GRADE 8 MATHEMATICS
ACCELERATED STRAND: ALGEBRA 1

Overview:

Domains	Seeing Structure in Expressions	Arithmetic with Polynomials and Rational Functions	Creating Equations	Reasoning with Equations and Inequalities
Clusters	• Interpret the structure of expressions • Write Expressions in equivalent forms to solve problems	• Perform arithmetic operations on polynomials • Understand the relationship between zeros and factors of polynomials • Use polynomial identities to solve problems • Rewrite rational expressions	• Create equations that describe numbers or relationships	• Understand solving equations as a process of reasoning and explain the reasoning • Solve equations and inequalities in one variable • Solve systems of equations • Represent and solve equations and inequalities graphically
Mathematical Practices	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics.	5. Use appropriate tools strategically. 6. Attend to precision.	7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
Major Thematic Grade 8 Units	**<u>English Language Arts: across the content areas</u>** • Reading • Writing • Speaking & Listening • Language • Figure it Out: Mysteries – What makes us want to read? • Science or Fiction – How do we determine where the line should be drawn between what we consider as fiction and what we explore as science? Does fiction fuel science or does science drive the writing of fiction? • The Road Not Taken: Going Against Conventional Wisdom – Does society always provide us with the best advice? How do we learn what to value and what choices to make? Can literature help us define the greater good?		**<u>Science</u>** • Structure of Matter • Properties of Matter • Basics of Energy • Forms of Energy • Forces and Motion • Simple Machines	**<u>Social Studies</u>** • Indigenous Cultures • Colonial Heritage • Events to the American Revolution • War for Independence • Constitution • New Nation • Age of Andrew Jackson • Regional Development • Industrial Beginnings • Pre-Civil War – Reconstruction

The fundamental purpose of this accelerated 8th Grade course is to formalize and extend the mathematics that students learned through the end of seventh grade. The critical areas, called units, deepen and extend understanding of linear and exponential relationships by contrasting them with each other and by applying linear models to data that exhibit a linear trend, and students engage in methods for analyzing, solving, and using quadratic functions. In addition, the units will introduce methods for analyzing and using quadratic functions, including manipulating expressions for them, and solving quadratic equations. Students understand and apply the Pythagorean theorem, and use quadratic functions to model and solve problems. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations.

This course differs from High School Algebra 1 in that it contains content from 8th grade. While coherence is retained, in that it logically builds from the Accelerated 7th Grade, the additional content when compared to the high school course demands a faster pace for instruction and learning.

Critical Area 1: Work with quantities and rates, including simple linear expressions and equations forms the foundation for this unit. Students use units to represent problems algebraically and graphically, and to guide the solution of problems. Student experience with quantity provides a foundation for the study of expressions, equations, and functions. This unit builds on earlier experiences with equations by asking students to analyze and explain the process of solving an equation. Students develop fluency writing, interpreting, and translating between various forms of linear equations and inequalities, and using them to solve problems. They master the solution of linear equations and apply related solution techniques and the laws of exponents to the creation and solution of simple exponential equations.

Critical Area 2: Building on earlier work with linear relationships, students learn function notation and language for describing characteristics of functions, including the concepts of domain and range. They explore many examples of functions, including sequences; they interpret functions given graphically, numerically, symbolically, and verbally, translate between representations, and understand the limitations of various representations. They work with functions given by graphs and tables, keeping in mind that depending upon the context, these representations are likely to be approximate and incomplete. Their work includes functions that can be described or approximated by formulas as well as those that cannot. When functions describe relationships between quantities arising from a context, students reason with the units in which those quantities are measured. Students explore systems of equations and inequalities, and they find and interpret their solutions. Students build on and informally extend their understanding of integral exponents to consider exponential functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. They interpret arithmetic sequences as linear functions and geometric sequences as exponential functions.

Critical Area 3: Students use regression techniques to describe relationships between quantities. They use graphical representations and knowledge of the context to make judgments about the appropriateness of linear models. With linear models, they look at residuals to analyze the goodness of fit.

Critical Area 4: In this unit, students build on their knowledge from unit 2, where they extended the laws of exponents to rational exponents. Students apply this new understanding of number and strengthen their ability to see structure in and create quadratic and exponential expressions. They create and solve equations, inequalities, and systems of equations involving quadratic expressions.

Critical Area 5: In preparation for work with quadratic relationships students explore distinctions between rational and irrational numbers. They consider quadratic functions, comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from among these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function. Students learn that when quadratic equations do not have real solutions the number system must be extended so that solutions exist, analogous to the way in which extending the whole numbers to the negative numbers allows $x+1 = 0$ to have a solution. Formal work with complex numbers comes in Algebra II. Students expand their experience with functions to include more specialized functions—absolute value, step, and those that are piecewise-defined.

Domain: Expressions and Equations
8.EE
Cluster: Analyze and solve linear equations and pairs of simultaneous linear equations.

8. Analyze and solve pairs of simultaneous linear equations.
   a. Understand that 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.
   - I can graph two linear equations on the same coordinate plane and identify their point of intersection if possible.
   - I can defend that the point of intersection of two lines on the same coordinate plane is a solution for both equations.

   b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. *For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.*
   - I can rewrite an equation from standard form into slope-intercept form.
   - I can solve a system of two linear equations algebraically.
   - I can estimate the solution of a system of linear equations by graphing.

   c. Solve real-world and mathematical problems from a variety of cultural contexts, including those of Montana American Indians, leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.*
   - I can solve real-world mathematical problems from a variety of cultures which involve systems of linear equations.

Domain: Functions
8.F
Cluster: Define, evaluate, and compare functions.

1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.[1]
   ([1]Function notation is not required in Grade 8.)
   - I can define a function as a rule for ordered pairs that shows each input has exactly one output.
   - I can relate input to output in graphical form as ordered pairs.

2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a linear*

function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

- I can create a function table.
- I can graph the contents of a function table.
- I can write a function rule in y = m * x + b form from multiple sources.
- I can compare and analyze two functions represented in different forms.

3. Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.*
   - I can identify the attributes of linear or non-linear functions based on multiple sources.

Cluster: Use functions to model relationships between quantities.

4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
   - I can determine the rate of change and initial value from a table, a graph, an equation, and a verbal model.
   - I can write a function rule (y = m * x + b) from any of the other three representations.

5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.
   - I can write a verbal model of a graph showing a functional relationship.
   - I can produce an approximate graph of a functional relationship from a verbal model.

<u>Domain: Geometry</u>

<u>8.G</u>

Cluster: Understand and apply the Pythagorean Theorem.

6. Explain a proof of the Pythagorean Theorem and its converse.
   - I can explain and prove the Pythagorean Theorem and its converse.

7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. *For example, determine the unknown height of a Plains Indian tipi when given the side length and radius.*
   - I can apply the Pythagorean Theorem to determine unknown side lengths in 2D and 3D real world situations.

8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
   - I can apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Domain: Statistics and Probability
8.SP
Cluster: Investigate patterns of association in bivariate data.

1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
    - I can define and create examples of clustering, outliers, positive or negative association, linear association, and nonlinear association.
    - I can construct and interpret scatter plots to investigate patterns of association.

2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.
    - I can sketch a line of best fit for a graph of bivariate data.(scatter plot)
    - I can construct and interpret scatter plots to investigate patterns of association.
    - I can use the closeness of the data points to the line of best fit to assess the correlation between the predicted values and the actual data.

3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. *For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.*
    - I can interpret the slope and intercept of a line of best fit in the context of the bivariate data set.

4. Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data including data from Montana American Indian sources on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. *For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?*
    - I can construct a two-way frequency table from a variety of cultural contexts, including data from Montana American Indian sources.
    - I can interpret relative frequencies calculated for rows or columns to describe possible associations between the two variables.

Number and Quantity Content Standards

Domain: The Real Number System N-RN
Cluster: Extend the properties of exponents to rational exponents.

1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of

rational exponents. *For example, we define* $5^{1/3}$ *to be the cube root of 5 because we want* $(5^{1/3})^3 = 5^{(1/3)3}$ *to hold, so* $(5^{1/3})^3$ *must equal 5.*

- I can apply the properties of exponent to rational exponents.
- I can explain how rational exponents follow from the properties of integer exponents. (See above)

2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

- I can write radical expressions using rational exponents and vice versa.

Cluster: Use properties of rational and irrational numbers.

3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.
    - I can use the closure property or show by example the sum or product or two rational numbers are rational.
    - I can use the closure property or show by example the sum of a rational and an irrational number is irrational.
    - I can use the closure property or show by example the product or a nonzero rational number and an irrational is irrational.

Domain: Quantities N-Q

Cluster: Reason quantitatively and use units to solve problems.

1. Use units as a way to understand problems from a variety of contexts (e.g., science, history, and culture), including those of Montana American Indians, 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.
    - I can interpret units in the context of the problem.
    - I can use unit analysis to check the reasonableness of my solution.
    - I can choose and interpret an appropriate scale given data to be represented on a graph or display.

2. Define appropriate quantities for the purpose of descriptive modeling.
    - I can determine an appropriate quantity to model a situation.

3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
    - I can choose a level of accuracy appropriate to the measuring tool or situation.

Algebra Content Standards

Domain: Seeing Structure in Expressions A-SSE

Cluster: Interpret the structure of expressions.

1. Interpret expressions that represent a quantity in terms of its context.
    a. Interpret parts of an expression, such as terms, factors, and coefficients.
    - I can interpret expressions that represent a quantity in terms of its context.
    - I can identify the different parts of an expression and explain their meaning within the context of a problem.

    b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.*

- I can interpret expressions and make sense of the multiple factors and terms by explaining the meaning of the individual parts.

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* $(x^2 - y^2)(x^2 + y^2)$*.*
   - I can rewrite algebraic expressions in equivalent forms such as factored or simplified form.
   - I can use factoring techniques such as common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor an expression completely.
   - I can simplify expressions by combining like terms, using the distributive property and using other operations with polynomials.

Cluster: Write expressions in equivalent forms to solve problems.

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
   a. Factor a quadratic expression to reveal the zeros of the function it defines.
   - I can choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
   - I can write expressions in equivalent forms by factoring to find the zeros of a quadratic function and explain the meaning of the zeros.

   b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
   - I can complete the square in a quadratic expression to convey the vertex form and determine the maximum or minimum value of the quadratic function, and to explain the meaning of the vertex.

   c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*
   - I can use properties of exponents (such as power of a power, product of powers, power of a product, power of a quotient) to write an equivalent form of an exponential function to reveal and explain specific information about its approximate rate of growth or decay.

<u>Domain: Arithmetic with Polynomials and Rational Expressions A-APR</u>

Cluster: Perform arithmetic operations on polynomials.

1. Understand 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.
   - I can identify polynomials.
   - I can add, subtract, and multiply polynomials.
   - I can recognize how closure applies under these operations.

<u>Domain: Creating Equations A-CED</u>

Cluster: Create equations that describe numbers or relationships.

1. Create equations and inequalities in one variable and use them to solve problems from a variety of contexts (e.g., science, history, and culture), including those of Montana American Indians. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
   - I can create linear, quadratic, rational and exponential equations and inequalities in one variable and use them in a contextual situation to solve problems.

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
   - I can create equations in two or more variables to represent relationships between quantities.
   - I can graph equations in two variables on a coordinate plane and label the axes and scales.

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. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
   - I can write and use a system of equations and/or inequalities to solve a real world problem.
   - I can use equations and inequalities to represent problem constraints and objectives (linear programming).

4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*
   - I can solve multi-variable formulas or literal equations for a specific variable.

<u>Domain: Reasoning with Equations and Inequalities A-REI</u>

Cluster: Understand solving equations as a process of reasoning and explain reasoning.

1. 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. Construct a viable argument to justify a solution method.
   - I can construct a convincing argument that justifies each step in the solution process assuming an equation has a solution.

Cluster: Solve equations and inequalities in one variable.

1. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
   - I can solve linear equations in one variable, including equations with coefficients represented by letters.
   - I can solve linear inequalities in one variable, including inequalities with coefficients represented by letters.

2. Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)2 = q$ that has the same solutions. Drive the quadratic formula from this form.

- I can solve quadratic equations in one variable.
- I can transform a quadratic equation to an equation in the form $(x – p2 = q$ by completing the square.
- I can drive the quadratic formula by completing the square on a quadratic equation.

b. Solve quadratic equations by inspection (e.g., for $x2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

- I can solve quadratic equations in one variable by simple inspection, taking the square root, factoring, and completing the square.
- I can explain why taking the square root of both sides of an equation can yield two solutions.
- I can use the quadratic formula to solve quadratic equation, recognizing the formula produces all complex solutions and write the solutions in the form $a \pm bi$ where a and b are real numbers.

Cluster: Solve systems of equations.

3. 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.
   - I can produce, with justification, from a system of two equations an equivalent simpler system.

4. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
   - I can solve systems of equations using substitution, linear combination, and graphing.

5. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x2 + y2 = 3$.
   - I can solve a system containing a linear equation and a quadratic equation in two variables algebraically and graphically.

Cluster: Represent and solve equations and inequalities graphically.

10. Understand 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 (which could be a line).
    - I can find any solution to an equation in two variables from the graph of that equation.

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 and exponential.

- I can explain why the intersection of $y = f(x)$ and $y = g(x)$ is the solution of $f(x) = g(x)$ for any combination of linear, polynomial, rational, absolute value, exponential, and logarithmic functions.
- I can use technology to graph the equations and find their points of intersection.
- I can use tables of values or successive approximations to find solutions.

12. 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.
    - I can graph the solutions to a linear inequality in two variables as a half-plane, excluding the boundary for strict inequalities.

Functions Content Standards

Domain: Interpreting Functions F-IF

Cluster: Understand the concept of a function and use function notation.

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
    - I can use the definition of a function to determine whether a relationship is a function given a table, graph or words.
    - I can identify x as an element of the domain and $f(x)$ as an element in the range given the function f.
    - I can identify that the graph of the function f is the graph of the function $y=f(x)$.

2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
    - I can use function notation, $f(x)$, when a relation is determined to be a function.
    - I can evaluate functions for inputs in their domains.
    - I can interpret statements that use function notation in terms of a context in which they are used.

3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
    - I can recognize that arithmetic and geometric sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
    - I can write a recursive formula in function notation for a generated sequence.

Cluster: Interpret functions that arise in applications in terms of the context.

4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★

- I can identify key features in graphs and tables to include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior for a linear, exponential and quadratic function.
- I can sketch the graph of a function given its key features.

5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★
   - I can interpret a graph to determine the appropriate numerical domain being described in the linear, exponential and quadratic functions.

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.★
   - I can calculate and interpret the average rate of change of a function presented symbolically or as a table.
   - I can estimate the average rate of change over a specified interval of a function from its graph.

Cluster: Analyze functions using different representations.

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★
   a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
   - I can graph linear functions showing intercepts.
   - I can graph quadratic functions showing intercepts, a maximum or a minimum.

   b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
   - I can graph square root, cube root and piecewise-defined functions, including step functions and absolute value functions.

   e. Graph exponential showing intercepts.
   - I can graph exponential functions, showing intercepts and end behavior.

8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
   a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
   - I can use the process of factoring and completing the square in a quadratic function to show zeros, a maximum or minimum, and symmetry of the graph, and interpret these in terms of a real-world situation.
   - I can explain different properties of a function that are revealed by writing a function in equivalent forms.

   b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.

- I can use the properties of exponents to interpret exponential functions as growth or decay.
- I can identify the percent rate of change in an exponential function.

9. 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.*
   - I can compare the key features of two linear, exponential, quadratic, absolute value, step and piecewise defined functions that are represented in different ways.

Domain: Building Functions F-BF

Cluster: Build a function that models a relationship between two quantities.

1. Write a function that describes a relationship between two quantities.⋆
   a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
   - I can write an explicit or recursive expression or describe the calculations needed to model a function given a situation.
   - I can write a linear, quadratic or exponential function that describes a relationship between two quantities.

   b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*
   - I can combine function types, such as linear and exponential, using arithmetic operations.

2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations from a variety of contexts (e.g., science, history, and culture, including those of the Montana American Indian), and translate between the two forms.⋆
   - I can make connections between linear functions and arithmetic sequences, and exponential functions and geometric sequences.
   - I can write and translate between the recursive and explicit formula for a arithmetic sequence and use the formulas to model a situation.
   - I can write and translate between the recursive and explicit formula for a geometric sequence and use the formulas to model a situation

Cluster: Build new functions from existing functions.

3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
   - I can experiment to identify, using technology, the transformational effects on the graph of a function $f(x)$ (*linear, exponential, quadratic or absolute value functions*) when $f(x)$ is

replaced by *f(x)+k*, *k·f(x)*, *f(kx)*, and *f(x+k)* for specific values of k, both positive and negative.

- I can find the value of k given the graph of a transformed function.
- I can recognize even and odd functions from their graphs and equations.

4. Find inverse functions.

   a. Solve an equation of the form *f(x) = ax + b* for a simple function f that has an inverse and write an expression for the inverse. *For linear functions only.*

   - I can solve a linear function for the dependent variable and write the inverse of a linear function by interchanging the dependent and independent variables.

<u>Domain: Linear, Quadratic, and Exponential Models F-LE</u>

Cluster: Construct and compare linear, quadratic, and exponential models and solve problems.

1. Distinguish between situations that can be modeled with linear functions and with exponential functions.
   a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
   - I can determine a situation as linear or exponential by examining rates of change between data points.
   - I can show there is a constant difference in a linear function over equal intervals.
   - I can show there is a constant ratio in an exponential function over equal intervals.

   b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
   - I can describe situations where one quantity grows or decays by a constant ratio per unit interval relative to another.

   c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
   - I can describe situations where one quantity changes at a constant rate per unit interval relative to another.

2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
   - I can write a linear or exponential function given an arithmetic or geometric sequence, a graph, a description of the relationship, or two points which can be read from a table.

3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
   - I can use graphs and tables to make the connection that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or any other polynomial function.

Cluster: Interpret expressions for functions in terms of the situation they model.

5. Interpret the parameters in a linear or exponential function in terms of a context.
   - I can explain the meaning of the coefficients, constants, factors, exponents, and intercepts in a linear or exponential function in terms of a context.

Modeling Content Standards

Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions. Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods. When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.

Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards.

Statistics and Probability Content Standards

Domain: Interpreting Categorical and Quantitative Data S-ID

Cluster: Summarize, represent, and interpret data on a single count or measurement variable.

1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
    - I can construct dot plots, histograms and box plots on a real number line.

2. 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.
    - I can describe a distribution using center and spread.
    - I can use the correct measure of center and spread to describe a distribution that is symmetric or skewed.
    - I can compare two or more different data sets using the center and spread of each.

3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
    - I can identify outliers (extreme data points) using IQR and their effects on data sets.
    - I can interpret differences in different data sets in context.
    - I can interpret differences due to possible effects of outliers.

Cluster: Summarize, represent, and interpret data on two categorical and quantitative variables.

5. 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.
    - I can create a two-way table from two categorical variables and read values from a two-way table
    - I can interpret joint, marginal, and relative frequencies in context.
    - I can recognize associations and trends in data from a two-way table.

6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear models. Discuss general principles referring to quadratic, and exponential models.
    - I can create a scatter plot from two quantitative variables.
    - I can describe the form (linear, quadratic or exponential), strength (strong to weak) and
        1. direction (positive or negative) of the relationship.

- I can explain the meaning of slope and y-intercept (linear model) or the meaning of the growth rate and y-intercept (exponential model) or the meaning of the coefficients (quadratic model) in context.
- I can use algebraic methods or technology to fit the data to a linear, exponential or quadratic function.

b. Informally assess the fit of a function by plotting and analyzing residuals.

- I can calculate a residual.
- I can create and analyze a residual plot.

c. Fit a linear function for a scatter plot that suggests a linear association.

- I can use algebraic methods or technology to fit the data to a linear function.
- I can use the function to predict values.

Cluster: Interpret linear models.

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
   - I can explain the meaning of the slope and y-intercept in context.

8. Compute (using technology) and interpret the correlation coefficient of a linear fit.
   - I can use a calculator or computer to find the correlation coefficient for a linear association.
   - I can interpret the meaning of the correlation coefficient in the context of the data.

9. Distinguish between correlation and causation.
   - I can explain the difference between correlation and causation.

Standards	Explanations and Examples
Students are expected to:	**The Standards for Mathematical Practice describe ways in which students ought to engage with the subject matter as they grow in mathematical maturity and expertise.**
8.MP.1. Make sense of problems and persevere in solving them.	In grade 8, students solve real world problems through the application of algebraic and geometric concepts. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check their thinking by asking themselves, “What is the most efficient way to solve the problem?”, “Does this make sense?”, and “Can I solve the problem in a different way?”
8.MP.2. Reason abstractly and quantitatively.	In grade 8, students represent a wide variety of real world contexts through the use of real numbers and variables in mathematical expressions, equations, and inequalities. They examine patterns in data and assess the degree of linearity of functions. Students contextualize to understand the meaning of the number or variable as related to the problem and decontextualize to manipulate symbolic representations by applying properties of operations.
8.MP.3. Construct viable arguments and critique the reasoning of others.	In grade 8, students construct arguments using verbal or written explanations accompanied by expressions, equations, inequalities, models, and graphs, tables, and other data displays (i.e. box plots, dot plots, histograms, etc.). They further refine their mathematical communication skills through mathematical discussions in which they critically evaluate their own thinking and the thinking of other students. They pose questions like “How did you get that?”, “Why is that true?” “Does that always work?” They explain their thinking to others and respond to others’ thinking.
8.MP.4. Model with mathematics.	In grade 8, students model problem situations symbolically, graphically, tabularly, and contextually. Students form expressions, equations, or inequalities from real world contexts and connect symbolic and graphical representations. Students solve systems of linear equations and compare properties of functions provided in different forms. Students use scatterplots to represent data and describe associations between variables. Students need many opportunities to connect and explain the connections between the different representations. They should be able to use all of these representations as appropriate to a problem context.
8.MP.5. Use appropriate tools strategically.	Students consider available tools (including estimation and technology) when solving a mathematical problem and decide when certain tools might be helpful. For instance, students in grade 8 may translate a set of data given in tabular form to a graphical representation to compare it to another data set. Students might draw pictures, use applets, or write equations to show the relationships between the angles created by a transversal.
8.MP.6. Attend to precision.	In grade 8, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to the number system, functions, geometric figures, and data displays.
8.MP.7. Look for and make use of structure.	Students routinely seek patterns or structures to model and solve problems. In grade 8, students apply properties to generate equivalent expressions and solve equations. Students examine patterns in tables and graphs to generate equations and describe relationships. Additionally, students experimentally verify the effects of transformations and describe them in terms of congruence and similarity.
8.MP.8. Look for and express regularity in repeated reasoning.	In grade 8, students use repeated reasoning to understand algorithms and make generalizations about patterns. Students use iterative processes to determine more precise rational approximations for irrational numbers. During multiple opportunities to solve and model problems, they notice that the slope of a line and rate of change are the same value. Students flexibly make connections between covariance, rates, and representations showing the relationships between quantities.

Grade 8 Accelerated Montana Common Core Vocabulary

Standard	Vocabulary	Standard	Vocabulary	Standard	Vocabulary	Standard	Vocabulary	Standard	Vocabulary
S.ID.2	absolute deviation	A.REI.3	equation	8.G.6	leg	8.G.6	Pythagorean Theorem	S.ID.5	two way table
F.IF.7	absolute value	A.CED.4	equivalent equation	A.REI.3	like terms	F.LE.1	quadratic equation	A.CED.3	union
F.IF.7	absolute value equation	A.CED.4	equivalent expression	8.SP.2	line of best fit/trend line	A.CED.1	quadratic formula	F.LE.1	unit rate
F.IF.7	absolute value function	A.REI.5	equivalent inequalities	A.REI.3	linear	F.LE.1	quadratic function	8.SP.4	univariate
A.RIE.3	additive identity	F.LE.1	exponent	8.SP.1	linear association	A.REI.2	radical	A.CED.3	universal set
A.REI.3	additive inverse	A.CED.1	exponential	A.CED.1	linear equation	A.REI.2	radical expression	A.CED.1	variable
F.LE.2	arithmetic sequence	F.IF.8	exponential decay	A.CED.2	linear function	A.REI.2	radical function	F.LE.1	vertex
F.IF.7	axis of symmetry	F.LE.1	exponential function	A.CED.1	linear inequality	A.REI.2	radical symbol	F.LE.1	vertex form of a quadratic equation
A.CED.1	base	F.IF.8	exponential growth	F.IF.7	linear model	F.IF.1	range	F.LE.3	vertical motion model
A.REI.4	binomial	A.SSE.1	expression	F.IF.8	linear regression	F.IF.6	rate	A.REI.1	x and y intercepts
8.SP. 4	bivariate	A.REI.2	extraneous solution	F.IF.7	linear representation	F.IF.6	rate of change	A.SSE.3	zero exponent
S.ID.1	box and whisker plot	F.BF.1	extrapolation	A.CED.4	literal equation	F.IF.6	ratio	A.SSE.3	zeros of a function
S.ID.9	causation	S.ID.3	extreme value	A.SSE.3	maximum value/maxima	N.RN.1	rational equation		
A.REI.2	closed system	A.SSE.1	factor	S.ID.3	measures of central tendency	N.RN.1	rational number		
8.SP.1	clustering	A.SSE.3	factor completely	A.SSE.3	minimum value/minima	N.RN.3	real number		
A.SSE.1	coefficient	A.REI.4	factoring	A.APR.1	monomial	A.REI.3	reciprocal		
A.REI.4	completing the square	F.IF.8	family of function	A.REI.3	multiplicative identity	F.BF.1	recursive		
A.CED.3	compound inequality	S.ID.5	frequency	A.REI.3	multiplicative inverse	A.CED.1	relation		
A.REI.4	compound interest	A.CED.1	function	8.SP.1	negative association/correlation	A.REI.2	restricted domain		
A.REI.3	consistent dependent system	A.REI.1	function notation	A.SSE.3	negative exponent	A.SSE.3	roots		
A.REI.3	consistent independent system	F.LE.2	geometric sequence	8.SP.1	no correlation	F.IF.7	scale		
F.IF.6	constant of variation	A.CED.2	graph ordered pairs	8.SP.1	nonlinear	8.SP.1	scatter plot		
A.REI.3	constant term	F.IF.8	growth factor	8.SP.1	nonlinear association	A.CED.3	set		
A.CED.3	constraints	F.IF.8	growth rate	F.IF.8	order of mag	F.IF.6	slope		
8.G.6	converse	S.ID.1	histogram	A.CED.2	ordered pair	F.IF.7	slope-intercept form		
A.CED.2	coordinate plane	8.G.6	hypotenuse	F.IF.7	origin	A.REI.3	solution		
S.ID.9	correlation	A.REI.5	identity	8.F.1	output	A.REI.5	solution to a system		
S.ID.8	correlation coefficient	A.REI.3	inconsistent system	8.SP.1	outlier	A.REI.5	solution to inequality		
N.RN.1	cube root	8.F.1	independent variable	F.IF.7	parabola	N.RN.1	square root		
A.REI.4	decay factor	A.CED.1	inequality	F.IF.8	parent function	A.REI.2	square root function		
A.APR.1	degree of polynomial	8.F.1	input	F.IF.8	parent quadratic function	S.ID.2	standard deviation		
8.F.1	dependent variable	N.RN.1	integer	N.RN.1	perfect square	A.REI.10	standard form		
A.CED.1	direct variation	N.RN.1	integer exponent	A.SSE.3	perfect square trinomial	F.LE.1	standard form of a quadratic function		
A.REI.4	discriminant	F.BF.1	interpolation	F.IF.4	periodicity	F.IF.7	step function		

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A.REI.3	distributive property	S.ID.2	interquartile range	F.IF.7	piecewise function	8.SP.1	strong correlation		
F.IF.1	domain	8.EE.8	intersection	F.IF.7	point slope form	F.IF.4	symmetry		
S.ID.1	dot plot	F.BF.4	inverse function	A.APR.1	polynomials	A.REI.12	system of linear inequalities		
A.CED.3	element	A.REI.3	inverse operations	8.SP.1	positive association/correlation	8.EE.8	system of linear equations		
A.CED.3	empty set	N.RN.1	irrational number	F.LE.1	power	A.REI.3	term		
F.LE.1	equal intervals	A.SSE.2	leading coefficient	F.IF.8	properties of exponents	A.APR.1	trinomial		