Unit 4 - Quadratic Functions
Algebra I

Friday, December 11, 2015, 10:20AM

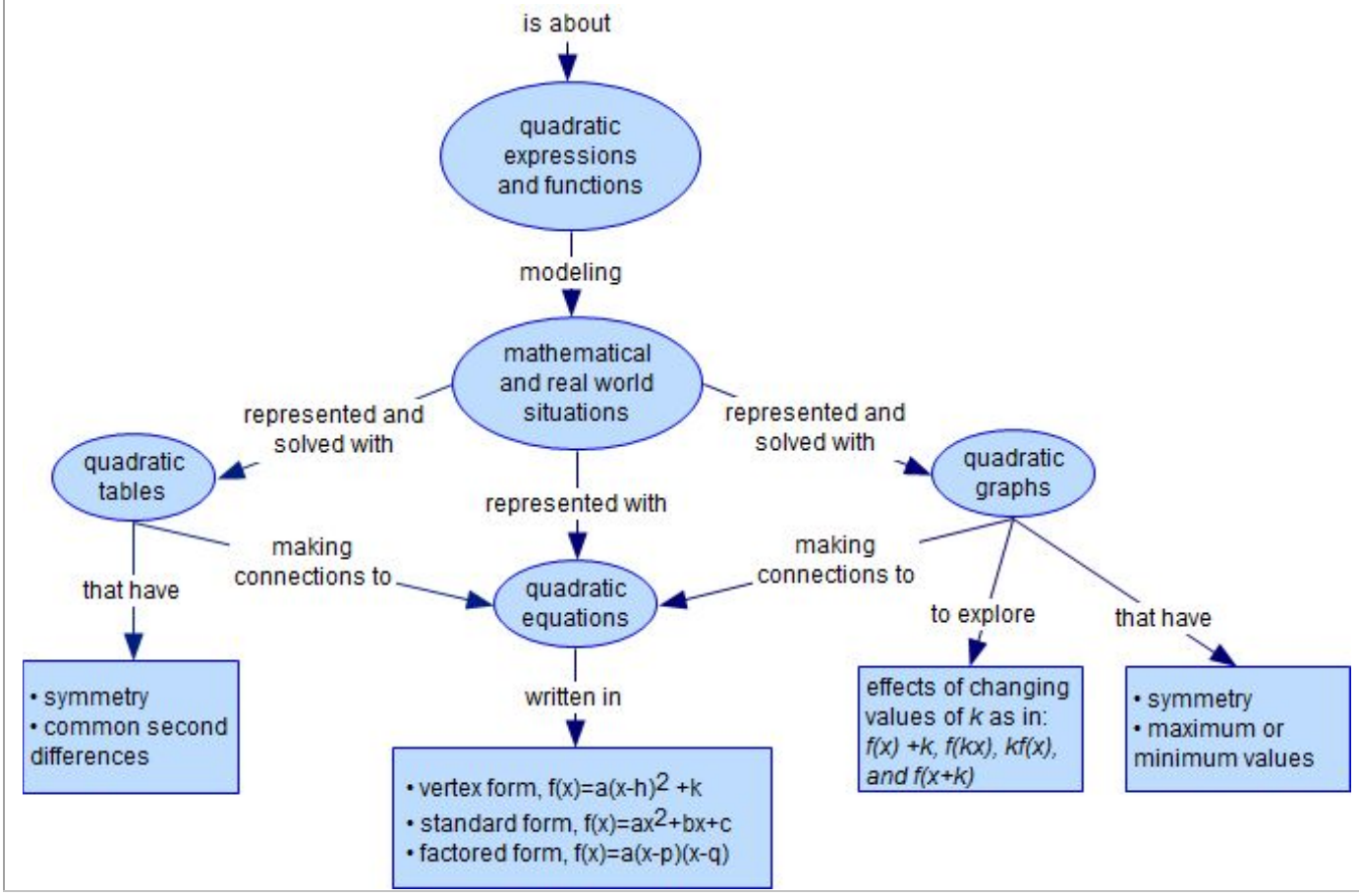
Common Core > 2015-2016 > Grade 9 > Mathematics > Algebra I (**CC**) > Week 19 - Week 23

Common Core Initiative

Overarching Questions and Enduring Understandings

How can quadratic functions model real-world situations as seen in tables, graphs, and equations that represent these situations?

Graphic Organizer



Unit Abstract

In eighth grade students began exploring different function families by studying linear functions and how they compare to nonlinear functions. In Algebra 1, they continue this exploration by developing a deeper understanding of linear functions and formalizing their understanding of exponential functions; they studied the key characteristics found in tables, graphs, and equations for linear and exponential functions. In this unit, students will use knowledge of these characteristics to build a new understanding of quadratic functions (e.g., end behavior, symmetry, constant second difference, maximum) which will include making comparisons among the three function families. Both exponential functions and quadratic functions have changing rates of change as seen in tables and graphs. As such, quadratics provide another useful context to find the average rate of change over a unit interval and compare rates for successive intervals.

In this unit students will study quadratic functions represented algebraically in several forms: polynomial form, *f(x)* =

$ax^2 + bx + c$; factored form, $f(x) = a(x - p)(x - q)$; and vertex form, $f(x) = a(x - h)^2 + k$. They will use applets and/or graphing utilities to analyze the graphs and tables for each of these forms and identify what each form reveals about the function. Once, they understand the usefulness of different forms, students will employ algebraic skills to generate equivalent forms. Students will also explore how changing the parameters in algebraic forms affect the graphs and/or tables of these functions.
In this unit, students build a conceptual understanding of quadratic functions that lays the foundation for the more abstract work of solving quadratic equations in unit 5. Some of the more sophisticated work in unit 5 includes finding roots that may be imaginary. (A more formal study of operations with imaginary numbers will be done in Algebra 2.) Understanding the connections between x-intercepts and the roots of quadratic equations along with transformations of the graphs of quadratics helps students conceptualize the need for imaginary numbers.

Unit Overview (Word)

Unit Overview (PDF)

Content Expectations/Standards

High School: Algebra

Seeing Structure in Expressions

HSA-SSE.B. Write expressions in equivalent forms to solve problems.

- HSA-SSE.B.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
  - HSA-SSE.B.3a. Factor a quadratic expression to reveal the zeros of the function it defines.
- HSA-SSE.B.3b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

High School: Functions

Interpreting Functions

HSF-IF.C. Analyze functions using different representations.

- HSF-IF.C.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

Unit Level Standards

There are standards listed in this section for two reasons.

1. ***The standards have been modified to be appropriate for this unit. Text in gray font is part of the CCSS-M standard but does not apply to this unit. Text in brackets denotes a modification that has been made to the standard.***
2. ***The standards contain content that is developed and/or utilized across multiple units.***

Modified For this Unit

The Complex Number System

HSN-CN.A. Perform arithmetic operations with complex numbers.

- HSN-CN.A.1. Know there is a complex number i such that $i^2 = –1$, and every complex number has the form a + bi with a and b real.

Creating Equations

HSA-CED.A. Create equations that describe numbers or relationships.

- HSA-CED.A.1.Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

HSF-IF.C. Analyze functions using different representations.

- HSF-IF.C.7a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

Building Functions

HSF-BF.B. Build new functions from existing functions.

- HSF-BF.B.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both

positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Developed and/or Utilized Across Multiple Units

Quantities

HSN-Q.A. Reason quantitatively and use units to solve problems.

- HSN-Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.
- HSN-Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Seeing Structure in Expressions

HSA-SSE.A. Interpret the structure of expressions.

- HSA-SSE.A.1. Interpret expressions that represent a quantity in terms of its context.
  - HSA-SSE.A.1a. Interpret parts of an expression, such as terms, factors, and coefficients.
  - HSA-SSE.A.1b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.*
- HSA-SSE.A.2. Use the structure of an expression to identify ways to rewrite it. *For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.*

Creating Equations

HSA-CED.A. Create equations that describe numbers or relationships.

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

Reasoning with Equations and Inequalities

HSA-REI.D. Represent and solve equations and inequalities graphically.

- HSA-REI.D.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Interpreting Functions

HSF-IF.A. Understand the concept of a function and use function notation.

- HSF-IF.A.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
- HSF-IF.A.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

HSF-IF.B. Interpret functions that arise in applications in terms of the context.

- HSF-IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* ★
- HSF-IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.* ★
- HSF-IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

HSF-IF.C. Analyze functions using different representations.

- HSF-IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- HSF-IF.C.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*

	Building Functions **HSF-BF.A. Build a function that models a relationship between two quantities.** • HSF-BF.A.1. Write a function that describes a relationship between two quantities. o HSF-BF.A.1a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
Essential/Focus Questions 1. What are the characteristics of quadratic functions when represented in a graph, equation, table, and/or real-world situation? 2. What are some similarities and differences between quadratic, exponential, and linear functions? 3. How do changes in the values of the parameters in a quadratic function change the behavior of the graph and/or table? 4. What do different algebraic forms of quadratic equations reveal about graphical features of quadratic functions?	**Key Concepts** forms of quadratic functions (factored, standard, vertex) key features of quadratic graphs (vertex, axis of symmetry, minimum, maximum, x-intercept, y-intercept, end behavior) models of quadratic functions (tables, graphs, equations) quadratic patterns (recursive, common second difference, explicit) solutions to quadratic equations (zeros, real and imaginary roots, x-intercepts) transformations of quadratic functions
Assessment Tasks Assessment Overview	**Intellectual Processes** **Standards for Mathematical Practice** *Students will have opportunities to:* • **look for and make use of structure** in representations of quadratic functions (e.g.,reflecting a given point over the line of symmetry to find another point); • **make sense of problems and persevere in solving them** by transforming algebraic forms of quadratic functions to reveal features of the function; and • **use appropriate tools strategically** to examine how changes in the values of the parameters in a quadratic function change the behavior of its graph and/or table.
Lesson Sequence Lesson Overview Lesson Download_Quadratic Transformer LessonFormativeAssessment_TransformParabolas	**Resources** Unit Resources Professional Learning Task - Egg Launch (Student Thinking and Using Tools) Professional Learning Task- Possible Solution Strategies for the Toothpick Task