expression that shows the number of blocks in any case number.

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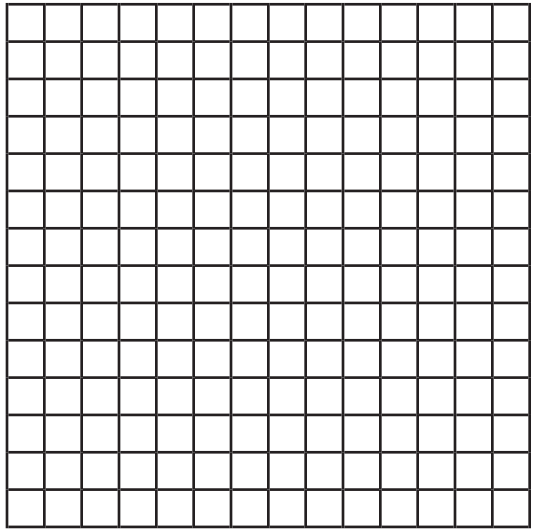
Make your own #2

Make a pattern that gets smaller as the case numbers increase.

Draw your pattern. Include at least 3 representations and label them by case number.

Make a table using numbers.

Make a coordinate graph to illustrate the pattern.



Describe your function using an algebraic expression that shows the number of blocks in any case number.