Algebra 1 Unit 6: Quadratic Functions

Unit Focus

This unit begins with students contrasting quadratic growth with linear and exponential growth. They further observe that eventually these quadratic patterns grow more quickly than linear patterns but more slowly than exponential patterns. Students examine the important example of free-falling objects whose height over time can be modeled with quadratic functions. They use tables, graphs, and equations to describe the movement of these objects, eventually looking at the situation where a projectile is launched upward. Through this investigation, students also begin to appreciate how the different coefficients in a quadratic function influence the shape of the graph. In addition to projectile motion, students examine other situations represented by quadratic functions including area and revenue.

Next, students examine the standard and factored forms of quadratic expressions. They investigate how each form is useful for understanding the graph of the function defined by these equivalent forms.

Finally, students investigate the vertex form of a quadratic function and understand how the parameters in the vertex form influence the graph. They learn how to determine the vertex of the graph from the vertex form of the function. They also begin to relate the different parameters in the vertex form to the general ideas of horizontal and vertical translation and vertical stretch, ideas which will be investigated further in a later course.

Stage 1: Desired Results - Key Understandings

Standard(s)

Common Core
Mathematics: 9-12

- Interpret parts of an expression, such as terms, factors, and coefficients. (CCSS.MATH.CONTENT.HSA.SSE.A.1.A)
- 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 $(x^2 - y^2)(x^2 + y^2)$. (CCSS.MATH.CONTENT.HSA.SSE.A.2)
- Factor a quadratic expression to reveal the zeros of the function it defines. (CCSS.MATH.CONTENT.HSA.SSE.B.3.A)
- Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. (CCSS.MATH.CONTENT.HSA.SSE.B.3.B)
- Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (CCSS.MATH.CONTENT.HSF.IF.A.2)
- 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;

Transfer

Students will be able to independently use their learning to...
T1 Initiate a plan using a variety of methods/strategies appropriately, execute it, and evaluate the reasonableness and accuracy of the solution.

Meaning

Understanding(s)	Essential Question(s)
Students will understand that... **U1** Mathematicians work to make sense of the problem before trying to solve it.	*Students will keep considering...* **Q1** How do I determine that my answer makes sense?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
Students will know... **K1** Vocabulary: quadratic expression, quadratic function, vertex (of a graph), zero (of a function), factored form, standard form (of a quadratic expression)	*Students will be skilled at...* **S1** Determining if a pattern represents a linear, exponential, or quadratic relationship. **S2** Using tables, equations, and graphs to represent the height of a falling object.

Stage 1: Desired Results - Key Understandings

symmetries; end behavior; and periodicity. (CCSS.MATH.CONTENT.HSF.IF.B.4) • 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. (CCSS.MATH.CONTENT.HSF.IF.B.5) • Graph linear and quadratic functions and show intercepts, maxima, and minima. (CCSS.MATH.CONTENT.HSF.IF.C.7.A) • Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. (CCSS.MATH.CONTENT.HSF.IF.C.8.A) • 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. (CCSS.MATH.CONTENT.HSF.IF.C. 9) • Determine an explicit expression, a recursive process, or steps for calculation from a context. (CCSS.MATH.CONTENT.HSF.BF.A.1.A) • 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. (CCSS.MATH.CONTENT.HSF.BF.B.3) • Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. (CCSS.MATH.CONTENT.HSF.LE.A.3) • Make sense of problems and persevere in solving them. (CCSS.MATH.MP.1) **Madison Public Schools Profile of a Graduate** • Analyzing: Examining information/data/ evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2)	**K2** A rectangle with the greatest area is in the shape of a square. **K3** A quadratic relationship can be expressed with a squared term. **K4** Exponential functions eventually grow faster than quadratic functions. **K5** The domain of a function can depend on the situation it represents. **K6** How the numbers in the factored form of a quadratic expression relate to the intercepts of its graphs. **K7** The vertical intercept is the constant value of an equation in standard form. **K8** How the "a" and "c" values of a quadratic function affect the graph. **K9** The effect on the graph of a quadratic function when performing algebraic transformations.	**S3** Identifying the vertex of a quadratic function and use it to find the zeros of a function. **S4** Modeling revenue with quadratic functions and graphs. **S5** Rewriting quadratic expressions in different forms by using an area model or the distributive property. **S6** Graphing quadratic functions in factored form. **S7** Identifying the vertex form of a quadratic function and relate the numbers in this form to its graph. **S8** Finding a maximum or a minimum of a quadratic function given in vertex form without graphing it.