



Standards: Grade 6

Introduction

In sixth through eighth grade, the major work of each grade focuses on applying and using operations with rational numbers, understanding ratio concepts and applying proportional reasoning, and simplifying expressions and solving equations.

In sixth grade, instructional time should focus on four major works: (1) connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems; (2) completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers; (3) writing, interpreting, and using expressions and equations; and (4) interpreting data to answer investigative questions.

Essential Competencies

Essential competencies have been identified at each grade level to represent foundational understandings that students need to succeed as they continue in future grade levels. This list is not exhaustive; students will engage with all grade-level standards. Educators may prioritize instructional time and, as needed, provide interventions based on the standards that support these competencies to ensure students are proficient. Through engagement with the skills and knowledge embedded within the *Utah Core Mathematics Standards*, by the end of sixth grade, students will be able to:

- Apply previous understanding of arithmetic to generate equivalent algebraic expressions. (A)
- Reason with and solve one-variable equations and inequalities and analyze

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the relationship between two quantities in a real-world context. (A)

- Fluently add, subtract, multiply, and divide with rational numbers. (Computational and procedural fluency) (NS)
- Define, identify, and explain the meaning of integers on number lines, coordinate grids, and in real-world context. (NS)
- Understand rate and ratio relationships. (RP)
- Build and use models to represent real-world ratio relationships and solve ratio/rate problems. (RP)
- Solve real-world and mathematical problems involving area, surface area, and volume. (G)
- Answer investigative questions about distributions, considering the interpretation of the following features: center, variability, overall shape, and deviations. (D)

Standards: Grade 6

More details about the standards, including relevant vocabulary, representations that support student learning, pre-requisite skills, and how the skills are integrated, can be found in the [Utah Mathematics Core Guides](#).

(Utah Mathematics Core Guides will be updated after these standards are approved by the Utah State Board of Education)

Algebra (A)

Build on previous learning in Operations and Algebraic Thinking to reason with and solve one-variable equations and inequalities.

6.A.1

Write and evaluate numerical expressions involving whole numbers *exponents*. Attend to order of operations when evaluating numerical expressions. (MP 7)

6.A.2

Write, read, and evaluate algebraic expressions, and *describe* how the *structure* of an expression represents relationships. (MP 7, 8)

6.A.3

Use *properties of operations* and arithmetic to generate equivalent expressions and *justify* why two expressions are equivalent. (MP 3, 5)

6.A.4

Use substitution to *reason* about whether a given number in a specified set makes an equation or inequality true. Provide *justification* to support that reasoning. (MP 3, 8)

6.A.5

Describe, represent and solve real-world and mathematical problems using variables within the *structure* of one-step equations and inequalities. (MP 7)

6.A.6

Create equations to *model* relationships between two quantities using variables, both *in and out of context*. (MP 2, 4)

Number Systems (NS)

Build on previous work involving operations to compute fluently with multi-digit numbers, decimal and fractions. Understand that there is a set of numbers called integers and create models to show and describe integers and their relationships.

6.NS.1

Build and use visual fraction models to make sense of and solve problems dividing fractions by fractions. *Add and remove context with* problems involving division of fractions by fractions and interpret the quotients. (MP 2, 4)

6.NS.2

Use *place value relationships and properties of operations to represent* and apply an algorithm to divide multi-digit decimals *fluently*. Limit division to a whole number dividend with a decimal divisor or a decimal dividend with a whole number divisor.

Determine and *justify* situations where estimation is appropriate. (MP 3, 6, 7)

6.NS.3

Fluently add, subtract, multiply, and divide multi-digit whole numbers and decimals. Use estimation to check the reasonableness of solutions. (MP 6)

6.NS.4

Find the greatest common factor between two whole numbers 1 to 100 and the least common multiples of two whole numbers 1 to 12 by making use of *structures and patterns*. Relate greatest common factors to the distributive property. (e.g., re-express $36 + 8$ as $4(9 + 2)$). (MP 7)

6.NS.5

Use positive and negative numbers together to represent quantities in *real world contexts*, explain the meaning of zero in *context*. *Communicate* understanding that positive and negative numbers are used together to describe quantities having opposite directions or values. (MP 2, 3)

6.NS.6

Build and use models to show positive and negative numbers on a number line and coordinate plane. Use models to order positive and negative numbers. (MP 4)

6.NS.7

Build and use number line models and real-world contexts to define absolute value as a number's distance from zero. Compare and interpret absolute value *in and out of context*. (MP 2, 4)

Ratio and Proportional Relationships (RP)

Understand ratio concepts and use ratio reasoning to solve problems.

6.RP.1

Describe the *ratio relationship* between two quantities using *ratio language* in real-world and mathematical situations; flexibly move between *ratio notation* ($a:b$, a to b ,

a/b) and ratio language (for every a items, there are b items; there are a units of x per b units of y). (MP7)

6.RP.2

Explain and *represent* unit rates associated with ratio relationships. (MP 7)

6.RP.3

Build and use models including tables, double number lines, and/or tape diagrams to represent and reason *about* real-world ratio relationships with whole number quantities. (MP 4)

6.RP.4

Solve real-world problems involving ratios and rates *using tables, double number lines, tape diagrams, or other appropriate representations*. (MP 5)

6.RP.5

Use ratio reasoning *as a tool* to convert measurement units when given a unit conversion chart. (MP 5)

Geometry (G)

Solve real-world and mathematical problems involving area, surface area, and volume. Draw polygons on the coordinate plane.

6.G.1

Find the area of right triangles, other triangles, special quadrilaterals, and polygons by *composing and decomposing into rectangles, triangles and/or other shapes*. (MP 7)

6.G.2

Build and use nets to represent 3-dimensional figures composed of rectangles and triangles. *Use nets as tools* to find the surface area of the figure. (MP 4, 5)

6.G.3

Select and use tools appropriately to solve *real-world and decontextualized*

mathematical problems involving surface area and volume of right rectangular prisms with fractional edge lengths. (MP 2, 5)

6.G.4

Construct polygons on the coordinate plane given coordinates for the vertices. Use coordinates to find the length of a side joining points with the same x coordinate or the same y coordinate. Apply these techniques to *solve problems with and without real-world context*. (MP 2)

Data Science (D)

Investigate and analyze situations with large data sets. Describe and represent structures and patterns of statistical variability of data. Interpret data to answer investigative questions about distributions, considering the interpretation of the following features of distributions: center, variability, overall shape, and deviations. Identify ways to refine investigative questions, data collection, visualization, or analysis.

6.D.1

Formulate statistical questions that anticipate variability in data and how the data may impact the statistical question. (MP 1)

6.D.2

Select and use tools appropriately and strategically to generate, collect, and organize data. *Ask questions* about how the data were collected and whether the data are useful to answer the statistical question of interest. (MP 1, 5)

6.D.3

Create *precise and reasonable* visual representations, including histograms, dot plots, and box plots. *Justify* which graph or plot best represents the data. Analyze and interpret visual representations and numerical summaries for measures of center and measures of variability. (MP 3, 6)

6.D.4

Use features of distributions, including center, variability, shape, and outliers, to

answer statistical questions, justify conclusions, and identify ways to refine the statistical questions, data collection, visualization, or analysis. (MP 3)

Mathematical Practices

Mathematical Practice 1: Ask and answer questions to build mathematical knowledge

In grades 6-8, students formulate questions to explore mathematical ideas involving real-world problems that use rate, ratio, and percents; in the context of data analysis, students interpret quantitative bivariate data to answer investigative questions, asking questions about patterns, associations, and potential outliers within the data.

Mathematical Practice 2: Add or remove context to make sense of mathematics

In grades 6-8, students understand what the numbers, symbols, pictures, words, etc. in their work represent when working with algebraic equations and expressions. Students flexibly move between concrete, pictorial, and abstract representations of mathematical ideas like linear functions. They move back and forth between a problem's context and its representation to use the form that best fits the situation.

Mathematical Practice 3: Construct, justify, and communicate clear and reasonable arguments

In grades 6-8, students construct, justify, and communicate arguments in various mathematical contexts such as: solving problems involving ratios and rates and explaining their thinking about proportional relationships, to justify and explain the logical steps needed to solve multi-step equations and inequalities, and to communicate informal arguments to establish angle relationships for parallel lines cut by a transversal and angle relationships for triangles.

Mathematical Practice 4: Model with mathematics

In grades 6-8, students build visual models of fractions to extend their understanding of multiplication and division. They build a variety of models to extend their understanding of proportional relationships and linear functions.

Mathematical Practice 5: Select and use tools appropriately and strategically

In grades 6-8, students focus on building foundational skills through the diverse use of mathematical tools. Students use algebraic tools to generate equivalent expressions and solve multi-step equations involving positive and negative numbers. For geometry, students engage with geometric concepts by using both classical tools like a straight edge and compass and dynamic geometry software to explore, construct, and analyze shapes. Students use computer based tools to explore data, utilizing graphical displays and numerical summaries as statistical tools to analyze and interpret data.

Mathematical Practice 6: Attend to precision and reasonableness

In grades 6-8, students attend to mathematical precision and reasonableness in their communication, calculations and processes. They calculate flexibly, accurately, and efficiently, using clear and concise notation to record their work. Students apply this skill when adding, subtracting, multiplying and dividing multi-digit whole numbers and decimals. Students attend to the reasonableness of solutions when solving multi-step, real world problems using positive and negative rational numbers, and when finding rational approximations of irrational numbers.

Mathematical Practice 7: Describe and represent structures, patterns, and relationships

In grades 6-8, students describe and represent their mathematical understanding of structures, pattern and relationships to extend their understanding of multiplication and division in order to divide fractions by fractions; to develop and apply properties of integer exponents to generate equivalent numerical expressions and to use the structure of similar triangles to explain why the slope of a non-vertical line is constant between any two points on the coordinate plane.

Mathematical Practice 8: Use mathematical regularity to make conjectures and evaluate the results

In grades 6-8, students develop and assess conjectures related to proportional relationships and apply the concepts of unit rate and percent. They also develop and assess conjectures about the properties of irrational numbers by comparing them to the set of rational numbers, and make conjectures about dilations and congruency of geometric figures.

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Standards: Grade 7

Introduction

In sixth through eighth grade, the major work of each grade focuses on applying and using operations with rational numbers, understanding ratio concepts and applying proportional reasoning, and simplifying expressions and solving equations.

In seventh grade, instructional time should focus on four major works: (1) developing understanding of and applying proportional relationships; (2) developing understanding of operations with rational numbers and working with expressions and linear equations; (3) solving problems involving scale drawings and informal geometric constructions, and working with two- and three-dimensional shapes to solve problems involving area, surface area, and volume; and (4) drawing inferences about populations based on samples.

Essential Competencies

Essential competencies have been identified at each grade level to represent foundational understandings that students need to succeed as they continue in future grade levels. This list is not exhaustive; students will engage with all grade-level standards. Educators may prioritize instructional time and, as needed, provide interventions based on the standards that support these competencies to ensure students are proficient. Through engagement with the skills and knowledge embedded within the *Utah Core Mathematics Standards*, by the end of seventh grade, students will be able to:

- Use properties of operations to generate equivalent expressions and solve real-world problems using algebraic equations and inequalities. (A)
- Add, subtract, multiply, and divide rational numbers including negative and positive numbers to solve problems with and without context. (NS)
- Flexibly use various representations of fractions, percents, and decimals. (NS)
- Recognize proportional relationships with and without context. Use patterns

in proportional relationships to reason about and solve problems. (RP)

- Understand the meaning of percent connected to ratios, and solve percent problems. (RP)
- Find the perimeter and area of triangles, quadrilaterals, and polygons. Find the surface area and volume of right rectangular prisms. Find the area and circumference of a circle. (G)
- Solve for unknown angles measures using angle relationships (G)
- Make inferences about populations based on samples, supported by measures of center and measures of variability. (D)
- Investigate chance processes and develop, use, and evaluate probability models. (D)

Standards: Grade 7

More details about the standards, including relevant vocabulary, representations that support student learning, pre-requisite skills, and how the skills are integrated, can be found in the [Utah Mathematics Core Guides](#).

(Utah Mathematics Core Guides will be updated after these standards are approved by the Utah State Board of Education)

Algebra (A)

Use properties of operations to generate equivalent expressions. Represent and solve mathematical problems using algebraic expressions and equations.

7.A.1

Apply properties of operations as *tools* to add, subtract, factor and expand linear expressions with rational coefficients in different forms. (MP 5)

7.A.2

Use algebraic tools to solve equations and inequalities representing real-world problems of the form $px+q=r$ and $p(x+q)=r$ using positive and negative rational

numbers. *Attend to the reasonableness* of the solutions. (MP 5, 6)

7.A.3

Given a context, construct equations and inequalities to *model* real-world problems of the form $px+q=r$ and $p(x+q)=r$ using positive and negative rational numbers. (MP 4)

7.A.4

Build and use models including tables, graphs, and equations to represent the relationship between the independent and dependent variables; and explain how changes in one variable relates to changes in the other variable. (MP 4)

The Number System (NS)

Build upon understanding of fractions and decimals to define the set of rational numbers. Apply understanding of rational numbers and operations to solve problems.

7.NS.1

Explain what makes a number rational and how rational numbers, in their various forms (fraction, decimal and percent), connect with the *whole and integer number systems*. *Fluently* convert between forms and *explain* how the representations are equivalent. (MP 6, 7)

7.NS.2

Build and use models including a horizontal or vertical number line diagram to extend previous understanding of addition and subtraction to add and subtract rational numbers *in and out of context* including signed decimals and fractions. (MP 2, 4)

7.NS.3

Build and use models, such as area models, tape diagrams, number lines, and chip models, to multiply and divide rational numbers in *mathematical and real-world contexts*. (MP 2, 4)

7.NS.4

Fluently add, subtract, multiply and divide rational numbers including signed decimals and fractions *in mathematical and real world context*. Use estimation to check the *reasonableness* of solutions. (MP 5, 6)

Ratio and Proportional Relationships (RP)

Use ratio and rate understanding to develop, recognize, and model proportional relationships. Use patterns in these relationships to reason about and solve real-world problems. Apply proportional reasoning to understand and solve percent problems.

7.RP.1

Calculate unit rates associated with ratios of fractions, including lengths, areas and other quantities. Use unit rate as a tool to *make and evaluate conjectures* about proportional relationships (MP 8)

7.RP.2

Explain that a percent of a quantity is a rate per 100. Describe and *represent structures and patterns* that connect percent to ratio. (MP 7)

7.RP.3

Build and use models including tables, graphs, double number lines, or tape diagrams to find a percent of a quantity as a rate per 100. Solve problems involving finding the whole, the part, or the percent. (MP 4)

7.RP.4

Recognize *structures and patterns* when analyzing real world contexts to determine whether two quantities have a proportional relationship. Use tables, graphs, equations, diagrams and verbal descriptions to justify whether a relationship is proportional. (MP 3, 7)

7.RP.5

Build and use models (tables, graphs, equations, diagrams and verbal descriptions)

to represent proportional relationships and identify and interpret the constant of proportionality. (MP 4)

7.RP.6

Use proportional relationships *as a tool* to solve multi-step and percent problems such as simple interest, tax, markups and markdowns, gratuities and commissions, fees, and percent increase and decrease. (MP 5)

7.RP.7

Interpret the meaning of a point (x,y) on the graph of a proportional relationship in a given context. *Interpret and explain the relationship* between the points $(0, 0)$ and $(1, r)$ where r is the unit rate. (MP 4, 7)

Geometry (G)

Draw, construct, and describe geometrical figures from given criteria. Use and connect 2D and 3D geometrical figures to real-life situations and use them to solve real-world and mathematical problems.

7.G.1

Select and use tools such as a compass, straightedge, dynamic geometry software to draw and accurately describe scaled drawings. *Use* scale drawings to determine and *explain scale factors* and to solve real world and mathematical problems. (MP 5, 7)

7.G.2

Select and use tools appropriately and strategically to create triangles from given conditions to determine whether a unique triangle, more than one triangle, or no triangle can be formed. (MP 5)

7.G.3

Fluently solve real-world and mathematical problems involving perimeter and area of circles, triangles, quadrilaterals and polygons as well as surface area of right prisms. (MP 2, 6)

7.G.4

Describe and use the relationship between the area of a base of a right-prism and its volume to solve real world and mathematical problems. (MP 7)

7.G.5

Describe and represent structures, patterns, and relationships related to supplementary, complementary, vertical, and adjacent angles to solve for unknown angle measures in a figure. (MP 7)

Data Science (D)

Investigate and analyze situations with large data sets. Make inferences about populations based on samples. Draw informal comparative inferences about two populations. Investigate chance processes and develop, use, and evaluate probability models. Identify ways to refine investigative questions, data collection, visualization, or analysis.

7.D.1

Formulate statistical questions that anticipate variability in data collected from a random sample of a population. (MP 1)

7.D.2

Select and use technological tools to generate, collect, and organize randomly sampled data that is representative of a population. *Explain* why random sampling is more likely to produce representative samples and *support valid inferences*. (MP 3, 5)

7.D.3

Create *precise and reasonable* visual representations, including histograms (with technology), dot plots, and box plots. Analyze and interpret visual representations and numerical summaries for measures of center (mean and/or median) and measures of variability (mean absolute deviation and/or inter-quartile range). (MP 6)

7.D.4

Construct, justify, and communicate answers to questions about a population and comparisons about two different populations. Compare features such as center (mean and median), variability (mean absolute deviation and inter-quartile range) and overall shape (symmetric or nonsymmetric). (MP 3)

7.D.5

Communicate clear understanding that the probability of a chance event is the likelihood of an event occurring and is expressed as a number between 0 and 1. (MP 6)

7.D.6

Estimate the probability of a chance event by analyzing outcomes from repeated trials. Given the probability, *predict* the approximate relative frequency of an event and evaluate whether observed results are *reasonable*. (MP 6, 8)

7.D.7

Build and use probability models such as organized lists, tables, tree diagrams, and simulations to find or estimate probabilities of simple and compound events. (MP 4)

7.D.8

Build a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies. If the agreement is not good, explain possible sources for discrepancy. (e.g., find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the simulation appear to be equally likely based on the observed frequencies?) (MP 4)

Mathematical Practices

Mathematical Practice 1: Ask and answer questions to build mathematical knowledge

In grades 6-8, students formulate questions to explore mathematical ideas involving real-world problems that use rate, ratio, and percents; in the context of data analysis, students interpret quantitative bivariate data to answer investigative

questions, asking questions about patterns, associations, and potential outliers within the data.

Mathematical Practice 2: Add or remove context to make sense of mathematics

In grades 6-8, students understand what the numbers, symbols, pictures, words, etc. in their work represent when working with algebraic equations and expressions. Students flexibly move between concrete, pictorial, and abstract representations of mathematical ideas like linear functions. They move back and forth between a problem's context and its representation to use the form that best fits the situation.

Mathematical Practice 3: Construct, justify, and communicate clear and reasonable arguments

In grades 6-8, students construct, justify, and communicate arguments in various mathematical contexts such as: solving problems involving ratios and rates and explaining their thinking about proportional relationships, to justify and explain the logical steps needed to solve multi-step equations and inequalities, and to communicate informal arguments to establish angle relationships for parallel lines cut by a transversal and angle relationships for triangles.

Mathematical Practice 4: Model with mathematics

In grades 6-8, students build visual models of fractions to extend their understanding of multiplication and division. They build a variety of models to extend their understanding of proportional relationships and linear functions.

Mathematical Practice 5: Select and use tools appropriately and strategically

In grades 6-8, students focus on building foundational skills through the diverse use of mathematical tools. Students use algebraic tools to generate equivalent expressions and solve multi-step equations involving positive and negative numbers. For geometry, students engage with geometric concepts by using both classical tools like a straight edge and compass and dynamic geometry software to

explore, construct, and analyze shapes. Students use computer based tools to explore data, utilizing graphical displays and numerical summaries as statistical tools to analyze and interpret data.

Mathematical Practice 6: Attend to precision and reasonableness

In grades 6-8, students attend to mathematical precision and reasonableness in their communication, calculations and processes. They calculate flexibly, accurately, and efficiently, using clear and concise notation to record their work. Students apply this skill when adding, subtracting, multiplying and dividing multi-digit whole numbers and decimals. Students attend to the reasonableness of solutions when solving multi-step, real world problems using positive and negative rational numbers, and when finding rational approximations of irrational numbers.

Mathematical Practice 7: Describe and represent structures, patterns, and relationships

In grades 6-8, students describe and represent their mathematical understanding of structures, pattern and relationships to extend their understanding of multiplication and division in order to divide fractions by fractions; to develop and apply properties of integer exponents to generate equivalent numerical expressions and to use the structure of similar triangles to explain why the slope of a non-vertical line is constant between any two points on the coordinate plane.

Mathematical Practice 8: Use mathematical regularity to make conjectures and evaluate the results

In grades 6-8, students develop and assess conjectures related to proportional relationships and apply the concepts of unit rate and percent. They also develop and assess conjectures about the properties of irrational numbers by comparing them to the set of rational numbers, and make conjectures about dilations and congruency of geometric figures.

Standards: Grade 8

Introduction

In sixth through eighth grade, the major work of each grade focuses on applying and using operations with rational numbers, understanding ratio concepts and applying proportional reasoning, and simplifying expressions and solving equations.

In eighth grade, instructional time should focus on three major works: (1) formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations; (2) grasping the concept of a function and using functions to describe quantitative relationships; (3) analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

Essential Competencies

Essential competencies have been identified at each grade level to represent foundational understandings that students need to succeed as they continue in future grade levels. This list is not exhaustive; students will engage with all grade-level standards. Educators may prioritize instructional time and, as needed, provide interventions based on the standards that support these competencies to ensure students are proficient. Through engagement with the skills and knowledge embedded within the *Utah Core Mathematics Standards*, by the end of eighth grade, students will be able to:

- Work with integer exponents and radicals. (A)
- Analyze and solve linear equations and inequalities. (A)
- Analyze graphs to solve systems of two linear equations in two variables and interpret their solutions. (A)
- Extend understanding of the number line to include rational and an approximation of irrational numbers. (NS)

- Use linear functions to model relationships between two variables. (F)
- Describe key features of linear relationships and compare the properties of linear and nonlinear functions. (F)
- Understand and describe both congruence and similarity in terms of transformations. (G)
- Explore and verify angle relationships connected to parallel lines cut by a transversal. (G)
- Understand and use the Pythagorean Theorem. (G)
- Interpret data to answer investigative questions about quantitative bivariate data. (D)

Standards: Grade 8

More details about the standards, including relevant vocabulary, representations that support student learning, pre-requisite skills, and how the skills are integrated, can be found in the [Utah Mathematics Core Guides](#).

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Algebra (A)

Build on prior understanding of expressions and equations to include work with integer exponents and radicals. Through the use of multiple representations, make connections between linear relationships and solve single-variable equations and inequalities.

8.A.1

Use structure and patterns to develop and apply the properties of integer exponents to generate equivalent expressions. (MP 7)

8.A.2

Use operations to simplify and evaluate algebraic expressions, including those

involving rational coefficients, exponents, and polynomial terms. Justify the equivalence of expressions *using the properties of operations*. (MP 7)

8.A.3

Use algebraic tools strategically to represent solutions to equations in the form $x^2 = p$ and $x^3 = p$. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. (MP 5)

8.A.4

Represent the structure and patterns of numbers expressed in scientific notation to estimate very large or very small quantities, and express how many times as much one is than the other. (MP 7)

8.A.5

Apply structures, properties and patterns of exponents to perform all four operations with scientific notation. Interpret scientific notation in terms of a context. (MP 2, 7)

8.A.6

Represent patterns by graphing proportional relationships and interpret the unit rate as the slope of the graph. *Use the structure* of similar triangles to explain why the slope is the same between any two distinct points on a non-vertical line in the coordinate plane. (MP 7)

8.A.7

Represent and compare linear relationships using graphs, tables, and equations *with or without context*. Interpret slope and intercepts in *context*. (MP 2, 4)

8.A.8

Solve symbolic and real-world single-variable equations and inequalities with rational number coefficients and *justify solution steps using the properties of operations and equality*. (MP 7).

8.A.9

Build and use graphic models to analyze and solve systems of two linear equations in

two variables and interpret their solutions. *Analyze the underlying structure* of the system including slopes, y-intercepts, context or graphs, to classify whether it has one, zero, or infinitely many solutions and justify why. (MP 4, 7)

The Number System (NS)

Understand that there is a set of numbers which are not rational, called irrational numbers. Create models to show and describe irrational numbers and their relationships to rational numbers.

8.NS.1

Compare patterns in the decimal expansions of rational and irrational numbers to describe the defining characteristics of an irrational number. Classify numbers as rational or irrational. (MP7)

8.NS.2

Find rational approximations of irrational numbers, *attending to precision and reasonableness*. Use a number line diagram as a *model* to compare values of irrational numbers. (MP 4, 6)

8.NS.3

Evaluate expressions containing irrational numbers, expressing exact values in radical form and estimating approximate values using decimals, *with and without context*. (MP 2)

8.NS.4

Justify closure properties for addition and multiplication of rational and irrational numbers. (MP 3)

Functions (F)

Describe functions and their features. Use functions to model relationships between two variables.

8.F.1

Determine whether a relation is a function, and *construct and communicate a clear argument* that justifies this determination. (MP 3)

8.F.2

Given a *representation* (verbal description, table, two coordinate pairs, or an equation of $y=mx+b$), determine and interpret the rate of change and the initial value *in and out of context*. (MP 2, 4)

8.F.3

Construct a function *to model* a linear relationship between two quantities when given a verbal description, a table, and a graph. (MP 4)

8.F.4

Given a graph of two quantities (linear and non-linear), *describe and represent* features of the relationship, including intervals where the function is increasing or decreasing, the location of its maximum and minimum values. *Build graphic models* that satisfy given qualitative features. (MP 4, 7)

8.F.5

Use multiple representations (tables, graphs, equations, diagrams and verbal descriptions) to compare the properties of linear and nonlinear functions with and without a context. *Justify* whether a function is linear or non-linear. (MP 3)

Geometry (G)

Understand and describe both congruence and similarity in terms of transformations. Explore and verify angle relationships connected to parallel lines cut by a transversal. Understand and use the Pythagorean Theorem.

8.G.1

Define and justify congruence of figures using rigid transformations (rotations, reflections, and translations), with and without coordinates. *Explain* how transformations affect position, orientation, angle measures and side lengths. (MP 3, 8)

8.G.2

Define and justify similarity of figures using dilations and rigid transformations with and without coordinates. *Explain* how dilations affect side lengths and angle measures. (MP 3, 8)

8.G.3

Use established definitions and properties to justify and clearly communicate the distinction between congruence and similarity in terms of transformations. (MP 3, 7)

8.G.4

Create and communicate informal arguments that establish angle relationships for parallel lines cut by a transversal and angle relationships for triangles, including the angle sum and exterior angle. (MP 3)

8.G.5

Use the Pythagorean Theorem when solving problems with right triangles and finding distance between two coordinate points. *Use geometric structures* (such as area dissections) and *numerical patterns* (such as Pythagorean triples) to analyze proofs of the Pythagorean Theorem. (MP 7)

8.G.6

Solve real-world and mathematical problems *with or without a context* involving right triangles, distance, and volume of cones, cylinders, and spheres. (MP 2)

Data Science (D)

Investigate and analyze situations with large data sets. Investigate patterns of association in bivariate data. Identify ways to refine investigative questions, data collection, visualization, or analysis.

8.D.1

Formulate statistical questions about bivariate data sets (quantitative and categorical) that can be used to investigate patterns of association between two

quantities. (MP 1)

8.D.2

Select and use appropriate technological tools to identify existing data sets or generate, collect, and organize data to investigate associations between two quantities. (MP 5)

8.D.3

Use scatterplots to describe and compare variability in bivariate data for quantitative variables. For scatterplots that suggest a linear association, *represent the relationship* with a linear equation, and informally assess the line of fit by judging the closeness of the data points to the line. (MP 7)

8.D.4

Describe, represent and explain patterns of association such as clustering, positive or negative association, linear or nonlinear association and effects of outliers. (MP 7)

8.D.5

Answer statistical questions by interpreting quantitative bivariate data. *Construct, justify, and communicate clear and reasonable arguments regarding the data. Use the equation of a linear model* to solve problems in the context of bivariate measurement data, including interpreting the slope and intercept. Identify ways to refine the question, data collection, visualization, or analysis. (MP 3, 4)

8.D.6

Construct and use two-way tables to describe and compare variability in bivariate data for categorical variables. Calculate and interpret *relative frequencies* for rows or columns in a two-way table. (MP 7)

8.D.7

Construct, analyze, and communicate clear and reasonable arguments to answer statistical questions about the association between categorical bivariate data. Use the relative frequencies calculated for rows or columns as evidence to justify and describe possible associations between the two variables. (MP 3)

Mathematical Practices

Mathematical Practice 1: Ask and answer questions to build mathematical knowledge

In grades 6-8, students formulate questions to explore mathematical ideas involving real-world problems that use rate, ratio, and percents; in the context of data analysis, students interpret quantitative bivariate data to answer investigative questions, asking questions about patterns, associations, and potential outliers within the data.

Mathematical Practice 2: Add or remove context to make sense of mathematics

In grades 6-8, students understand what the numbers, symbols, pictures, words, etc. in their work represent when working with algebraic equations and expressions. Students flexibly move between concrete, pictorial, and abstract representations of mathematical ideas like linear functions. They move back and forth between a problem's context and its representation to use the form that best fits the situation.

Mathematical Practice 3: Construct, justify, and communicate clear and reasonable arguments

In grades 6-8, students construct, justify, and communicate arguments in various mathematical contexts such as: solving problems involving ratios and rates and explaining their thinking about proportional relationships, to justify and explain the logical steps needed to solve multi-step equations and inequalities, and to communicate informal arguments to establish angle relationships for parallel lines cut by a transversal and angle relationships for triangles.

Mathematical Practice 4: Model with mathematics

In grades 6-8, students build visual models of fractions to extend their understanding of multiplication and division. They build a variety of models to extend their understanding of proportional relationships and linear functions.

Mathematical Practice 5: Select and use tools appropriately and strategically

In grades 6-8, students focus on building foundational skills through the diverse use of mathematical tools. Students use algebraic tools to generate equivalent expressions and solve multi-step equations involving positive and negative numbers. For geometry, students engage with geometric concepts by using both classical tools like a straight edge and compass and dynamic geometry software to explore, construct, and analyze shapes. Students use computer based tools to explore data, utilizing graphical displays and numerical summaries as statistical tools to analyze and interpret data.

Mathematical Practice 6: Attend to precision and reasonableness

In grades 6-8, students attend to mathematical precision and reasonableness in their communication, calculations and processes. They calculate flexibly, accurately, and efficiently, using clear and concise notation to record their work. Students apply this skill when adding, subtracting, multiplying and dividing multi-digit whole numbers and decimals. Students attend to the reasonableness of solutions when solving multi-step, real world problems using positive and negative rational numbers, and when finding rational approximations of irrational numbers.

Mathematical Practice 7: Describe and represent structures, patterns, and relationships

In grades 6-8, students describe and represent their mathematical understanding of structures, pattern and relationships to extend their understanding of multiplication and division in order to divide fractions by fractions; to develop and apply properties of integer exponents to generate equivalent numerical expressions and to use the structure of similar triangles to explain why the slope of a non-vertical line is constant between any two points on the coordinate plane.

Mathematical Practice 8: Use mathematical regularity to make conjectures and evaluate the results

In grades 6-8, students develop and assess conjectures related to proportional

relationships and apply the concepts of unit rate and percent. They also develop and assess conjectures about the properties of irrational numbers by comparing them to the set of rational numbers, and make conjectures about dilations and congruency of geometric figures.

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