Lessons - Quadratic Functions

COURSE: ALGEBRA
Unit 5: Quadratic Functions
Time Frame for developmental lessons: 15 days
Time Frame for Charter Schools: 20 days

Unit Resources:

Common Core Standards for this Unit

Sample Lesson Sequencing

Unit Chunks:

1. Interpret Quadratic Function Features
2. Analyze Multiple Representations
3. Relating Domain and Range

Essential Qs	Core Math	Unit Resources
How are parabolas used in the real world?	**Interpret Quadratic Function Features** Students will be able to interpret key features of a quadratic function through various representations (*focus on graphs and situations*). Students will: ● Understand and recognize the **relationships between** variables that model quadratic functions ○ determine if a function is a quadratic by identifying quadratic functions and non quadratic functions in graphs, tables, sets of points, and pattern sets ○ explain/justify the connection between the quadratic parent function and the shape of the graph being a parabola (for example: Why do quadratic functions produce a parabola when graphed?)	**Analyzing patterns that describe quadratic relationships:** ● Painted Cubes ● Odd Numbers ● Toothpick Stairs ● Differences ● Sidewalk Patterns ● Skeleton Tower (supports CC standards **F-BF 1** and **F-BF 1a**) **Identifying key function**

	○ recognize when a situation can be best represented by a quadratic model (ex: a parabola can be used for max and min problems as well as revenue, in real life) ○ calculate and interpret the rate of change of a quadratic from a function rule, graph, or numerical representation ○ recognize whether a function is even or odd from its graph or its function ○ writing recursive rules of quadratic functions ● Create quadratic and/or exponential equations/expressions by appropriately assigning variables and numbers to quantities in a situation and can explain the meaning of each value/term used ○ understands how to use variables to represent an unknown/changing quantity or a constant to represent a known/unchanging value ○ compare quadratic and exponential functions: exponents can be variables too (not just numbers) ○ *Students will understand what each part of the equation represents* ● Interpret the key features of a quadratic function from a graph or situation ○ understand and can articulate/interpret the meaning of key features of a parabola within context of a given situation ○ explain what the zeros, max, min, symmetry, and y-intercept mean in context (application problems) ○ Identify the key features both algebraically and graphically ● Understand the vertex as the central point of the parabola and its unique location on the axis of symmetry ○ use the axis of symmetry and a given point to identify its reflected point across the axis of symmetry, can articulate that points reflected across the axis of symmetry share a y value and can explain why ○ justify why the vertex lies between the roots of a parabola ○ explain why the vertex limits the range, identify and justify the vertex as the maximum or minimum point on the parabola ○ Solve application problems where the x or y coordinate of the maximum or minimum is the solution *SWBAT describe work by using these terms appropriately and consistently:* quadratic, parabola, vertex, turning point, maximum, minimum, reflection, axis of symmetry, x-intercepts, roots, zeros, reflection point of the y intercept, function, domain, range, increasing, decreasing, y-intercept	**features on a graph:** ● Consuelo's Graph ● Egg Launch Contest (finding and making sense of the vertex, supports CC standards **F-IF 4** and **F-IF 7a**) ● Quadratic Function Modelling Task (supports CC standard **F-IF 6**) **Other Resources and support on how to use them**

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Essential Qs	Core Math	Unit Resources
How can we find connections between multiple representations?	**Analyzing Multiple Representations** Students will understand that a quadratic function relationship can be represented in multiple ways. Students will: ● There are many different variations of quadratic functions and each variation highlights different traits ○ identify which form of a quadratic is most efficient to use to determine specific features of a parabola ○ recognize when real world situations can be modelled by a quadratic function ● Make fluent connections between different representations including graphs, tables, equations/rules, and situations (developed through inspection), identify the domain and range of a quadratic function from multiple representations ○ compare properties of two different quadratic functions that could be represented in any of the following ways: function rule, table, graph, or verbal description ● Translate from algebraic representations to graphic or numeric (table) representations and identify key features using the various representations ○ graph a parabola by hand using its quadratic equation ○ prove that two algebraic representations of a quadratic function are equivalent (between factored form, standard form, and vertex form) ● Use analysis from a parabola (zeros, max, min, symmetry, y-intercept, etc.) to generate an appropriate quadratic function in multiple forms (standard form, vertex form, factored form) *SWBAT describe work by using these terms appropriately and consistently*: binomial, trinomial, polynomial, factor, standard form, vertex form, factored form, coefficient, distribute, function, domain, range, increasing, decreasing, y-intercept, quadratic, parabola, vertex, turning point, maximum, minimum, reflection, axis of symmetry, x-intercepts, roots, zeros, reflection point of the y intercept	**Describing features of a quadratic function using various equations, points, etc. pertaining to it:** ● Quadratic (do #1-7, revisit #8-9 during Unit 6 with completing the square) Recognizing the relationship between two forms of a quadratic based on the values of that quadratic: ● Oh Snap! What's the Relationship? **Other Resources and support on how to use them**

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Essential Qs	Core Math	Unit Resources
How can we generalize from specific cases to general rules?	**Relating Domain & Range** Students will understand that the values within a function's range are determined and rely on the domain. Students will: ● Determine the domain and range of a quadratic function from its graph or a situation that can be modeled quadratically ○ determine intervals for the domain and range that capture the features that make the quadratic function unique and can adjust the scale/calculator window to appropriately capture this information ○ recognize and can justify restrictions on the domain and range for application problems ● Articulate how the features of the quadratic equation relate the domain and range values ○ describe how a, b, c from $ax^2 + bx + c$ affect the parabola ● Starting with f(x), identify how the domain and range will change with the following transformations: f(x) + k, k f(x), f(kx), and f(x+k) for specific values of k (both positive and negative) ○ use technology to help explain why f(x) changes in the way that it does for each of the above transformations ○ determine the value of k from its graph and can justify k using abstract or concrete evidence from the domain and range values ● Generate a quadratic function given pairs of domain and range values that appropriately capture the relationship between x & y *SWBAT describe work by using these terms appropriately and consistently:* domain, range, vertex, turning point, maximum, minimum, transformation, reflection, translation , input, output, increasing, decreasing, independent, dependent, rate of change, function, quadratic, parabola, y-intercept, axis of symmetry, x-intercepts, roots, zeros, standard form, vertex form, factored form, coefficient, distribute, order of operations	**Exploring transformations** This applet is intended to let your students visualize the effect of tranformations on quadratic functions. Once students have explored it (or alternatively you have used it as a whole class demonstration) students should work on justifying why the various transformations work. **Other Resources and support on how to use them**

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Common Core Learning Standards:

Interpret functions that arise in applications in terms of the context

- **F-IF 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*.
- **F-IF 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.*
- **F-IF 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.

Analyze functions using different representations

- **F-IF 7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- **F-IF 7a** Graph linear and quadratic functions and show intercepts, maxima, and minima.
- **F-IF 8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
    - **NOTE:** *Only in cases where we are writing the function based on information given from a graph, a table of values or a pattern.*
- **F-IF 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.*

Build a function that models a relationship between two quantities

- **F-BF 1** Write a function that describes a relationship between two quantities.
- **F-BF 1a** Determine an explicit expression, a recursive process, or steps for calculation from a context.
- **F-BF 1b** Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*

Build new functions from existing functions

- **F-BF 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.*

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