STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

New Jersey Student Learning Standards
Mathematics

Algebra 1 Guide to **Rigor**

Rigor requires students to engage with and demonstrate challenging mathematics with appropriate balance among the following:

- Conceptual Understanding: Educators develop students' conceptual understanding through tasks, brief problems, questions, multiple representations and opportunities for students to write and speak about their understanding. `
- Procedural Skill and Fluency: Educators expect, support and provide guidelines for procedural skill and fluency with core calculations and mathematical procedures when called for in the standards for the grade or course.
- Application: Educators provide opportunities for students to independently apply mathematical concepts in real-world situations and solve challenging problems with persistence, choosing and applying an appropriate model or strategy to new situations.

In the New Jersey Student Learning Standards, each standard is aligned to one or more components of rigor. Thus, each standard aims to promote student growth in conceptual understanding, procedural skill and fluency, and/or application. Key words and phrases in the standards indicate which component(s) of rigor the standard is targeting: standards targeting conceptual understanding often use terms like *understand*, *recognize*, or *interpret*; standards targeting procedural skill and fluency tend to use words like *fluently*, *solve (equations)*, or *graph*; and standards targeting application tend to use words like *word problems*, *real-world problems*, or *'in context'*;

This document is a reference guide for teachers to help them more quickly identify the components of rigor in each Algebra 1 New Jersey Student Learning Standard as they design lessons/units evidencing the relevant components of rigor

Specific modeling standards appear throughout the high school standards indicated by a star symbol (★). The star symbol sometimes appears on the heading for a group of standards; in that case, it should be understood to apply to all standards in that group.

NJ Student Learning Standards for Algebra 1 **Algebra: Seeing Structure in Expressions**	**Component(s) of Rigor**
A-SSE.A.1 **Interpret** expressions that represent a quantity in terms of its context. (★)	• conceptual understanding • application
A-SSE.A.1a **Interpret** parts of an expression, such as terms, factors, and coefficients.	• conceptual understanding

NJ Student Learning Standards for Algebra 1 **Algebra: Seeing Structure in Expressions**	**Component(s) of Rigor**
A-SSE.A.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.*	• conceptual understanding
A-SSE.A.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* $(x^2 - y^2)(x^2 + y^2)$.	• conceptual understanding

NOTE: This 'major' cluster has an associated cluster heading "Interpret the structure of expressions".

NJ Student Learning Standards for Algebra 1 **Algebra: Seeing Structure in Expressions**	**Component(s) of Rigor**
A-SSE.B.3 **Choose and produce** an equivalent form of an expression **to reveal and explain** properties of the quantity represented by the expression.	• conceptual understanding • procedural skill
A-SSE.B.3a **Factor** a quadratic expression **to reveal** the zeros of the function it defines.	• conceptual understanding
A-SSE.B.3b **Complete the square** in a quadratic expression **to reveal** the maximum or minimum value of the function it defines	• conceptual understanding • procedural skill
A-SSE.B.3c **Use the properties of exponents** to **transform** expressions for exponential functions. *For example, the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate is 15%*	• procedural skill

NOTE: This 'supporting' cluster has an associated cluster heading "Write expressions in equivalent forms to solve problems".

NJ Student Learning Standards for Algebra 1 **Algebra: Arithmetic with Polynomial and Rational Expressions**	**Component(s) of Rigor**
A-APR.A.1 **Understand** that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; **add, subtract, and multiply** polynomials.	• conceptual understanding • procedural skill

NOTE: This 'major' cluster has an associated cluster heading "Perform arithmetic operations on polynomials".

NJ Student Learning Standards for Algebra 1 **Algebra: Arithmetic with Polynomial and Rational Expressions**	**Component(s) of Rigor**
A-APR.B.3 **Identify** zeros of polynomials when suitable factorizations are available, and **use the zeros to construct** a rough graph of the function defined by the polynomial.	• conceptual understanding • procedural skill

NOTE: This 'supporting' cluster has an associated cluster heading "Understand the relationship between zeros and factors of polynomials".

NJ Student Learning Standards for Algebra 1 **Algebra: Creating Equations**	**Component(s) of Rigor**
A-CED.A.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	• conceptual understanding • procedural skill • application
A-CED.A.2 **Create** equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	• conceptual understanding • procedural skill • application
A-CED.A.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.*	• conceptual understanding • application
A-CED.A.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.*	• conceptual understanding • procedural skill • application

NOTE: This 'major' cluster has an associated cluster heading "Create equations that describe numbers or relationships".

NJ Student Learning Standards for Algebra 1 **Algebra: Reasoning with Equations and Inequalities**	**Component(s) of Rigor**
A-REI.A.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.	• conceptual understanding

NOTE: This 'major' cluster has an associated cluster heading "Understand solving equations as a process of reasoning and explain the reasoning".

NJ Student Learning Standards for Algebra 1 **Algebra: Reasoning with Equations and Inequalities**	**Component(s) of Rigor**
A-REI.B.3 **Solve** linear equations and inequalities in one variable, including equations with coefficients represented by letters.	• procedural skill
A-REI.B.4 **Solve** quadratic equations in one variable.	• procedural skill
A-REI.B.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.	• conceptual understanding • procedural skill
A-REI.B.4b **Solve** quadratic equations by inspection (e.g., for $x^2 = 49$), 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.	• conceptual understanding • procedural skill

NOTE: This 'major' cluster has an associated cluster heading "Solve equations and inequalities in one variable".

NJ Student Learning Standards for Algebra 1 **Number and Quantity: The Real Number System**	**Component(s) of Rigor**
A-REI.C.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.	• conceptual understanding
A-REI.C.6 **Solve** systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.	• conceptual understanding • procedural skill

NOTE: This 'additional' cluster has an associated cluster heading "Solve systems of equations".

NJ Student Learning Standards for Algebra 1 **Algebra: Reasoning with Equations and Inequalities**	**Component(s) of Rigor**
A-REI.D.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).	• conceptual understanding
A-REI.D.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.★	• conceptual understanding • procedural skill
A-REI.D.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.	• procedural skill

NOTE: This 'major' cluster has an associated cluster heading "Represent and solve equations and inequalities graphically".

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-IF.A.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 $y = f(x)$.	• conceptual understanding
F-IF.A.2 **Use** function notation, **evaluate** functions for inputs in their domains, and **interpret** statements that use function notation in terms of a context.	• conceptual understanding • procedural skill • application

NOTE: This 'major' cluster has an associated cluster heading "Interpret the structure of expressions".

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-IF.A.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 ≥1*	• conceptual understanding

NOTE: This 'major' cluster has an associated cluster heading "Interpret the structure of expressions".

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-IF.B.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.*★	• conceptual understanding • application
F-IF.B.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.*★	• conceptual understanding • application
F-IF.B.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.★	• conceptual understanding • procedural skill • application

NOTE: This 'major' cluster has an associated cluster heading "Interpret functions that arise in applications in terms of the context".

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-IF.C.7 **Graph** functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★	• conceptual understanding • procedural skill • application
F-IF.C.7a **Graph** linear and quadratic functions and **show** intercepts, maxima, and minima	• conceptual understanding • procedural skill
F-IF.C.7b **Graph** square root, cube root, and piecewise-defined functions, including step functions and absolute value functions	• conceptual understanding • procedural skill
F-IF.C.8 **Write** a function defined by an expression in different but equivalent forms **to reveal and explain** different properties of the function.	• conceptual understanding • procedural skill

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-IF.C.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.	• conceptual understanding • procedural skill • application
F-IF.C.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.*	• conceptual understanding

NOTE: This 'supporting' cluster has an associated cluster heading "Analyze functions using different representations".

NJ Student Learning Standards for Algebra 1 **Functions: Interpreting Functions**	**Component(s) of Rigor**
F-BF.A.1 **Write** a function that describes a relationship between two quantities.★	• conceptual understanding • application
F-BF.A.1a **Determine** an explicit expression, a recursive process, or steps for calculation from a context.	• conceptual understanding • application

NOTE: This 'supporting' cluster has an associated cluster heading "Build a function that models a relationship between two quantities".

NJ Student Learning Standards for Algebra 1 **Functions: Building Functions**	**Component(s) of Rigor**
F-BF.B.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.*	• conceptual understanding • procedural skill

NOTE: This 'additional' cluster has an associated cluster heading "Build new functions from existing functions".

NJ Student Learning Standards for Algebra 1 **Functions: Linear and Exponential Models**	**Component(s) of Rigor**
F-LE.A.1 **Distinguish** between situations that can be modeled with linear functions and with exponential functions.	• conceptual understanding • application
F-LE.A.1a **Prove** that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.	• conceptual understanding
F-LE.A.1b **Recognize** situations in which one quantity changes at a constant rate per unit interval relative to another.	• conceptual understanding • application

NJ Student Learning Standards for Algebra 1 **Functions: Linear and Exponential Models**	**Component(s) of Rigor**
F-LE.A.1c **Recognize** situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.	• conceptual understanding • application
F-LE.A.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).	• conceptual understanding • procedural skill • application
F-LE.A.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	• conceptual understanding

NOTE: This 'supporting' cluster has an associated cluster heading "Construct and compare linear and exponential models and solve problems".

NJ Student Learning Standards for Algebra 1 **Functions: Linear and Exponential Models**	**Component(s) of Rigor**
F-LE.B.5 **Interpret** the parameters in a linear or exponential function in terms of a context.	• conceptual understanding

NOTE: This 'supporting' cluster has an associated cluster heading "Interpret expressions for functions in terms of the situation they model".

NJ Student Learning Standards for Algebra 1 **Number and Quantity: Quantities**	**Component(s) of Rigor**
N-Q.A.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.	• conceptual understanding
N-Q.A.2 **Define** appropriate quantities for the purpose of descriptive modeling.	• conceptual understanding
N-Q.A.3 **Choose** a level of accuracy appropriate to limitations on measurement when reporting quantities.	• conceptual understanding

NOTE: This 'supporting' cluster has an associated cluster heading "Reason quantitatively and use units to solve problems".

NJ Student Learning Standards for Algebra 1 **Number and Quantity: The Real Number System**	**Component(s) of Rigor**
N-RN.B.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.	• conceptual understanding

NOTE: This 'additional' cluster has an associated cluster heading "Use properties of rational and irrational numbers".

NJ Student Learning Standards for Algebra 1 **Statistics and Probability: Interpreting Categorical and Quantitative Data**	**Component(s) of Rigor**
S-ID.A.1 **Represent** data with plots on the real number line (dot plots, histograms, and box plots).	• procedural skill • application
S-ID.A.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.	• conceptual understanding • application
S-ID.A.3 **Interpret** differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).	• conceptual understanding • application

NOTE: This 'additional' cluster has an associated cluster heading "Summarize, represent, and interpret data on a single count or measurement variable".

NJ Student Learning Standards for Algebra 1 **Statistics and Probability: Interpreting Categorical and Quantitative Data**	**Component(s) of Rigor**
S-ID.B.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.	• conceptual understanding • procedural skill • application
S-ID.B.6 **Represent** data on two quantitative variables on a scatter plot, and **describe** how the variables are related.	• conceptual understanding • procedural skill
S-ID.B.6a **Fit a function** to the data (including with the use of technology**); 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 and exponential models.	• conceptual understanding • procedural skill • application
S-ID.B.6b Informally **assess the fit** of a function by plotting and analyzing residuals, including with the use of technology.	• conceptual understanding • procedural skill
S-ID.B.6c **Fit** a linear function for a scatter plot that suggests a linear association.	• conceptual understanding • procedural skill

NOTE: This 'supporting' cluster has an associated cluster heading "Summarize, represent, and interpret data on two categorical and quantitative variables".

NJ Student Learning Standards for Algebra 1 **Statistics and Probability: Interpreting Categorical and Quantitative Data**	**Component(s) of Rigor**
S-ID.C.7 **Interpret** the slope (rate of change) and the intercept (constant term) of a linear model **in the context** of the data.	• conceptual understanding • application
S-ID.C.8 **Compute** (using technology) and **interpret** the correlation coefficient of a linear fit.	• conceptual understanding
S-ID.C.9 **Distinguish** between correlation and causation.	• conceptual understanding

NOTE: This 'major' cluster has an associated cluster heading "Interpret linear models".