Functions Mathematics Standards

Comparison Tool for Standards Transition

Updated June 2012

This document can be used to assist educators in analyzing the commonalities between the new Alaska mathematics standards and the Fourth Edition (Grade Level Expectations). This document is a first start toward a transition and districts may choose to augment with more detail.

The first column contains the new math standards. The second column shows the Grade Level Expectations (GLEs) that align to the new standards. The third column provides comments, usually highlighting differences between the new standards and GLEs that align in higher grades. Additionally, the comments may include a notation about an increase in rigor. Rigor may be defined as a standard that requires deeper understanding, higher-order thinking, expanded analytical processes, or simply a skill introduced at an earlier grade.

Note that some GLEs are coded with an L. This signifies that the GLE was not assessed on the statewide assessment; it was to be assessed at the local level. No new standards are identified as being for local assessment. Students advancing through the grades are expected to meet each year’s grade-specific standards and retain or further develop skills and understandings mastered in preceding grades.

In most cases there are not complete matches between the two sets of standards, and it should not be assumed that either the content or skills found in one set of standards will match completely with those of the other set.

| **New Math Standards** | **Grade Level Expectations** | **Comment** |
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| 6.RP.2. Understand the concept of a unit rate (*a*/*b* associated with a ratio *a:b* with *b ≠* 0, and use rate language in the context of a ratio relationship) and apply it to solve real world problems (e.g., unit pricing, constant speed).  *For example, “This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar.” “We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger.”* | **[6] E&C-5** developing and interpreting scale models  Any aligned GLE found in the higher grades will need to be absorbed in the lower grade as part of the transition. | Grade 6 GLE provides a specific real-world model for understanding unit rate.  **[7] E&C-6** solving proportions using a given scale  **[8] E&C-5** using ratio and proportion |

The new standards represent a shift in the purpose of the standards. They are more instructional in nature, intended to guide classroom curriculum. The new standards do not serve as an assessment document, unlike the GLEs. The Department with the support of stakeholders will prepare an assessment framework that will guide the development of the new assessments. The new standards will be assessed starting spring 2016. Until then, all districts will continue administering the Standards Based Assessments aligned to the GLEs through spring 2015.

**The GLEs that are not matched to the new standards can be found in a separate document, HS Math GLEs.** The comment column indicates where the GLE may be matched to a new standard in a lower or higher grade. Although some GLEs will be taught at other grade levels, teachers must provide opportunities for these GLEs to be reviewed in preparation for the spring Standards Based Assessments through spring 2015.

| **Grade 6 Math GLEs not matched by new standards** | **Comments** |
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| **The student demonstrates conceptual understanding of fractions (proper or mixed numbers), decimals, percents (whole number), or integers by**  **[6] N-2** identifying place value positions from thousandths to millions (L) | Grade 4 and 5 Standards  **(4.NF.6, 4.NF.7, 5.NBT.3)** |

This GLE must be reviewed prior to the SBA through spring 2015.

Finally, the new standards for each grade level define what students should understand and be able to do by the end of each grade which includes the Standards for Mathematical Practice. The Standards for Mathematical Practice describe characteristics and traits that mathematics educators at all levels should seek to develop in their students. They describe ways that students should be engaging with mathematics as they progress through school. The integration of these standards into classroom instruction is a key strategy for increasing cognitive demand and conceptual learning. The Standards for Mathematical Practice are included in the separate document, HS Math GLEs.

The next page provides an overview of this conceptual category.

**Functions Overview**

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| **Interpreting Functions**   * Understand the concept of a function and use function notation. * Interpret functions that arise in applications in terms of the context. * Analyze functions using different representations.   **Building Functions**   * Build a function that models a relationship between two quantities. * Build new functions from existing functions.   **Linear, Quadratic, and Exponential Models**   * Construct and compare linear, quadratic, and exponential models and solve problems. * Interpret expressions for functions in terms of the situation they model.   **Trigonometric Functions**   * Extend the domain of trigonometric functions using the unit circle. * Model periodic phenomena with trigonometric functions. * Prove and apply trigonometric identities. | **In High School, students:**   * Learn function notation and develop the concepts of domain and range, explore many examples of functions, including sequences, interpret functions given graphically, numerically, symbolically, and verbally, translate between representations, and understand the limitations of various representations; * Build on and informally extend their understanding of integer exponents to consider exponential functions, compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change, and interpret arithmetic sequences as linear functions and geometric sequences as exponential functions; * Consider quadratic functions by comparing key characteristics, select from among these functions to model phenomena, learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions, identify the real solutions of a quadratic equation, and expand their experience with functions to include more specialized functions; * Use the coordinate plane to extend trigonometry to model periodic phenomena; and * Extend their work with exponential functions to include solving exponential equations with logarithms, explore the effects of transformations on graphs of diverse functions, and identify appropriate types of functions to model a situation adjusting parameters and analyzing appropriateness of fit and making judgments about the domain. |
| **Connections to Expressions, Equations, Modeling, and Coordinates:** Determining an output value for a particular input involves evaluating an expression; finding inputs that yield a given output involves solving an equation. Questions about when two functions have the same value for the same input lead to equations, whose solutions can be visualized from the intersection of their graphs. Because functions describe relationships between quantities, they are frequently used in modeling. Sometimes functions are defined by a recursive process, which can be displayed effectively using a spreadsheet or other technology. | **Mathematical Practices (MP)**   1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning. |

**Interpreting Functions - Alaska New Mathematics Standards**

| **New Math Standards** | **Grade Level Expectations** | **Comment** |
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| **Understand the concept of a function and use function notation** |  |  |
| 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*). | NEW – not addressed in the GLEs | Function and function notation is not addressed in the GLEs. Domain and range are specifically addressed in the GLEs. |
| 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. | NEW – not addressed in the GLEs | Function notation or domain/range is not included in the GLEs. |
| F-IF.2.3. 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.* | NEW – not addressed in the GLEs | GLEs do not address recognizing functions from a table of values, recursive functions, or domain.  Extending sequences to the nth term and generalizing patterns happens earlier than high school. (see **[8] F&R-1**) |

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| **Interpret functions that arise in applications in terms of the context** |  |  |
| 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.\** | NEW – not addressed in the GLEs |  |
| 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 negative numbers would be an appropriate domain for the function.\** | NEW – not addressed in the GLEs | Domain and constraints are not addressed in the GLEs. |
| 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.\* | **[9] S&P-4** identifying and/or showing the meaning of a best fit line  **[10] S&P**-4 using a best fit line to describe trends and make predictions about data  **[9] E&C-4** determining rate by using ratio and proportion | These GLEs are broad and do not explicitly cover the new standard. Rate of change is not addressed in the GLEs. |

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| **Analyze functions using different representations** |  |  |
| 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.\*  a. Graph linear and quadratic functions and show intercepts, maxima, and minima.  b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.  c. Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.  d. (+) Graph rational functions, identifying zeros and discontinuities (asymptotes/holes) using technology, and algebraic methods when suitable factorizations are available, and showing end behavior.  e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. | a. NEW – not addressed in the GLEs  b. **[9] F&R-2** generalizing relationships (linear, quadratic, absolute value,) using a table of ordered pairs, a graph, or an equation  c.**,** d, and e. NEW – not addressed in the GLEs | a. GLE deals with graphing linear and quadratic functions but do not mention intercepts, maxima, and minima. Methods for this standard are under the GLE below.  **[9] PS-3** representing mathematical problems numerically, graphically, and/or symbolically, translating among these alternative representations; or using appropriate vocabulary, symbols, or technology to explain, justify, and defend strategies and solutions |

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| F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.  a. 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.  b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.* | a.and b. NEW – not addressed in the GLEs |  |
| 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.* | NEW – not addressed in the GLEs | The GLEs do not compare properties of two functions. |

**Building Functions - Alaska New Mathematics Standards**

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| **New Math Standards** | **Grade Level Expectations** | **Comment** |
| **Build a function that models a relationship between two quantities** |  |  |
| F-BF.1. Write a function that describes a relationship between two quantities.\*  a. Determine an explicit expression, a recursive process, or steps for calculation from a context.  b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*  c. (+) Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.* | a. **[9] F&R-2** generalizing relationships (linear, quadratic, absolute value,) using a table of ordered pairs, a graph, or an equation    b. and c. NEW – not addressed in the GLEs | a.The GLEdeals with explicit expressions but not with recursive process or steps. |
| F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.\* | NEW – not addressed in the GLEs |  |

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| **Build new functions from existing functions** |  |  |
| 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.* | NEW – not addressed in the GLEs |  |
| F-BF.4. Find inverse functions.  a. Solve an equation of the form *f(x*) = *c* for a simple function f that has an inverse and write an expression for the inverse. *For example, f(x) =2x3 for x > 0 or  f(x) = (x+1)/(x–1) for x* ≠*1.*  b. (+) Verify by composition that one function is the inverse of another.  c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.  d. (+) Produce an invertible function from a non-invertible function by restricting the domain. | NEW – not addressed in the GLEs |  |
| F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. | NEW – not addressed in the GLEs |  |

**Linear, Quadratic, and Exponential Models - Alaska New Mathematics Standards**

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| **New Math Standards** | **Grade Level Expectations** | **Comment** |
| **Construct and compare linear, quadratic, and exponential models and solve problems** |  |  |
| F –LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.  a. Show that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.  b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.  c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. | a. NEW – not addressed in the GLEs  b. **[9] G-5** graphing or identifying (using equations or formulas to determine the slope of line segments) on a coordinate plane  **[8] F&R-2** generalizing relationships (linear) using a table of ordered pairs, a graph, or an equation  c. NEW – not addressed in the GLEs |  |
| F –LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values. | **[9] F&R-2** generalizing relationships (linear, quadratic, absolute value,) using a table of ordered pairs, a graph, or an equation | Not specifically in GLEs as the GLEs target linear but not exponential. |
| 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. | NEW – not addressed in the GLEs |  |

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| F –LE.4. For exponential models, express as a logarithm the solution to *ab*ct = *d* where *a*, *c*, and *d* are numbers and the base *b* is 2, 10, or *e*; evaluate the logarithm using technology. | NEW – not addressed in the GLEs |  |
| **Interpret expressions for functions in terms of the situation they model** |  |  |
| F –LE.5. Interpret the parameters in a linear or exponential function in terms of a context. | NEW – not addressed in the GLEs |  |

**Trigonometric Functions - Alaska New Mathematics Standards**

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| **New Math Standards** | **Grade Level Expectations** | **Comment** |
| **Extend the domain of trigonometric functions using the unit circle** |  |  |
| F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. | NEW – not addressed in the GLEs |  |
| F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. | NEW – not addressed in the GLEs |  |
| F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosines, and tangent for π*-x*, π +*x*, and 2π –*x* in terms of their values for *x*, where *x* is any real number. | NEW – not addressed in the GLEs |  |
| F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. | NEW – not addressed in the GLEs |  |
| **Model periodic phenomena with trigonometric functions** |  |  |
| F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.\* | NEW – not addressed in the GLEs |  |
| F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. | NEW – not addressed in the GLEs |  |
| F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.\* | NEW – not addressed in the GLEs |  |
| **Prove and apply trigonometric identities** |  |  |
| F-TF.8. Prove the Pythagorean identity sin2(θ) + cos2(θ) = 1 and use it to calculate trigonometric ratios. | NEW – not addressed in the GLEs |  |
| F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. | NEW – not addressed in the GLEs |  |