Unit 1: Transformations, Functions & Quadratics

Content Area: **Mathematics**
Course(s): **Algebra II Honors**
Time Period: **September**
Length: **9 Weeks**
Status: **Published**

Unit Overview

During this unit, students will…

- Build new functions from existing functions.
- Analyze functions using different representations.
- Perform arithmetic operations with complex numbers.
- Use complex numbers to solve quadratic equations.
- Understand solving equations as a process of reasoning, and explain his/her reasoning.
- Solve quadratic equations in one variable.
- Represent and solve quadratic equations graphically.
- Write an equation for a parabola when given a focus and directrix.
- Analyze functions using different representations.
- Build functions that model relationships between two quantities.
- Solve systems of 3 equations in 3 variables.

CHAPTER 1, 2 & SUPPLEMENTAL

**Large unit--> can chunk into 2 parts (for CP).
1) Functions part: domain, range, transformations, identify vertex, parent functions, function evaluation (graph and algebraically), writing/modeling functions, function operations?, composition of functions, relation vs function, inverses?, compound/piecewise functions
2) Quadratics part: solving by square roots, factoring, completing the square, discriminant, quadratic formula, imaginary & complex numbers, domain, graph quadratics, quadratic word problems,

By the end of January, administer the Algebra II Link It! NJSLS Form B.

Transfer

Students will be able to independently use their learning to...

- Use patterns of transformation to sketch graphs of simple functions, or to write equations of simple functions based on their graphs.
- Compare important attributes of given functions.
- Give the domain of simple polynomial, rational, and square root functions.
- Recognize and perform operations on complex numbers.
- Solve quadratic equations.
- Model real-life situations using quadratic functions.
- Explain what is meant by a system of equations, and solve systems of 2 or 3 equations.
- Write and solve algebraic models and functions to describe real-world situations.

- Perform operations on functions.

For more information, read the following article by Grant Wiggins.

http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=60

Meaning

Understandings

Students will understand that...

- Introducing a constant into the equation of a function causes the graph of the function to shift, stretch, or reflect in the coordinate plane.
- Functions can be represented in a variety of different formats.
- Quadratic equations can be solved using a variety of methods.
- Real numbers are a part of a larger, complex number, system.
- Some quadratic equations have only complex number solutions.
- Quadratic equations can be used to model many real-life situations.
- Solutions to systems of equations are ordered pairs (or triplets) that solve each equation within the system.
- Algebraic models are useful in describing real-life situations.
- Input values are sometimes restricted due to the nature of the function.
- The concept of a function & function notation.

Essential Questions

Students will keep considering...

- How can you sketch accurate graphs of functions? How can translations and reflections be used when doing so?
- How can algebraic concepts and their properties be described by careful use of mathematical language?
- How can a given quadratic equation be solved both effectively and efficiently?
- How is graphing useful in both factoring expressions and solving equations?
- What are imaginary and complex numbers? Why are they important?
- When might you use quadratic equations in real life?

- How can you find the solution to a system of two or more equations?
- How do mathematical ideas interconnect and build on one another to produce a coherent whole?
- How can various mathematical expressions be simplified both effectively and efficiently?
- What does it mean for functions to be inverses of one another? How can you define the inverse of a given function?

Application of Knowledge and Skill

Students will know...

Students will know...

- Introducing a constant to the equation of a function has the effect of shifting, stretching, or reflecting the graph of the function in the coordinate plane.
- Our number system contains complex numbers
- Equations can be quadratic in nature and look differently than others on a graph
- That a variety of methods may be used to solve quadratic equations, though, depending on the equation, one method is often more efficient than others.
- A solution to a system of equations must solve every equation within the system.

Students will be skilled at...

Students will be skilled at...

- Using patterns of transformations to graph and write equations for functions.
- Performing operations with functions, including function composition.
- Analyzing the relationships among functions represented as tables of values, algebraic formulas, written statements, and graphs.
- Writing equations for the inverses of functions.
- Defining and performing operations on imaginary and complex numbers.
- Solving quadratic equations, including those with complex solutions.
- Writing quadratic functions based on given information, and to model real-world situations.
- Solving systems of equations both graphically and algebraically

Academic Vocabulary

Algebraically

Axis of Symmetry

Complex conjugate

Complex number

Constant Function

Continuous

Data Display

Directrix

Elimination Method for Solving Linear Systems

Exponential Function

Focus of a parabola

Formula

Function composition

Graph

Graphically

Imaginary number

Interpret

Intersection Point

Inverse Functions

Irrational number

level of accuracy

Limitation

Linear Function

Linear System of Equation in 3 Variables

Maximum value

Measurement

Minimum value

Modeling

Nonlinear system of equations

One-to-One Function

Origin

Parabola

Parent Function

Quadratic function

Quantity

Radical Function

Rational Function

Rational Number

Reflection

Shrink

Simplify

Solution

Solve

Stretch

Stretched - Vertically

Stretched - Horizontally

Substitution Method for solving Linear Systems

System of Equations

Transformation

Unit

Vertex

Vertex Form

Zero of a function

Learning Goal 1.1

Graph functions using transformations of a variety of parent functions and give the domain of those functions. Student's will explain transformations and domain of functions in context.

Target 1.1.1

SWBAT:

- Use and identify six parent functions and provide reasoning for the shapes of their graphs (constant, linear, quadratic, cubic, absolute value, and square root) **(DOK 1)**
- Identify, through experimenting with technology, the effect on the graph of a function by replacing $f(x)$ with $f(x) + k$, $k{\cdot}f(x)$, k$f(x)$, and $f(x + k)$ for both positive and negative values of k. **(DOK 2)**
- Recognize even and odd functions from their graphs and equations. **(DOK 2)**
- Use parent functions to model real-world data and make estimates for unknown values. **(DOK 2)**
- Determine the equation of a function, when given a graph. **(DOK 3)**
- Compare the key features of two functions represented in different ways (including graphically, in tables, by equations, by verbal description, etc.). **(DOK 4)**

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-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.

Learning Goal 1.2

Recognize and use function notation. Write, solve, and graph functions and apply functional relationships in context.

Supplemental material - barely touches upon in the book -- should be a review from Algebra 1

Target 1.2.1

SWBAT compose basic types of functions (including linear and quadratic functions) and use in context. **(DOK 3)**

Note: Students are not expected to simplify p(x)/q(x) unless q(x) is a monomial.

MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.F-BF.A.1a	Determine an explicit expression, a recursive process, or steps for calculation from a context.
MA.F-BF.A.1b	Combine standard function types using arithmetic operations.
MA.F-BF.A.1c	Compose functions.
MA.F-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.
MA.A-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 $(x^2 - y^2)(x^2 + y^2)$.

Target 1.2.2

SWBAT:

- Translate between the various representations of functions. **(DOK 2)**
- Solve problems by using the various representations of functions. **(DOK 3)**

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-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.

Target 1.2.3

- SWBAT compare properties of two functions. **(DOK 3)**
- Estimate and compare rates of change. **(DOK 3)**

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.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.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.

Target 1.2.4

SWBAT:

- Write and graph piecewise functions. **(DOK 2)**

- Use piecewise functions to describe real-world situations. **(DOK 4)**

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Target 1.2.5

SWBAT transform functions & recognize transformations of functions. **(DOK 3)**

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.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Target 1.2.6

SWBAT write, evaluate and perform composition of functions and their inverses. **(DOK 3)**

MA.F-BF.A.1b	Combine standard function types using arithmetic operations.
MA.F-BF.A.1c	Compose functions.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.6	Attend to precision.
MA.K-12.8	Look for and express regularity in repeated reasoning.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Target 1.2.7

SWBAT determine whether the inverse of a function is a function and write rules for the inverses of functions. **(DOK 2)**

MA.F-BF.A.1c	Compose functions.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
MA.K-12.6	Attend to precision.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Target 1.2.8

SWBAT apply functions to problem situations and use mathematical models to make predictions. **(DOK 4)**

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Learning Goal 1.3

Students will be able to write, transform, and solve quadratic equations using an appropriate method specific to the initial equation, and use quadratic equations in context.

Note: These techniques are to include inspection (mental math), taking square roots, completing the square, the quadratic formula, factoring. and solving graphically.

Target 1.3.1

SWBAT:

- Transform quadratic functions. **(DOK 2)**
- Describe the effects of changes in the coefficients of $y=a(x-h)^2 + k$. **(DOK 2)**

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-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
	Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
	Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
	Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.
	Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

Target 1.3.2

SWBAT:

- Define, identify, and graph quadratic functions. **(DOK 2)**
- Identify and use maximums and minimums of quadratic functions to solve problems. **(DOK 3)**

MA.F-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.F-IF.C.8a	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.
MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
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	Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens,

constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7 × 8 equals the well remembered 7 × 5 + 7 × 3, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

Target 1.3.3

SWBAT:

- Solve quadratic equations by graphing or factoring. **(DOK 3)**
- Determine a quadratic function from its roots. **(DOK 3)**

MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.F-IF.C.8a	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.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
MA.A-REI.D.11	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Target 1.3.4

SWBAT:

- Solve quadratic equations by completing the square. **(DOK 3)**
- Write quadratic equations in vertex form. **(DOK 3)**

NOTE: **After this section-- Complex numbers learning goal then come back to complete quadratics learning goal.

MA.F-IF.C.8a	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.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

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Target 1.3.5

SWBAT...

- Solve quadratic equations using the Quadratic Formula. **(DOK 3)**
- Classify roots using the discriminant. **(DOK 3)**

MA.N-CN.C.7	Solve quadratic equations with real coefficients that have complex solutions.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.

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Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt.

	They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
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Target 1.3.6

SWBAT:

- Solve quadratic inequalities by using tables and graphs. **(DOK 2)**
- Solve quadratic inequalities by using algebra. **(DOK 3)**

MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
	Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
	Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a

ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

Target 1.3.7

SWBAT:

- Use quadratic functions to model data. **(DOK 3)**
- Use quadratic models to analyze and predict. **(DOK 4)**

LGBTQ Connections: An example from Algebra II could be a linear programming problem constructed with the goal of finding the cheapest possible way to attend prom. The problem could include the cost of tickets per person, tuxedo rental, dresses, dinner, and a limo ride, and be explicit about including LGBTQ couples in any formal attire they choose. The teacher might also include the average cost of dinner by collecting data from the class. Once the least expensive way to attend is determined, the class can have a discussion regarding how our society determines prices and how those prices influence the choices available for students.
Resource: https://www.glsen.org/blog/how-do-we-make-math-class-more-inclusive-trans-and-non-binary-identities

MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
	Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

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Target 1.3.8

SWBAT:

- Derive the equation of a parabola when given a focus and directrix. **(DOK 4)+**
- Identify the vertex, focus, directrix, and axis of symmetry of a given parabola. **(DOK 4)**

MA.G-GPE.A.2	Derive the equation of a parabola given a focus and directrix.

Target 1.4.1

SWBAT:

- Define and use imaginary and complex numbers. **(DOK 2)**
- Solve quadratic equations with complex roots. **(DOK 3)**

MA.N-CN	The Complex Number System
MA.N-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.
MA.N-CN.A.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

Target 1.4.2

SWBAT perform operations with complex numbers. **(DOK 2)**

MA.N-CN.A	Perform arithmetic operations with complex numbers.

Target 1.5.1

SWBAT...

- Solve systems of three equations in three variables. **(DOK 3)**

Note: In Algebra II, tasks are limited to 3x3 systems.

MA.A-REI.C.6	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

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Target 1.5.2

SWBAT...

- Explain why the intersection of $y = f(x)$ and $y = g(x)$ is the solution of $f(x) = g(x)$. **(DOK 3)**
- Solve a system containing a linear equation and a quadratic equation in two variables graphically using pen and paper. **(DOK 3)**
- Find the solution(s) to systems of equations by using technology to graph the equations and determine their point of intersection. **(DOK 3)**
- Inspect a tables of values (using graphing technology) to reflect on the solution to the system. **(DOK 4)**

Note: Quadratic equations involved here may contain conic sections.

MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.A-REI.C.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
MA.A-REI.D.11	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

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Target 1.5.4

SWBAT...

- Use knowledge of systems of equations (3x3 linear/linear and quadratic) to solve a problem in context. **(DOK 4)**

Note: Tasks may involve linear and quadratic functions and should have a real-world context.

MA.F-BF.A.1	Write a function that describes a relationship between two quantities.
MA.F-BF.A.1a	Determine an explicit expression, a recursive process, or steps for calculation from a context.
MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.A-REI.C.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
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	Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.
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Formative Assessment and Performance Opportunities

- academic games
- Albert
- Class discussions
- Classwork
- Do nows
- Exit tickets
- Google Forms
- Homework
- Kahoot!
- Khan Academy
- Problem based learning
- Quizizz
- student interviews
- Teacher observation
- whiteboard/communicator opportunities

Summative Assessment

- Link it Exams
- Projects
- Quizzes
- student interviews
- Tests
- Unit Exam

21st Century Life and Careers

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.

CRP.K-12.CRP11	Use technology to enhance productivity.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.

Technology

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.

Accommodations and Modifications

- 504 Accommodations
- centers/stations
- challenge questions
- Common Core Workbook Reference 1-1 (Exploring Transformations)
- Common Core Workbook Reference 1-2 (Introduction to Parent Functions)
- Common Core Workbook Reference 12-9 (Operations with Complex Numbers)
- Common Core Workbook Reference 2-1 (Using Transformations to Graph Quadratic Functions)
- Common Core Workbook Reference 2-2 (Properties of Quadratic Functions in Standard form)
- Common Core Workbook Reference 2-3 (Solving quadratic equations by graphing and factoring)
- Common Core Workbook Reference 2-4 (Completing the Square)
- Common Core Workbook Reference 2-5 (Complex Numbers and Roots)
- Common Core Workbook Reference 2-6 (The Quadratic Formula)
- Common Core Workbook Reference 2-7 (Solving Quadratic Inequalities)
- Common Core Workbook Reference 6-1 (Multiple Representations of Functions)
- Common Core Workbook Reference 6-2 (Comparing Functions)
- Common Core Workbook Reference 6-3 (Piecewise Functions)
- Common Core Workbook Reference 6-4 (Transforming Functions)
- Common Core Workbook Reference 6-5 (Operations with Functions)
- Common Core Workbook Reference 6-6 (Functions and Their Inverses)
- Common Core Workbook Reference Chapter 12 (Conic Sections
- Graphic organizers to model 4 ways of solving quadratics & when to use each method
- Graphing Calculator Exploration of Transformations of Graphs
- IEP Modifications
- manipulatives
- Oreo/Peanut butter cup to model composition of functions

- Parent graphs chart
- scaffolding questions
- small group instruction
- Sticky notes to model composition of functions
- Unit 1 Exam Review
- use of technology

Unit Resources

- Albert
- Algebra 2 Teachers Collaboration Google Classroom - Digital Resources & Videos
- Desmos
- Explorations in Core Math for Common Core: Algebra 2 (Holt McDougal)
- Geometer sketchpad
- Google Classroom
- Kahoot
- Khan Academy
- Kuta software
- Loom
- NCTM website
- online textbook materials
- PARCC/NJSLA Released Questions
- Quizizz
- SJMAP Resources
- Text
- You Tube

Interdisciplinary Connections

Real world applications involving quadratic functions helps students to find the max, zeros, and y-intercepts for an object that rises and falls. (MA.9-12.F-IF.C.7A)

9-12.HS-PS2-4.5.1	Use mathematical representations of phenomena to describe explanations.