

## 8th Grade Essential Standards Justification

The identified Essential Standards are targeted for emphasis, indicating that there could be a higher proportion of questions on those standards in the AASA. The state assessment will retain the same length and duration. ALL STANDARDS remain valid and subject to inclusion in each year's AASA. *All justifications listed on this document were developed by a working group of Arizona math educators and leaders.*

1. Develop understanding of irrational numbers.
2. Develop understanding of expressions and equations, including solving linear equations, linear inequalities, and systems of linear equations.
3. Develop understanding of the concept of a function and use functions to describe quantitative relationships, including modeling an association in bivariate data with a linear equation.

- (1) Students use their understanding of multiplication and apply properties to develop understanding of radicals and integer exponents. They use their knowledge of rational numbers to develop understanding of irrational numbers.
- (2) Students recognize equations for proportions ( $y/x = m$  or  $y = mx$ ) as special linear equations ( $y = mx + b$ ), understanding that the constant of proportionality ( $m$ ) is the slope, and the graphs are lines through the origin. They understand that the slope ( $m$ ) of a line is a constant rate of change, so that if the input or x-coordinate changes by an amount  $A$ , the output or y-coordinate changes by the amount  $m \cdot A$ . Students fluently solve linear equations and linear inequalities in one variable. They solve systems of two linear equations in two variables to analyze situations and solve problems. Students understand when they use properties of equality and logical equivalence, they maintain the solutions of the original equation.
- (3) Students grasp the concept of a function as a rule that assigns to each input exactly one output. They can translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations. Students use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For scatter plots that suggest linear association, students informally fit a straight line and assess the model fit by judging the closeness of the data points to the line.

*The Standards for Mathematical Practice complement the content standards so that students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years.*

**Develop understanding of irrational numbers.** Students use their understanding of multiplication and apply properties to develop understanding of radicals and integer exponents. They use their knowledge of rational numbers to develop understanding of irrational numbers.

| Coding                                                                                                 | Standard                                                                                                                                                                                                                                                                                                                              | Justification                                                                                                                                                                                      |
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| 8.EE.A.1                                                                                               | Understand and apply the properties of integer exponents to generate equivalent numerical expressions.                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>If these are written with numerical expressions that include simplifying perfect cubes and squares then this would also loop in 8.EE.A.2, 2a, 2b</li> </ul> |
| <b>Additional standards that support the core concept(s) and grade-level instructional priorities.</b> |                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                    |
| 8.NS.A.1                                                                                               | Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion. Know that numbers whose decimal expansions do not terminate in zeros or in a repeating sequence of fixed digits are called irrational.                                                                |                                                                                                                                                                                                    |
| 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 their values.                                                                                                                                                           |                                                                                                                                                                                                    |
| 8.NS.A.3                                                                                               | Understand that given any two distinct rational numbers, $a < b$ , there exist a rational number $c$ and an irrational number $d$ such that $a < c < b$ and $a < d < b$ . Given any two distinct irrational numbers, $a < b$ , there exist a rational number $c$ and an irrational number $d$ such that $a < c < b$ and $a < d < b$ . |                                                                                                                                                                                                    |
| 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. Know that $\sqrt{2}$ is irrational.                                                                                                                                          |                                                                                                                                                                                                    |
| 8.EE.A.2.a                                                                                             | Evaluate square roots of perfect squares less than or equal to 225.                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                    |
| 8.EE.A.2.b                                                                                             | Evaluate cube roots of perfect cubes less than or equal to 1000.                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                    |
| 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 express how many times larger or smaller one is than the other.                                                                                                                                 | <ul style="list-style-type: none"> <li>Visited in science standards as well</li> </ul>                                                                                                             |

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| <b>8.EE.A.4</b>   | <b>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.</b> | <ul style="list-style-type: none"> <li>• Visited in science as well</li> </ul>                                                                                                                                                          |
| <b>8.G.B.8</b>    | <b>Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.</b>                                                                                                                                                                  |                                                                                                                                                                                                                                         |
| <b>8.G.C.9</b>    | <b>Understand and use formulas for volumes of cones, cylinders and spheres and use them to solve real-world context and mathematical problems.</b>                                                                                                                    |                                                                                                                                                                                                                                         |
| <b>8.SP.B.5</b>   | <b>Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.</b>                                                                                                                                                            | <ul style="list-style-type: none"> <li>• Will be included in 5b questions</li> </ul>                                                                                                                                                    |
| <b>8.SP.B.5.a</b> | <b>Understand that the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.</b>                                                                                                                       | <ul style="list-style-type: none"> <li>• Will be included in 5b questions</li> </ul>                                                                                                                                                    |
| <b>8.SP.B.5.c</b> | <b>Design and use a simulation to generate frequencies for compound events.</b>                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• This may require design thinking and the design process, with prototyping and revision. This will likely not be appropriate for assessment but is more appropriate for instruction.</li> </ul> |

**Develop understanding of expressions and equations, including solving linear equations, linear inequalities, and systems of linear equations.** Students recognize equations for proportions ( $y/x = m$  or  $y = mx$ ) as special linear equations ( $y = mx + b$ ) understanding that the constant of proportionality ( $m$ ) is the slope, and the graphs are lines through the origin. They understand that the slope ( $m$ ) of a line is a constant rate of change, so that if the input or  $x$ -coordinate changes by an amount  $A$ , the output or  $y$ -coordinate changes by the amount  $m \cdot A$ .

Students fluently solve linear equations and linear inequalities in one variable. They solve systems of two linear equations in two variables to analyze situations and solve problems. Students understand when they use properties of equality and logical equivalence, they maintain the solutions of the original equation.

| Coding     | Standard                                                                                                                                                                                                                                                                                        | Justification                                                                                                                                                                                                                                                                                                                                                                                          |
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| 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 $(0, b)$ . | <ul style="list-style-type: none"> <li>This understanding of slope is an essential foundation for high school mathematics. We want students to go beyond saying “slope is rise over run” to the understanding that the slope is the same no matter what two points you choose grounded in the use of similar triangles.</li> </ul>                                                                     |
| 8.EE.C.7.b | Solve linear equations and inequalities with rational number coefficients, including solutions that require expanding expressions using the distributive property and collecting like terms.                                                                                                    | <ul style="list-style-type: none"> <li>Although this states that we expand using the distributive property, we will also want to include simplifying by “un-scaling” by dividing each side by the scalar also [<math>2(x-7) = 16</math> could be unscaled to <math>x-7 = 8</math>]</li> <li>This is a critical component of solving, as it has many concepts embedded in this one standard.</li> </ul> |
| 8.EE.C.8.c | Solve mathematical problems and problems in real-world context leading to two linear equations in two variables.                                                                                                                                                                                | <ul style="list-style-type: none"> <li>Questions for this standard NEED to include 8.EE.C.8.a and b, asking what the solution means in the context of the relationships. This may mean that there is a single solution, no solution, or infinitely many solutions and these can be related back to the specific context</li> </ul>                                                                     |
| 8.G.B.7    | Apply the Pythagorean Theorem to determine unknown side                                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>This is essential understanding to prepare for</li> </ul>                                                                                                                                                                                                                                                                                                       |

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|                                                                                                        | lengths in right triangles in real-world context and mathematical problems in two and three dimensions.                                                                                                                                                                                                                                                      | high school Geometry.                                                                                                                                                                                |
| 8.G.A.2                                                                                                | Understand that a two-dimensional figure is congruent to another if one can be obtained from the other by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that demonstrates congruence.                                                                                                             | <ul style="list-style-type: none"> <li>This is essential as a foundation for Algebra 1 transformations and transformations in high school Geometry.</li> </ul>                                       |
| 8.G.A.3                                                                                                | Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>This is the first time students experience dilations and it is essential for understanding high school Geometry.</li> </ul>                                   |
| 8.G.A.4                                                                                                | Understand that a two-dimensional figure is similar to another if, and only if, one can be obtained from the other by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that demonstrates similarity.                                                                        | <ul style="list-style-type: none"> <li>Same as 8.G.A.3 and 8.G.A.2</li> </ul>                                                                                                                        |
| 8.SP.B.5.b                                                                                             | Represent sample spaces for compound events using organized lists, tables, tree diagrams and other methods. Identify the outcomes in the sample space which compose the event.                                                                                                                                                                               | <ul style="list-style-type: none"> <li>Foundation for high school and beyond statistical design and interpretation</li> <li>This standard includes <b>8.SP.B.5</b> and <b>8.SP.B.5.a</b>.</li> </ul> |
| <b>Additional standards that support the core concept(s) and grade-level instructional priorities.</b> |                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                      |
| 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. <i>For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</i>                                             |                                                                                                                                                                                                      |
| 8.EE.C.7.a                                                                                             | Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solution. 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 (where $a$ and $b$ are different numbers). |                                                                                                                                                                                                      |
| 8.EE.C.8.a                                                                                             | Understand that solutions to a system of two linear equations in                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>Should be included in 8.EE.C.8.c</li> </ul>                                                                                                                   |

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|            | 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 including cases of no solution and infinite number of solutions. Solve simple cases by inspection.                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>Should be included in 8.EE.C.8.c</li> </ul>           |
| 8.G.A.1    | Verify experimentally the properties of rotations, reflections, and translations. Properties include: lines are taken to lines, line segments are taken to line segments of the same length, angles are taken to angles of the same measure, parallel lines are taken to parallel lines.                                                                                                                                 |                                                                                              |
| 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. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.</i> | <ul style="list-style-type: none"> <li>Will be revisited in high school standards</li> </ul> |
| 8.G.B.6    | Understand the Pythagorean Theorem and its converse.                                                                                                                                                                                                                                                                                                                                                                     |                                                                                              |

**Develop understanding of the concept of a function and use functions to describe quantitative relationships, including modeling an association in bivariate data with a linear equation.** Students grasp the concept of a function as a rule that assigns to each input exactly one output. They can translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations.

Students use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For scatter plots that suggest linear association, students informally fit a straight line and assess the model fit by judging the closeness of the data points to the line.

| Coding  | Standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Justification                                                                                                                                                                                                                                                                                    |
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| 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. (Function notation is not required in Grade 8.)                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>Understanding that the input maps to the output through a function is essential. You can also assess on questions that don't use expressions and equations. Verbal description is important. We recommend the use of multiple representations.</li> </ul> |
| 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. <i>For example, the function <math>A = s^2</math> giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4), and (3,9) which are not on a straight line.</i>                                                                                                                       | <ul style="list-style-type: none"> <li>This is significant learning in 8th grade that includes table, graph, and equation.</li> <li>8.SP.A.3 can offer rich contexts for this standard</li> </ul>                                                                                                |
| 8.F.B.4 | Given a description of a situation, generate 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 a graph. Track how the values of the two quantities change together. Interpret the rate of change and initial value of a linear function in terms of the situation it models, its graph, or its table of values. | <ul style="list-style-type: none"> <li>This is a partner with 8.SP.A.2 and therefore the situation modeled should come from data modeling and should include an interpretation of the data and context in terms of the linear relationship.</li> </ul>                                           |

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| <b>8.F.B.5</b>                                                                                         | <b>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.</b>                                                                                                                         | <ul style="list-style-type: none"> <li>Essential for success in HS. Context and graphs</li> </ul>                                                                                             |
| <b>Additional standards that support the core concept(s) and grade-level instructional priorities.</b> |                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                               |
| <b>8.F.A.2</b>                                                                                         | <b>Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.</i></b>                                               | <ul style="list-style-type: none"> <li>This is important in scope and sequence in the classroom. The other representations are covered through the standards highlighted in green.</li> </ul> |
| <b>8.SP.A.1</b>                                                                                        | <b>Construct and interpret scatter plots for bivariate measurement data to investigate and describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.</b>                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>This can be included in 8.F.B.4 to highlight these items to ensure the focus of function. (see comment on 8.F.B.4)</li> </ul>                          |
| <b>8.SP.A.2</b>                                                                                        | <b>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.</b>                                                                                                                     |                                                                                                                                                                                               |
| <b>8.SP.A.3</b>                                                                                        | <b>Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.</b>                                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>This is a partner for 8.F.A.3 and these can offer rich contexts for 8.F.A.3</li> </ul>                                                                 |
| <b>8.SP.A.4</b>                                                                                        | <b>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.</b> | <ul style="list-style-type: none"> <li>This standard is quite complex and will be revisited in high school.</li> </ul>                                                                        |