

Investigation Menu Week 2 - Days 2, 3, 4 & 5

Introduction

This investigation menu includes both linear and quadratic functions. Whenever we can add choice to students' mathematics learning it enhances their engagement and enjoyment. In the different tasks on offer students will be asked all the ways they can see the growth using multiple representations, they will consider how to generalize the patterns, and they will consider what they can learn about growth from looking at different representations. These pattern tasks give students more important experience of using algebra to express relationships.

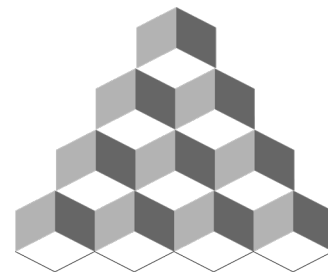
Connection to CCSS

- MP 1
- MP 2
- MP 7
- MP 8
- HSA.CED.A.2

The exploration of patterns can extend across multiple days. In our notes below we offer a structure for one day of work, that can be repeated across multiple days with different patterns.

Agenda

Activity	Time	Description/Prompt	Materials
Launch	10 min	Students select the activity they want to explore.	<ul style="list-style-type: none"> • Suspension Bridges • Toothpick Squares • Flowerbeds • Dotty Pattern • Squares Over Squares
Explore	25 min	<p>Investigate the activity.</p> <p>Make a poster showing at least four representations to show how the pattern is growing: words, graph, table, visual, and algebraic expression. Use color-coding to show the connections between the representations.</p>	<ul style="list-style-type: none"> • Maths journal • Toothpicks • Square tiles • Circle counters • Colored pencils
Extend		Have students select another activity from the menu.	<ul style="list-style-type: none"> • Maths journal



To the Teacher

Our goal for these tasks is that students gain more experience investigating patterns and describing them algebraically, through open, exploratory activities. It is likely that you will encounter a wide range of student understanding of algebraic relationships. The “low floor, high ceiling” nature of the tasks means that students will be able to work on the ideas that are right for them. It may be that students are best served continuing to work on a problem over a few lessons, while others may be better served moving to different problems.

If a student finishes before others, an excellent extension question to ask them, is can they see the growth of the pattern in a different way?

Launch

Share with students they will have an opportunity to continue to work on their ideas about multiple representations and growth patterns. Let them know they will choose from five investigations. Provide each student a copy of each problem and suggest that they keep them all to share and do with family and friends outside of class.

Pass out each activity in the menu to each student: Suspension Bridge Cables, Toothpick squares, Flowerbeds, Dotty Pattern, and Squares over Squares

We suggest that students choose other students to work with, in small groups, and that groups start their work together by giving each student time to look at the problem on their own, then have everyone share how they see the pattern growth. If all students start by sharing their visual thinking, they become more invested in the group work and there is less chance that anyone will be left out of the work.

Explore

Some representations will be more straightforward to create while others will take a lot of time. Encourage students to try to create other representations rather than spending all their time on one for example, if you see students working for a long time writing the equation for the Suspension Bridge problem.

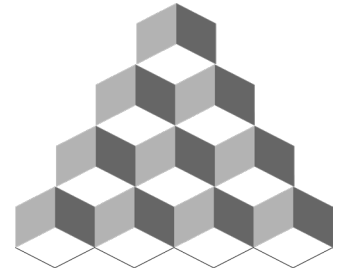
Discuss

Have students form larger discussion groups with other students working on the same investigation. Invite all discussion groups to start by sharing how they see the pattern.

Make Posters

Invite students to make a poster that shows their growth pattern, illustrates some different cases, shows the growth using 4 different representations, and uses color coding to connect between the different cases.

If students are working on different patterns you may want to save displaying the posters until the end of the week and the conclusion of the menu of tasks.

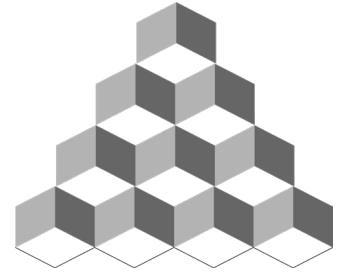


Extend

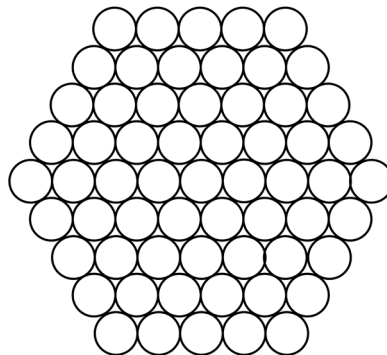
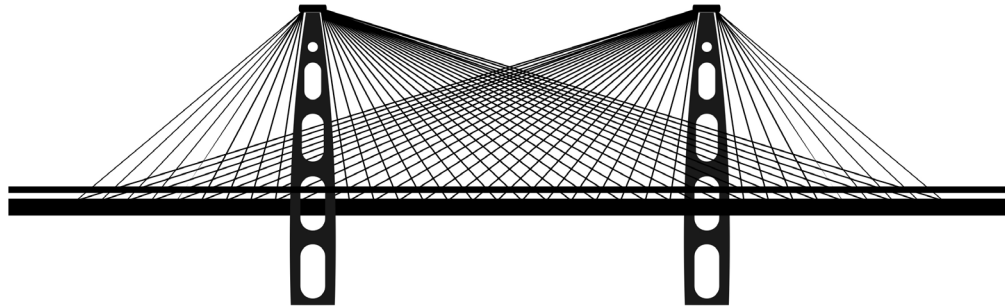
Have students select another activity from the menu. Ask students to find a different way of seeing the growth in the pattern.

Look-Fors

- How are students using information from the visual pattern to create their different representations (such as tables or graphs)? When students are making sense of different multiple representations they can sometimes over simplify the growth pattern. For example, they may notice one aspect of the growth and use that in their table or graph, not realizing there are other aspects of the pattern that they are not including. If this happens invite other students to share how they are describing the pattern, to make space for students to engage in sense making and reasoning about the connection between representations
- What representations are students using? We gave students some choice in the different representations they use so that they are given the opportunity to make their own decisions. This is an occasion for the teacher to see what representations students are using and which ones they avoid. Graphs are often overlooked so this is something to watch out for. Graphing can be used with paper and pens or with graphing technology. If you notice graphs are not being used for this activity that is OK because there are opportunities in the following activities for graphing.
- How are students using color? Encourage students to use color to tell a story, make a connection, count, outline and show growth. As you move around the classroom you could ask students to share with you what their colors represent. This is a nice occasion to ask a question you don't know the answer to (the best kind!) and seek to understand what your students are communicating. If students are not using them to make connections you might offer this idea as something to do.



Suspension Bridge Handout



When making a cable for a suspension bridge many strands are assembled into a hexagonal formation and then compacted together. The diagram illustrates a 'size 5' cable made up of 61 strands.

How would the patterns grow?

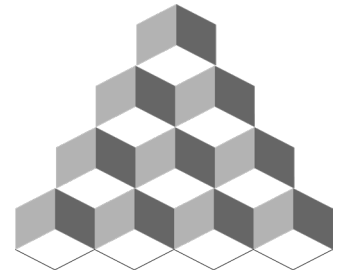
How many strands are needed for a size 10 cable?

What about a cable of any size?

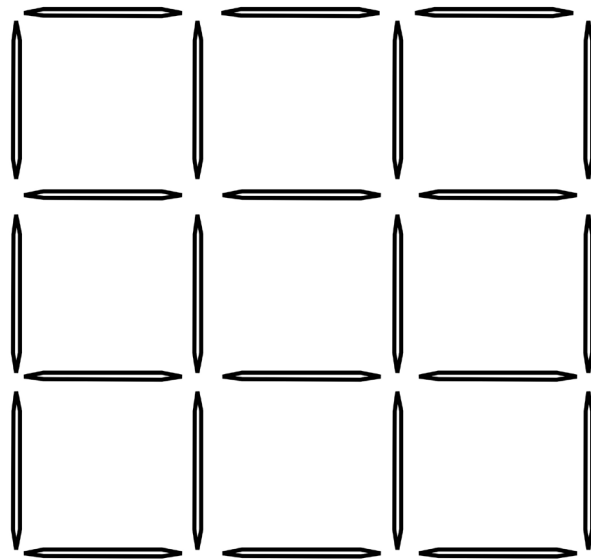
Use at least four representations to show how the pattern is growing: words, graph, table, visual, or algebraic expression. Show the connections between the representations using color-coding, arrows, and words.

Adapted from Bell, A. (1995). Purpose in School Algebra. *The Journal of Mathematical Behavior*, 14(1), 41-73.

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Toothpick Squares Handout



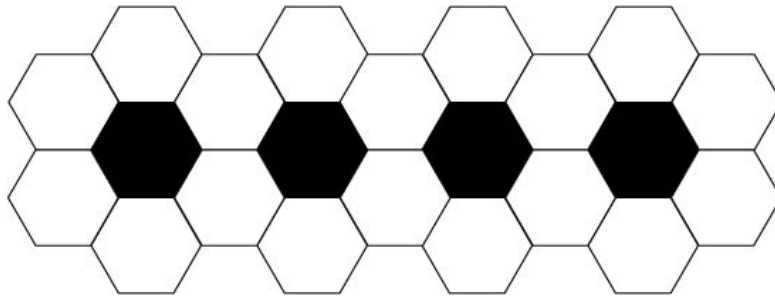
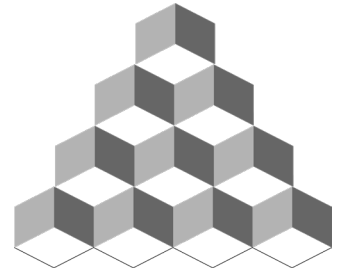
How would the pattern grow?

How would you describe how many toothpicks you would need to make a 13 by 13 square?

How many toothpicks would you need to make any sized square?

Use at least four representations to show how the pattern is growing: words, graph, table, visual, or algebraic expression. Show the connections between the representations using color-coding, arrows, and words.

Flowerbed Handout



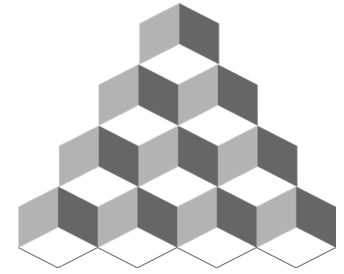
The colored hexagons are flowerbeds surrounded by white tiles.

How do you see the pattern growing?

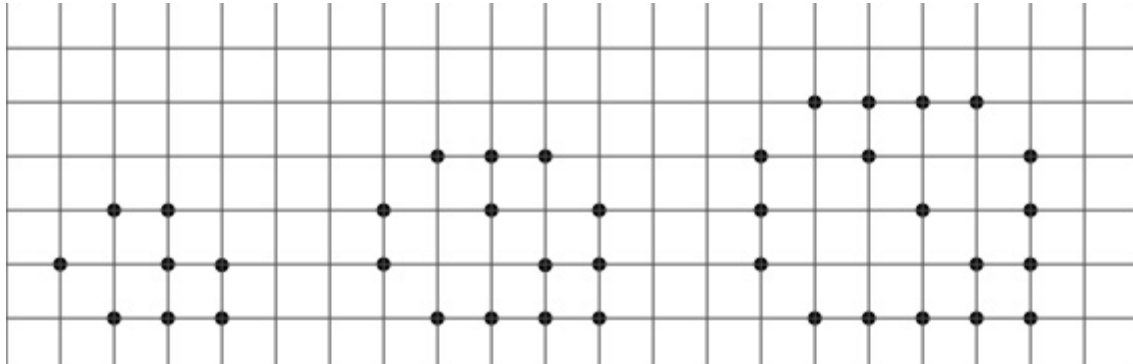
How many tiles would surround 10 flowerbeds?

How many tiles would you need for any number of flowerbeds?

Use at least four representations to show how the pattern is growing: words, graph, table, visual, or algebraic expression. Show the connections between the representations using color-coding, arrows, and words.



Dotty Pattern Handout



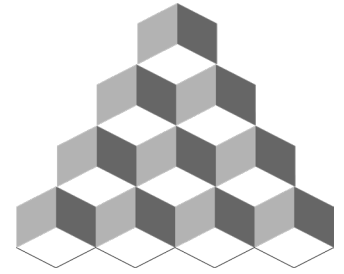
How do you see the pattern growing?

How many dots will be in the tenth case

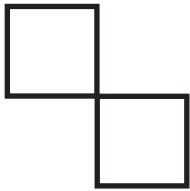
How many dots would be in any case?

Use at least four representations to show how the pattern is growing: words, graph, table, visual, or algebraic expression. Show the connections between the representations using color-coding, arrows, and words.

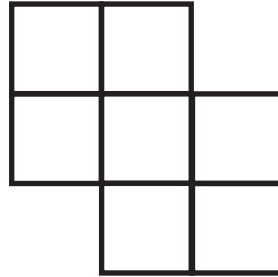
Visual pattern from <http://www.visualpatterns.org/121-140.html>



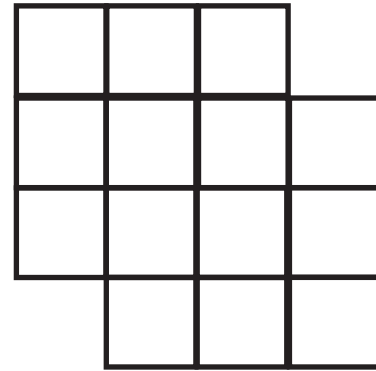
Squares Over Squares Handout



Case 1



Case 2



Case 3

How do you see the pattern growing?

How many unit squares will be in the tenth case?

How many unit squares would be in any case?

Use at least four representations to show how the pattern is growing: words, graph, table, visual, or algebraic expression. Show the connections between the representations using color-coding, arrows, and words.