Unit 1, Lesson 1

Something to Talk About

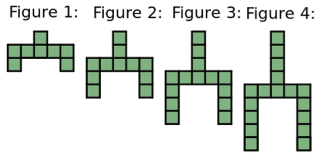
Jump Start

"Which One Doesn't Belong?" Five functions are given below. Determine which function is different than the others and be prepared to justify your answer.

A. $f(x) = 3(x - 1)$

B. $f(n) = f(n - 1) + 2,\ f(0) = 7$

C.



D.

x	$f(x)$
0	8
1	1
2	−6
3	−13
4	−20

E.

x	$f(x)$
0	5
1	6
2	9
3	14
4	21

Learning Focus

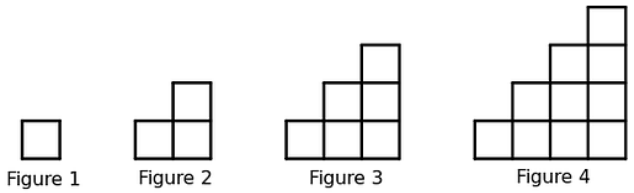
Model a growing pattern with tables, graphs, and equations.

Analyze the type of growth exhibited by a pattern.

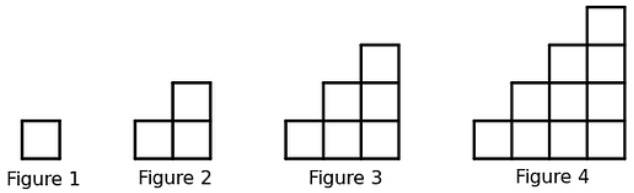
What do different representations tell us about a pattern?

Open Up the Math: Launch, Explore, Discuss

Let's start with a little "Notice and Wonder." Given the pattern below, what do you notice? What do you wonder?



Cell phones often indicate the strength of the phone's signal with a series of bars. The image shows how this might look for various levels of service.



1. Assuming the pattern continues, draw the next figure in the sequence.
2. How many blocks will be in Figure 10?
3. Examine the sequence of figures and find a rule or formula for the number of tiles in any figure number.

Ready for More?

Using the same sequence of figures, model the relationship between the perimeter of a figure and the figure number with a table, an explicit equation, and a recursive equation.

Table:

Explicit Equation:

Recursive Equation:

Takeaways

Quadratic Function

Table: _____

Graph: _____

Recursive equation: _____

Next: _____

Explicit Equation: _____

Vocabulary

- **quadratic equations**
- **quadratic function**

Bold terms are new in this lesson.

Lesson Summary

In this lesson we investigated a new kind of function called a quadratic function. We modeled a sequence of figures with tables, graphs, and explicit and recursive equations to identify features of quadratic functions and how they appear in each representation.

Unit 1, Lesson 2

I Rule!

Jump Start

Complete:

- When I look at a table, I recognize a linear function if: _____
- When I look at a graph, I recognize a linear function if: _____
- When I look at an equation, I recognize a linear function if: _____

Learning Focus

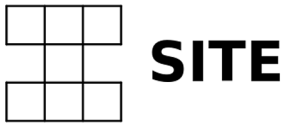
Model patterns with functions.

Compare and contrast linear and quadratic functions.

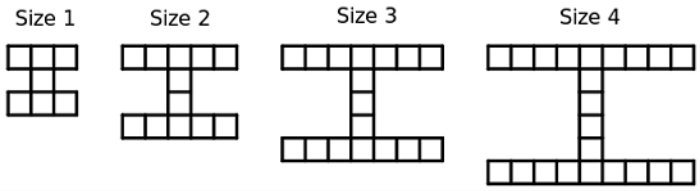
How are quadratic functions different than linear functions?

Open Up the Math: Launch, Explore, Discuss

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:

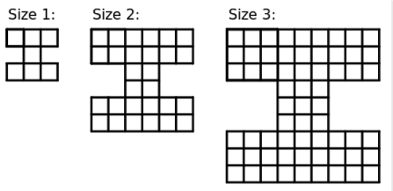


He is working on creating the logo in various sizes to be placed on different pages on the website. Marco developed the following designs:



1. 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:



2. 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.

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

4. 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?

Ready for More?

Consider the function $f(x) = 7x^2$. If there is no story context given, what are the domain and range of the function? Describe the features of the graph of the function and relate the features to the equation.

Takeaways

	Linear	Quadratic
Rate of change		
Diagram		
Equation		
Table		
Graph		

Vocabulary

- **parabola**

Bold terms are new in this lesson.

Lesson Summary

In this lesson we modeled a quadratic and a linear function and compared representations. We learned that the graph of a quadratic function is called a parabola.

Unit 1, Lesson 3
Scott's Muscle March

Learning Focus

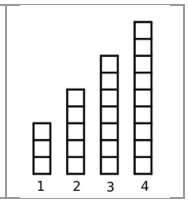
Model a quadratic function with tables, graphs, and equations.

Understand the first difference of a quadratic function.

How can a quadratic function be built from a linear function?

Open Up the Math: Launch, Explore, Discuss

Scott was determined to eat right and get in shape. He joined a gym and added push-ups to his daily exercise routine. He started keeping track of the number of push-ups he completed each day in the bar graph, with day one showing he completed three push-ups. After four days, Scott was certain he could continue this pattern of increasing the number of push-ups for at least a few months.



1. Model the number of push-ups Scott will complete on any given day. Include both explicit and recursive equations.

Scott's gym is sponsoring a "Muscle March" promotion. The goal of "Muscle March" is to raise money for charity by doing push-ups. Scott has decided to participate and has sponsors that will donate money to the charity if he can do a total of at least 500 push-ups, and they will donate an additional $10 for every 100 push-ups he can do beyond that. So now Scott is going to track the total number of push-ups done up to any given day of the month.

2. Estimate the total number of push-ups that Scott will do in a month if he continues to increase the number of push-ups he does each day in the pattern shown.

3. Draw the diagram that shows the total number of push-ups that Scott has done in the month at the end of each day.

4. How many push-ups will Scott have done after a week?

5. Model the total number of push-ups that Scott has completed on any given day during "Muscle March." Include both recursive and explicit equations.

Ready for More?

Will Scott meet his goal and earn the donation for the charity? Will he get a bonus? If so, how much? Explain.

Takeaways

Characteristics of Quadratic Functions:

Lesson Summary

In this lesson we modeled a situation with a diagram, table, graph, and equations. We learned that quadratic functions can be models for the sum of an arithmetic sequence and furthered our understanding of the type of change exhibited by quadratic functions.

Unit 1, Lesson 4

Rabbit Run

Learning Focus

Model a story context with table, graph, and equation.

Identify features of a function from a graph.

Are all quadratic functions increasing?

Are all quadratic functions discrete?

Open Up the Math: Launch, Explore, Discuss

Misha has a new rabbit that she named Wascal. She wants to build Wascal a pen so that the rabbit has space to move around safely. Misha has purchased a 72 foot roll of fencing to build a rectangular pen.

1. If Misha uses the whole roll of fencing, what are some of the possible dimensions of the pen?
2. If Misha wants a pen with the largest possible area, what dimensions should she use for the sides? Justify your answer.
3. Write a model for the area of the rectangular pen in terms of the length of one side. Include both an equation and a graph.
4. What kind of function is this? How do you know?
5. How does this function compare to the quadratic function in *I Rule*?

Ready for More?

If the rabbit pen does not need to be a rectangle, is there a way to get more area with 72 feet of fencing around the perimeter?

Takeaways

Is this a quadratic function?

Vocabulary

- **vertex of a parabola**

Bold terms are new in this lesson.

Lesson Summary

In this lesson we examined a quadratic function that was a model for area but had many different features than those we have seen previously. We learned that all quadratic functions have a linear rate of change and constant second difference, but some may be continuous and have intervals of increase and decrease depending on the domain.

Unit 1, Lesson 5

The Tortoise and the Hare

Jump Start

Which function has the greatest average rate of change in the interval given?

A. $f(x) = 2x - 3$

   Interval $[-2,3]$

B. $g(x) = x(x - 3)$

   Interval $[2,4]$

C. $h(x) = 3^x$

   Interval $[0,2]$

Learning Focus

Compare quadratic and exponential functions.

Determine which type of function, quadratic or exponential, grows faster in a given interval.

How does the growth of a quadratic function compare to the growth of an exponential function?

How can tables, graphs, and equations help to understand how quadratic and exponential functions grow?

Open Up the Math: Launch, Explore, Discuss

In the children's story of the tortoise and the hare, the hare mocks the tortoise for being slow. The tortoise replies, "Slow and steady wins the race." The hare says, "We'll just see about that," and challenges the tortoise to a race. The distance from the starting line of the hare is given by the function: $d = t^2$ (d in meters and t in seconds)

Because the hare is so confident that he can beat the tortoise, he gives the tortoise a 1 meter head start. The distance from the starting line of the tortoise, including the head start, is given by the function: $d = 2^t$ (d in meters and t in seconds)

1. At what time does the hare catch up to the tortoise?
2. If the race course is very long, who wins: the tortoise or the hare? Why?
3. At what time(s) are they tied?
4. If the race course were 15 meters long who wins: the tortoise or the hare? Why?

5. Use the properties $d = 2^t$ and $d = t^2$ to explain the speeds of the tortoise and the hare in the following time intervals:

Interval	Tortoise $d = 2^t$	Hare $d = t^2$
$[0,2)$		
$[2,4)$		
$[4,\infty)$		

Ready for More?

In the case of the tortoise and the hare, the exponential function exceeded the quadratic function for large values of t. Would this be the case if the quadratic function were doubled? Compare $y = 2x^2$ and $y = 2^x$ and decide which function grows faster for large values of x. Explain why your answer is correct.

Takeaways

	Quadratic Function	Exponential Function
Shape of Graph:		
Equation:		
Table:		
Rate of Change:		

Lesson Summary

In this lesson we compared quadratic and exponential functions. We learned that in some intervals for small values of x, quadratic functions may be greater than exponential functions. For large values of x, exponential functions greatly exceed quadratic functions because of the difference in their rates of change.

Unit 1, Lesson 6

Be the Change

Learning Focus

Determine if a relation is linear, exponential, quadratic, or some other kind of function.

Determine the type of growth and key features of the function.

What characteristics of each representation make it easy to identify the function type?

Open Up the Math: Launch, Explore, Discuss

Today's lesson is a card sort activity to show what you know about quadratic functions. The instructions are:

1. Lay out the set of A cards that show a representation of a different function on each card.
2. Select any B card. The B cards are the same functions as the A cards, but different representations.
3. Match your B card with an A card that shows the same function.
4. Now that you have two representations of a function, find a C card that has information that matches the function.
5. Repeat until all the cards are matched in sets of three, an A card, a B card, and a C card.
6. When all your cards have been matched to one of the C cards, complete the missing information about the functions.

1. Complete:

   C1 Matches with: _____

   Type of function: _____

   Type of change: _____

   Second difference: _____

   $312.5 < f(55) < 450$

2. Complete:

   C2 Matches with: _____

   Type of function: _____

   Type of change: _____

   Change factor for an interval of 1 is 0.85.

   $f(0) =$_____ $f(3) =$_____

   In this context, $f(3)$ means:_____

3. Complete:

   C3 Matches with: _____

   Quadratic Function

   Linear rate of change

   x-intercepts: $\left(-\frac{3}{4}, 0\right)$ and _____

   y-intercept: _____

4. Complete:

   C4 Matches with: _____

   Exponential Function

   Type of change: _____

   Domain: $\{n | n \in Z, n \geq -3\}$

   Range: _____

5. Complete:

   C5 Matches with:_____

   Type of function:_____

   Type of change:_____

   Minimum: $(2,4)$

   Interval of decrease:_____

   Interval of increase:_____

6. Complete:

   C6 Matches with:_____

   Type of function:_____

   Rate of change:_____

   $f(2) =$ _____

   $f(x) = 6$ at $x =$

7. Complete:

   C7 Matches with:_____

   Linear Function

   Constant rate of change:_____

   Domain:_____

   Range: $[55, \infty)$

8. Complete:

   C8 Matches with:_____

   Quadratic Function

   Type of change:_____

   Second difference:_____

   Domain: $\{n | n \in N\}$

   Range:_____

9. Complete:

   C9 Matches with:_____

   Quadratic Function

   Type of change:_____

   $f(3) =$_____

   y-intercept:_____

10. Complete:

    C10 Matches with:_____

    Type of Function:_____

    Linear rate of change

    Second Difference:_____

    Domain: $(-\infty, \infty)$

    Range:_____

Ready for More?

Try to create one more representation for each of the quadratic functions. Watch out! This can get tricky.

Takeaways

Finding features of quadratic functions:

Lesson Summary

In this lesson we sharpened our skills in distinguishing quadratic functions from linear and exponential functions. We made connections with equations and graphs of quadratic equations and discussed efficient methods for identifying features of quadratic functions.