Mathematics *Standards of Learning* for Virginia Public Schools 2023 Algebra 1

The successful mastery of Algebra 1 is widely considered to be the gatekeeper to success in the study of upper-level mathematics. The study of algebraic thinking begins in kindergarten and is progressively formalized prior to the study of the algebraic content found in the Algebra 1 *Standards of Learning*. The progression of algebraic content includes patterning, generalization of arithmetic concepts, proportional reasoning, and representing mathematical relationships using tables, symbols, and graphs. All students are expected to achieve proficiency with the Algebra 1 *Standards*. The study of Algebra 1 assists students in generalizing patterns and representing relevant, contextual situations with algebraic models. To assist students in developing meaning and connecting algebraic concepts to geometry and statistics, consideration should be given to the sequential development of concepts and skills by using concrete materials to support the transition from the numeric to the symbolic. Connections between Algebra 1 and other subject areas through contextual applications may help students attach meaning to the abstract concepts of algebra.

These *Standards* require students to use algebra as a tool for representing and solving a variety of contextual problems. Tables and graphs will be used to interpret algebraic expressions, equations, and inequalities and to analyze behaviors of functions. These *Standards* include a transformational approach to graphing functions and writing equations when given the graph of the equation. Transformational graphing builds a strong connection between algebraic and graphic representations of functions.

Technology tools will be used to assist in teaching and learning. Graphing technologies facilitate visualizing, analyzing, and understanding algebraic and statistical behaviors and provide a powerful tool for solving problems, verifying solutions, and making connections.

Expressions and Operations

A.EO.1 The student will represent verbal quantitative situations algebraically and evaluate these expressions for given replacement values of the variables.

Students will demonstrate the following Knowledge and Skills:

a) Translate between verbal quantitative situations and algebraic expressions, including contextual situations.

b) Evaluate algebraic expressions which include absolute value, square roots, and cube roots for given replacement values to include rational numbers, without rationalizing the denominator.

A.EO.2 The student will perform operations on and factor polynomial expressions in one variable.

Students will demonstrate the following Knowledge and Skills:

a) Determine sums and differences of polynomial expressions in one variable, using a variety of strategies, including concrete objects and their related pictorial and symbolic models.

b) Determine the product of polynomial expressions in one variable, using a variety of strategies, including concrete objects and their related pictorial and symbolic models, the application of the distributive property, and the use of area models. The factors should be limited to five or fewer terms (e.g., $(4x + 2)(3x + 5)$ represents four terms and $(x + 1)(2x^2 + x + 3)$ represents five terms).

c) Factor completely first- and second-degree polynomials in one variable with integral coefficients. After factoring out the greatest common factor (GCF), leading coefficients should have no more than four factors.

d) Determine the quotient of polynomials, using a monomial or binomial divisor, or a completely factored divisor.

e) Represent and demonstrate equality of quadratic expressions in different forms (e.g., concrete, verbal, symbolic, and graphical).

A.EO.3 The student will derive and apply the laws of exponents.

Students will demonstrate the following Knowledge and Skills:

a) Derive the laws of exponents through explorations of patterns, to include products, quotients, and powers of bases.

b) Simplify multivariable expressions and ratios of monomial expressions in which the exponents are integers, using the laws of exponents.

A.EO.4 The student will simplify and determine equivalent radical expressions involving square roots of whole numbers and cube roots of integers.

Students will demonstrate the following Knowledge and Skills:

a) Simplify and determine equivalent radical expressions involving the square root of a whole number in simplest form.

b) Simplify and determine equivalent radical expressions involving the cube root of an integer.

c) Add, subtract, and multiply radicals, limited to numeric square and cube root expressions.

d) Generate equivalent numerical expressions and justify their equivalency for radicals using rational exponents, limited to rational exponents of $\frac{1}{2}$ and $\frac{1}{3}$ (e.g., $\sqrt{5} = 5^{\frac{1}{2}}$; $\sqrt[3]{8} = 8^{\frac{1}{3}} = (2^3)^{\frac{1}{3}} = 2$).

Equations and Inequalities

A.EI.1 The student will represent, solve, explain, and interpret the solution to multistep linear equations and inequalities in one variable and literal equations for a specified variable.

Students will demonstrate the following Knowledge and Skills:

a) Write a linear equation or inequality in one variable to represent a contextual situation.

b) Solve multistep linear equations in one variable, including those in contextual situations, by applying the properties of real numbers and/or properties of equality.

c) Solve multistep linear inequalities in one variable algebraically and graph the solution set on a number line, including those in contextual situations, by applying the properties of real numbers and/or properties of inequality.

d) Rearrange a formula or literal equation to solve for a specified variable by applying the properties of equality.

e) Determine if a linear equation in one variable has one solution, no solution, or an infinite number of solutions.

f) Verify possible solution(s) to multistep linear equations and inequalities in one variable algebraically, graphically, and with technology to justify the reasonableness of the answer(s). Explain the solution method and interpret solutions for problems given in context.

A.EI.2 The student will represent, solve, explain, and interpret the solution to a system of two linear equations, a linear inequality in two variables, or a system of two linear inequalities in two variables.

Students will demonstrate the following Knowledge and Skills:

a) Create a system of two linear equations in two variables to represent a contextual situation.

b) Apply the properties of real numbers and/or properties of equality to solve a system of two linear equations in two variables, algebraically and graphically.

c) Determine whether a system of two linear equations has one solution, no solution, or an infinite number of solutions.

d) Create a linear inequality in two variables to represent a contextual situation.

e) Represent the solution of a linear inequality in two variables graphically on a coordinate plane.

f) Create a system of two linear inequalities in two variables to represent a contextual situation.

g) Represent the solution set of a system of two linear inequalities in two variables, graphically on a coordinate plane.

h) Verify possible solution(s) to a system of two linear equations, a linear inequality in two variable, or a system of two linear inequalities algebraically, graphically, and with technology to justify the reasonableness of the answer(s). Explain the solution method and interpret solutions for problems given in context.

A.EI.3 The student will represent, solve, and interpret the solution to a quadratic equation in one variable.

Students will demonstrate the following Knowledge and Skills:

a) Solve a quadratic equation in one variable over the set of real numbers with rational or irrational solutions, including those that can be used to solve contextual problems.

b) Determine and justify if a quadratic equation in one variable has no real solutions, one real solution, or two real solutions.

c) Verify possible solution(s) to a quadratic equation in one variable algebraically, graphically, and with technology to justify the reasonableness of answer(s). Explain the solution method and interpret solutions for problems given in context.

Functions

A.F.1 The student will investigate, analyze, and compare linear functions algebraically and graphically, and model linear relationships.

Students will demonstrate the following Knowledge and Skills:

a) Determine and identify the domain, range, zeros, slope, and intercepts of a linear function, presented algebraically or graphically, including the interpretation of these characteristics in contextual situations.

b) Investigate and explain how transformations to the parent function $y = x$ affect the rate of change (slope) and the y-intercept of a linear function.

c) Write equivalent algebraic forms of linear functions, including slope-intercept form, standard form, and point-slope form, and analyze and interpret the information revealed by each form.

d) Write the equation of a linear function to model a linear relationship between two quantities, including those that can represent contextual situations. Writing the equation of a linear function will include the following situations:

   i) given the graph of a line;

   ii) given two points on the line whose coordinates are integers;

   iii) given the slope and a point on the line whose coordinates are integers;

   iv) vertical lines as $x = a$; and

   v) horizontal lines as $y = c$.

e) Write the equation of a line parallel or perpendicular to a given line through a given point.

f) Graph a linear function in two variables, with and without the use of technology, including those that can represent contextual situations.

g) For any value, x, in the domain of f, determine $f(x)$, and determine x given any value $f(x)$ in the range of f, given an algebraic or graphical representation of a linear function.

h) Compare and contrast the characteristics of linear functions represented algebraically, graphically, in tables, and in contextual situations.

A.F.2 The student will investigate, analyze, and compare characteristics of functions, including quadratic, and exponential functions, and model quadratic and exponential relationships.

Students will demonstrate the following Knowledge and Skills:

a) Determine whether a relation, represented by a set of ordered pairs, a table, a mapping, or a graph is a function; for relations that are functions, determine the domain and range.

b) Given an equation or graph, determine key characteristics of a quadratic function including x-intercepts (zeros), y-intercept, vertex (maximum or minimum), and domain and range (including when restricted by context); interpret key characteristics as related to contextual situations, where applicable.

c) Graph a quadratic function, $f(x)$, in two variables using a variety of strategies, including transformations $f(x) + k$ and $kf(x)$, where k is limited to rational values.

d) Make connections between the algebraic (standard and factored forms) and graphical representation of a quadratic function.

e) Given an equation or graph of an exponential function in the form $y = ab^x$ (where b is limited to a natural number), interpret key characteristics, including y-intercepts and domain and range; interpret key characteristics as related to contextual situations, where applicable.

f) Graph an exponential function, $f(x)$, in two variables using a variety of strategies, including transformations $f(x) + k$ and $kf(x)$, where k is limited to rational values.

g) For any value, x, in the domain of f, determine $f(x)$ of a quadratic or exponential function. Determine x given any value $f(x)$ in the range of f of a quadratic function. Explain the meaning of x and $f(x)$ in context.

h) Compare and contrast the key characteristics of linear functions ($f(x) = x$), quadratic functions ($f(x) = x^2$), and exponential functions ($f(x) = b^x$) using tables and graphs.

Statistics

A.ST.1 The student will apply the data cycle (formulate questions; collect or acquire data; organize and represent data; and analyze data and communicate results) with a focus on representing bivariate data in scatterplots and determining the curve of best fit using linear and quadratic functions.

Students will demonstrate the following Knowledge and Skills:

a) Formulate investigative questions that require the collection or acquisition of bivariate data.

b) Determine what variables could be used to explain a given contextual problem or situation or answer investigative questions.

c) Determine an appropriate method to collect a representative sample, which could include a simple random sample, to answer an investigative question.

d) Given a table of ordered pairs or a scatterplot representing no more than 30 data points, use available technology to determine whether a linear or quadratic function would represent the relationship, and if so, determine the equation of the curve of best fit.

e) Use linear and quadratic regression methods available through technology to write a linear or quadratic function that represents the data where appropriate and describe the strengths and weaknesses of the model.

f) Use a linear model to predict outcomes and evaluate the strength and validity of these predictions, including through the use of technology.

g) Investigate and explain the meaning of the rate of change (slope) and *y*-intercept (constant term) of a linear model in context.

h) Analyze relationships between two quantitative variables revealed in a scatterplot.

i) Make conclusions based on the analysis of a set of bivariate data and communicate the results.