Grade 9 - Mathematics (Algebra 1)
Reasoning with Equations and Inequalities (2017-18) (12 - 15 Days)
Aug - Sep

Last Updated: 8/10/2017

Overview

Why is communication important in Math?
Students understand the process is just as important as the product in Math.

Students will use reasoning around previously learned content to solve problems while providing models to justify their solutions. They will learn to justify their thinking and their solutions to help create a classroom environment in which collaborating is the norm. The focus of content is creating and reasoning with equations and inequalities. Rearranging formulas(literal equations) is included to build on properties of equality.

Standards:

- Standard 1: Number Sense, Properties, and Operations
  - GLE 1: The complex number system includes real numbers and imaginary numbers
    - EO b: Use properties of rational and irrational numbers. (CCSS: N-RN)
  - GLE 2: Quantitative reasoning is used to make sense of quantities and their relationships in problem situations
    - EO a: Reason quantitatively and use units to solve problems (CCSS: N-Q)
    - EO a.i: Use units as a way to understand problems and to guide the solution of multi-step problems. (CCSS: N-Q.1)
    - EO a.i.1: Choose and interpret units consistently in formulas. (CCSS: N-Q.1)
    - EO a.i.2: Choose and interpret the scale and the origin in graphs and data displays. (CCSS: N-Q.1)
    - EO a.ii: Define appropriate quantities for the purpose of descriptive modeling. (CCSS: N-Q.2)
    - EO a.iii: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (CCSS: N-Q.3)
- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 3: Expressions can be represented in multiple, equivalent forms
    - EO a: Interpret the structure of expressions.(CCSS: A-SSE)
    - EO a.i: Interpret expressions that represent a quantity in terms of its context.* (CCSS: A-SSE.1)
    - EO a.i.1: Interpret parts of an expression, such as terms, factors, and coefficients. (CCSS: A-SSE.1a)
    - EO c: Perform arithmetic operations on polynomials. (CCSS: A-APR)
  - GLE 4: Solutions to equations, inequalities and systems of equations are found using a variety of tools
    - EO a: Create equations that describe numbers or relationships. (CCSS: A-CED)
    - EO a.i: Create equations and inequalities in one variable and use them to solve problems. (CCSS: A-CED.1)
    - EO a.iii: 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. (CCSS: A-CED.3)
    - EO a.iv: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (CCSS: A-CED.4)
    - EO b: Understand solving equations as a process of reasoning and explain the reasoning. (CCSS: A-REI)
    - EO b.i: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. (CCSS: A-REI.1)
    - EO c: Solve equations and inequalities in one variable. (CCSS: A-REI)
    - EO c.i: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (CCSS: A-REI.3)
    - EO e: Represent and solve equations and inequalities graphically. (CCSS: A-REI)
    - EO e.i: Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve. (CCSS: A-REI.10)
    - EO e.ii: 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.* (CCSS: A-REI.11)
- Standard MP: Mathematical Practices
  - GLE 1: Developing mathematical practices are processes and proficiencies necessary to flexibly use skills and concepts in multiple contexts.
    - EO 3: Construct viable arguments and critique the reasoning of others.
    - EO 4: Model with mathematics.
    - EO 6: Attend to precision

District Unit of Study Updates:

Date	Comments
6/9/2017 6:47:31 PM	Added Unit Overview
8/2/2017 8:36:57 PM	Final draft of 2017 Alg 1 Unit 1 Bundle added.
8/6/2017 10:09:38 PM	Included Number Systems: Real Numbers standards in Seeing Structures Organizing Concept so problems are more observational than theoretical.
8/6/2017 10:57:07 PM	Clarification of literal equations and using math practices
8/6/2017 11:11:22 PM	Clarified use of real numbers
8/6/2017 11:39:58 PM	Systems of equations will be in unit 2
8/6/2017 11:50:34 PM	Minimize repetition
8/7/2017 2:13:57 AM	Revise Do statement for clarity
8/7/2017 2:50:20 AM	removed confusing wording in understanding
8/7/2017 3:53:27 AM	Systems of equations is addressed in 8th grade so it is appropriate for this unit
8/10/2017 9:26:30 PM	Know not included to explain how solving system of equations is similar to solving equations with a variable on each side

Desired Results

Big Ideas:

- Communication, Reasoning/Proof, Modeling, Problem Solving,

Overarching Understandings:	Overarching Essential Questions:
• Communicating and reflecting on mathematical thinking clarifies and deepens knowledge.	• How does communication with others affect our thinking/learning? • How does showing and explaining my work deepen understanding?
• Effective mathematical reasoning and proof involves making claims about relationships and justifying those claims by relying on the properties that are the structure of mathematics.	• How are solving and proving different? • What is the best way to show my reasoning?
• Problem solvers use mathematical models to translate real world situations into representations that can be used to find/defend solutions.	• How can I justify my solution to others? • How can we make connections and use them to solve problems? • How do you create a model to use for problem solving? • How does flexibility with models support you with problem solving?
• Properties that govern arithmetic and algebra are used together with notions of equivalence to solve problems.	• What are properties in math? How do they help us?

Organizing Concepts

Creating and Reasoning with Equations and Inequalities

Students will understand that...

- Equations and inequalities are used to compare values in various situations.
- Equivalent expressions are used to simplify and solve various problems involving linear relationships.
- The graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.

Essential Questions

- What are some similarities in solving equations?
- When is a solution to a problem infinite? When is it finite?
- Why use inequalities?

Students will know...

- Procedures and reasoning for writing and solving application problems including both equations and inequalities (e.g. Types of problems – consecutive number, rate, age, perimeter, area).
- Formulas for area, volume, and Pythagorean Theorem
- Procedures and reasoning for solving proportions.
- Properties of equality (addition, subtraction, multiplication, division, reflexive, symmetric, transitive, substitution, and distributive).
- Solution to one variable inequality represented by symbols and on number lines.
- The solution to an equation in the form $ax + b = cx + d$ gives a value $x = e$. e is the x coordinate of the point of intersection of $y = ax + b$ and $y = cx + d$.
- Types of solutions (one, infinite, no solution).

Students will be able to...

- Graph inequalities in one variable, including compound inequalities.
- Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution.
- Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- Create equations and inequalities in one variable and use them to solve problems. (include variety of situations such as proportional, area, volume, and multistep)
- Describe and interpret the solution set of a system of linear equations graphically and relate that to the algebraic solution.
- Use rational and irrational numbers in problem solving situations.

Seeing Structures in Expressions

Students will understand that...

- Algebraic and numeric procedures are interconnected and build on one another to produce a coherent whole.
- Rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related.
- The nature of equivalence allows expressions and equations to be rewritten in different forms.

Essential Questions

- How many different ways can you correctly rewrite a formula?
- When does simplifying numeric or algebraic expressions make sense? When does it not?
- Why can multiple algebraic expressions be used to express relationships?

Students will know...

- Exponent rules for $(a^n)(a^m)$, $(a^n)^m$, and a^m/a^n
- A literal equation is an equation that has two or more variables.
- Strategies for simplifying expressions with variables (e.g. combining like terms, distributive property)

Students will be able to...

- Add, subtract, and multiply algebraic expressions when using the distributive property and combining like terms.
- Determine solutions to multi-step algebraic and numeric problems involving addition, subtraction, multiplication and division of rational numbers.
- Interpret numberic and algebraic expressions in terms of the context.
- Interpret parts of an exponential expression in terms of its context.
- Rearrange formulas to highlight a quantity of interest (literal equations). (Include geometric formulas for area ,volume, and Pythagorean Theorem)

Using the Mathematical Practices

Students will understand that...

- Modeling linear functions requires choosing and interpreting the scale, the origin, and other parameters in graphs based on context.
- Problem solvers attend to precision.
- Problem solvers evaluate answers and make changes if needed.
- Problem solvers make assumptions and estimate to make complex problems easier.
- Problem solvers model with mathematics.
- Units help us make sense of and model real life situations

Students will know...

- Components of a quality graph
- Situations that commonly use a decimal(i.e. money, percent) vs. fraction(i.e. recipes).
- Units for metric and customary length/weight/liquid capacity/volume, speed(rate)

Essential Questions

- HOw can you use a diagram, equation, table or graph to model the problem?
- How did your teammates think differently about the problem?
- How do you know if a graphical representation is accurate?
- How does precision affect the solution to a problem solving situation?
- How does what you model determine the type of model?
- Is your answer reasonable? Explain why or why not.

Students will be able to...

- Choose units and a level of accuracy appropriate to quantities in a problem.
- Label final answers with correct units.
- Model a real-life math problem using diagrams, graphs, tables, and equations.
- Reason quantitatively to determine if my answer is reasonable..

Creating and Reasoning with Equations and Inequalities: Systems of Equations

Students will understand that...

Students will know...

Essential Questions

Students will be able to...

- 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.

Grade 9 - Mathematics (Algebra 1)
Modeling with Linear Functions (2017-18) (20 - 25 Days)
Sep - Oct

Last Updated: 6/12/2017

Overview

How do lines represent everyday situations?
Students understand how to analyze and interpret multiple representations of linear functions.

Students will review their knowledge of linear functions from middle school. They will have the opportunity to extend their learning through the introduction of arithmetic sequences and the use of function notation. In addition, they will interpret linear functions, including systems of linear equations and inequalities in the context of real-world situations.

Standards:

- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 1: Functions model situations where one quantity determines another and can be represented algebraically, graphically, and using tables
    - EO a: Formulate the concept of a function and use function notation. (CCSS: F-IF)
    - EO a.i: Explain that a function is a correspondence from one set (called the domain) to another set (called the range) that assigns to each element of the domain exactly one element of the range. (CCSS: F-IF.1)
    - EO a.ii: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (CCSS: F-IF.2)
    - EO b: Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)
    - EO b.i: 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. * (CCSS: F-IF.4)
    - EO b.ii: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.* (CCSS: F-IF.5)
    - EO b.iii: Calculate and interpret the average rate of change of a function over a specified interval. Estimate the rate of change from a graph.* (CCSS: F-IF.6)
    - EO c: Analyze functions using different representations. (CCSS: F-IF)
    - EO c.i: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. * (CCSS: F-IF.7)
    - EO c.vi.3: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (CCSS: F-IF.9)
    - EO d: Build a function that models a relationship between two quantities. (CCSS: F-BF)
    - EO d.i: Write a function that describes a relationship between two quantities.* (CCSS: F-BF.1)
    - EO e: Build new functions from existing functions. (CCSS: F-BF)
    - EO e.i: 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, and find the value of k given the graphs. (CCSS: F-BF.3)
    - EO e.ii: Experiment with cases and illustrate an explanation of the effects on the graph using technology.
  - GLE 2: Quantitative relationships in the real world can be modeled and solved using functions
    - EO b: Interpret expressions for function in terms of the situation they model. (CCSS: F-LE)
    - EO b.i: Interpret the parameters in a linear or exponential function in terms of a context. (CCSS: F-LE.5)
  - GLE 3: Expressions can be represented in multiple, equivalent forms
  - GLE 4: Solutions to equations, inequalities and systems of equations are found using a variety of tools
    - EO a: Create equations that describe numbers or relationships. (CCSS: A-CED)
    - EO a.ii: Create equations in two or more variables to represent relationships between quantities and graph equations on coordinate axes with labels and scales. (CCSS: A-CED.2)
    - EO a.iii: 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. (CCSS: A-CED.3)
    - EO d: Solve systems of equations. (CCSS: A-REI)
    - EO d.i: Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. (CCSS: A-REI.5)
    - EO d.ii: Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables. (CCSS: A-REI.6)
    - EO e: Represent and solve equations and inequalities graphically. (CCSS: A-REI)
    - EO e.i: Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve. (CCSS: A-REI.10)
    - EO e.ii: 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.* (CCSS: A-REI.11)
    - EO e.iii: Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. (CCSS: A-REI.12)

District Unit of Study Updates:

Date	Comments
6/9/2017 6:47:58 PM	Added Unit Overview
5/1/2016 2:52:39 AM	Working on Desired Results

Desired Results

Big Ideas:

- Communication, Modeling, Problem Solving, Patterns, Relationships,

Overarching Understandings:

- Communicating and reflecting on mathematical thinking clarifies and deepens knowledge.
- Effective mathematical reasoning and proof involves making claims about relationships and justifying those claims by relying on the properties that are the structure of mathematics.
- Problem solvers use mathematical models to translate real world situations into representations that can be used to find/defend solutions.
- Recognizing patterns and functional relationships helps to comprehend change and make predictions.

Overarching Essential Questions:

- Am I using the language of mathematics?
- How does showing and explaining my work deepen understanding?
- What is the best way to show my reasoning?
- How do you know where to start when problem solving?
- How do you know your solution is correct?
- How does flexibility with models support you with problem solving?
- What is the best way to model a problem?
- How does recognizing patterns and relationships predict and explain change in the world?
- What can patterns reveal?

Organizing Concepts

Creating and Reasoning with Equations and Inequalities

Students will understand that...

- Systems of equations and systems of inequalities are used to model problems with more than one option.
- Asolution to a linear inequality in two variables is an ordered pair (x, y) that makes the inequality true.
- Equivalent expressions are used to simplify and solve various problems involving linear relationships.
- Graphs are useful tools for understanding and managing information about the world around us.
- The graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
- The graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- The nature of equivalence allows equations to be rewritten in different forms.

Students will know...

- Procedures and reasoning for writing and solving application proportion problems.
- Asolution set of systems of linear inequalities is the intersection of the corresponding half-planes.
- Boundary lines may or may not be part of the solutions to a linear inequality.
- Procedures and reasoning for solving systems of equations graphically and algebraically (using substitution and elimination).
- Solutions to a system of two linear equations in two-variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
- Solutions to linear inequalities are half-planes.
- Types of solutions (one, infinite, no solution).

Essential Questions

- How are equations and graphs related?
- How are systems of linear inequalities useful in interpreting real-world situations?
- How can you use an inequality to describe a real-life situation?
- What are the advantages and disadvantages of graphing systems? When is it better to use algebraic methods to solve a system?
- When is a solution to a problem infinite? When is it finite?

Students will be able to...

- Create equations in two variables to represent relationships between quantities and graph equations on coordinate axes with labels and scales.
- Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- Graph the solutions to a multi-step linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality).
- Represent and solve multi-step linear equations graphically, analyzing the solution sets.
- Determine if a soultion is viable
- Represent constraints by systems of equations and inequalities and interpret solutions as viable or nonviable options in a modeling context.
- Solve multi-step contextual problems that require writing and analyzing systems of equations and inequalities in two variables to find viable solutions.

Functions: Building

Students will understand that...

- Changing the way a function is represented does not change the function.
- Mathematics uses multiple representations of functions to explore the properties of functions and the properties of families of functions.
- Real world situations can be represented graphcially and symbolically.

Students will know...

- Linear relationships represented through tables, graphs, and equations.

Essential Questions

- How can we tell which representation works best for a particular situation?
- How do you know if a relation is a linear function?

Students will be able to...

- Graph linear functions expressed symbolically and show key features of the graph (intercepts), by hand in simple cases and using technology for more complicated cases.
- Solve multi-step contextual problems by constructing linear function models.
- Build a linear function that models a relationship between two quantities.
- Build new functions from existing functions and identify the effect on the graph of replacing f(x) by f(x) + k, and k f(x) for specific values of k, and find the value of k given the graphs.
- Given a context, write and analyze a linear function that describes a relationship between two quantities.

Functions: Interpreting

Students will understand that...

- The characteristics of linear functions and their representations are useful in solving real-world problems.
- When analyzing linear functions, different representations may be used based on the situation presented.
- Afunction is a correspondence from one set (called the domain) to another set (called the range) that assigns to each element of the domain exactly one element of the range.
- Functions can be represented in multiple ways, including algebraic (symbolic), graphical, verbal and tabular representations. Links among these different representation are important to studying relationships and change.

Students will know...

- Components of a quality graph.
- Discrete and continuous domains and the difference between them
- Function notation.
- Functions are single-valued mappings from one set (the domain of the function) to another (its range).
- Independent and Dependent variables
- Key features of a graph (intercepts, slope).
- Reasoning and procedures for determining the rate of change.
- Slope describes the linear relationship between two values and is constant.
- Steps to graph functions using a calculator (including changing window, choosing appropriate window, move between tables and graphs).
- Steps to graph linear equations.
- That a function is a consistent and predictable relationship where the value of one quantity (the dependent variable) depends on the value of another quantity (the independent variable).

Essential Questions

- How can multiple representations be used to express relationships?
- How can you determine whether a function is linear or non-linear?
- How do you analyze a function using tables, graphs, or algebraic formulas?
- How does interpreting key features of a line help us understand situations?
- What are the characteristics of a function and how can you use those characteristics to represent the function in multiple ways?

Students will be able to...

- Compare properties of two linear functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- Determine if a given relation is a function.
- For a linear function that models a relationship between two quantities, interpret key features in terms of the quantities and context, such as rate of change and intercepts, from graphs and tables.
- 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 for linear functions that model a relationship between two quantities (including in terms of a real-world context).
- Interpret the parameters in a linear function in terms of a real-world context.
- Relate the domain of the linear function to its graph and the quantitative relationship it describes.
- Sketch graphs of linear functions expressed symbolically, verbally or in a table and show key features of the graph.
- Use function notation, evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context.

Grade 9 - Mathematics (Algebra 1)
Introduction to Exponential Functions (2017-18) (20 - 24 Days)
Jan - Feb

Last Updated: 6/12/2017

Overview

How do you model a situation that changes exponentially?
Students will be able to represent basic exponential functions in multiple ways.

Students will explore and interpret exponential situations and translate between multiple representations. They will be limited to exponential functions with integer exponents. Students will be introduced to geometric sequences as a representation of exponential situations. Finally, students should be able to compare and contrast linear and exponential functions, focusing on the difference between additive and multiplicative change.

Standards:

- Standard 1: Number Sense, Properties, and Operations
  - GLE 2: Quantitative reasoning is used to make sense of quantities and their relationships in problem situations
    - EO a: Reason quantitatively and use units to solve problems (CCSS: N-Q)
    - EO a.ii: Define appropriate quantities for the purpose of descriptive modeling. (CCSS: N-Q.2)
- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 1: Functions model situations where one quantity determines another and can be represented algebraically, graphically, and using tables
    - EO a.i: Explain that a function is a correspondence from one set (called the domain) to another set (called the range) that assigns to each element of the domain exactly one element of the range. (CCSS: F-IF.1)
    - EO a.ii: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (CCSS: F-IF.2)
    - EO a.iii: Demonstrate that sequences are functions,sometimes defined recursively, whose domain is a subset of the integers. (CCSS: F-IF.3)
    - EO b: Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)
    - EO b.i: 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. * (CCSS: F-IF.4)
    - EO b.ii: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.* (CCSS: F-IF.5)
    - EO b.iii: Calculate and interpret the average rate of change of a function over a specified interval. Estimate the rate of change from a graph.* (CCSS: F-IF.6)
    - EO c: Analyze functions using different representations. (CCSS: F-IF)
    - EO c.i: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. * (CCSS: F-IF.7)
    - EO c.vi: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. (CCSS: F-IF.8)
    - EO c.vi.2: Use the properties of exponents to interpret expressions for exponential functions. (CCSS: F-IF.8b)
    - EO c.vi.3: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (CCSS: F-IF.9)
    - EO d: Build a function that models a relationship between two quantities. (CCSS: F-BF)
    - EO d.i: Write a function that describes a relationship between two quantities.* (CCSS: F-BF.1)
    - EO e.ii: Experiment with cases and illustrate an explanation of the effects on the graph using technology.
  - GLE 2: Quantitative relationships in the real world can be modeled and solved using functions
    - EO a: Construct and compare linear, quadratic, and exponential models and solve problems. (CCSS: F-LE)
    - EO a.i: Distinguish between situations that can be modeled with linear functions and with exponential functions. (CCSS: F-LE.1)
    - EO a.i.1: Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. (CCSS: F-LE.1a)
    - EO a.i.2: Identify situations in which one quantity changes at a constant rate per unit interval relative to another. (CCSS: F-LE.1b)
    - EO a.i.3: Identify situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. (CCSS: F-LE.1c)
    - EO a.ii: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs. (CCSS: F-LE.2)
    - EO a.iii: Use graphs and tables to describe that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. (CCSS: F-LE.3)
    - EO b: Interpret expressions for function in terms of the situation they model. (CCSS: F-LE)
    - EO b.i: Interpret the parameters in a linear or exponential function in terms of a context. (CCSS: F-LE.5)
  - GLE 3: Expressions can be represented in multiple, equivalent forms
    - EO a.i.1: Interpret parts of an expression, such as terms, factors, and coefficients. (CCSS: A-SSE.1a)
    - EO a.i.2: Interpret complicated expressions by viewing one or more of their parts as a single entity. (CCSS: A-SSE.1b)
    - EO b: Write expressions in equivalent forms to solve problems. (CCSS: A-SSE)
    - EO b.i.3: Use the properties of exponents to transform expressions for exponential functions. (CCSS: A-SSE.3c)

District Unit of Study Updates:

Date	Comments
6/9/2017 6:49:35 PM	Added Unit Overview

Desired Results

Big Ideas:

- Modeling, Patterns, Relationships, Change,

Overarching Understandings:

- Problem solvers use mathematical models to translate real world situations into representations that can be used to find/defend solutions.
- Relationships can be described and generalizations made for mathematical situations that have numbers, shapes, symbols, and data that repeat in predictable ways.
- Recognizing patterns and functional relationships helps to comprehend change and make predictions.

Overarching Essential Questions:

- How do you create a model to use for problem solving?
- How does flexibility with models support you with problem solving?
- How can you describe a pattern?
- How does recognizing patterns and relationships predict and explain change in the world?

Organizing Concepts

Functions: Building

Students will understand that...

- Exponential functions and relations are used to model real-world situations and to make predictions.
- Real world situations can be represented graphcially and symbolically.

Students will know...

- Characteristics of exponential growth and exponential decay present in multiple representations including geometric sequences, given a graph, a description of a relationship, or twoinput-output pairs (including reading these from a table)
- Key Vocabulary – common ratio, exponential growth, exponential decay

Essential Questions

- What is the relationship between geometric sequences and exponential functions?
- How are exponential growth and decay used to solve real world problems?
- What characteristics of a problem situation make it fit an exponential model?

Students will be able to...

- Create a function from a context that describes an exponential relationship between two quantities.
- Construct exponential functions, including geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
- Represent exponential functions symbolically, in real-life scenarios, graphically, with a verbal descripiton, as a sequence and with input-output pairs to solve mathematical and contextual problems.

Functions: Interpreting

Students will understand that...

- A function's rate of change is one of the main characteristics that determine what kinds of real-world phenomena the function can model.
- Exponential functions model an initial amount that is repeatedly multiplied by the same positive number. In the rules for these functions, the independent variable is an exponent.
- Functions and relations are used to model real-world situations and to make predictions.
- In exponential functions, if the input is increased by 1 unit, the output is multiplied by a constant factor.

Essential Questions

- How do you know a graph represents an exponential situation?
- What are the characteristics and importance of the exponential function?
- What is the difference between an exponential and a linear situation/function?

Students will know...

- Reasoning and procedures for determining the average rate of change over a specified interval.
- Key features of an exponential graph: intercepts, domain, range, end behavior, increasing or decreasing
- Steps to graph functions using a calculator (including changing window, choosing appropriate window, move between tables and graphs).

Students will be able to...

- Determine the domain and relate the domain to the quantitative relationship it describes for exponential functions.
- Calculate and interpret the average rate of change of an exponential function (presented symbollically or as a table) and estimate the rate of change from a graph. Compare rates of change associated with different intervals.
- Compare properties of two exponential functions (domains in the integers) each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one exponential function and an algebraic expression for another exponential function, say which function is growing at a faster rate.
- Distinguish between situations that can be modeled with linear functions and with exponential functions.
- Explain and use function notation, evaluate exponential functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- Graph exponential functions expressed algebraically and show key features of the graph by hand in simple cases or using technology in more complicated cases.
- Interpret the parameters in an exponential function in terms of a context.
- Relate the domain of an exponential function to its graph and, where applicable, to the quantitative relationship it describes.

Seeing Structures in Expressions

Students will understand that...

- Exponential functions are characterized by a rate of change that is proportional to the value of the function.
- Negative exponents indicate repeated division (exponential decay)
- Positive exponents indicate repeated multiplication (exponential growth)

Essential Questions

- How do the coefficient, base, and exponent of an exponential expression affect the result of the expression?
- What does a negative exponent mean?
- Why is $x^0 = 1$?

Students will know...

- Any number raised to the 0 power equals 1.
- General form for exponential functions $y = ab^x$, where $a \neq 0$, $b > 0$, $b \neq 0$

Students will be able to...

- Show that exponential functions grow or decay by equal factors over equal intervals (constant percent).
- Evaluate exponential expressions, including for accuracy within context and justify the results.
- Interpret parts of an exponential expression in terms of its context.

Grade 9 - Mathematics (Algebra 1)
Quadratic Functions and Polynomial Operations (2017-18) (28 - 33 Days)
Jan - Feb

Last Updated: 6/12/2017

Overview

How can key features and solutions of quadratics be found from multiple models?
Students will be able to solve and analyze quadratic functions represented in multiple ways.

Students will be introduced to quadratic functions. They will perform arithmetic operations with polynomials to create quadratic functions. Looking at various forms of quadratic functions, students will be able to identify different key features. Multiple methods to find solutions of quadratics will be explored. Students will be able to identify all real solutions and recognize when solutions are imaginary.

Standards:

- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 1: Functions model situations where one quantity determines another and can be represented algebraically, graphically, and using tables
    - EO a: Formulate the concept of a function and use function notation. (CCSS: F-IF)
    - EO a.ii: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (CCSS: F-IF.2)
    - EO b: Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)
    - EO b.i: 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. * (CCSS: F-IF.4)
    - EO b.ii: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.* (CCSS: F-IF.5)
    - EO b.iii: Calculate and interpret the average rate of change of a function over a specified interval. Estimate the rate of change from a graph.* (CCSS: F-IF.6)
    - EO c: Analyze functions using different representations. (CCSS: F-IF)
    - EO c.i: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. * (CCSS: F-IF.7)
    - EO c.ii: Graph linear and quadratic functions and show intercepts, maxima, and minima. (CCSS: F-IF.7a)
    - EO c.vi: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. (CCSS: F-IF.8)
    - EO c.vi.1: 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: F-IF.8a)
    - EO c.vi.3: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (CCSS: F-IF.9)
    - EO d: Build a function that models a relationship between two quantities. (CCSS: F-BF)
    - EO d.i: Write a function that describes a relationship between two quantities.* (CCSS: F-BF.1)
    - EO e: Build new functions from existing functions. (CCSS: F-BF)
    - EO e.i: 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, and find the value of k given the graphs. (CCSS: F-BF.3)
    - EO e.ii: Experiment with cases and illustrate an explanation of the effects on the graph using technology.
  - GLE 2: Quantitative relationships in the real world can be modeled and solved using functions
  - GLE 3: Expressions can be represented in multiple, equivalent forms
    - EO a.ii: Use the structure of an expression to identify ways to rewrite it.(CCSS: A-SSE.2)
    - EO c: Perform arithmetic operations on polynomials. (CCSS: A-APR)
    - EO c.i: Explain that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. (CCSS: A-APR.1)
    - EO d.ii: 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. (CCSS: A-APR.3)
  - GLE 4: Solutions to equations, inequalities and systems of equations are found using a variety of tools
    - EO c.ii: Solve quadratic equations in one variable. (CCSS: A-REI.4)
    - EO c.ii.2: Solve quadratic equations by inspection, taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. (CCSS: A-REI.4b)
    - EO e: Represent and solve equations and inequalities graphically. (CCSS: A-REI)
    - EO e.i: Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve. (CCSS: A-REI.10)
    - EO e.ii: 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.* (CCSS: A-REI.11)

District Unit of Study Updates:

Date	Comments
6/9/2017 6:48:47 PM	Added Unit Overview

Desired Results

Big Ideas:

- Equivalence, Modeling, Patterns, Relationships, Quantitative Reasoning, Connections, Change,

Overarching Understandings:	Overarching Essential Questions:
• Problem solvers use mathematical models to translate real world situations into representations that can be used to find/defend solutions.	• How do you know where to start when problem solving? • How does flexibility with models support you with problem solving?
• The context of a problem determines the precision needed and the reasonableness of a solution.	• When is it important to be precise?
• Any number, shape, measure, expression, or equation can be represented in an infinite number of ways that are equivalent.	• How do we know when two things are equivalent? • If we change the way something looks does it change its value?
• Properties that govern arithmetic and algebra are used together with notions of equivalence to solve problems.	• What are properties in math? How do they help us?
• Recognizing patterns and functional relationships helps to comprehend change and make predictions.	• How does recognizing patterns and relationships predict and explain change in the world?

Organizing Concepts

Creating and Reasoning with Equations and Inequalities

Students will understand that...

- Quadratic equations can be solved using a variety of techniques.
- The graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- The nature of equivalence allows equations to be rewritten in different forms.

Students will know...

- Procedures and reasoning for solving quadratic equations by inspection (for example $x^2 = 49$), graphing, factoring, taking the square roots, completing the square and the quadratic formula.
- How to determine the number of real solutions using the discriminant.
- Procedures and reasoning for applying mathematical operations to polynomials.
- Quadratic equations may have two real solutions, one real solution, or no real solutions.

Essential Questions

- How do I decide the best method to solve a quadratic equation?
- How many solutions can a quadratic equation have?
- Why is a solution to a quadratic equation useful?
- Why is it useful to know various methods for solving a quadratic equation?

Students will be able to...

- Create quadratic equations in one variable and use them to solve problems.
- Create quadratic equations in two or more variables to represent quadratic relationships between quantities and graph equations on coordinate axes with labels and scales.
- Factor a quadratic expression to reveal the zeros of the function it defines.
- Identify and correct errors in a given solution of a quadratic equation.
- Recognize when the quadratic formula gives complex solutions.
- Represent and solve quadratic equations graphically, analyzing the solution sets.
- Solve quadratic equations in one variable by inspection, taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.
- Utilize structure and rewriting as strategies for solving a quadratic equation.

Functions: Building

Students will understand that...

- Changing the way a function is represented does not change the function.
- Quadratic functions can be transformed in order to describe multiple, real-world situations.
- Real world situations can be represented graphcially and symbolically.

Students will know...

- Factored form of a quadratic $f(x) = a(x - p)(x - q)$.
- Standard form of a quadratic equations $f(x) = ax^2 + bx + c$ for some constants a, b, and c where a is not 0
- The Parent Quadratic Function, $\mathbf{y = x^2}$
- Vertex form $f(x) = a(x-h)^2 + k$
- Ways to model quadratic functions (symbolically, graphically, numerically in a table, in words)

Essential Questions

- How can we tell which representation works best for a particular situation?
- How do quadratic relations model real-world problems and their solutions?
- What is the best model for this pattern or situation?
- What is the purpose of putting a quadratic function in vertex form?

Students will be able to...

- Build quadratic functions from existing functions and 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), and find the value of k given the graphs. Experiment with cases using technology.
- Build quadratic functions that model a relationship between two quantities.
- Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
- Create an appropriate graph, given the equation of a transformed quadratic function.
- Easily find the x-intercepts of a graph from an equation in factored form.
- Easily find transformations from an equation in vertex form to create a graph.
- Given a problem with a real-world context involving a quadratic function, determine the steps for calculation of a solution.

Functions: Interpreting

Students will understand that...

- Functions can be represented in multiple ways, including algebraic (symbolic), graphical, verbal and tabular representations. Links among these different representation are important to studying relationships and change.
- Functions written in different but equivalent forms reveal different properties of the function.

Students will know...

- An introduction to recursive patterns that could represent quadratic relationships.
- Key features of a quadratic graph – intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; end behavior; and symmetries.
- Key vocabulary: roots, zeros, maximum, minimum, axis of symmetry, vertex, parabola, focus, directrix, completing the square.
- Multiple representations of quadratic functions: tables, graphs, equations, words
- Procedures and reasoning for factoring and completing the square
- Procedures and reasoning to graph and solve quadratic functions on the graphing calculator – setting up window, finding points of intersection, use of tables, etc.

Essential Questions

- How can I use graphs to describe relationships?
- How can multiple representations be used to express relationships?
- What are the characteristics of a function and how can you use those characteristics to represent the function in multiple ways?
- Where can you find a quadratic function in the real world?

Students will be able to...

- Given a scenario, graph, or table, determine the most appropriate form of a quadratic function.
- Calculate/Estimate and interpret the average rate of change of a quadratic function (presented symbollically or as a table) over a specified interval.
- Compare properties of two quadratic functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- Give a verbal description in context of an equation, table, or graph.
- Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- Relate the domain of a quadratic function to its graph and, where applicable, to the quantitative relationship it describes.
- Use any process for a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
- Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

Grade 9 - Mathematics (Algebra 1)
Descriptive Statistics (2017-18) (14 - 18 Days)
Feb - Feb

Last Updated: 6/12/2017

Overview

How do you interpret data to make informed decisions?
Students will be able to analyze and interpret both quantitative and categorical data.

Students will learn how to represent quantitative data using scatter plots and linear regressions. They will also be able to determine the accuracy of the line of best fit by analyzing residuals. In making decisions, students will be able to determine if there is correlation and/or causation. In addition, students will build upon their previous learning of two-way tables and be able to understand if there is an association among the data.

Standards:

- Standard 3: Data Analysis, Statistics, and Probability
  - GLE 1: Visual displays and summary statistics condense the information in data sets into usable knowledge
    - EO a: Summarize, represent, and interpret data on a single count or measurement variable. (CCSS: S-ID)
    - EO a.ii: Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. (CCSS: S-ID.2)
    - EO a.iii: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). (CCSS: S-ID.3)
    - EO b: Summarize, represent, and interpret data on two categorical and quantitative variables. (CCSS: S-ID)
    - EO b.i: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. (CCSS: S-ID.5)
    - EO b.ii: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. (CCSS: S-ID.6)
    - EO b.ii.1: 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, quadratic, and exponential models in Algebra 1. Emphasize exponential functions with non-integer domains and trig functions in Algebra 2. (CCSS: S-ID.6a)
    - EO b.ii.2: Informally assess the fit of a function by plotting and analyzing residuals. (CCSS: S-ID.6b)
    - EO b.ii.3: Fit a linear function for a scatter plot that suggests a linear association. (CCSS: S-ID.6c)
    - EO c: Interpret linear models. (CCSS: S-ID)
    - EO c.i: Interpret the slope and the intercept of a linear model in the context of the data. (CCSS: S-ID.7)
    - EO c.ii: Using technology, compute and interpret the correlation coefficient of a linear fit. (CCSS: S-ID.8)
    - EO c.iii: Distinguish between correlation and causation. (CCSS: S-ID.9)
- Standard MP: Mathematical Practices
  - GLE 1: Developing mathematical practices are processes and proficiencies necessary to flexibly use skills and concepts in multiple contexts.
    - EO 3: Construct viable arguments and critique the reasoning of others.
    - EO 4: Model with mathematics.

District Unit of Study Updates:

Date	Comments
6/9/2017 6:50:08 PM	Added Unit Overview

Desired Results

Big Ideas:

- Modeling, Relationships, Data Decision Making,

Overarching Understandings:

- Relationships can be described and generalizations made for mathematical situations that have numbers, shapes, symbols, and data that repeat in predictable ways.
- Recognizing patterns and functional relationships helps to comprehend change and make predictions.
- Informed decision making is dependent upon the ability to develop, agree with or refute arguments based on understanding how data is collected, represented, summarized and analyzed.

Overarching Essential Questions:

- How can you describe a pattern?
- How does recognizing patterns and relationships predict and explain change in the world?
- How can data help us answer questions?
- How do you collect, organize and display data in order to make informed decisions?

Organizing Concepts

Interpreting Categorical and Quantitative Data

Students will understand that...

- A variety of statistical methods can be used to describe, compare, and contrast data.
- Data are gathered and displayed to discover patterns and deviations from the pattern.
- Analyzing data provides the opportunity to interpret, predict, and make informed decisions.
- By extending patterns we can make accurate and successful predictions about future trends.
- Functions may be used to describe data.
- Patterns in bivariate data can be seen by displaying frequencies and relative frequencies in two way tables.
- Procedures and reasoning to determine which measure of central tendency shoudl be used to represent the data.
- Standard deviation represents how closely the data are clustered
- The difference between quantitative and categorical data
- The strength and correlation of data can be expressed through a correlation coefficient.

Students will know...

- Residuals – the difference between an observed y-value and its predicted y-value (found on the line of best fit)
- Data distributions: negatively skewed, symmetric , positively skewed
- Key Vocabulary for bivariate data: line of best fit, residual, linear regression, correlation coefficient, causation, frequency
- The difference between correlation and causation.
- Frequency - marginal, joint, relative, and conditional relative
- Two-way tables represent categorical data and scatterplots represent quantitative data.

Essential Questions

- How can the collection, organization, and display of data help to interpret, evaluate inferences, and make predictions about real-life situations and circumstances?
- How can summary statistics or data displays be accurate but misleading?
- Why should attention be paid to an unexpected outcome?
- Why would we use different measures of central tendency?

Students will be able to...

- Construct and interpret scatter plots and two-way frequency tables for bivariate measurement data to investigate patterns of association between two quantities.
- Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- Recognize and explain patterns of association and trends in the data based upon relative frequencies.
- Use functions fitted to data to solve problems in the context of the data.
- Interpret the slope and the intercept of a linear model in the context of the data.
- Informally assess the fit of a function by plotting and analyzing residuals.
- Using technology, compute and interpret the correlation coefficient of a linear fit.
- Use linear regressions to determine a line of best fit for data represented in a scatter plot.

Grade 9 - Mathematics (Algebra 1)
Analyzing Functions (2017-18) (20 - 25 Days)
Mar - Apr

Last Updated: 6/12/2017

Overview

Why are multiple types of functions needed to model real world phenomena?
Students will be able to recognize key features of linear, quadratic, and exponential functions and extend that knowledge to representations of unknown functions.

Students will be able to determine which type of function (linear, quadratic, or exponential) should model a certain situation based upon the characteristics. They will be interpreting the domain, average rate of change over a fixed interval, and identifying the intervals over which a graph is increasing/decreasing/constant. Students will use technology to extend their learning to unfamiliar functions including radical, absolute value, piecewise functions, and nonlinear systems.

Standards:

- Standard 1: Number Sense, Properties, and Operations
  - GLE 2: Quantitative reasoning is used to make sense of quantities and their relationships in problem situations
- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 1: Functions model situations where one quantity determines another and can be represented algebraically, graphically, and using tables
    - EO a: Formulate the concept of a function and use function notation. (CCSS: F-IF)
    - EO a.ii: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (CCSS: F-IF.2)
    - EO b: Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)
    - EO b.i: 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. * (CCSS: F-IF.4)
    - EO b.ii: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.* (CCSS: F-IF.5)
    - EO b.iii: Calculate and interpret the average rate of change of a function over a specified interval. Estimate the rate of change from a graph.* (CCSS: F-IF.6)
    - EO c: Analyze functions using different representations. (CCSS: F-IF)
    - EO c.i: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. * (CCSS: F-IF.7)
    - EO c.vi: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. (CCSS: F-IF.8)
    - EO c.vi.3: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (CCSS: F-IF.9)
  - GLE 2: Quantitative relationships in the real world can be modeled and solved using functions
    - EO a: Construct and compare linear, quadratic, and exponential models and solve problems. (CCSS: F-LE)
    - EO a.i: Distinguish between situations that can be modeled with linear functions and with exponential functions. (CCSS: F-LE.1)
    - EO a.i.1: Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. (CCSS: F-LE.1a)
    - EO a.iii: Use graphs and tables to describe that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. (CCSS: F-LE.3)
    - EO b.i: Interpret the parameters in a linear or exponential function in terms of a context. (CCSS: F-LE.5)
  - GLE 3: Expressions can be represented in multiple, equivalent forms
    - EO d: Understand the relationship between zeros and factors of polynomials. (CCSS: A-APR)
    - EO d.ii: 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. (CCSS: A-APR.3)
  - GLE 4: Solutions to equations, inequalities and systems of equations are found using a variety of tools
    - EO e.i: Explain that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve. (CCSS: A-REI.10)
    - EO e.ii: 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.* (CCSS: A-REI.11)

District Unit of Study Updates:

Date	Comments
6/9/2017 6:50:37 PM	Added Unit Overview

Desired Results

Big Ideas:

- Modeling, Relationships, Change,

Overarching Understandings:

- Effective mathematical reasoning and proof involves making claims about relationships and justifying those claims by relying on the properties that are the structure of mathematics.
- Problem solvers use mathematical models to translate real world situations into representations that can be used to find/defend solutions.
- Recognizing patterns and functional relationships helps to comprehend change and make predictions.

Overarching Essential Questions:

- What is the best way to show my reasoning?
- What is the best way to model a problem?
- How does recognizing patterns and relationships predict and explain change in the world?
- What types of change are involved in this problem?

Organizing Concepts

Functions: Interpreting

Students will understand that...

- Functions can be classified into different families of functions, each with its own unique characteristics. Different families can be used to model different real-world phenomena
- Functions provide a means to describe how related quantities vary together. We can classify, predict, and characterize various kinds of relationships by attending to the rate at which one quantitiy varies with respect to the other.
- Members of a family of functions share the same type of rate of change. This characteristic rate of change determines the kinds of real-world phenomena that the functions in the family can model.
- The exploration of multiple representations of functions develops a deeper understanding of the relationship between the variables of the function.

Essential Questions

- Why are multiple types of functions needed to model real world phenomena?
- Why do some functions require average rates of change to be investigating over a specified interval versus the entire function?
- How can I use graphs to describe relationships?
- How do you analyze a function using tables, graphs, or algebraic formulas?

Students will know...

- Reasoning and procedures for determining the average rate of change over a specified interval.
- Discrete and continuous domains and the difference between them
- Key features of a graph including linear, quadratic, square root, cube root, piecewise-defined (including step and absolute value) and exponential functions with domains in the integers.
- Steps to graph functions using a calculator (including changing window, choosing appropriate window, move between tables and graphs).

Students will be able to...

- 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.)* Functions types should be limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions, absolute value functions) and exponential functions with domains in the integers.
- Calculate and interpret the average rate of change of a function (represented symbolically or as a table) over a specified interval utilizing linear functions, quadratic functions, square root functions, cube root functions, and piece-wise defined (including step functions and absolute value functions), and/or exponential functions with domains in the integers.
- Determine the domain and relate the domain to the quantitative relationship it describes for linear, quadratics,square root, cube root, piecewise, step, absolute value, and exponential functions.
- Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Include linear, quadratic, square root, cube root, piecewise (including step and absolute value) and exponential functions.
- Describe the rate of change from a graph utilizing linear functions, quadratic functions, square root functions, cube root functions, and piecewise-defined (including step functions and absolute value functions), and/or exponential functions with domains in the integers.
- Explain and use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- Give a verbal description in context of an equation, table, or graph.

Linear, Quadratic and Exponential Models

Students will understand that...

- Afunction's rate of change is one of the main characteristics that determines what kind of real-world phenomena the function can model.
- The relationship between variables in a function allows people to use functions to model relationships in the real world such as compound interest, population growth and decay, projectile motion, or payment plans.
- Two important families of functions characterized by laws of growth are linear functions (which grow at a constant rate) and exponential functions (which grow at a constant percent rate).

Students will know...

- Characteristics of exponential functions
- Characteristics of linear functions
- Characteristics of quadratic functions

Essential Questions

- Describe why certain phenomena can be modeled with Linear functions? Quadratic Functions? Exponential Functions?
- How can a table, graph, and function notation be used to explain how one function family is different from and/or similar to another?

Students will be able to...

- Compare properties of two functions represented in multiple ways (algebraically, graphically, numerically in tables, or by verbal descriptions).
- Construct and compare linear, quadratic and exponential models and solve problems.
- Distinguish between situations that can be modeled with linear functions and with exponential functions.
- Find the solutions of where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect, e.g. using technology to graph the functions, make tables of values or find successive approximations.
- Interpret the parameters in a linear, quadratic or exponential function in terms of a context.

Grade 9 - Mathematics (Algebra 1)
Algebraic Reasoning with Geometric Concepts (2017-18) (12 - 15 Days)
May - May

Last Updated: 6/12/2017

Overview

How can we use algebra to help us understand Geometry?
Students will have the opportunity to use their algebraic reasoning to model geometric situations.

Students will apply their algebraic reasoning to model geometric situations. This unit is an opportunity to show mastery in algebra skills that have been learned throughout the year. Students will explore previously learned geometric concepts and problem solve with their algebra skills. They will discuss their reasoning and find ways to communicate precise and viable justifications for their work.

Standards:

- Standard 2: Patterns, Functions, and Algebraic Structures
  - GLE 4: Solutions to equations, inequalities and systems of equations are found using a variety of tools
    - EO a: Create equations that describe numbers or relationships. (CCSS: A-CED)
    - EO a.i: Create equations and inequalities in one variable and use them to solve problems. (CCSS: A-CED.1)
    - EO a.iv: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (CCSS: A-CED.4)
    - EO c: Solve equations and inequalities in one variable. (CCSS: A-REI)
- Standard 4: Shape, Dimension, and Geometric Relationships
  - GLE 1: Objects in the plane can be transformed, and those transformations can be described and analyzed mathematically
    - EO c.i: Prove theorems about lines and angles. (CCSS: G-CO.9)
    - EO c.ii: Prove theorems about triangles. (CCSS: G-CO.10)
  - GLE 3: Objects in the plane can be described and analyzed algebraically
    - EO a: Express Geometric Properties with Equations. (CCSS: G-GPE)
    - EO a.ii.4: Use coordinates and the distance formula to compute perimeters of polygons and areas of triangles and rectangles.* (CCSS: G-GPE.7)
  - GLE 4: Attributes of two- and three-dimensional objects are measurable and can be quantified
    - EO a.ii: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.* (CCSS: G-GMD.3)

District Unit of Study Updates:

Date	Comments
6/9/2017 6:51:03 PM	Added Unit Overview

Desired Results

Big Ideas:

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Overarching Understandings:

Overarching Essential Questions:

Organizing Concepts

Creating and Reasoning with Equations and Inequalities

Students will understand that...

- Equations and inequalities are used to compare values in various situations.
- The nature of equivalence allows equations to be rewritten in different forms.

Students will know...

- Procedures and reasoning for writing and solving application problems including both equations and inequalities (e.g. Types of problems – consecutive number, rate, age, perimeter, area).
- Formulas for area, volume, and Pythagorean Theorem

Essential Questions

Students will be able to...

- Create equations and inequalities in one variable and use them to solve problems. (include variety of situations such as proportional, area, volume, and multistep)

Seeing Structures in Expressions

Students will understand that...

Students will know...

Essential Questions

- How many different ways can you correctly rewrite a formula?

Students will be able to...

- Rearrange formulas to highlight a quantity of interest (literal equations). (Include geometric formulas for area ,volume, and Pythagorean Theorem)

Using the Mathematical Practices

Students will understand that...

- Problem solvers make sense of problems and persevere in solving them.
- The use and development of geometric formulas requires algebraic manipulation to determine values of quantities.

Students will know...

- Formulas for surface area and volume of geometric shapes (cones, cylinders, spheres, pyramids)
- Procedures and reasoning for determining the perimeter, area and volume with polynomial side lengths
- Structured steps for applying geometric formulas – write formula, substitute values for variables, show work, correctly, label units, check if answer is reasonable

Essential Questions

- How do polynomial dimensions affect your reasoning of perimeter, area and volume?
- What reasoning is used when dimensions are given as polynomial expressions?

Students will be able to...

- Solve perimeter, area and volume problems in which side lengths are polynomial expressions.