



# *A Story of Ratios:* A Curriculum Overview for Grades 6–8

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## Introduction

This document provides an overview of the academic year for Grades 6 through 8, beginning with a curriculum map and followed by detailed grade-level descriptions.

The curriculum map is a chart that shows, at a glance, the sequence of modules comprising each grade of the Grades 6 through 8 curricula. The map also indicates the approximate number of instructional days designated for each module of each grade. Details that elaborate on the curriculum map are found in the grade-level descriptions.

Each grade-level description begins with a list of the six to seven modules that comprise the instruction of that grade. That introductory component is followed by three sections: the Summary of Year, the Rationale for Module Sequence, and the alignment chart with the grade-level standards.

The Summary of Year portion of each grade level includes four pieces of information:

- The critical instructional areas for the grade, as described in the Common Core State Standards for Mathematics<sup>1</sup> (CCSS-M)
- The Key Areas of Focus<sup>2</sup> for the grade
- The Required Fluencies for the grade
- The Major Emphasis Clusters<sup>3</sup> for the grade

The Rationale for Module Sequence portion of each grade level provides a brief description of the instructional focus of each module for that grade and explains the developmental sequence of the mathematics.

The alignment chart for each grade lists the standards that are addressed in each module of the grade. Note that when a cluster is referred to without a footnote, it is taught in its entirety. There are also times when footnotes are relevant to particular standards within a cluster. All standards for each grade have been carefully included in the module sequence. Some standards are deliberately included in more than one module so that a strong foundation can be built over time.

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<sup>1</sup> [http://www.corestandards.org/wp-content/uploads/Math\\_Standards1.pdf](http://www.corestandards.org/wp-content/uploads/Math_Standards1.pdf)

<sup>2</sup> [http://www.achievethecore.org/downloads/E0702\\_Description\\_of\\_the\\_Common\\_Core\\_Shifts.pdf](http://www.achievethecore.org/downloads/E0702_Description_of_the_Common_Core_Shifts.pdf)

<sup>3</sup> <http://www.parcconline.org/resources/educator-resources/model-content-frameworks/mathematics-model-content-framework>

	Grade 6	Grade 7	Grade 8		2015-16*
1st TRIMESTER	M1: Ratios and Unit Rates (35 days)	M1: Ratios and Proportional Relationships (30 days)	M1: Integer Exponents and Scientific Notation (20 days)	1st QUARTER	
	M2: Arithmetic Operations Including Division of Fractions (25 days)	M2: Rational Numbers (30 days)	M2: The Concept of Congruence (25 days)		
2nd TRIMESTER	M3: Rational Numbers (25 days)	M3: Expressions and Equations (35 days)	M3: Similarity (25 days)	2nd QUARTER	
	M4: Expressions and Equations (45 days)	M4: Percent and Proportional Relationships (25 days)	M4: Linear Equations (40 days)		
3rd TRIMESTER	M5: Area, Surface Area, and Volume Problems (25 days)	M5: Statistics and Probability (25 days)	M5: Examples of Functions from Geometry (15 days)	3rd QUARTER	
	M6: Statistics (25 days)	M6: Geometry (35 days)	M6: Linear Functions (20 days)		
			M7: Introduction to Irrational Numbers Using Geometry (35 days)	4th QUARTER	

Key:					
Number	Geometry	Ratios and Proportions	Expressions and Equations	Statistics and Probability	Functions

\*The columns indicating trimesters and quarters are provided to give you a rough guideline. Please use this additional column for your own pacing considerations based on the specific dates of your academic calendar.

## Sequence of Grade 6 Modules Aligned with the Standards

Module 1: Ratios and Unit Rates

Module 2: Arithmetic Operations Including Division of Fractions

Module 3: Rational Numbers

Module 4: Expressions and Equations

Module 5: Area, Surface Area, and Volume Problems

Module 6: Statistics

### Summary of Year

Grade 6 mathematics is about (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) developing understanding of statistical thinking.

**Key Areas of Focus for Grade 6:** Ratios and proportional reasoning; early expressions and equations

**Required Fluency:** 6.NS.B.2 Multi-digit division  
6.NS.B.3 Multi-digit decimal operations

### Major Emphasis Clusters

Ratios and Proportional Relationships

- Understand ratio concepts and use ratio reasoning to solve problems.

The Number System

- Apply and extend previous understandings of multiplication and division to divide fractions by fractions.
- Apply and extend previous understandings of numbers to the system of rational numbers.

Expressions and Equations

- Apply and extend previous understandings of arithmetic to algebraic expressions.
- Reason about and solve one-variable equations and inequalities.
- Represent and analyze quantitative relationships between dependent and independent variables.

### Rationale for Module Sequence in Grade 6

In Module 1, students build on their prior work in measurement and in multiplication and division as they study the concepts and language of ratios and unit rates. They use proportional reasoning to solve problems. In particular, students solve ratio and rate problems using tape diagrams, tables of equivalent ratios, double number line diagrams, and equations. They plot pairs of values generated from a ratio or rate on the first quadrant of the coordinate plane.

Students expand their understanding of the number system and build their fluency in arithmetic operations in Module 2. Students learned in Grade 5 to divide whole numbers by unit fractions and unit fractions by whole numbers. Now, they apply and extend their understanding of multiplication and division to divide fractions by fractions. The meaning of this operation is connected to real-world problems as students are asked to create and solve fraction division word problems. Students continue (from Grade 5) to build fluency with adding, subtracting, multiplying, and dividing multi-digit decimal numbers using the standard algorithms.

Major themes of Module 3 are to understand rational numbers as points on the number line and to extend previous understandings of numbers to the system of rational numbers, which now include negative numbers. Students extend coordinate axes to represent points in the plane with negative number coordinates and, as part of doing so, see that negative numbers can represent quantities in real-world contexts. They use the number line to order numbers and to understand the absolute value of a number. They begin to solve real-world and mathematical problems by graphing points in all four quadrants, a concept that continues throughout to be used into high school and beyond.

With their sense of number expanded to include negative numbers, in Module 4 students begin formal study of algebraic expressions and equations. Students learn equivalent expressions by continuously relating algebraic expressions back to arithmetic and the properties of arithmetic (commutative, associative, and distributive). They write, interpret, and use expressions and equations as they reason about and solve one-variable equations and inequalities and analyze quantitative relationships between two variables.

Module 5 is an opportunity to practice the material learned in Module 4 in the context of geometry; students apply their newly acquired capabilities with expressions and equations to solve for unknowns in area, surface area, and volume problems. They find the area of triangles and other two-dimensional figures and use the formulas to find the volumes of right rectangular prisms with fractional edge lengths. Students use negative numbers in coordinates as they draw lines and polygons in the coordinate plane. They also find the lengths of sides of figures, joining points with the same first coordinate or the same second coordinate, and apply these techniques to solve real-world and mathematical problems.

In Module 6, students develop an understanding of statistical variability and apply that understanding as they summarize, describe, and display distributions. In particular, careful attention is given to measures of center and variability.

Alignment Chart<sup>4</sup>

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
<p><b>Module 1:</b> <b>Ratios and Unit Rates</b> (35 days)</p>	<p><b>Understand ratio concepts and use ratio reasoning to solve problems.</b></p> <p><b>6.RP.A.1</b> Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. <i>For example, “The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak.” “For every vote candidate A received, candidate C received nearly three votes.”</i></p> <p><b>6.RP.A.2</b> Understand the concept of a unit rate <math>a/b</math> associated with a ratio <math>a:b</math> with <math>b \neq 0</math>, and use rate language in the context of a ratio relationship. <i>For example, “This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is <math>3/4</math> cup of flour for each cup of sugar.” “We paid \$75 for 15 hamburgers, which is a rate of \$5 per hamburger.”<sup>5</sup></i></p> <p><b>6.RP.A.3</b> Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.</p> <ol style="list-style-type: none"> <li>Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.</li> <li>Solve unit rate problems including those involving unit pricing and constant speed. <i>For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?</i></li> <li>Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means <math>30/100</math> times the quantity); solve problems involving finding the whole, given a part and the percent.</li> <li>Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</li> </ol>

<sup>4</sup> When a cluster is referred to in this chart without a footnote, the cluster is taught in its entirety.

<sup>5</sup> Expectations for unit rates in this grade are limited to non-complex fractions.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
<p><b>Module 2:</b> <b>Arithmetic Operations Including Division of Fractions</b> (25 days)</p>	<p><b>Apply and extend previous understandings of multiplication and division to divide fractions by fractions.</b></p> <p><b>6.NS.A.1</b> Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. <i>For example, create a story context for <math>(2/3) \div (3/4)</math> and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that <math>(2/3) \div (3/4) = 8/9</math> because <math>3/4</math> of <math>8/9</math> is <math>2/3</math>. (In general, <math>(a/b) \div (c/d) = ad/bc</math>.) How much chocolate will each person get if 3 people share <math>1/2</math> lb of chocolate equally? How many <math>3/4</math>-cup servings are in <math>2/3</math> of a cup of yogurt? How wide is a rectangular strip of land with length <math>3/4</math> mi and area <math>1/2</math> square mi?</i></p> <p><b>Compute fluently with multi-digit numbers and find common factors and multiples.</b></p> <p><b>6.NS.B.2</b> Fluently divide multi-digit numbers using the standard algorithm.<sup>6</sup></p> <p><b>6.NS.B.3</b> Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.<sup>7</sup></p> <p><b>6.NS.B.4</b> Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor. <i>For example, express <math>36 + 8</math> as <math>4(9 + 2)</math>.</i></p>
<p><b>Module 3:</b> <b>Rational Numbers</b> (25 days)</p>	<p><b>Apply and extend previous understandings of numbers to the system of rational numbers.</b></p> <p><b>6.NS.C.5</b> Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.</p> <p><b>6.NS.C.6</b> Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane</p>

<sup>6</sup> This fluency standard begins in this module and is practiced throughout the remainder of the year.

<sup>7</sup> This fluency standard begins in this module and is practiced throughout the remainder of the year.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
	<p>with negative number coordinates.</p> <ol style="list-style-type: none"> <li>Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., <math>-(-3) = 3</math>, and that 0 is its own opposite.</li> <li>Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.</li> <li>Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.</li> </ol> <p><b>6.NS.C.7</b> Understand ordering and absolute value of rational numbers.</p> <ol style="list-style-type: none"> <li>Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. <i>For example, interpret <math>-3 &gt; -7</math> as a statement that <math>-3</math> is located to the right of <math>-7</math> on a number line oriented from left to right.</i></li> <li>Write, interpret, and explain statements of order for rational numbers in real-world contexts. <i>For example, write <math>-3^{\circ}\text{C} &gt; -7^{\circ}\text{C}</math> to express the fact that <math>-3^{\circ}\text{C}</math> is warmer than <math>-7^{\circ}\text{C}</math>.</i></li> <li>Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world situation. <i>For example, for an account balance of <math>-30</math> dollars, write <math> -30  = 30</math> to describe the size of the debt in dollars.</i></li> <li>Distinguish comparisons of absolute value from statements about order. <i>For example, recognize that an account balance less than <math>-30</math> dollars represents a debt greater than 30 dollars.</i></li> </ol> <p><b>6.NS.C.8</b> Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.</p>



Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
<p><b>Module 4:</b> <b>Expressions and Equations</b> (45 days)</p>	<p><b>Apply and extend previous understandings of arithmetic to algebraic expressions.<sup>8</sup></b></p> <p><b>6.EE.A.1</b> Write and evaluate numerical expressions involving whole-number exponents.</p> <p><b>6.EE.A.2</b> Write, read, and evaluate expressions in which letters stand for numbers.</p> <ol style="list-style-type: none"> <li>Write expressions that record operations with numbers and with letters standing for numbers. <i>For example, express the calculation “Subtract <math>y</math> from 5” as <math>5 - y</math>.</i></li> <li>Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. <i>For example, describe the expression <math>2(8 + 7)</math> as a product of two factors; view <math>(8 + 7)</math> as both a single entity and a sum of two terms.</i></li> <li>Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). <i>For example, use the formulas <math>V = s^3</math> and <math>A = 6s^2</math> to find the volume and surface area of a cube with sides of length <math>s = 1/2</math>.</i></li> </ol> <p><b>6.EE.A.3</b> Apply the properties of operations to generate equivalent expressions. <i>For example, apply the distributive property to the expression <math>3(2 + x)</math> to produce the equivalent expression <math>6 + 3x</math>; apply the distributive property to the expression <math>24x + 18y</math> to produce the equivalent expression <math>6(4x + 3y)</math>; apply properties of operations to <math>y + y + y</math> to produce the equivalent expression <math>3y</math>.</i></p> <p><b>6.EE.A.4</b> Identify when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them). <i>For example, the expressions <math>y + y + y</math> and <math>3y</math> are equivalent because they name the same number regardless of which number <math>y</math> stands for.</i></p>

<sup>8</sup> 6.EE.A.2c is also taught in Module 4 in the context of geometry.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
	<p><b>Reason about and solve one-variable equations and inequalities.</b><sup>9</sup></p> <p><b>6.EE.B.5</b> Understand solving an equation or inequality as a process of answering a question: Which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true.</p> <p><b>6.EE.B.6</b> Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.</p> <p><b>6.EE.B.7</b> Solve real-world and mathematical problems by writing and solving equations of the form <math>x + p = q</math> and <math>px = q</math> for cases in which <math>p</math>, <math>q</math>, and <math>x</math> are all nonnegative rational numbers.</p> <p><b>6.EE.B.8</b> Write an inequality of the form <math>x &gt; c</math> or <math>x &lt; c</math> to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form <math>x &gt; c</math> or <math>x &lt; c</math> have infinitely many solutions; represent solutions of such inequalities on number line diagrams.</p> <p><b>Represent and analyze quantitative relationships between dependent and independent variables.</b></p> <p><b>6.EE.C.9</b> Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. <i>For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation <math>d = 65t</math> to represent the relationship between distance and time.</i></p>
<p><b>Module 5:</b> <b>Area, Surface Area, and Volume Problems</b> (25 days)</p>	<p><b>Solve real-world and mathematical problems involving area, surface area, and volume.</b></p> <p><b>6.G.A.1</b> Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.</p>

<sup>9</sup> Except for 6.EE.B.8, this cluster is also taught in Module 4 in the context of geometry.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
	<p><b>6.G.A.2</b> Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas <math>V = l w h</math> and <math>V = b h</math> to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.</p> <p><b>6.G.A.3</b> Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.</p> <p><b>6.G.A.4</b> Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.</p>
<p><b>Module 6:</b> <b>Statistics</b> (25 days)</p>	<p><b>Develop understanding of statistical variability.</b></p> <p><b>6.SP.A.1</b> Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. <i>For example, “How old am I?” is not a statistical question, but “How old are the students in my school?” is a statistical question because one anticipates variability in students’ ages.</i></p> <p><b>6.SP.A.2</b> Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.</p> <p><b>6.SP.A.3</b> Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.</p> <p><b>Summarize and describe distributions.</b></p> <p><b>6.SP.B.4</b> Display numerical data in plots on a number line, including dot plots, histograms, and box plots.</p> <p><b>6.SP.B.5</b> Summarize numerical data sets in relation to their context, such as by:</p> <ol style="list-style-type: none"> <li>Reporting the number of observations.</li> </ol>

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 6 Modules
	<ul style="list-style-type: none"><li>b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.</li><li>c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.</li><li>d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.</li></ul>

## Sequence of Grade 7 Modules Aligned with the Standards

Module 1: Ratios and Proportional Relationships

Module 2: Rational Numbers

Module 3: Expressions and Equations

Module 4: Percent and Proportional Relationships

Module 5: Statistics and Probability

Module 6: Geometry

### Summary of Year

Grade 7 mathematics is about (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.

**Key Areas of Focus for Grade 7:** Ratios and proportional reasoning; arithmetic of rational numbers

### Rationale for Module Sequence in Grade 7

In Module 1, students build on their Grade 6 experiences with ratios, unit rates, and fraction division to analyze proportional relationships. They decide whether two quantities are in a proportional relationship, identify constants of proportionality, and represent the relationship by equations. These skills are then applied to real-world problems including scale drawings.

Students continue to build an understanding of the number line in Module 2 from their work in Grade 6. They learn to add, subtract, multiply, and divide rational numbers. Module 2 includes rational numbers as they appear in expressions and equations—work that is continued in Module 3.

### Major Emphasis Clusters

Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems.

The Number System

- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

Expressions and Equations

- Use properties of operations to generate equivalent expressions.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Module 3 consolidates and expands students' previous work with generating equivalent expressions and solving equations. Students solve real-life and mathematical problems using numerical and algebraic expressions and equations. Their work with expressions and equations is applied to finding unknown angles and problems involving area, volume, and surface area.

Module 4 parallels Module 1's coverage of ratio and proportion but this time with a concentration on percent. Problems in this module include simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, and percent error. Additionally, this module includes percent problems about populations, which prepare students for probability models about populations covered in the next module.

In Module 5, students learn to draw inferences about populations based on random samples. Through the study of chance processes, students learn to develop, use, and evaluate probability models.

The year concludes with students drawing and constructing geometrical figures in Module 6. They also revisit unknown angle, area, volume, and surface area problems, which now include problems involving percentages of areas or volumes.

### Alignment Chart<sup>10</sup>

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
<p><b>Module 1:</b> <b>Ratios and Proportional Relationships</b> (30 days)</p>	<p><b>Analyze proportional relationships and use them to solve real-world and mathematical problems.<sup>11</sup></b></p> <p><b>7.RP.A.1</b> Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks <math>\frac{1}{2}</math> mile in each <math>\frac{1}{4}</math> hour, compute the unit rate as the complex fraction <math>\frac{1/2}{1/4}</math> miles per hour, equivalently 2 miles per hour.</i></p> <p><b>7.RP.A.2</b> Recognize and represent proportional relationships between quantities.</p> <p>a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.</p>

<sup>10</sup> When a cluster is referred to in this chart without a footnote, the cluster is taught in its entirety.

<sup>11</sup> Percent and proportional relationships are covered in Module 4.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p>b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</p> <p>c. Represent proportional relationships by equations. <i>For example, if total cost <math>t</math> is proportional to the number <math>n</math> of items purchased at a constant price <math>p</math>, the relationship between the total cost and the number of items can be expressed as <math>t = pn</math>.</i></p> <p>d. Explain what a point <math>(x, y)</math> on the graph of a proportional relationship means in terms of the situation, with special attention to the points <math>(0, 0)</math> and <math>(1, r)</math> where <math>r</math> is the unit rate.</p> <p><b>7.RP.A.3</b> Use proportional relationships to solve multistep ratio and percent problems. <i>Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.</i></p> <p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b><sup>12</sup></p> <p><b>7.EE.B.4</b><sup>13</sup> Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.</p> <p>a. Solve word problems leading to equations of the form <math>px + q = r</math> and <math>p(x + q) = r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></p> <p><b>Draw, construct, and describe geometrical figures and describe the relationships between them.</b><sup>14</sup></p> <p><b>7.G.A.1</b> Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.</p>

<sup>12</sup> The balance of this cluster is taught in Modules 2, 3, and 4.

<sup>13</sup> In this module, the equations are derived from ratio problems. 7.EE.B.4a is returned to in Module 2 and Module 3.

<sup>14</sup> 7.G.A.1 is also covered in Module 4. The balance of this cluster is taught in Module 6.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
<p><b>Module 2:</b> <b>Rational Numbers</b> (30 days)</p>	<p><b>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</b></p> <p><b>7.NS.A.1</b> Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.</p> <ol style="list-style-type: none"> <li>Describe situations in which opposite quantities combine to make 0. <i>For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.</i></li> <li>Understand <math>p + q</math> as the number located a distance <math> q </math> from <math>p</math>, in the positive or negative direction depending on whether <math>q</math> is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.</li> <li>Understand subtraction of rational numbers as adding the additive inverse, <math>p - q = p + (-q)</math>. Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.</li> <li>Apply properties of operations as strategies to add and subtract rational numbers.</li> </ol> <p><b>7.NS.A.2</b> Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</p> <ol style="list-style-type: none"> <li>Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as <math>(-1)(-1) = 1</math> and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.</li> <li>Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If <math>p</math> and <math>q</math> are integers, then <math>-(p/q) = (-p)/q = p/(-q)</math>. Interpret quotients of rational numbers by describing real-world contexts.</li> <li>Apply properties of operations as strategies to multiply and divide rational numbers.</li> </ol>



Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p>d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.</p> <p><b>7.NS.A.3</b> Solve real-world and mathematical problems involving the four operations with rational numbers.<sup>15</sup></p> <p><b>Use properties of operations to generate equivalent expressions.</b><sup>16</sup></p> <p><b>7.EE.A.2</b><sup>17</sup> Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. <i>For example, <math>a + 0.05a = 1.05a</math> means that “increase by 5%” is the same as “multiply by 1.05.”</i></p> <p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b><sup>18</sup></p> <p><b>7.EE.B.4</b><sup>19</sup> Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.</p> <p>a. Solve word problems leading to equations of the form <math>px + q = r</math> and <math>p(x + q) = r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></p>
<p><b>Module 3:</b> <b>Expressions and Equations</b> (35 days)</p>	<p><b>Use properties of operations to generate equivalent expressions.</b></p> <p><b>7.EE.A.1</b> Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.</p> <p><b>7.EE.A.2</b> Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. <i>For example, <math>a + 0.05a = 1.05a</math> means</i></p>

<sup>15</sup> Computations with rational numbers extend the rules for manipulating fractions to complex fractions.

<sup>16</sup> The balance of this cluster is taught in Module 3.

<sup>17</sup> In this module, this standard is applied to expressions with rational numbers in them.

<sup>18</sup> The balance of this cluster is taught in Module 3.

<sup>19</sup> In this module the equations include negative rational numbers.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p style="text-align: center;"><i>that “increase by 5%” is the same as “multiply by 1.05.”</i></p> <p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b></p> <p><b>7.EE.B.3<sup>20</sup></b> Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. <i>For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.</i></p> <p><b>7.EE.B.4</b> Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.</p> <ol style="list-style-type: none"> <li>Solve word problems leading to equations of the form <math>px + q = r</math> and <math>p(x + q) = r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></li> <li>Solve word problems leading to inequalities of the form <math>px + q &gt; r</math> or <math>px + q &lt; r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. <i>For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.</i></li> </ol>

<sup>20</sup> Problems in this module take on any form but percent, which is included in Module 4.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p><b>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</b> <sup>21</sup></p> <p><b>7.G.B.4</b> Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.</p> <p><b>7.G.B.5</b> Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.</p> <p><b>7.G.B.6</b> Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.</p>
<p><b>Module 4:</b> <b>Percent and Proportional Relationships</b><sup>22</sup> (25 days)</p>	<p><b>Analyze proportional relationships and use them to solve real-world and mathematical problems.</b></p> <p><b>7.RP.A.1</b> Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks <math>\frac{1}{2}</math> mile in each <math>\frac{1}{4}</math> hour, compute the unit rate as the complex fraction <math>\frac{1/2}{1/4}</math> miles per hour, equivalently 2 miles per hour.</i></p> <p><b>7.RP.A.2</b> Recognize and represent proportional relationships between quantities.</p> <ol style="list-style-type: none"> <li>Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.</li> <li>Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</li> <li>Represent proportional relationships by equations. <i>For example, if total cost <math>t</math> is proportional to the number <math>n</math> of items purchased at a constant price <math>p</math>, the relationship between the total cost and the number of items can be expressed as <math>t = pn</math>.</i></li> </ol>

<sup>21</sup> Emphasis of 7.G.B.5 and 7.G.B.6 in this module is on solving equations. The standards are returned to in Module 6.

<sup>22</sup> The emphasis in this module is on percent.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p>d. Explain what a point <math>(x, y)</math> on the graph of a proportional relationship means in terms of the situation, with special attention to the points <math>(0, 0)</math> and <math>(1, r)</math> where <math>r</math> is the unit rate.</p> <p><b>7.RP.A.3</b> Use proportional relationships to solve multistep ratio and percent problems. <i>Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.</i></p> <p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b><sup>23</sup></p> <p><b>7.EE.B.3</b> Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. <i>For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional <math>\frac{1}{10}</math> of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar <math>9\frac{3}{4}</math> inches long in the center of a door that is <math>27\frac{1}{2}</math> inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.</i></p> <p><b>Draw, construct, and describe geometrical figures and describe the relationships between them.</b><sup>24</sup></p> <p><b>7.G.A.1</b> Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.</p>
<p><b>Module 5:</b> <b>Statistics and Probability</b> (25 days)</p>	<p><b>Use random sampling to draw inferences about a population.</b></p> <p><b>7.SP.A.1</b> Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.</p>

<sup>23</sup> 7.EE.B.3 is introduced in Module 3. The balance of this cluster was taught in the first three modules.

<sup>24</sup> 7.G.A.1 is introduced in Module 1. The balance of this cluster is taught in Module 6.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p><b>7.SP.A.2</b> Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. <i>For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.</i></p> <p><b>Draw informal comparative inferences about two populations.</b></p> <p><b>7.SP.B.3</b> Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. <i>For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.</i></p> <p><b>7.SP.B.4</b> Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. <i>For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.</i></p> <p><b>Investigate chance processes and develop, use, and evaluate probability models.</b></p> <p><b>7.SP.C.5</b> Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around <math>\frac{1}{2}</math> indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.</p> <p><b>7.SP.C.6</b> Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. <i>For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.</i></p> <p><b>7.SP.C.7</b> Develop 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 of the discrepancy.</p>

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p>a. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. <i>For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.</i></p> <p>b. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. <i>For example, 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 spinning penny appear to be equally likely based on the observed frequencies?</i></p> <p><b>7.SP.C.8</b> Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.</p> <p>a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.</p> <p>b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., “rolling double sixes”), identify the outcomes in the sample space which compose the event.</p> <p>c. Design and use a simulation to generate frequencies for compound events. <i>For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?</i></p>
<p><b>Module 6:</b> <b>Geometry</b> (35 days)</p>	<p><b>Draw, construct, and describe geometrical figures and describe the relationships between them.</b><sup>25</sup></p> <p><b>7.G.A.2</b> Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.</p>

<sup>25</sup> The balance of this cluster is taught in Modules 1 and 4.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 7 Modules
	<p><b>7.G.A.3</b> Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.</p> <p><b>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</b><sup>26</sup></p> <p><b>7.G.B.5</b> Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.</p> <p><b>7.G.B.6</b> Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.</p>

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<sup>26</sup> 7.G.B.4 is taught in Module 3; 7.G.B.5 and 7.G.B.6 are introduced in Module 3.

## Sequence of Grade 8 Modules Aligned with the Standards

Module 1: Integer Exponents and Scientific Notation

Module 2: The Concept of Congruence

Module 3: Similarity

Module 4: Linear Equations

Module 5: Examples of Functions from Geometry

Module 6: Linear Functions

Module 7: Introduction to Irrational Numbers Using Geometry

### Summary of Year

Grade 8 mathematics is about (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.

**Key Area of Focus for Grade 8:** Linear algebra

### Rationale for Module Sequence in Grade 8

This year begins with students extending the properties of exponents to integer exponents in Module 1. They use the number line model to support their understanding of the rational numbers and the number system. The number system is revisited at the end of the year (in Module 7) to develop the *real* number line through a detailed study of irrational numbers.

### Major Emphasis Clusters

#### Expressions and Equations

- Work with radicals and integer exponents.
- Understand the connections between proportional relationships, lines, and linear equations.
- Analyze and solve linear equations and pairs of simultaneous linear equations.

#### Functions

- Define, evaluate, and compare functions.

#### Geometry

- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand and apply the Pythagorean theorem.



In Module 2, students study congruence by experimenting with rotations, reflections, and translations of geometrical figures. Their study of congruence culminates with an introduction to the Pythagorean theorem in which the teacher guides students through the “square-within-a-square” proof of the theorem. Students practice the theorem in real-world applications and mathematical problems throughout the year. (In Module 7, students learn to prove the Pythagorean theorem on their own and are assessed on that knowledge in that module.)

The experimental study of rotations, reflections, and translations in Module 2 prepares students for the more complex work of understanding the effects of dilations on geometrical figures in their study of similarity in Module 3. They use similar triangles to solve unknown angle, side length and area problems. Module 3 concludes with revisiting a proof of the Pythagorean theorem from the perspective of similar triangles.

In Module 4, students use similar triangles learned in Module 3 to explain why the slope of a line is well-defined. Students learn the connection between proportional relationships, lines, and linear equations as they develop ways to represent a line by different equations (e.g.,  $y = mx + b$ ,  $y - y_1 = m(x - x_1)$ ). They analyze and solve linear equations and pairs of simultaneous linear equations. The equation of a line provides a natural transition into the idea of a function explored in the next two modules.

Students are introduced to functions in the context of linear equations and area/volume formulas in Module 5. They define, evaluate, and compare functions using equations of lines as a source of linear functions and area and volume formulas as a source of non-linear functions.

In Module 6, students return to linear functions in the context of statistics and probability as bivariate data provides support in the use of linear functions.

By Module 7, students have been using the Pythagorean theorem for several months. They are sufficiently prepared to learn and explain a proof of the theorem on their own. The Pythagorean theorem is also used to motivate a discussion of irrational square roots (irrational cube roots are introduced via volume of a sphere). Thus, as the year began with looking at the number system, so it concludes with students understanding irrational numbers and ways to represent them (radicals, non-repeating decimal expansions) on the real number line.

Alignment Chart<sup>27</sup>

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
<b>Module 1:</b> <b>Integer Exponents and Scientific Notation</b> (20 days)	<b>Work with radicals and integer exponents.<sup>28</sup></b> <p><b>8.EE.A.1</b> Know and apply the properties of integer exponents to generate equivalent numerical expressions. <i>For example, <math>3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27</math>.</i></p> <p><b>8.EE.A.3</b> Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. <i>For example, estimate the population of the United States as <math>3 \times 10^8</math> and the population of the world as <math>7 \times 10^9</math>, and determine that the world population is more than 20 times larger.</i></p> <p><b>8.EE.A.4</b> Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.</p>
<b>Module 2:</b> <b>The Concept of Congruence</b> (25 days)	<b>Understand congruence and similarity using physical models, transparencies, or geometry software.<sup>29</sup></b> <p><b>8.G.A.1</b> Verify experimentally the properties of rotations, reflections, and translations:</p> <ol style="list-style-type: none"> <li>Lines are taken to lines, and line segments to line segments of the same length.</li> <li>Angles are taken to angles of the same measure.</li> <li>Parallel lines are taken to parallel lines.</li> </ol> <p><b>8.G.A.2</b> Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.</p>

<sup>27</sup> When a cluster is referred to in this chart without a footnote, the cluster is taught in its entirety.

<sup>28</sup> 8.EE.A.2 is covered in Module 7.

<sup>29</sup> 8.G.A.3, 8.G.A.4, and the balance of 8.G.A.5 are taught in Module 3.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>8.G.A.5<sup>30</sup></b> Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.</i></p> <p><b>Understand and apply the Pythagorean Theorem.<sup>31</sup></b></p> <p><b>8.G.B.6<sup>32</sup></b> Explain a proof of the Pythagorean Theorem and its converse.</p> <p><b>8.G.B.7<sup>33</sup></b> Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p>
<p><b>Module 3:</b> <b>Similarity</b> (25 days)</p>	<p><b>Understand congruence and similarity using physical models, transparencies, or geometry software.<sup>34</sup></b></p> <p><b>8.G.A.3</b> Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</p> <p><b>8.G.A.4</b> Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.</p> <p><b>8.G.A.5</b> Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.</i></p>

<sup>30</sup> Congruence is addressed in this module. The balance of this standard (similarity) is taught in Module 3.

<sup>31</sup> 8.G.B.6 and 8.G.B.7 are also taught in Module 3. The balance of 8.G.B.6 and 8.G.B.7 are covered in Module 7, along with standard 8.G.B.8.

<sup>32</sup> The Pythagorean theorem is proved in this module guided by the teacher (square within a square proof). Students are not responsible for explaining a proof until Module 7.

<sup>33</sup> This standard is started in this module and practiced during the year. No solutions that involve irrational numbers are introduced until Module 7.

<sup>34</sup> The balance of this cluster is taught in Module 1.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>Understand and apply the Pythagorean Theorem.</b><sup>35</sup></p> <p><b>8.G.B.6</b><sup>36</sup> Explain a proof of the Pythagorean Theorem and its converse.</p> <p><b>8.G.B.7</b><sup>37</sup> Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p>
<p><b>Module 4:</b> <b>Linear Equations</b> (40 days)</p>	<p><b>Understand the connections between proportional relationships, lines, and linear equations.</b></p> <p><b>8.EE.B.5</b> Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. <i>For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</i></p> <p><b>8.EE.B.6</b> Use similar triangles to explain why the slope <math>m</math> is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation <math>y = mx</math> for a line through the origin and the equation <math>y = mx + b</math> for a line intercepting the vertical axis at <math>b</math>.</p> <p><b>Analyze and solve linear equations and pairs of simultaneous linear equations.</b></p> <p><b>8.EE.C.7</b> Solve linear equations in one variable.</p> <ol style="list-style-type: none"> <li>Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form <math>x = a</math>, <math>a = a</math>, or <math>a = b</math> results (where <math>a</math> and <math>b</math> are different numbers).</li> <li>Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.</li> </ol>

<sup>35</sup> 8.G.B.6 and 8.G.B.7 are also taught in Module 2. The balance of standards 8.G.B.6 and 8.G.B.7 are covered in Module 7, along with standard 8.G.B.8.

<sup>36</sup> The Pythagorean theorem is proved in this module with guidance by the teacher (proof using similar triangles). Students are not responsible for explaining a proof until Module 7.

<sup>37</sup> This standard is started in this module and practiced during the year. No solutions that involve irrational numbers are introduced until Module 7.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>8.EE.C.8</b> Analyze and solve pairs of simultaneous linear equations.</p> <ol style="list-style-type: none"> <li>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.</li> <li>Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. <i>For example, <math>3x + 2y = 5</math> and <math>3x + 2y = 6</math> have no solution because <math>3x + 2y</math> cannot simultaneously be 5 and 6.</i></li> <li>Solve real-world and mathematical problems leading to two linear equations in two variables. <i>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></li> </ol>
<p><b>Module 5:</b> <b>Examples of Functions from Geometry</b> (15 days)</p>	<p><b>Define, evaluate, and compare functions.</b><sup>38</sup></p> <p><b>8.F.A.1</b> 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.<sup>39</sup></p> <p><b>8.F.A.2</b> Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>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></p> <p><b>8.F.A.3</b> Interpret the equation <math>y = mx + b</math> as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. <i>For example, the function <math>A = s^2</math> 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></p>

<sup>38</sup> Linear and non-linear functions are compared in this module using linear equations and area/volume formulas as examples.

<sup>39</sup> Function notation is not required in Grade 8.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.</b></p> <p><b>8.G.C.9<sup>40</sup></b> Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.</p>
<p><b>Module 6:</b> <b>Linear Functions</b> (20 days)</p>	<p><b>Use functions to model relationships between quantities.</b></p> <p><b>8.F.B.4</b> 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 <math>(x, y)</math> 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.</p> <p><b>8.F.B.5</b> 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.</p> <p><b>Investigate patterns of association in bivariate data.<sup>41</sup></b></p> <p><b>8.SP.A.1</b> 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.</p> <p><b>8.SP.A.2</b> 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.</p> <p><b>8.SP.A.3</b> Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. <i>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></p>

<sup>40</sup> Solutions that introduce irrational numbers are not introduced until Module 7.

<sup>41</sup> 8.SP standards are used as applications to the work done with 8.F standards.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>8.SP.A.4</b> 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 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. <i>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></p>
<p><b>Module 7:</b> <b>Introduction to Irrational Numbers Using Geometry</b> (35 days)</p>	<p><b>Know that there are numbers that are not rational, and approximate them by rational numbers.</b></p> <p><b>8.NS.A.1</b> Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.</p> <p><b>8.NS.A.2</b> Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., <math>\pi^2</math>). <i>For example, by truncating the decimal expansion of <math>\sqrt{2}</math>, show that <math>\sqrt{2}</math> is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.</i></p> <p><b>Work with radicals and integer exponents.</b><sup>42</sup></p> <p><b>8.EE.A.2</b> Use square root and cube root symbols to represent solutions to equations of the form <math>x^2 = p</math> and <math>x^3 = p</math>, where <math>p</math> is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that <math>\sqrt{2}</math> is irrational.</p> <p><b>Understand and apply the Pythagorean Theorem.</b></p> <p><b>8.G.B.6</b> Explain a proof of the Pythagorean Theorem and its converse.</p> <p><b>8.G.B.7</b> Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p> <p><b>8.G.B.8</b> Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.</p>

<sup>42</sup> The balance of this cluster is taught in Module 1.

Module and Approximate Number of Instructional Days	Standards Addressed in Grade 8 Modules
	<p><b>Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.</b></p> <p><b>8.G.C.9</b> Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.<sup>43</sup></p>

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<sup>43</sup> Solutions that introduce irrational numbers are allowed in this module.