# Mathematics | Grade 8

**The descriptions below provide an overview of the concepts and skills that students explore throughout the 8th grade.**

### The Number System

This is the culminating area for the number system from 6th and 7th grade. Students now know there are numbers that are not rational, called irrational numbers. Students approximate irrational numbers by rational numbers locating them on a number line and students estimate the value of irrational expressions.

### Expressions and Equations

Students work with radicals and integer exponents. Students understand the connections between proportional relationships, lines, and linear equations. Students advance their knowledge developed in 7th grade about equations to analyze and solve linear equations and pairs of simultaneous linear equations. Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions ($y/x = m$ or $y = mx$) as special linear equations ($y = mx + b$), understanding that the constant of proportionality ($m$) is the slope, and the graphs are lines through the origin. They understand that the slope ($m$) of a line is a constant rate of change, so that if the input or x-coordinate changes by an amount $A$, the output or y-coordinate changes by the amount $m \cdot A$. Students solve systems of two linear equations in two variables and relate the systems to pairs of lines in the plane; these intersect, are parallel, or are the same line. Students use linear equations, systems of linear equations, linear functions, and their understanding of slope of a line to analyze situations and solve problems.

### Functions

This begins the formal study of functions, a mathematical concept that for the student will continue throughout high school. Students grasp the concept of a function as a rule that assigns to each input exactly one output. They understand that functions describe situations where one quantity determines another. They can translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations.

### Geometry

Students use ideas about distance and angles and how they behave under translations, rotations, reflections, and dilations, to describe and analyze two-dimensional figures and to solve problems. Students show that the sum of the angles in a triangle is the angle formed by a straight line and that various configurations of lines give rise to similar triangles because of the angles created when a transversal cuts parallel lines. Students understand the statement of the Pythagorean Theorem and its converse and can explain why the Pythagorean Theorem holds. They apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths, and to analyze polygons. Students complete their work on volume by solving problems involving cones, cylinders, and spheres.

### Statistics and Probability

Students extend their knowledge from 7th grade by working with scatter plots for bivariate data and understand linear associations and the use of linear models to solve problems interpreting the slope and intercept. Students continue work with probability by finding probability of compound events and represent the data using organized lists, tables, and tree diagrams.

## Standards for Mathematical Practice

Being successful in mathematics requires the development of approaches, practices, and habits of mind that need to be in place as one strives to develop mathematical fluency, procedural skills, and conceptual understanding. The Standards for Mathematical Practice are meant to address these areas of expertise that teachers should seek to develop in their students. These approaches, practices, and habits of mind can be summarized as "processes and proficiencies" that successful mathematicians have as a part of their work in mathematics. Additional explanations are included in the main introduction of these standards.

| Standards for Mathematical Practice |
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| 1. Make sense of problems and persevere in solving them.<br>2. Reason abstractly and quantitatively.<br>3. Construct viable arguments and critique the reasoning of others.<br>4. Model with mathematics.<br>5. Use appropriate tools strategically.<br>6. Attend to precision.<br>7. Look for and make use of structure.<br>8. Look for and express regularity in repeated reasoning. |

## Literacy Standards for Mathematics

Communication in mathematics employs literacy skills in reading, vocabulary, speaking and listening, and writing. Mathematically proficient students communicate using precise terminology and multiple representations including graphs, tables, charts, and diagrams. By describing and contextualizing mathematics, students create arguments and support conclusions. They evaluate and critique the reasoning of others, analyze, and reflect on their own thought processes. Mathematically proficient students have the capacity to engage fully with mathematics in context by posing questions, choosing appropriate problem-solving approaches, and justifying solutions. Further explanations are included in the main introduction.

| Literacy Skills for Mathematical Proficiency |
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| 1. Use multiple reading strategies.<br>2. Understand and use correct mathematical vocabulary.<br>3. Discuss and articulate mathematical ideas.<br>4. Write mathematical arguments. |

## The Number System (NS)

| Cluster Headings | Content Standards |
|---|---|
| **A. Know that there are numbers that are not rational, and approximate them by rational numbers.** | **8.NS.A.1** 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 or terminates, and convert a decimal expansion which repeats eventually or terminates into a rational number.<br><br>**8.NS.A.2** Use rational approximations of irrational numbers to compare the size of irrational numbers locating them approximately on a number line diagram. Estimate the value of irrational expressions such as $\pi^2$. *For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.* |

## Expressions and Equations (EE)

| Cluster Headings | Content Standards |
|---|---|
| **A. Work with radicals and integer exponents.** | **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.*<br><br>**8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where $p$ is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.<br><br>**8.EE.A.3** 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. *For example, estimate the population of the United States as $3 \times 10^8$ and the population of the world as $7 \times 10^9$, and determine that the world population is more than 20 times larger.*<br><br>**8.EE.A.4** 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. |
| **B. Understand the connections between proportional relationships, lines, and linear equations.** | **8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*<br><br>**8.EE.B.6** Use similar triangles to explain why the slope $m$ is the same between any two distinct points on a non-vertical line in the coordinate plane; know and derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at $b$. |

| Cluster Headings | Content Standards |
|---|---|
| **C. Analyze and solve linear equations and systems of two linear equations.** | **8.EE.C.7** Solve linear equations in one variable.<br>**a.** 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 $x = a$, $a = a$, or $a = b$ results (where $a$ and $b$ are different numbers).<br>**b.** Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. |
| | **8.EE.C.8** Analyze and solve systems of two linear equations.<br>**a.** Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.<br>**b.** Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. *For example,* 3x + 2y = 5 *and* 3x + 2y = 6 *have no solution because* 3x + 2y *cannot simultaneously be 5 and 6.*<br>**c.** Solve real-world and mathematical problems leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.* |

## Functions (F)

| Cluster Headings | Content Standards |
|---|---|
| **A. Define, evaluate, and compare functions.** | **8.F.A.1** Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. (Function notation is not required in $8^{th}$ grade.)<br><br>**8.F.A.2** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a linear function represented by a table of values and another linear function represented by an algebraic expression, determine which function has the greater rate of change.*<br><br>**8.F.A.3** Know and interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *For example, the function* $A = s^2$ *giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.* |

| Cluster Headings | Content Standards |
|---|---|
| **B. Use functions to model relationships between quantities.** | **8.F.B.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two ($x$, $y$) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values.<br><br>**8.F.B.5** Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. |

## Geometry (G)

| Cluster Headings | Content Standards |
|---|---|
| **A. Understand and describe the effects of transformations on two-dimensional figures and use informal arguments to establish facts about angles.** | **8.G.A.1** Verify experimentally the properties of rotations, reflections, and translations:<br>**a.** Lines are taken to lines, and line segments to line segments of the same length.<br>**b.** Angles are taken to angles of the same measure.<br>**c.** Parallel lines are taken to parallel lines. |
| | **8.G.A.2** Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. |
| | **8.G.A.3** 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. *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.* |
| **B. Understand and apply the Pythagorean Theorem.** | **8.G.B.4** Explain a proof of the Pythagorean Theorem and its converse.<br><br>**8.G.B.5** Know and apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.<br><br>**8.G.B.6** Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. |
| **C. Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.** | **8.G.C.7** Know and understand the formulas for the volumes of cones, cylinders, and spheres, and use them to solve real-world and mathematical problems. |

## Statistics and Probability (SP)

| Cluster Headings | Content Standards |
|---|---|
| **A. Investigate patterns of association in bivariate data.** | **8.SP.A.1** Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.<br><br>**8.SP.A.2** Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line and informally assess the model fit by judging the closeness of the data points to the line.<br><br>**8.SP.A.3** Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. *For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.* |
| **B. Investigate chance processes and develop, use, and evaluate probability models** | **8.SP.B.4** Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. 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. 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. |

Major content of the grade is indicated by the light green shading of the cluster heading and standard's coding.

| | Major Content | | Supporting Content |
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