Public Schools of North Carolina
State Board of Education | Department of Public Instruction

8th Grade Mathematics ● Unpacked Content

For the new Common Core standards that will be effective in all North Carolina schools in the 2012-13.

This document is designed to help North Carolina educators teach the Common Core (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

How do I send Feedback?
We intend the explanations and examples in this document to be helpful and specific. That said, we believe that as this document is used, teachers and educators will find ways in which the unpacking can be improved and made ever more useful. Please send feedback to us at feedback@dpi.state.nc.us and we will use your input to refine our unpacking of the standards. Thank You!

Just want the standards alone?
You can find the standards alone at www.corestandards.org .

The Number System 8.NS

Common Core Cluster

Know that there are numbers that are not rational, and approximate them by rational numbers.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.NS.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, and convert a decimal expansion which repeats eventually into a rational number.	**8.NS.1** Students distinguish between rational and irrational numbers. Any number that can be expressed as a fraction is a rational number. Students recognize that the decimal equivalent of a fraction will either terminate or repeat. Fractions that terminate will have denominators containing only prime factors of 2 and/or 5. This understanding builds on work in 7th grade when students used long division to distinguish between repeating and terminating decimals. Students convert repeating decimals into their fraction equivalent using patterns or algebraic reasoning. One method to find the fraction equivalent to a repeating decimal is shown below. Change $0.\overline{4}$ to a fraction. - Let $x = 0.444444\ldots..$ - Multiply both sides so that the repeating digits will be in front of the decimal. In this example, one digit repeats so both sides are multiplied by 10, giving $10x = 4.4444444\ldots.$ - Subtract the original equation from the new equation. $\begin{array}{r} 10x = 4.4444444\ldots. \\ \underline{x = 0.444444\ldots..} \\ 9x = 4 \end{array}$ - Solve the equation to determine the equivalent fraction. $\frac{9x}{9} = \frac{4}{9}$ $x = \frac{4}{9}$ Additionally, students can investigate repeating patterns that occur when fractions have a denominator of 9, 99, or

	11. For example, $\frac{4}{9}$ is equivalent to $0.\overline{4}$, $\frac{5}{9}$ is equivalent to $0.\overline{5}$, etc.
8.NS.2 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., π^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.*	**8.NS.2** Students locate rational and irrational numbers on the number line. Students compare and order rational and irrational numbers. Additionally, students understand that the value of a square root can be approximated between integers and that non-perfect square roots are irrational. Students also recognize that square roots may be negative and written as $-\sqrt{28}$. To find an approximation of $\sqrt{28}$, first determine the perfect squares $\sqrt{28}$ is between, which would be 25 and 36. The square roots of 25 and 36 are 5 and 6 respectively, so we know that $\sqrt{28}$ is between 5 and 6. Since 28 is closer to 25, an estimate of the square root would be closer to 5. One method to get an estimate is to divide 3 (the distance between 25 and 28) by 11 (the distance between the perfect squares of 25 and 36) to get 0.27. The estimate of $\sqrt{28}$ would be 5.27 (the actual is 5.29).

Expressions and Equations 8.EE

Common Core Cluster

Work with radicals and integer exponents.

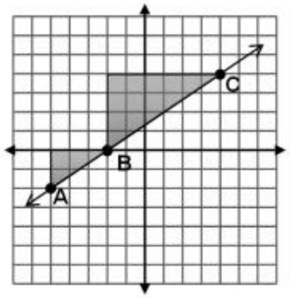
Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.	**8.EE.1** Integer (positive and negative) exponents are further used to generate equivalent numerical expressions when multiplying, dividing or raising a power to a power. Using numerical bases and the laws of exponents, students generate equivalent expressions.
8.EE.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.	**8.EE.2** Students recognize that squaring a number and taking the square root $\sqrt{\ }$ of a number are inverse operations; likewise, cubing a number and taking the cube root $\sqrt[3]{\ }$ are inverse operations. This understanding is used to solve equations containing square or cube numbers. Equations may include rational numbers such as $x^2 = \frac{1}{4}$, $x^2 = \frac{4}{9}$ or $x^3 = \frac{1}{8}$ (NOTE: Both the numerator and denominators are perfect squares or perfect cubes.) Students recognize perfect squares and cubes, understanding that non-perfect squares and non-perfect cubes are irrational. Students understand that in geometry a square root is the length of the side of a square and a cube root is the length of the side of a cube. The value of p for square root and cube root equations must be positive.
8.EE.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* 3×10^8 *and the population of the world as* 7×10^9*, and determine that the world population is more than 20 times larger.*	**8.EE.3** Students express numbers in scientific notation. Students compare and interpret scientific notation quantities in the context of the situation. If the exponent increases by one, the value increases 10 times. Students understand the magnitude of the number being expressed in scientific notation and choose an appropriate corresponding unit. For example, 3×10^8 is equivalent to 30 million, which represents a large quantity. Therefore, this value will affect the unit chosen.

8.EE.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.	**8.EE.4** Students use laws of exponents to multiply or divide numbers written in scientific notation. Additionally, students understand scientific notation as generated on various calculators or other technology.

Expressions and Equations 8.EE

Common Core Cluster

Understand the connections between proportional relationships, lines, and linear equations.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.EE.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.*	**8.EE.5** Students build on their work with unit rates from 6th grade and proportional relationships in 7th grade to compare graphs, tables and equations of proportional relationships. Students identify the unit rate (or slope) in graphs, tables and equations to compare two or more proportional relationships.
8.EE.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; 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.	**8.EE.6** Triangles are similar when there is a constant rate of proportion between them. Using a graph, students construct triangles between two points on a line and compare the sides to understand that the slope (ratio of rise to run) is the same between any two points on a line.  The triangle between A and B has a vertical height of 2 and a horizontal length of 3. The triangle between B and C has a vertical height of 4 and a horizontal length of 6. The simplified ratio of the vertical height to the horizontal length of both triangles is 2 to 3, which also represents a slope of $\frac{2}{3}$ for the line. Students write equations in the form $y = mx$ for lines going through the origin, recognizing that m represents the slope of the line. Students write equations in the form $y = mx + b$ for lines not passing through the origin, recognizing that m represents the slope and b represents the y-intercept.

Expressions and Equations 8.EE

Common Core Cluster

Analyze and solve linear equations and pairs of simultaneous linear equations.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.EE.7 Solve linear equations in one variable. 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). 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.7** Students solve one-variable equations with the variables being on both sides of the equals sign. Students recognize that the solution to the equation is the value(s) of the variable, which make a true equality when substituted back into the equation. Equations shall include rational numbers, distributive property and combining like terms. Equations have one solution when the variables do not cancel out. For example, $10x - 23 = 29 - 3x$ can be solved to $x = 4$. This means that when the value of x is 4, both sides will be equal. If each side of the equation were treated as a linear equation and graphed, the solution of the equation represents the coordinates of the point where the two lines would intersect. In this example, the ordered pair would be (4, 17). $10 \bullet 4 - 23 = 29 - 3 \bullet 4$ $40 - 23 = 29 - 12$ $17 = 17$ Equations having no solution have variables that will cancel out and constants that are not equal. This means that there is not a value that can be substituted for x that will make the sides equal. For example, the equation $-x + 7 - 6x = 19 - 7x$, can be simplified to $-7x + 7 = 19 - 7x$. If $7x$ is added to each side, the resulting equation is $7 = 19$, which is not true. No matter what value is substituted for x the final result will be $7 = 19$. If each side of the equation were treated as a linear equation and graphed, the lines would be parallel. An equation with infinitely many solutions occurs when both sides of the equation are the same. Any value of x will produce a valid equation. For example the following equation, when simplified will give the same values on both sides. $-\frac{1}{2}(36a - 6) = \frac{3}{4}(4 - 24a)$ $-18a + 3 = 3 - 18a$ If each side of the equation were treated as a linear equation and graphed, the graph would be the same line.
c. Solve real-world and mathematical	Students graph two linear equations, recognizing that the ordered pair for the point of intersection is the x-value

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.*	that will generate the given *y*-value for both equations. Students recognize that graphed lines with one point of intersection (different slopes) will have one solution, parallel lines (same slope, different y-intercepts) have no solutions, and lines that are the same (same slope, same y-intercept) will have infinitely many solutions. Students are not expected to change linear equations in standard form to slope-intercept form or solve systems using elimination. Given either two equations in slope-intercept form or one equation in standard form and one equation in slope-intercept form, students use substitution to solve the system.

Functions 8.F

Common Core Cluster

Define, evaluate, and compare functions.

<table>
<tr><th>Common Core Standard</th><th>Unpacking
What does this standard mean that a student will know and be able to do?</th></tr>
<tr><td>8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.[1]
[1] Function notation is not required in Grade 8.</td><td>8.F.1 Students distinguish between functions and non-functions, using equations, graphs, and tables. Non-functions occur when there is more than one <i>y</i>-value is associated with any <i>x</i>-value. Students are not expected to use the function notation <i>f(x)</i> at this level.</td></tr>
<tr><td>8.F.2 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></td><td>8.F.2 Students compare functions from different representations. For example, compare the following functions to determine which has the greater rate of change.
Function 1: $y = 2x + 4$
Function 2:<table><tr><th>x</th><th>y</th></tr><tr><td>-1</td><td>-6</td></tr><tr><td>0</td><td>-3</td></tr><tr><td>2</td><td>3</td></tr></table></td></tr>
<tr><td>8.F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. <i>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</i></td><td>8.F.3 Students use equations, graphs and tables to categorize functions as linear or non-linear. Students recognize that points on a straight line will have the same rate of change between any two of the points.</td></tr>
</table>

line.

Functions 8.F

Common Core Cluster

Use functions to model relationships between quantities.

Common Core Standard	Unpacking What does this standard mean that a student will know and be able to do?
8.F.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.	See below

8.F.4 Students identify the rate of change (slope) and initial value (y-intercept) from tables, graphs, equations or verbal descriptions.

Students recognize that in a table the y-intercept is the y-value when x is equal to 0. The slope can the determined by finding the ratio $\frac{y}{x}$ between the change in two y-values and the change between the two corresponding x-values.

The y-intercept in the table below would be (0, 2). The distance between 8 and -1 is 9 in a negative direction → -9; the distance between -2 and 1 is 3 in a positive direction. The slope is the ratio of rise to run or $\frac{y}{x}$ or $\frac{-9}{3}$ = -3.

x	y
-2	8
0	2
1	-1

Using graphs, students identify the y-intercept as the point where the line crosses the y-axis and the slope as the $\frac{\text{rise.}}{\text{run}}$

In a linear equation the coefficient of x is the slope and the constant is the y-intercept. Students need to be given the equations in formats other than $y = mx + b$, such as $y = ax + b$ (format from graphing calculator), $y = b + mx$ (often the format from contextual situations), etc. Note that point-slope form and standard forms are not expectations at this level.

In contextual situations, the y-intercept is generally the starting value or the value in the situation when the

	independent variable is 0. The slope is the rate of change that occurs in the problem. Rates of change can often occur over years. In these situations it is helpful for the years to be "converted" to 0, 1, 2, etc. For example, the years of 1960, 1970, and 1980 could be represented as 0 (for 1960), 10 (for 1970) and 20 (for 1980). Students use the slope and *y*-intercepts to write a linear function in the form $y = mx + b$. Situations may be given as a verbal description, two ordered pairs, a table, a graph, or rate of change and another point on the line. Students interpret slope and y-intercept in the context of the given situation.
8.F.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.	**8.F.5** Given a verbal description of a situation, students sketch a graph to model that situation. Given a graph of a situation, students provide a verbal description of the situation.

Geometry 8.G

Common Core Cluster

Understand congruence and similarity using physical models, transparencies, or geometry software.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.G.1 Verify experimentally the properties of rotations, reflections, and translations: a. Lines are taken to lines, and line segments to line segments of the same length. b. Angles are taken to angles of the same measure. c. Parallel lines are taken to parallel lines.	**8.G.1** In a translation, every point of the pre-image is moved the same distance and in the same direction to form the image. A reflection is the “flipping” of an object over a line, known as the “line of reflection”. A rotation is a transformation that is performed by “spinning” the figure around a fixed point known as the center of rotation. The figure may be rotated clockwise or counterclockwise. Students use compasses, protractors and ruler or technology to explore figures created from translations, reflections and rotations. Characteristics of figures, such as lengths of line segments, angle measures and parallel lines are explored before the transformation (pre-image) and after the transformation (image). Students understand that these transformations produce images of exactly the same size and shape as the pre-image and are known as rigid transformations.
8.G.2 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.	**8.G.2** This standard is the students’ introduction to congruency. Congruent figures have the same shape and size. Translations, reflections and rotations are examples of rigid transformations. A rigid transformation is one in which the pre-image and the image both have exactly the same size and shape since the measures of the corresponding angles and corresponding line segments remain equal (are congruent). Students examine two figures to determine congruency by identifying the rigid transformation(s) that produced the figures. Students recognize the symbol for congruency (≅) and write statements of congruency.

8.G.3 Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.	**8.G.3** Students identify resulting coordinates from translations, reflections, and rotations (90°, 180°and 270°both clockwise and counterclockwise), recognizing the relationship between the coordinates and the transformation. For example, a translation of 5 left and 2 up would subtract 5 from the *x*-coordinate and add 2 to the *y*-coordinate. D (-4, -3) → D' (-9, -1). A reflection across the *x*-axis would change B (6, -8) to B' (6, 8) Additionally, students recognize the relationship between the coordinates of the pre-image, the image and the scale factor following a dilation from the origin. Dilations are non-rigid transformations that enlarge (scale factors greater than one) or reduce (scale factors less than one) the size of a figure using a scale factor.
8.G.4 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.	**8.G.4** This is the students' introduction to similarity and similar figures. Students understand similar figures have angles with the same measure and sides that are proportional. Similar figures are produced from dilations. Students describe the sequence that would produce similar figures, including the scale factors. Students understand that a scale factor greater than one will produce an enlargement in the figure, while a scale factor less than one will produce a reduction in size.
8.G.5 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.*	**8.G.5** Students use exploration and deductive reasoning to determine relationships that exist between a) angle sums and exterior angle sums of triangles, b) angles created when parallel lines are cut by a transversal, and c) the angle-angle criterion for similarity of triangle. Students construct various triangles and find the measures of the interior and exterior angles. Students make conjectures about the relationship between the measure of an exterior angle and the other two angles of a triangle. (the measure of an exterior angle of a triangle is equal to the sum of the measures of the other two interior angles) and the sum of the exterior angles (360°). Using these relationships, students use deductive reasoning to find the measure of missing angles. Students construct parallel lines and a transversal to examine the relationships between the created angles. Students recognize vertical angles, adjacent angles and supplementary angles from 7th grade and build on these relationships to identify other pairs of congruent angles. Using these relationships, students use deductive reasoning to find the measure of missing angles. Students construct various triangles having line segments of different lengths but with two corresponding congruent angles. Comparing ratios of sides will produce a constant scale factor, meaning the triangles are similar.

Geometry 8.G

Common Core Cluster

Understand and apply the Pythagorean Theorem.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.G.6 Explain a proof of the Pythagorean Theorem and its converse.	**8.G.6** Students explain the Pythagorean Theorem as it relates to the area of squares coming off of all sides of a right triangle. Students also understand that given three side lengths with this relationship forms a right triangle.
8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.	**8.G.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.	**8.G.8** One application of the Pythagorean Theorem is finding the distance between two points on the coordinate plane. Students build on work from 6th grade (finding vertical and horizontal distances on the coordinate plane) to determine the lengths of the legs of the right triangle drawn connecting the points. Students understand that the line segment between the two points is the length of the hypotenuse. The use of the distance formula is not an expectation.

Geometry 8.G

Common Core Cluster

Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.G.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.	**8.G.9** Students build on understandings of circles and volume from 7th grade to find the volume of cylinders, cones and spheres. Students understand the relationship between the volume of a) cylinders and cones and b) cylinders and spheres to the corresponding formulas.

Statistics and Probability 8.SP

Common Core Cluster

Investigate patterns of association in bivariate data.

Common Core Standard	**Unpacking** What does this standard mean that a student will know and be able to do?
8.SP.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.	**8.SP.1** Bivariate data refers to two variable data, one to be graphed on the x-axis and the other on the y-axis. Students represent measurement (numerical) data on a scatter plot, recognizing patterns of association. These patterns may be linear (positive, negative or no association) or non-linear
8.SP.2 Know that straight lines are widely used to model relationships	**8.SP.2** Students understand that a straight line can represent a scatter plot with linear association. The most appropriate linear model is the line that comes closest to most data points. The use of linear regression is not

<table>
<tr><td>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</td><td>expected.</td></tr>
<tr><td>8.SP.3 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>

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data 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></td><td>8.SP.3 Linear models can be represented with a linear equation. Students interpret the slope and y-intercept of the line in the context of the problem.

8.SP.4 Students recognize that categorical data can also be described numerically through the use of a two-way table. A two-way table is a table that shows categorical data classified in two different ways. The frequency of the occurrences are used to identify possible associations between the variables. For example, a survey was conducted to determine if boys eat breakfast more often than girls. The following table shows the results:

<table>
<tr><th></th><th>Male</th><th>Female</th></tr>
<tr><td>Eat breakfast on a regular basis</td><td>190</td><td>110</td></tr>
<tr><td>Do not eat breakfast on a regular basis</td><td>130</td><td>165</td></tr>
</table>

Students can use the information from the table to compare the probabilities of males eating breakfast (190 of the 320 males → 59%) and females eating breakfast (110 of the 375 females →29%) to answer the question. From this data, it can be determined that males do eat breakfast more regularly than females.</td></tr>
</table>