Unit 4 - Quadratic Functions and Modeling

Content Area: **Mathematics**
Course(s): **Honors Algebra I 8**
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Unit Overview

In preparation for work with quadratic relationships students explore distinctions between rational and irrational numbers. They consider quadratic functions, comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from among these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function.

Enduring Understandings

- Equivalent forms of linear, exponential and quadratic functions can be created to analyze and compare functions and features of functions. The same function can be represented algebraically in different forms and the differences can be interpreted in terms of the graph or context.
- Quadratic, linear or exponential function can be modeled, and the situation can be used in context to specify the domain and range as it relates to the understanding of real-world application of algebra concepts.
- Functions are a mathematical way to describe relationships between two quantities that vary.
- Functions can be represented in a variety of ways.
- Many real world functional relationships can be represented by equations. Equations can be used to find the solution of given real-world problems.
- Mathematical relationships can be presented graphically, in tables, or in verbal descriptions and the meaning of features in each representation can be interpreted in terms of the situation.
- The connection between the graph of the equation y = (x) and the function itself can be made, and the coordinates of any point on the graph represent an input and output, expressed as (x, f(x)).
- Translation between the tabular, graphical, and symbolic representations of a function can be explored between these representations and the situation's context.

Essential Questions

- How does each element of the domain correspond to exactly one element of the range?
- How can functions describe real-world situations, model predictions and solve problems?
- How can you represent and describe functions?
- How can you represent the same function algebraically in different forms and interpret these differences in terms of the graph or context?
- How do the graphs of mathematical models and data help us better understand the world in which we live?

- How would you relate and interpret features of relationships represented in a graph, table, and verbal descriptions?

Student Learning Objectives (SLOs)

- Calculate (over a specified period if presented symbolically or as a table) or estimate (if presented graphically) and interpret the average rate of change of a function.
- Compare (using graphs and tables) linear, quadratic, and exponential models to determine that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function, include interpretation of parameters in terms of a context.
- 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.
- Identify the effects of translations [f(x) + k, k f(x), f(kx), and f(x + k)] on a function, find the value of k given the graphs.
- Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
- Sketch the graph of a function that models a relationship between two quantities (expressed symbolically or from a verbal description) showing key features (including intercepts, minimums/maximums, domain, and rate of change) by hand in simple cases and using technology in more complicated cases and relate the domain of the function to its graph.
- Use properties of integer exponents to explain and convert between expressions involving radicals and rational exponents, using correct notation. For example, we define 51/3 to be the cube root of 5 because we want (51/3) 3 = 5(1/3)3 to hold, so (51/3) 3 must equal 5.
- Use the properties of rational and irrational numbers to explain why the sum or product of two rational numbers is rational; the sum of a rational number and an irrational number is irrational; and the product of a nonzero rational number and an irrational number is irrational.
- Write a function that describes a linear or quadratic relationship between two quantities given in context using an explicit expression, a recursive process, or steps for calculation and relate these functions to the model.
- Write functions in different but equivalent forms by manipulating quadratic expressions using methods such as factoring and completing the square.

Standards/Indicators

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.F-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.
MA.K-12.5	Use appropriate tools strategically.
MA.F-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
MA.K-12.6	Attend to precision.

MA.F-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.
MA.K-12.7	Look for and make use of structure.
MA.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.
MA.K-12.8	Look for and express regularity in repeated reasoning.
MA.F-IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
MA.A-APR.B.3	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
MA.F-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
MA.F-BF.A.1	Write a function that describes a relationship between two quantities.
MA.F-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, 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.
MA.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.
MA.F-LE.B.5	Interpret the parameters in a linear or exponential function in terms of a context.

Lesson Titles

- Exponential Growth and Decay
- Graphing f(x)= a(x - h)2 + k
- Graphing Linear Equations in Slope-Intercept Form
- Graphing Linear Equations is Standard Form
- Graphing Square Root Functions
- Solving Quadratic Equations by Graphing
- Comparing Linear, Exponential and Quadratic Functions
- Exponential Functions
- Function Notation
- Graphing Cube Root Functions
- Graphing Cube Root Functions
- Graphing Linear Equations in Slope-Intercept Form
- Graphing Square Root Functions
- Linear Functions
- Properties of Radicals
- Using Intercept Form

Career Readiness, Life Literacies & Key Skills

WRK.K-12.P.1	Act as a responsible and contributing community members and employee.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
WRK.K-12.P.9	Work productively in teams while using cultural/global competence.

Inter-Disciplinary Connections

English

World languages

Arts

Economics

Science

Geography

History

Government and Civics

LA.RL.8	Reading Literature
LA.RH.6-8.1	Cite specific textual evidence to support analysis of primary and secondary sources.
LA.RH.6-8.2	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.
LA.RH.6-8.3	Identify key steps in a text's description of a process related to history/social studies (e.g., how a bill becomes law, how interest rates are raised or lowered).
LA.RH.6-8.4	Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to domains related to history/social studies.
LA.RH.6-8.7	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
LA.RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts.
LA.RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
LA.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
LA.WHST.6-8.1	Write arguments focused on discipline-specific content.
LA.WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research.
	Vocabulary Acquisition and Use
SCI.7-8.5.1.8	All students will understand that science is both a body of knowledge and an evidence-

	based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.
SCI.7-8.5.2.8	All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.
SOC.6.1.8	U.S. History: America in the World: All students will acquire the knowledge and skills to think analytically about how past and present interactions of people, cultures, and the environment shape the American heritage. Such knowledge and skills enable students to make informed decisions that reflect fundamental rights and core democratic values as productive citizens in local, national, and global communities.
SOC.6.2.8	World History/Global Studies: All students will acquire the knowledge and skills to think analytically and systematically about how past interactions of people, cultures, and the environment affect issues across time and cultures. Such knowledge and skills enable students to make informed decisions as socially and ethically responsible world citizens in the 21st century.

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK

- Students will explain (orally and in writing) how to model a situation with a quadratic, linear or exponential function, and will be able to use the situation's context to specify the domain and range.
- Students will identify and orally explain key characteristics of functions using the function language and notation to analyze and compare functions.
- Students will relate and interpret orally and in writing using complex sentences the meaning and features of relationships arising from a situation – whether presented graphically, in tabular form, and/or as verbal descriptions.
- Students will write how to translate between the tabular, graphical, and symbolic representations of a function, and between these representations and the situation's context.

Modifications

ELL Modifications

- Be flexible with time frames
- digital translators
- Focus on domain specific vocabulary and keywords
- group students
- Modify assessments
- Provide students an opportunity to compare two functions (quadratic and exponential), represented in different ways (table, graph, or situation).
- Provide support as ELL move through all levels of language acquisition
- Understanding and use the formal mathematical language of functions.

IEP & 504 Modifications

- allow students to correct errors for additional credit
- break larger assignments into smaller tasks
- engage the students in identifying appropriate domain for the functions.
- Have students evaluate different functions (linear, quadratics, and exponential) for a given variable.
- less questions per page
- Pre-teaching vocabulary
- Provide a copy of completed notes to study from
- provide formulas
- reduce homework length
- study guides

G&T Modifications

- Ask students' higher level questions
- Avoid drill and practice
- Inquiry based learning
- Provide additional rigorous challenge problems
- Provide the students several opportunities to collect data to model different situations related to linear, quadratic, exponential functions, and trigonometric functions

At Risk Modifications

- Additional help during Academic Enrichment
- Guided notes
- Modeling/showing lots of examples
- Review, restate and reword directions
- Study guides

Formative Assessment

- 5 Questions
- Challenge problem
- Current events
- Math history
- Pair share
- relate to prior knowledge
- senteo

- Stand up
- Thumbs up
- video clips

Summative Assessment

- Project - Stained Glass Window
- Quiz - Exponential Growth and Decay
- Quiz - Growth/Decay Rates/Factors
- Test- Graphing Functions

Alternative Assessments

Performance tasks
Project-based assignments
Problem-based assignments
Presentations

Benchmark Assessments

Skills-based assessment- math practice

Resources & Materials

- Graphing tools
- PMI - Quadratic Functions
- Structure and Method Book 1

Technology

- Algebraic Fractions pt 2 https://www.youtube.com/watch?v=aMswqN951OY
- Algebraic Fractions https://www.youtube.com/watch?v=jSnHRp8TjXY
- Chromebook
- desmos
- desmos.com
- equatio
- Graphing Calculators

- https://www.youtube.com/watch?v=Llrngdh3Rrg
- https://www.youtube.com/watch?v=XX_MW4fVeTM
- Interactive Promethean Board
- IXL
- MathXL
- peardeck

TECH.9.4.2.TL.1	Identify the basic features of a digital tool and explain the purpose of the tool (e.g., 8.2.2.ED.1).
TECH.9.4.2.TL.2	Create a document using a word processing application.
TECH.9.4.2.TL.3	Enter information into a spreadsheet and sort the information.
TECH.9.4.2.TL.4	Navigate a virtual space to build context and describe the visual content.
TECH.9.4.2.TL.7	Describe the benefits of collaborating with others to complete digital tasks or develop digital artifacts (e.g., W.2.6., 8.2.2.ED.2).