Orange East Supervisory Union Feb 2020
Mathematics: Grade 8

Grade Eight Mathematics Focus: Expressions and Equations; Working with and modeling bivariate data; Functions; Pythagorean Theorem

Solve linear equations and systems of linear equations; Using functions to describe quantitative relationships; Analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence; understanding and applying the Pythagorean Theorem.

Expressions & Equations

Common Core State Standards

- 8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions
- 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
- 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
- 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
- 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
- 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; 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.C.7 Solve linear equations in one variable
  - 8.EE.C.7.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
  - 8.EE.C.7.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 pairs of simultaneous linear equations
  - 8.EE.C.8.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
  - 8.EE.C.8.B Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection.
  - 8.EE.C.8.C Solve real-world and mathematical problems leading to two linear equations in two variables

Unit Name:	**Enduring Understanding**	**Essential Questions**
Expressions and Equations	• Linear relationships are used to model and solve real life situations • Scientific notation can be used to represent very large or small quantities	• What is the meaning of the slope and intercept of a line in the context of a situation? • What does the steepness of a line tell you about the magnitude of the rate of change? • How can you create a linear equation from information given in a table or a graph? • How do you know if a pair of linear equations have one solution, no solution or infinite solutions? • How do you evaluate and simplify equations

		by applying the rules for powers and roots? • What is the difference between scientific notation and standard notation?
Knows: • Direct Variation goes through the origin • Inverse Operations • How to balance an equation • Distributive property • To combine like terms • How to write and graph a proportional relationship	**Understands:** • Lines represent solutions of linear equations • The slope represents the change in y-value over the change in x-values • The y-intercept represents where the line crosses the y-axis, where x is equal to zero • The slope of a line can be derived using two points or a table • That slope is the concept of rate • That squaring and taking the square root of a number are inverse operations • A number is expressed in scientific notation when a single digit is ≥ 1 *and less than* 10 times and integer power of ten	**Does:** • Graph linear equations • Find the slopes of lines by using two points or tables • Write and graph proportional relationships (direct variation) • Graph lines in slope-intercept form • Write equations of lines in slope-intercept form. • Solve multi-step equations, including those with no or infinite solutions • Solve equations with variables on both sides. • Rewrite equations to solve for one variable in terms of another variable • Solve systems of linear equations by graphing, substitution, and elimination, including those with no or infinite solutions • 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 • Expresses large and small numbers using scientific notation
Essential Vocabulary: Direct Variation, exponents/powers, square roots/roots, scientific notation, slope, y-intercept, similar triangles, distributive property, like terms		

The Number System		
Common Core State Standards • 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, and convert a decimal expansion which repeats eventually into a rational number. • 8.NS.A.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).		
Unit Name: **The Number System**	**Enduring Understanding** • Not all numbers are rational numbers • Irrational numbers can be located on a number line by using rational numbers	**Essential Questions** • Why does one need to distinguish between rational and irrational numbers? • How does one locate irrational numbers on a number line?

Knows:	**Understands:**	**Does:**
● Numbers that are not rational are called irrational ● The process of dividing one number by another ● How to truncate or round a decimal expansion to a specific number of places ● How to compare decimal values ● The perfect square numbers (if not memorized, students should know how to find the perfect square numbers by multiplying each whole number by itself)	● All numbers, rational and irrational, have a location on a number line ● Every number has a decimal expansion ● Every rational number has a decimal expansion that terminates or eventually repeats ● A number in the form $^{a}/_{b}$ means a is divided by b ● Every irrational square root can be estimated by its location between two rational square roots, (ex: $\sqrt{7}$ is between $\sqrt{4}$ and $\sqrt{9}$)	● Find square roots of perfect squares and evaluate expressions involving square roots ● Find cube roots of perfect cubes and evaluate expressions involving cube roots ● Use square roots and cube roots to solve equations ● Define irrational numbers, approximate square roots, and approximate values of expressions involving irrational numbers ● Find rational approximations of irrational numbers ● Write and evaluate expressions using integer exponents ● Multiply and divide powers with the same base ● Find a power of a power or product of powers ● Simplify expressions involving the quotient of powers ● Evaluate expressions involving zero or negative integer exponents ● Identify, write, and compare numbers in scientific notation ● Add, subtract, multiply, and divide numbers in scientific notation ● Locate and compare approximations of irrational numbers on a number line ● Show that the decimal expansion of a rational number terminates or repeats eventually ● Convert a decimal expansion which repeats eventually into a rational number
Essential Vocabulary: roots, square roots, scientific notation, quotient of powers, power of a power, base, integer exponents, cube roots, irrational numbers, approximate, real numbers		

<table>
<tr><th colspan="3">Functions</th></tr>
<tr><td colspan="3">Common Core State Standards
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.
8.F.A.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
8.F.A.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.
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.
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.</td></tr>
<tr><td>Unit Name:
Functions</td><td>Enduring Understanding
A function has exactly one output for every input
A function can be represented in multiple ways
There are many different functional relationships that are non-linear</td><td>Essential Questions
What are the distinguishing characteristics of a graph of a function?
Why and how can functions model real-world relationships?
Why does one need to define a function?
When should functions be evaluated and compared?</td></tr>
<tr><td>Knows:
X represents all input values
Y represents all output values
Linear functions form a non-vertical line
Domain represents x-values
Range represents y-values
Properties of functions
When points do not fall in a straight line, then the function is not linear
Increasing when it goes up from left to right</td><td>Understands:
When to use a function to represent relationships
How to compare and write functions using tables, equations, and pictures
How to write function rules to represent a relationship
How to use input-output tables to represent functions
The slope-intercept form of a line defines a linear function (Y = mx + b)
The graph of a function is the set of ordered pairs consisting of an input and corresponding output
Linear functions can be used to model linear functions between two quantities
The rate of change of a linear function in terms of the situation it models, its graph or a table of values
The initial value of a linear function in terms of the situation it models, its graph or a table of</td><td>Does:
Define, evaluate, and compare relations and functions
Determine whether relations are functions
Write function rules and use input-output tables to represent functions
Use graphs to represent functions
Write linear functions using graphs or tables
Identify and compare linear and nonlinear functions
Analyze the relationship between two quantities using graphs
Sketch graphs to represent the relationship between two quantities
Use functions to model relationships between quantities
Compare properties of two functions each represented in a different way
Determine the rate of change and initial value of a function from the description of a relationship or two values from a table or a graph</td></tr>
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• Decreasing when it goes down from left to right	values	

Essential Vocabulary: Function, input, output, substitute, rate of change, initial value, horizontal change, vertical change, linear function, constant, constant rate of change, equation form, slope, y-intercept, qualitative graph, direct variation

Statistics and Probability		
Common Core State Standards • 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. • 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. • 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. • 8.SP.A.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.		
Unit Name:	**Enduring Understanding** • Scatterplots show whether or not there is an association between two quantities • Patterns of association can appear between two quantities of bi-variate data and be represented using a two-way table	**Essential Questions** • Why is it important to describe patterns of an association between two quantities? • When is a scatter plot used to determine if there is an association between two quantities? • When is a two-way table used to determine if there is an association between two variables?
Knows: • Positive association represents a positive slope of the model line • Negative association represents a negative slope of the model line • A linear association is represented by a line	**Understands:** • Investigate patterns of association in bi-variate data • Lines used to model the association between two quantities will provide more information than just the data points themselves • The model line gets more accurate as more data points are located on the line • Once the equation of a linear model is found, it can be used to solve problems in the	**Does:** • Construct, interpret, and describe patterns in scatter plots • Find lines of fit and use lines of fit to solve problems • Read, make, and interpret two-way tables • Choose appropriate data displays and identify and analyze misleading data displays • Describe patterns such as outliers, clustering, positive association, negative association, linear association and non-linear association

• A non-linear association is represented by non-linear data • Straight lines are widely used to model relationships between two quantitative variables • A two-way table summarizes data about two categorical variables collected from the same subjects • Relative frequencies for rows or columns in a two-way table can be used to describe possible associations between the two variables	context of bivariate measurement data • The slope and intercept of the linear model can be interpreted in the context of the problem • Patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table • How to interpret outliers and clusters in a data set	• Informally fit a straight for scatter plots that suggests a linear association • Informally assess the model fit by judging the closeness of the data points to the line for scatter plots that suggest a linear association • Use the equation of a linear model to solve problems in the context of bivariate data, interpreting the slope and y-intercept • Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subject • Use relative frequencies calculated for rows or columns to describe possible association between the two variables
Essential Vocabulary: scatter plots, lines of fit, two-way tables, bi-variate data, slope, y-intercept, frequencies, relative frequencies, quantitative variables, outlier, association, positive association, negative association, linear, non-linear, residual, interpretation, categorical data, variable, cluster		

Geometry

Common Core State Standards

- 8.G.A.1 - Verify experimentally the properties of rotations, reflections, and translations:
  - 8.G.A.1.A - Lines are taken to lines, and line segments to line segments of the same length.
  - 8.G.A.1.B - Angles are taken to angles of the same measure.
  - 8.G.A.1.C - Parallel lines are taken to parallel lines.
- 8.G.A.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.A.3 - Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
- 8.G.A.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.A.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.
- 8.G.B.6 - Explain a proof of the Pythagorean Theorem and its converse.
- 8.G.B.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.B.8 - Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
- 8.G.C.9 - Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Unit Name:	**Enduring Understanding** ● The congruence or similarity of two dimensional figures through a sequence of rotations, reflections, translations, and dilations. ● The Pythagorean Theorem can be used to find the distance between two points.	**Essential Questions** ● Why does one need to perform transformations on figures? ● How does knowing two figures are congruent or similar help one to solve problems? ● How can one use the Pythagorean Theorem to solve real-world and mathematical problems?
Knows: ● How to use the Pythagorean Theorem to determine an unknown side of a right triangle ● The converse of the Pythagorean Theorem ($a^2+b^2=c^2$) ● Volume is measured in cubic units ● Formulas for the volumes of cones, cylinders, and spheres ● Congruent figures have the same shape and size ● Similar figures have the same shape but not necessarily the same size ● Translations can be described by using coordinates ● The sum of the interior angles in a triangle is 180 degrees	**Understands:** ● Congruence and similarity using physical models, transparencies, or geometry software. ● Application of the Pythagorean theorem ● Application of the converse of the Pythagorean Theorem ● Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres. ● Volume is a unit of measurement that indicates the number of cubic units a three dimensional shape can hold ● When two angles of one triangle are congruent to two angles of another triangle, then the triangles are similar ● When two angles of one triangle are congruent to two angles of another triangle, the third angles are also congruent ● There are relationships between the interior and exterior angles of a triangle ● There are relationships among the angles formed when two parallel lines are cut by a transversal ● For triangles, congruence of corresponding angles determines similarity	**Does:** ● Identify congruent and similar figures and name corresponding angles or sides of congruent and similar figures ● Identify translations, reflections, rotations, and dilations ● Translate, reflect, rotate or dilate figures in the coordinate plane ● Find unknown measurements of similar figures ● Identify the angles when parallel lines are cut by a transversal and find the measures of the angles ● Find the measures of interior and exterior angles of triangles ● Identify similar and congruent triangles ● Provide geometric proof of the Pythagorean Theorem ● Use the Pythagorean Theorem to find missing side lengths of right triangles ● Use the converse of the Pythagorean Theorem to identify right triangles ● Use the Pythagorean Theorem to find distance between two points in a coordinate plane and to solve real-life problems ● Find the volume of a cylinder and the height of a cylinder given the volume ● Find the volume of a cone and the height of a cone given the volume ● Find the volume of a sphere and the radius of a sphere given the volume ● Solve real-world problems involving area, volume, and surface area of cylinders, cones, and spheres ● Use angle measure to solve real-world problems

Essential Vocabulary: reflection, rotation, dilation, translation, proof, interior, exterior, transversal, parallel, coordinate plane, volume, Pythagorean Theorem, transformation, line of reflection, center of rotation, congruent, scale factor, center, corresponding angles, perpendicular, alternate interior angles, linear pair, same side interior angle, exterior angle, theorem, leg, hypotenuse, ordered pair, right triangle, square, cone, cylinder, sphere		