Unit 5
Quadratic Functions

Algebra I

Unit Description:

Students will use a variety of methods to solve quadratic equations and apply their learning to analyze real-world problems. Students will choose linear, piece-wise, systems of equations, quadratic, exponential, square root and cube root functions to model real-world data. Additionally, students will graph nonlinear systems consisting of a linear function and either a quadratic or exponential function.

Standards for Mathematical Practice

MP.1 Make sense of problems and persevere in solving them.
MP.2 Reason abstractly and quantitatively.
MP.3 Construct viable arguments and critique the reasoning of others.
MP.4 Model with mathematics.
MP.5 Use appropriate tools strategically.
MP.6 Attend to precision.
MP.7 Look for and make use of structure.
MP.8 Look for and express regularity in repeated reasoning.

Louisiana Student Standards for Mathematics (LSSM)

REI – Reasoning with Equations and Inequalities	
B. Solve equations and inequalities in one variable.	
A-REI.B.4	Solve quadratic equations in one variable. **a.** Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form. **b.** Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as "no real solution."
CED – Creating Equations	
B. Use properties of rational and irrational numbers.	
A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions. ★
IF – Interpreting Functions	
B. Interpret functions that arise in application in terms of the context.	
F-IF.B.4	For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model 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; and end behavior. ★
F-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. ★
C. Analyze functions using different representations.	
F-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. ★ **a.** Graph linear and quadratic functions and show intercepts, maxima, and minima.
F-IF.C.8	(Standard is first addressed in this Unit.) Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **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. **b.** Graph piecewise linear (to include absolute value) and exponential functions.
F-IF.C.9	Compare properties of two functions (linear, quadratic, piecewise linear [to include absolute value] or exponential) 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, determine which has the larger maximum.
S – Statistics and Probability	
C. Interpret linear models.	
S-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. **a.** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and quadratic models.
BF – Building Functions	
A. Build a function that models a relationship between two quantities.	
F-BF.A.1	Write a linear, quadratic, or exponential function that describes a relationship between two quantities. ★ **a.** Determine an explicit expression, a recursive process, or steps for calculation from a context.
B. Build new functions from existing functions.	

F-BF.B.3	Identify the effect on the graph of replacing $f(x)$ with $f(x) \pm k$, $kf(x)$, $f(kx)$, and $f(x \pm k)$ for specific values of k (both positive and negative). Without technology, find the value of k given the graphs of linear and quadratic functions. With technology, experiment with cases and illustrate an explanation of the effects on the graph that include cases where $f(x)$ is a linear, quadratic, piecewise linear (to include absolute value) or exponential function.
LE – Linear, Quadratic, and Exponential Models	
A. Construct and compare linear, quadratic, and exponential models and solve problems.	
F-LE.A.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.
SSE – Seeing Structure in Expressions	
B. Write expressions in equivalent forms to solve problems.	
A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★ **a.** Factor a quadratic expression to reveal the zeros of the function it defines. ★ **b.** Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. ★ **c.** Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. For example, the growth of bacteria can be modeled by either $f(t) = 3^{t+2}$ or $g(t) = 9(3^t)$ because the expression 3^{t+2} can be rewritten as $(3^t)(3^2) = 9(3^t)$.
APR – Arithmetic with Polynomials and Rational Expressions	
B. Understand the relationship between zeros and factors of polynomials.	
A-APR.B.3	Identify zeros of quadratic functions, and use the zeros to sketch a graph of the function defined by the polynomial.
N-Q Quantities	
A. Reason quantitatively and use units to solve problems.	
N-Q-A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

★As defined by LSSM, the basic modeling cycle involves:

1. identifying variables in the situation and selecting those that represent essential features,
2. formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables,
3. analyzing and performing operations on these relationships to draw conclusions,
4. interpreting the results of the mathematics in terms of the original situation,
5. validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable,
6. reporting on the conclusions and the reasoning behind them.

Choices, assumptions, and approximations are present throughout this cycle.

Enduring Understandings:	Essential Questions:
*Quadratic functions, like linear and exponential, can be used to model real-life situations. *Factoring polynomial expressions can reveal information about quantities and find critical points of the function. *There are various methods to solving quadratic functions, some methods lend themselves to certain types of modeling situations.	*How do parameters introduced in the context of the problem affect the symbolic, numeric and graphical representations of a quadratic function? *What connections can be made between various functions and various representations of functions?