East Middle 8th grade Algebra I
Instructional materials can be obtained from Trent Stout by email at: Trent.Stout@tcsedu.net

1st Nine Weeks

Properties of Real Numbers

Real numbers are all around us. The majority of numbers calculated are considered **real numbers.** This chapter defines a real number and explains important properties and rules that apply to real numbers.

Standards:

N-R N.3: Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Chapter Outline

- **Integers and Rational Numbers**
- **Addition of Rational Numbers**
- **Subtraction of Rational Numbers**
- **Multiplication of Rational Numbers**
- **Division of Rational Numbers**
- **Square Roots and Real Numbers**
- **Rational versus Irrational Numbers**

Expressions, Equations and Functions

The study of expressions, equations, and functions is the basis of mathematics. Each mathematical subject requires knowledge of manipulating equations to solve for a variable. Careers such as automobile accident investigators, quality control engineers, and insurance originators use equations to determine the value of variables.

Functions are methods of explaining relationships and can be represented as a rule, a graph, a table, or in words. The amount of money in a savings account, how many miles run in a year, or the number of trout in a pond are all described using functions.

Throughout this chapter, you will learn how to choose the best variables to describe a situation, simplify an expression using the Order of Operations, describe functions in various ways, write equations, and solve problems using a systematic approach.

Standards:

A-CED.1: Create equations and inequalities in one variable and use them to solve problems. ***Include equations arising from linear and quadratic functions, and simple rational and exponential functions.***

A-SSE.1: Interpret expressions that represent a quantity in terms of its context.

A-SSE.1b: Interpret complicated expressions by viewing one or more of their parts as a single entity. ***For example, interpret P*****(1+*r*)n** ***as the product of P and a factor not depending on P.***

A-SSE.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of "f" is the graph of the equation y = f(x).

Chapter Outline

- **Variable Expressions**
- **Order of Operation: PEMDAS**
- **The Distributive Property**
- **Translate Expressions**
- **Equations and Inequalities**
- **Functions as Rules and Tables**
- **Functions as Graphs**

Linear Equations

In this chapter, you will learn how to manipulate linear equations to solve for a particular variable. You already have some experience solving equations. This chapter is designed to help formalize the mental math you use to answer questions in daily life.

Standards:

N-Q.1: Use units as a way to understand problems and to guide the solution of multi- step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A-CED.1: Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A–CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A–CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*

A–CED.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*

A-REI.1: Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Chapter Outline

- **Solve One-Step Equations**
- **Solve Two-Step Equations**
- **Two-Step Equations from Verbal Models**
- **Solving Real-World Problems with Two-Step Equations**

- **Multi-Step Equations**
- **Equations with Variables on Both Sides**
- **Solve Multi-Step Equations Involving Rational Numbers**
- **Ratios & Proportions**
- **Scale and Indirect Measurement**
- **Find the Percent of Change**
- **Percent Problems**
- **Percent of Change**
- **Formulas for Problem Solving**
- **Real-World Problems Using Multi-Step Equations**

Graphing Linear Equations and Functions

The ability to graph linear equations and functions is important in mathematics. In fact, graphing equations and solving equations are two of the most important concepts in mathematics. If you master these, all mathematical subjects will be much easier, even Calculus!

This chapter focuses on the visual representations of linear equations. You will learn how to graph lines from equations and write functions of graphed lines. You will also learn how to find the slope of a line and how to use a slope to interpret a graph.

Weather, such as temperature and the distance of a thunderstorm can be predicted using linear equations. You will learn about these applications and more in this chapter.

Standards:

N-Q.1: Use units as a way to understand problems and to guide the solution of multi- step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A–CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. ***For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.***

A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the

solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12: Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

F-IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.

F-IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3: Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.*

F-IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*

F-IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*

F-IF.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-BF.3: Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them.*

A-REI.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

S-ID.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.9: Distinguish between correlation and causation.

Chapter Outline

- **The Coordinate (Cartesian) Plane**
- **Graphing Linear Equations**
- **Using Tables to Graph Functions**
- **Slope (Rate of Change)**
- **Graph: Slope-Intercept Form**
- **Graphs Using Intercepts**
- **Direct Variation**
- **Function Notation and Linear Functions**
- **Graphs of Absolute Value Equations**
- **Linear Inequalities in Two Variables**

2nd Nine Weeks

Writing Linear Equations

You saw in the last chapter that linear graphs and equations are used to describe a variety of real-life situations. In mathematics, the goal is to find an equation that explains a situation as presented in a problem. In this way, we can determine the rule that describes the relationship. Knowing the equation or rule is very important since it allows us to find the values for the variables. There are different ways to find the best equation to represent a problem. The methods are based on the information you can gather from the problem.

This chapter focuses on several formulas used to help write equations of linear situations, such as slope-intercept form, standard form, and point-slope form. This chapter also teaches you how to fit a line to data and how to use a fitted line to predict data.

Standards:

A.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

F-IF.8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-BF.1: Write a function that describes a relationship between two quantities.

S-ID.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-ID.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.8: Compute (using technology) and interpret the correlation coefficient of a linear fit.

Chapter Outline

- **Linear Equations in Slope-Intercept Form**
- **Linear Equations in Point-Slope Form**
- **Linear Equations in Standard Form**
- **Slope of a Line Using Two Points**
- **Comparing Equations of Parallel and Perpendicular Lines**
- **Equations of Parallel Lines**
- **Parallel or Perpendicular Lines**
- **Equations of Parallel and Perpendicular Lines**

Linear Inequalities and Absolute Value and Graphing Inequalities

This chapter moves beyond equations to the study of inequalities. Many situations have more than one correct answer. A police officer can issue a ticket for any speed exceeding the limit. A rider for the bumper boats must be less than 48 inches tall. Both these situations have many possible answers

Standards:

A-R EI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Chapter Outline

- **Inequalities Using Addition and Subtraction**
- **Inequalities Using Multiplication and Division**
- **Multi-Step Inequalities**
- **Solving Compound Inequalities**
- **Absolute Value Equations**
- **Absolute Value Inequalities**

Systems of Equations and Inequalities

Every equation and inequality you have studied thus far is an example of a **system**. A system is a set of equations or inequalities with the same variables. This chapter focuses on the methods used to solve a system such as graphing, substitution and elimination. You will combine your knowledge of graphing inequalities to solve a system of inequalities.

Standards:

A–CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. ***For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.***

A-REI.5: Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6: Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-R EI.12: Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Chapter Outline

- **Checking a Solution for a Linear System**
- **Solving Systems by Graphing**
- **Solving Systems by Substitution**
- **Solving Linear Systems by Addition or Subtraction**
- **Solving Systems by Multiplying One Equation to Cancel a Variable**
- **Solving Linear Systems by Multiplication**
- **Solving Systems by Multiplying Both Equations to Cancel a Variable**
- **Special Types of Linear Systems**
- **Applications of Linear Systems**
- **Systems of Linear Inequalities**

Exponents and Exponential Functions

Exponential functions occur in daily situations; money in a bank account, population growth, the decay of carbon-14 in living organisms, and even a bouncing ball. Exponential equations involve **exponents**, or the concept of repeated multiplication. This chapter focuses on combining expressions using the properties of exponents. The latter part of this chapter focuses on creating exponential equations and using the models to predict.

Standards:

A*-SSE.3c: Use the properties of exponents to transform expressions for exponential functions.** ***For example, the expression **1.15t** ***can be rewritten as*** **(1.151/12)12t ≈ 1.01212t** ***to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.***

F–LE.1c: Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

F–LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F–LE.3: Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F–LE.5: Interpret the parameters in a linear or exponential function in terms of a context.

Chapter Outline

- **Exponential Properties Involving Products**
- **Exponential Properties Involving Quotients**
- **Negative Exponents**
- **Zero, Negative, and Fractional Exponents**
- **Exponential Expressions**
- **Scientific Notation**

3rd Nine Weeks

Polynomials and Factoring

This chapter will present a new type of function: the **polynomial.** Chances are, polynomials will be new to you. However, polynomials are used in many careers and real life situations - to model the population of a city over a century, to predict the price of gasoline, and to predict the volume of a solid. This chapter will also present basic **factoring** - breaking a polynomial into its linear factors. This will help you solve many quadratic equations found in Chapter 10.

Standards:

A-SSE.1: Interpret expressions that represent a quantity in terms of its context.

A-SSE.1a: Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1b: Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r) n as the product of P and a factor not depending on P.

A-SSE.2: Use the structure of an expression to identify ways to rewrite it. For example, see x 4 – y 4 as (x 2) 2 – (y 2) 2 , thus recognizing it as a difference of squares that can be factored as (x 2 – y 2)(x 2 + y 2).

A-S SE.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

Chapter Outline

- **Recognize and Identify Monomials, Binomials and Trinomials**
- **Write and Classify Polynomials in Standard Form**
- **Addition and Subtraction of Polynomials**
- **Multiplication of Polynomials**
- **Special Products of Polynomials**
- **Monomial Factors of Polynomials**
- **Factoring Quadratic Expressions**
- **Factoring Special Products**
- **Factoring Completely**
- **Factoring by Grouping**
- **Factoring Polynomials Completely**

Rational Expressions and Equations

This chapter introduces the concept of **rational functions,** that is, equations in which the variable appears in the denominator of a fraction. A common rational function in the **inverse variation model,** similar to the direct variation model you studied in chapter 4 lesson 6. We finish the chapter with solving rational equations and using graphical representations to display data.

Chapter Outline

- **Inverse Variation Models**
- **Graphs of Rational Functions**
- **Division of Polynomials**
- **Rational Expressions**
- **Multiplication and Division of Rational Expressions**
- **Addition and Subtraction of Rational Expressions**
- **Solution of Rational Equations**

4th Nine Weeks

Radical Expressions and Equations

Radicals in mathematics are important. By using radicals as inverse operations to exponents, you can solve almost any exponential equation. Radicals such as the square root have been used for thousands of years. Square roots are extremely useful in geometry by finding the hypotenuse of a right triangle or solving for the side length of a square.

In this chapter you will learn the basics of radicals and apply these basics to geometry concepts, such as Pythagorean's Theorem, the Distance Formula, and the Midpoint Formula. The last several sections of this chapter will discuss **data analysis**, a method used to analyze data by creating charts and graphs.

Standards:

S-ID.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2: Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID.3: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-ID.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-ID.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.6a: Fit a function to the data; use functions fitted to data to solve problems in the context of the data. ***Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.***

S-ID.6b: Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6c: Fit a linear function for a scatter plot that suggests a linear association.

S-ID.8: Compute (using technology) and interpret the correlation coefficient of a linear fit.

Chapter Outline

- **Graphs of Square Root Functions**
- **Radical Expressions**
- **Radical Equations**
- **The Distance and Midpoint Formulas**
- **The Pythagorean Theorem and its Converse**

Quadratic Equations and Functions

As you saw in Chapter 8, algebraic functions not only produce straight lines but curved ones too. A special type of curved function is called a parabola. Perhaps you have seen the shape of a parabola before:

- The shape of the water from a drinking fountain
- The path a football takes when thrown
- The shape of an exploding firework
- The shape of a satellite dish
- The path a diver takes into the water
- The shape of a mirror in a car's headlamp

Many real life situations model a quadratic equation. This chapter will explore the graph of a quadratic equation and how to solve such equations using various methods.

Standards:

A-SSE.3a: Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3b: Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-REI.4: Solve quadratic equations in one variable.

A-REI.4a: Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)2 = q$ that has the same solutions. Derive the quadratic formula from this form.

A-REI.4b: Solve quadratic equations by inspection (e.g., for $x2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

A-REI.11: Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.7a: Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-IF.8a: Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). ***For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.***

F–LE.3: Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

Chapter Outline

- **Graphs of Quadratic Functions**
- **Solving Quadratic Equations by Graphing**
- **Solving Quadratic Equations Using Square Roots**
- **Zero Product Principle**
- **Zero Product Property for Quadratic Equations**
- **Polynomial Equations in Factored Form**
- **Solving Quadratic Equations by Completing the Square**
- **Solving Quadratic Equations Using the Quadratic Formula**
- **The Discriminant**
- **Linear, Exponential, and Quadratic Models**
- **Problem-Solving Strategies: Choose a Function Model**
- **Applications of Quadratic Functions**