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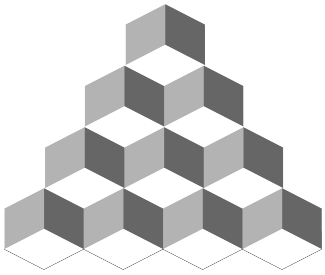

Shape of Things
Week 3 - Days 4 & 5

Introduction

In this activity students are given case 1 of a visual pattern. Their task is to continue the pattern visually by making each case grow as a linear or quadratic function. When they are finished, students will share their visual pattern with other groups so they can prove what type of function the pattern represents. Students will use multiple representations to justify their findings. This activity allows for many opportunities to define and refine students' working definitions of linear and quadratic relationships.

Connection to CCSS

- MP 2
- MP 7
- MP 8
- HSA.CED.A.2
- HSF.LE.A.1.B
- HSF.LE.A.2

Agenda

Activity	Time	Description/Prompt	Materials
Launch	10 min	• Share the pattern with students as you would in a dot card number talk. • Ask how many dots there are in the picture without counting one at a time. • Have students share their different ways of seeing and record this on the board.	• Case 1 of the dot pattern to display
Explore	30 min	Given case 1, ask students to: • Create at least five more cases of the visual pattern with linear or quadratic growth. • Create multiple representations (table, graph, written description) of the visual pattern to justify the growth as linear or quadratic. Use color-coding, arrows, and words to support the justification. • Write a general expression that models the pattern • Draw your visual pattern on a separate sheet of paper and give it to another pair of students. This drawing should include the first three cases.	• Maths journal • Blank paper • Colored pens/markers

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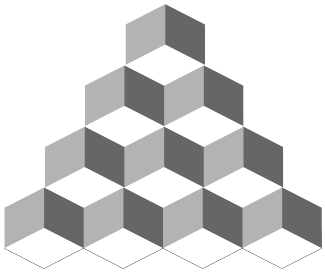
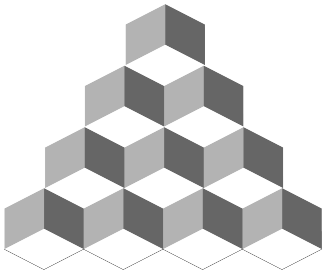


Agenda continued

Activity	Time	Description/Prompt	Materials
Explore 2	30 min	Once students have traded patterns, ask them to do the following: • Study the visual pattern from another pair of students in class. Is the pattern linear or quadratic? • Prepare a convincing argument, using multiple representations, to justify whether the pattern is linear or quadratic. • Write a general expression for the pattern. • Answer the following questions: What would the 50th case look like? How many would be in the 74th case? • Continue the pattern back where there would be negative case numbers. • Answer the following questions: Will the pattern continue or end? What would the negative case numbers look like? • What is the domain and range of the pattern?	• Maths journal • Colored pens/markers • Graph paper
Discuss	15 min	Form a group with the pair of students that you shared your pattern with and share your findings about the growth of the different visual patterns.	
Extend		Create two visual patterns that grow differently from your first one. Make one linear and the other quadratic.	• Maths journal
Reflect	5 min	How can you tell when a visual pattern is linear or quadratic?	• Maths journal

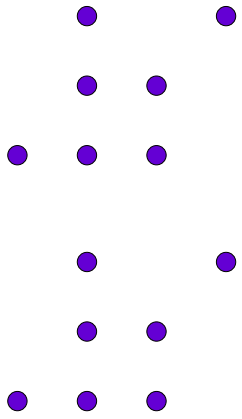


To the Teacher

We want this activity to be open so that students can make sense of how to continue the pattern with linear or quadratic growth. We do not imagine that you spend time discussing what each of these terms mean. Instead, we want the students to define and refine these concepts through their experience with the activity. We recommend you support the student pairs as needed. If there is a pair that would benefit from discussing how they think about linear and quadratic growth and/or multiple representations, have the discussion with them. We believe that for the most part students will be able to make sense together and this is why we want them working in pairs.

Launch

Project the dot card arrangement. Ask students how many dots there are and how they see it. Keep this launch about the ways of seeing, like a dot card number talk. If you would like to read more about dot card number talks see the dot card number talk lesson plan from week one lesson one for more ideas about this, https://www.youcubed.org/downloadable/algebra-week-1-productive-class-culture-lesson-2/ . Have students share all of their ways of seeing and record them all on the board with their corresponding numeric representation.



Case 1

Explore Part 1

Tell students they are going to continue working with the same figure. Set students up to work in pairs to design their own visual patterns using the given figure as case 1. Let students know they can choose to make a linear or quadratic pattern and they will use multiple representations to justify how they identify the growth.

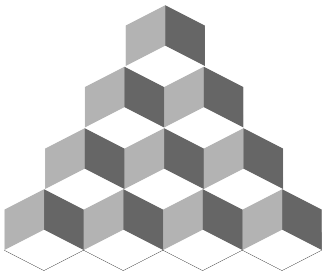
Encourage students to think creatively to find a pattern. If they are confused about what it means to have a quadratic or linear pattern you might tell them to worry about identifying the pattern once they have created the other representations. Or you might engage them in a short conversation about the different growth patterns they discussed in Apple Orchard from week 3 lesson 1 and identify them as linear or quadratic.

Explore Part 2

Once pairs have made all the representations for their pattern, have them draw at least three cases from the visual pattern on a sheet of paper to be given to another student pair. As pairs finish, randomly give each pair of students a different visual pattern. Have the pair of students justify whether or not the visual pattern is linear or quadratic. Students should make a proof using a table, graph, written description and a generalized expression to show the pattern is linear or quadratic.

Students will extend their work by illustrating what the 50th case would look like and answering how many dots would be in the 74th case. Our intent is not for students to draw an exact representation of the 50th case. Instead we prefer they make a sketch and label it to show what the 50th case would look like. They should use color-coding to identify the components of their work that are related in their different representations.

The next task is for students to think about and draw the figures that would represent the 0 case and the negative one and negative 2 two cases. We ask them to determine whether the pattern continues toward



negative infinity or does it end. What are the images for the negative case numbers? At this point students can state the domain and range for the function.

Discuss

Have pairs who exchange patterns sit together to form groups of four to discuss their conjectures about the pattern being linear or quadratic. While students are working encourage them to listen to how other students are seeing the pattern.

Open a class discussion so students can exchange ideas about how they know when the growth is linear or quadratic and how they determined the domain and range for their functions.

Extend

Create two visual patterns that grow differently from your first one. Make one linear and the other quadratic.

Look-Fors

- How are students continuing the visual pattern? Listen to how students are thinking about drawing cases 2 and beyond. Do they seem to approach it with an understanding about quadratic and linear growth? You might hear things like, "linear adds the same each time so let's decide how many dots to add each time and where to place them". Another approach students might take is to add dots as they want when creating the other cases and then adapt it, as they need to make it into a pattern. Allow students to struggle with this so they are making sense of how the linear and quadratic growth is different. If students complete a visual pattern that works but is not linear or quadratic you might have them adapt it. Otherwise, or make space for there to be other kinds of growth and change the question to, "is the visual pattern linear, quadratic or something else?"

- How are students creating multiple representations? When students are creating multiple representations are they drawing a figure for each entry on the table? Are the coordinates on the graph coming from the table? Are they writing equations based on the visual? Provide space for students to create representations using the connections that make sense to them.

- How are students deciding if a pattern is linear or quadratic? Take note of how students are using what they learned from Apple Orchard to think about growth in each representation. Look for how they record connections with color and arrows. When they do notice patterns, are students using them to determine linear or quadratic growth?

- How are students deciding what the negative integer cases would look like and the nature of the domain and range? Are they finding creative ways to continue the patterns or are they terminating them? Do they understand that the domain can represent what they justify? Do the domain and range match the case numbers they have created?

Reflect

How can you tell when a visual pattern is linear or quadratic?

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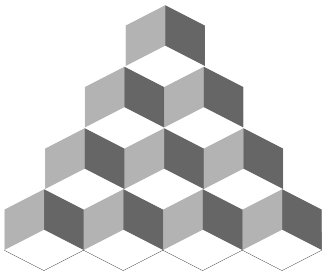
Shape of Things Visual



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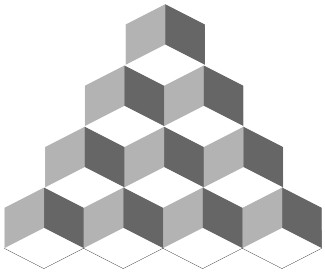

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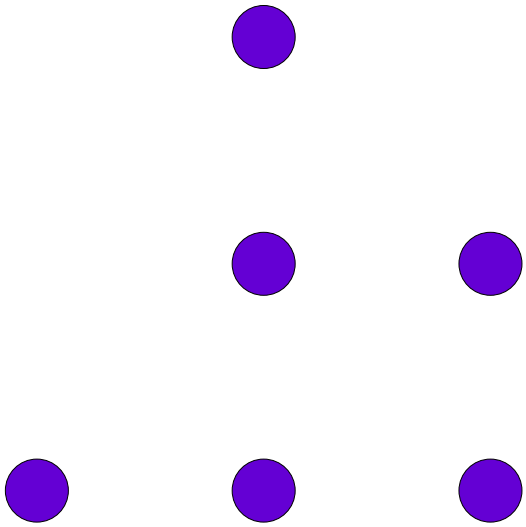

Case 1

Part 1:

- Given case 1, create a visual pattern with linear or quadratic growth with at least three cases.
- Create multiple representations of the visual pattern. Justify the growth pattern as linear or quadratic. Use color-coding, arrows, and words to support the justification.

Part 2:

- Draw your visual pattern on a separate sheet of paper to give to another pair of students.
- Study the visual pattern from another pair of students. Is the pattern linear or quadratic?
- Prepare a convincing argument, using multiple representations, to justify whether the pattern is linear or quadratic.
- Write a general expression for the pattern.
- Answer the following questions:
  - What would the 50th case look like?
  - How many would be in the 74th case?
- Continue the pattern back where there would be negative case numbers. Will the pattern continue or end? What would the negative case numbers look like?
- What is the domain and range of the pattern?

Part 3:

- Form a group of four to share and justify your ideas about the pattern having linear or quadratic growth.