Statewide Framework Document for: 279998

# Business Statistics

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments and leadership alignment may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for one credit of Statistics or 3rd credit of math.** Washington Mathematics Standards (Common Core State Standards) support foundational mathematical knowledge and reasoning. While it is important to develop a conceptual understanding of mathematical topics and fluency in numeracy and procedural skills, teachers should also focus on the application of mathematics to career fields to support the three (3) key shifts of CCSS. The Standards for Mathematical Practice develop mathematical habits of mind and are to be modeled and integrated throughout the course.  The details about each mathematical standard can be found at Common Core Mathematics Standards.

| School District Name | |
|---|---|
| **Course Title:** Business Statistics | **Total Framework Hours:** 180 |
| **CIP Code:** 279998    ☒ **Exploratory** ☐ **Preparatory** | **Date Last Modified:**  December 29, 2020 |
| **Career Cluster:**   Business, Management, and Administration | **Cluster Pathway:**  General Management |
| **Course Summary:** This applied statistics course will give students the opportunity to explore many practical concepts in modern statistics. Students will learn how to analyze sales,   purchasing, business systems and personal finance data using statistical methods and graphs. They will measure variability in data sets and account for   statistical error. Students will also look at distribution patterns including binomial and geometric distributions. | |
| **Eligible for Equivalent Credit in:** Math | **Total Number of Units:** 15 |

| **Unit 1:** Exploring | **Total Learning Hours for Unit:** 10 |
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**Unit Summary**:

In this unit, competencies include:

- Use a variety of graphical techniques to display a distribution given quantitative or categorical variables: Dotplot, Histogram, Relative Frequency   Histogram, Stemplot, Boxplot, Bar Chart, Ogive, Time Plot, and Pie Chart.
- Interpret the graphical displays and distributions with respect to shape, outliers, center, and spread: "S.O.C.S."
- Use a variety of numerical techniques to summarize a set of univariate data: mean, median, quartiles, five-number summary, interquartile range,   standard deviation, range, and variance.
- Interpret numerical summaries and distributions of a set of data in the *context* of the situation.
- Identify and calculate outliers in a set of data.
- Explore the effects of linear transformations of a set of data.
- Compare distributions using graphical displays: back-to-back stemplots and side-by-side boxplots.
- Use technology to calculate numerical summaries.
- Use technology to display distributions.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Complete a graphical representation of the shoe size of math students.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Complete a graphical representation of the shoe size of math students.

   6.A.2 Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks    appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy
   10.A.2 Prioritize, plan and manage work to achieve the intended resultu

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

 I. Formulate Question

    Students can make the statistics question

    distinction.  Questions seek generalization.


 **National Business Education Association (NBEA) Computation Standards:**

 Number Relationships and Operations

    Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.

Patterns, Functions, and Algebra
    Achievement Standard: Use algebraic operations to solve problems.
Statistics and Probability
    Achievement Standard: Analyze and interpret data using common statistical procedures.
Problem-Solving Applications
Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| **Aligned Washington State Academic Standards** | |
| --- | --- |
| **Mathematics: Common Core** | HS.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. <br> HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. <br> HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <br> HS.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.* <br> HS.F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <br> HS.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.* <br> HS.S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). <br> HS.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. <br> HS.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). <br> HS.S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them. <br> MP2 Reason abstractly and quantitatively. <br> MP3 Construct viable arguments and critique the reasoning of others. <br> MP4 Model with mathematics. <br> MP5 Use appropriate tools strategically. <br> MP6 Attend to precision. <br> MP7 Look for and make use of structure. <br> MP8 Look for and express regularity in repeated reasoning. |

| **Unit 2:** Describing Location in a Distribution | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:

In this unit, competencies include:

- Compute measures of relative standing for individuals in a distribution using standardized values ($z$-scores) and percentile ranks.
- Demonstrate an understanding of a density curve with respect to its mean and median.
- Demonstrate and understanding of a normal distribution and the empirical (68 - 95 - 99.7) rule.
- Use both tables and technology to find the proportion of observations within an interval using a normal distribution.
- Use a variety of techniques to assess whether a normal model is appropriate, such as a histogram or a normal probability plot.
- Interpret standardized values in context to compare relative standing among a set of data.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Explore the 68-95-99.7 rule through a fine-grained distribution activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Explore the 68-95-99.7 rule through a fine-grained distribution activity.
  - 3.A.1 Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
  - 8.B.1 Monitor, define, prioritize and complete tasks without direct oversight

**Industry Standards and/or Competencies**:

 I. Formulate Question

   Students can make the statistics question distinction.

 III. Analyze Data

   Understand and use distributions in analysis as a global concept.

   Measure variability within a group; measure variability between

   groups.  Compare group to group using displays and measures of

   variability.

   Quantification of association; fitting of models for association.

 IV. Interpret Results

   Students are able to look beyond the data in some

   contexts.  Interpret measures of strength of association.

   Interpret models of association.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations
   Achievement Standard: Apply basic mathematical operations to solve problems.
Number Relationships and Operations
   Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.
Patterns, Functions, and Algebra
   Achievement Standard: Use algebraic operations to solve problems.
Statistics and Probability
Achievement Standard: Analyze and interpret data using common statistical procedures.

| **Aligned Washington State Academic Standards** | |
|---|---|
| **Mathematics: Common Core** | HS.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. |
| | HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. |
| | HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| | HS.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. |
| | HS.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. |
| | HS.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. |
| | HS.A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| | HS.G.MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).* |
| | HS.G.MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).* |
| | HS.G.MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).* |
| | HS.S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). |
| | HS.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. |
| | HS.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). |
| | HS.S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. |

| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |
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| **Unit 3:** Examining Relationships | **Total Learning Hours for Unit:** 10 |
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**Unit Summary**:

In this unit, competencies include:

- Construct and interpret a scatterplot for a set of bivariate quantitative data.
- Use technology to compute and interpret the correlation coefficient between two variables.
- Know and understand the basic properties of the correlation coefficient.
- Identify the explanatory and response variables in context to a given situation.
- Describe direction, strength, and form of the overall pattern in a scatterplot.
- Use technology to calculate the least squares regression line.
- Explain and interpret the meaning of the slope and *y*-intercept of a regression line.
- Use statistics (mean and standard deviation) of both sets of data to calculate the least squares regression line.
- Use the regression line to interpolate and extrapolate given a specific value of *x*.
- Calculate and interpret the residuals of a regression line.
- Use the coefficient of determination, $r^2$, to interpret the regression line.
- Recognize, identify, and explain influential observations and outliers in a scatterplot.
- Identify and explain lurking variables.
- Understand correlation does not imply causation.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Determine if there is a relationship between height and shoe size.
- Complete *The Case of the Missing M&Ms* activity *(CCSS: Mathematical Modeling)*.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Complete The Case of the Missing M&Ms activity
  - 6.A.1 Use technology as a tool to research, organize, evaluate and communicate information

**Industry Standards and/or Competencies**:
**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question
   Students can make the statistics question distinction.
   Questions seek generalization.

III. Analyze Data
   Understand and use distributions in analysis as a global concept.
   Measure variability within a group; measure variability between groups.
   Quantification of association; fitting of models for association.

IV. Interpret Results
   Students are able to look beyond the data in some contexts.
   Generalize from sample to population.
   Interpret measures of strength of association.
   Interpret models of association.

| Aligned Washington State Academic Standards | |
|---|---|
| **Mathematics: Common Core** | HS.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. <br> HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. <br> HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <br> HS.A.SSE.1 Interpret expressions that represent a quantity in terms of its context.* <br> HS.A.SSE.1a Interpret parts of an expression, such as terms, factors, and coefficients. <br> HS.A.SSE.1b Interpret complicated expressions by viewing one or more of their parts as a single entity. <br> HS.A.SSE.2 Use the structure of an expression to identify ways to rewrite it. <br> HS.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. <br> HS.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. <br> HS.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. <br> HS.A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <br> HS.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). <br> HS.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.* |
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| | HS.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. |
| | HS.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). |
| | HS.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. |
| | HS.F.IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. |
| | HS.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.* |
| | HS.F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. |
| | HS.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.* |
| | HS.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.* |
| | HS.F.IF.7a Graph linear and quadratic functions and show intercepts, maxima, and minima. |
| | HS.F.IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. |
| | HS.F.IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. |
| | HS.F.IF.7d (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. |
| | HS.F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. |
| | HS.F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. |

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| | HS.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.<br>HS.F.IF.8b Use the properties of exponents to interpret expressions for exponential functions.<br>HS.F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).<br>HS.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.<br>HS.F.BF.4 Find inverse functions.<br>HS.F.BF.4a 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.<br> HS.F.BF.4b (+) Verify by composition that one function is the inverse of another.<br>HS.F.BF.4c (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.<br>HS.F.BF.4d (+) Produce an invertible function from a non-invertible function by restricting the domain.<br>HS.F.BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.<br>HS.F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context.<br>HS.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.<br>HS.S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.<br>HS.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.<br>HS.S.ID.6b Informally assess the fit of a function by plotting and analyzing residuals.<br>HS.S.ID.6c Fit a linear function for a scatter plot that suggests a linear association.<br>HS.S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.<br>HS.S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.<br>HS.S.ID.9 Distinguish between correlation and causation. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others. |

| MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |
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| **Unit 4:** More About Relationships Between Two Variables | **Total Learning Hours for Unit:** 10 |
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**Unit Summary:**

In this unit, competencies include:
- Identify when a transformation is necessary to achieve linearity.
- Use the transformations involving powers and logarithms to linearize curved relationships.
- Use technology to achieve and assess linearity for curved relationships.
- Use a residual plot to determine if a linear model is appropriate.
- Use a two-way table to describe the relationship between two categorical variables.
- Calculate the marginal distribution and joint frequencies of a two-way table.
- Calculate conditional relative frequencies of a two-way table.
- Recognize possible lurking variables interfering with cause-and-effect relationships.
- Describe how confounding is an issue with determining cause-and-effect relationships.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:
- Explore two variables (weight and length) with the activity *How to Weigh an Alligator*.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*
- Explore two variables (weight and length) with the activity How to Weigh an Alligator.
  - 2.A.1 Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation
  - 2.C.3 Synthesize and make connections between information and arguments

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

  IV. Formulate Question

  Students can make the statistics question distinction.

 III. Analyze Data

  Understand and use distributions in analysis as a global concept.

  Measure variability within a group; measure variability between

groups.  Compare group to group using displays and measures of variability.
Quantification of association; fitting of models for association.

IV.  Interpret Results
Students are able to look beyond the data in some contexts.  Interpret measures of strength of association.
Interpret models of association.


**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations
   Achievement Standard: Apply basic mathematical operations to solve problems.
Number Relationships and Operations
   Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.
Patterns, Functions, and Algebra
   Achievement Standard: Use algebraic operations to solve problems.
Statistics and Probability
   Achievement Standard: Analyze and interpret data using common statistical procedures.
Problem-Solving Applications
   Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| Aligned Washington State Academic Standards | |
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| **Mathematics: Common Core** | HS.N.RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.<br>HS.N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. Use properties of rational and irrational numbers.<br>HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. Cluster: Interpret the structure of expressions.<br>HS.A.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*<br>HS.A.SSE.3a Factor a quadratic expression to reveal the zeros of the function it defines.<br>HS.A.SSE.3b Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. |

| | HS.A.SSE.3c Use the properties of exponents to transform expressions for exponential functions. |
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| | HS.A.SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. |
| | HS.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. |
| | HS.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. |
| | HS.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. |
| | HS.A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| | HS.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). |
| | HS.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.* |
| | HS.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. |
| | HS.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). |
| | HS.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. |
| | HS.F.IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. |
| | HS.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.* |
| | HS.F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. |

HS.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.*

HS.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.*

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

HS.F.IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

HS.F.IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

HS.F.IF.7d (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

HS.F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

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

HS.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.

HS.F.IF.8b Use the properties of exponents to interpret expressions for exponential functions.

HS.F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

HS.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.

HS.F.BF.4 Find inverse functions.

HS.F.BF.4a 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.

HS.F.BF.4b (+) Verify by composition that one function is the inverse of another.

HS.F.BF.4c (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

HS.F.BF.4d (+) Produce an invertible function from a non-invertible function by restricting the domain.

HS.F.BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

HS.F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.

| | HS.F.LE.1a Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. |
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| | HS.F.LE.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. |
| | HS.F.LE.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. |
| | HS.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). |
| | HS.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. |
| | HS.F.LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and dare numbers and the base b is 2, 10, or e; evaluate the logarithm using technology. |
| | HS.F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context. |
| | HS.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. |
| | HS.S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. |
| | HS.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. |
| | HS.S.ID.6b Informally assess the fit of a function by plotting and analyzing residuals. |
| | HS.S.ID.6c Fit a linear function for a scatter plot that suggests a linear association. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them. |
| | MP2 Reason abstractly and quantitatively. |
| | MP3 Construct viable arguments and critique the reasoning of others. |
| | MP4 Model with mathematics. |
| | MP5 Use appropriate tools strategically. |
| | MP6 Attend to precision. |
| | MP7 Look for and make use of structure. |
| | MP8 Look for and express regularity in repeated reasoning. |

| **Unit 5:** Producing Data | **Total Learning Hours for Unit:** 10 |
|---|---|
| **Unit Summary**: | |
| In this unit, competencies include: | |

- Differentiate between observational studies, experiments, and surveys.
- Identify and perform different sampling methods: Simple Random Sample, Convenient Sample, Stratified Random Sample, Systematic Random Sample, and Cluster Sample.
- Identify and explain possible sources of *bias* within sampling and surveys.
- Identify and explain the three principles of experimental design: Randomization, Control, and Replication.
- Understand and explain the components of a completely randomized design and a randomized block design (matched pairs as well).
- Identify and explain the treatments, experimental units, control groups, and response variable of an experiment.
- Differentiate between the concept of control and a control group.
- Explain placebo and blinding within an experiment.
- Use a variety of techniques to randomly assign experimental units to groups for treatment: random digit table and technology.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:
- Explore different ways of collecting data and types of bias with the *Rolling Down the River* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*
- Explore different ways of collecting data and types of bias with the *Rolling Down the River* activity.
  4.A.2 Evaluate information critically and competently

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question

  Students can make the statistics question distinction.

  Students pose their own questions of interest.

  Questions seek generalization.

II. Collect Data

  Students make design for differences.

  Sampling designs with random selection.

  Experimental designs with randomization.

IV. Interpret Results

  Aware of the effect of randomization on the results of experiments.

  Understand the difference between observational studies and experiments.

**National Business Education Association (NBEA) Computation Standards:**

Patterns, Functions, and Algebra

  Achievement Standard: Use algebraic operations to solve problems.

Measurements

    Achievement Standard: Use common international standards of measurement when solving problems.

Statistics and Probability

    Achievement Standard: Analyze and interpret data using common statistical procedures.

Problem-Solving Applications

    Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| **Aligned Washington State Academic Standards** |  |
|---|---|
| **Mathematics: Common Core** | HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.<br>HS.S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.<br>HS.S.IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.<br>HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.<br>HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.<br>HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.<br>HS.S.IC.6 Evaluate reports based on data. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |

| **Unit 6:** Probability and Simulation: The Study of Randomness | **Total Learning Hours for Unit:** 10 |
|---|---|
| **Unit Summary**:<br>In this unit, competencies include: | |

- Understand and perform a simulation of random phenomena using technology and a random digit table.
- Construct a simulation using the five components: state problem, state assumptions, assign digits, simulate many trials, and state conclusion in context.
- Understand the three types of probability: theoretical, empirical, and personal probability.
- Learn the law of large numbers.
- Learn how to use the multiplication counting principle, Venn diagrams, tree diagrams, and two-way tables to calculate probabilities.
- Differentiate between the general addition rule and the general multiplication rule for calculating probabilities.
- Determine and understand when events are disjoint, complementary, and independent.
- Determine when the assumption of independence is appropriate.
- Understand how to calculate conditional probabilities for not independent events.
- Understand how to calculate probabilities for not disjoint events.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students complete the following activities:

- *Aardvark*—a sample simulation
- Edgar Martinez Simulation

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- *Aardvark*—a sample simulation

    2.C.3 Synthesize and make connections between information and arguments

    4.A.2 Evaluate information critically and competently

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

IV. Interpret Results

Students are able to look beyond the data in some contexts.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations

Achievement Standard: Apply basic mathematical operations to solve problems.

Patterns, Functions, and Algebra

Achievement Standard: Use algebraic operations to solve problems.

Statistics and Probability

Achievement Standard: Analyze and interpret data using common statistical procedures.

**Aligned Washington State Academic Standards**

| | |
|---|---|
| **Mathematics: Common Core** | HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.<br>HS.S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.<br>HS.S.IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.<br>HS.S.CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").<br>HS.S.CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.<br>HS.S.CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.<br>HS.S.CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities<br>HS.S.CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.<br>HS.S.CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.<br>HS.S.CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) - P(A and B), and interpret the answer in terms of the model.<br>HS.S.CP.8 (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.<br>HS.S.CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision. |

| | MP7 Look for and make use of structure. |
| --- | --- |
| | MP8 Look for and express regularity in repeated reasoning. |

| **Unit 7:** Random Variables | **Total Learning Hours for Unit:** 10 |
| --- | --- |
| **Unit Summary**: | |

In this unit, competencies include:

- Recognize and define discrete random variables.
- Construct a probability distribution table and histogram for a discrete random variable.
- Determine probabilities for discrete and continuous random variables.
- Use a normal model to determine probabilities for a continuous random variable.
- Calculate the mean, standard deviation, and variance of a discrete random variable.
- Calculate the expected value of a discrete random variable.
- Use simulation methods and the law of large numbers to approximate the mean of a discrete random variable.
- Use rules to calculate the sums and differences of discrete random variables.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Explore the probability of games using the *Casino Lab: Craps Expected Value (CCSS: Mathematical Modeling)* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Explore the probability of games using the *Casino Lab: Craps Expected Value*
  4.A.2 Evaluate information critically and competently

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

II. Collect Data

   Sampling designs with random selection.

III. Analyze Data

   Understand and use distributions in analysis as a global concept.

   Measure variability within a group; measure variability between

   groups.

IV. Interpret Results

   Students are able to look beyond the data in some contexts.


**National Business Education Association (NBEA) Computation Standards:**

Statistics and Probability

| Achievement Standard: Analyze and interpret data using common statistical procedures. | |
|---|---|
| **Aligned Washington State Academic Standards** | |
| **Mathematics: Common Core** | HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.<br>HS.S.MD.1 (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.<br>HS.S.MD.2 (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.<br>HS.S.MD.3 (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value.<br>HS.S.MD.4 (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value.<br>HS.S.MD.5 (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.<br>HS.S.MD.5a Find the expected payoff for a game of chance.<br>HS.S.MD.5b Evaluate and compare strategies on the basis of expected values.<br>HS.S.MD.6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).<br>HS.S.MD.7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game). |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |

| **Unit 8: The Binomial and Geometric Distributions** | **Total Learning Hours for Unit: 10** |
|---|---|
| **Unit Summary**: | |

In this unit, competencies include:
- Recognize and identify a random variable as binomial or geometric.
- Use the binomial formula to determine probabilities of a binomial random variable.
- Use technology to calculate probabilities of a binomial and geometric random variable.
- Construct histograms of the distribution of a binomial and geometric random variable.
- Calculate cumulative distributions of a binomial random variable.
- Calculate the mean and standard deviation of a binomial and geometric random variable.
- Use a normal model to approximate the probabilities of a binomial random variable.

**Performance Assessments**: (Districts to complete for each unit)
*Example assessments for this unit include:*
It is expected that students:
- Investigate binomial distributions in a song using Twelve Days of Christmas.

**Leadership Alignment**: (Districts to complete for each unit)
*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*
*Example:*
- Investigate binomial distributions in a song using Twelve Days of Christmas.
  3.A.3 Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
  4.B.1 Use information accurately and creatively for the issue or problem at hand

**Industry Standards and/or Competencies**:
III. Analyze Data
    Understand and use distributions in analysis as a global concept.
    Quantification of association; fitting of models for association.
IV. Interpret Results
    Aware of the effect of randomization on the results of experiments.


**National Business Education Association (NBEA) Computation Standards:**
Mathematical Foundations
    Achievement Standard: Apply basic mathematical operations to solve problems.
Statistics and Probability
    Achievement Standard: Analyze and interpret data using common statistical procedures.
Problem-Solving Applications
    Achievement Standard: Use mathematical procedures to analyze and solve business problems.

**Aligned Washington State Academic Standards**

| | |
|---|---|
| **Mathematics: Common Core** | HS.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. |

| | HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. |
| --- | --- |
| | HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| | HS.A.SSE.1 Interpret expressions that represent a quantity in terms of its context.* |
| | HS.A.SSE.1a Interpret parts of an expression, such as terms, factors, and coefficients. |
| | HS.A.SSE.1b Interpret complicated expressions by viewing one or more of their parts as a single entity. |
| | HS.A.SSE.2 Use the structure of an expression to identify ways to rewrite it. |
| | HS.A.APR.4 Prove polynomial identities and use them to describe numerical relationships. |
| | HS.A.APR.5 (+) Know and apply the Binomial Theorem for the expansion of $(x + y)n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. |
| | HS.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. |
| | HS.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. |
| | HS.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. |
| | HS.A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| | HS.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.* |
| | HS.F.IF.7a Graph linear and quadratic functions and show intercepts, maxima, and minima. |
| | HS.F.IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. |
| | HS.F.IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. |
| | HS.F.IF.7d (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. |
| | HS.F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. |
| | HS.F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. |
| | HS.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. |
| | HS.F.IF.8b Use the properties of exponents to interpret expressions for exponential functions. |
| | HS.F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). |

| | HS.F.BF.1 Write a function that describes a relationship between two quantities.* |
|---|---|
| | HS.F.BF.1a Determine an explicit expression, a recursive process, or steps for calculation from a context. |
| | HS.F.BF.1b Combine standard function types using arithmetic operations. |
| | HS.F.BF.1c (+) Compose functions. |
| | HS.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.* |
| | HS.F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them. |
| | MP2 Reason abstractly and quantitatively. |
| | MP3 Construct viable arguments and critique the reasoning of others. |
| | MP4 Model with mathematics. |
| | MP5 Use appropriate tools strategically. |
| | MP6 Attend to precision. |
| | MP7 Look for and make use of structure. |
| | MP8 Look for and express regularity in repeated reasoning. |

| **Unit 9:** Sampling Distributions | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:

In this unit, competencies include:

- Identify parameters and statistics in a sample or experiment.
- Understand how sampling variability affects the differences from sample to sample.
- Describe bias and variability of a statistic in terms of the mean and spread of its sampling distribution.
- Understand how sample size affects the variability of a sampling distribution.
- Recognize when to use sample proportions.
- Calculate the mean and standard deviation of the sampling distribution of a sample proportion.
- Understand how sample size affects variability of the sampling distribution of a sample proportion.
- Understand when a normal model is appropriate to approximate the probabilities of distribution for a sample proportion.
- Calculate the mean and standard deviation of the sampling distribution of a sample mean.
- Understand when a normal model is appropriate to calculate probabilities for the sampling distribution of a sample mean.
- Understand the central limit theorem.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Explore a serial number sample using the *German Tanks* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Example:*

- Explore a serial number sample using the *German Tanks* activity.

   6.A.2 Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question

   Students can make the statistics question

   distinction.  Questions seek generalization.

II. Collect Data

   Sampling designs with random selection.

III. Analyze Data

   Understand and use distributions in analysis as a global concept.

   Measure variability within a group; measure variability between

   groups.  Quantification of association; fitting of models for

   association.

IV. Interpret Results

   Generalize from sample to population.


**National Business Education Association (NBEA) Computation Standards:**

Statistics and Probability

Achievement Standard: Analyze and interpret data using common statistical procedures

| **Aligned Washington State Academic Standards** | |
|---|---|
| **Mathematics: Common Core** | HS.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. |
| | HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. |
| | HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| | HS.S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). |
| | HS.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. |
| | HS.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). |

| | HS.S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. |
|---|---|
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |

| **Unit 10:** Estimating with Confidence | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:
In this unit, competencies include:
- Construct and interpret a confidence interval for a population mean and a population proportion.
- Describe the margin of error for a confidence interval for a population mean and a population proportion.
- Calculate the sample size needed to construct a confidence interval for a specific margin of error.
- Understand how to use the $t$-distribution for constructing a confidence interval for a population mean.
- Identify the conditions that must be present in order to calculate a confidence interval for a population mean and population proportion.
- Explain and interpret the standard error of a sample mean and a sample proportion.
- Interpret a confidence interval in context.
- Understand how sample size changes our conditions for interpreting and calculating a confidence interval for a population mean.
- Use one-sample confidence interval procedures to calculate the confidence interval for matched pairs data.

**Performance Assessments**: (Districts to complete for each unit)
*Example assessments for this unit include:*
It is expected that students complete the following activities:
- MLB sampling C.I.
- Movie sampling C.I. *(CCSS: Mathematical Modeling).*

**Leadership Alignment**: (Districts to complete for each unit)
*Leadership alignment must include a unit specific project/activity that aligns with the 21ˢᵗ Century Leadership Skills.*
*Example:*
- MLB sampling C.I.
    1.A.2 Create new and worthwhile ideas (both incremental and radical concepts)
    1.A.3 Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts

**Industry Standards and/or Competencies**:

I. Formulate Question

Students can make the statistics question distinction.

Students pose their own questions of interest.

Questions seek generalization.

III. Analyze Data

Understand and use distributions in analysis as a global concept.

Measure variability within a group; measure variability between groups.

Describe and quantify sampling error.

IV. Interpret Results

Generalize from sample to population.

Aware of the effect of randomization on the results of experiments.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations

Achievement Standard: Apply basic mathematical operations to solve problems.

Number Relationships and Operations

Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.

Statistics and Probability

Achievement Standard: Analyze and interpret data using common statistical procedures.

Problem-Solving  Applications

Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| Aligned Washington State Academic Standards | |
| --- | --- |
| **Mathematics: Common Core** | HS.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. <br> HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. <br> HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <br> HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. <br> HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. <br> HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. <br> HS.S.IC.6 Evaluate reports based on data. |

| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |
|---|---|

| **Unit 11:** Testing a Claim | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:
In this unit, competencies include:
- Explain, interpret, and understand the logic of significance testing.
- Differentiate between the null hypothesis and the alternative hypothesis.
- Discuss and understand the meaning of statistically significant results.
- Construct and interpret a hypothesis test for a population mean.
- Compare a two-sided test of significance to a confidence interval for inference.
- Differentiate between statistical significance and practical significance.
- Explain and interpret the two types of errors in hypothesis testing.
- Define and discuss the power of a test.
- Understand and interpret a *p*-value.

**Performance Assessments**: (Districts to complete for each unit)
*Example assessments for this unit include:*
It is expected that students:
- Complete the *Red or Black Card* guessing *(CCSS: Mathematical Modeling)* activity.

**Leadership Alignment**: (Districts to complete for each unit)
*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*
*Example:*
- Complete the *Red or Black Card* guessing
   3.A.1 Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts

**Industry Standards and/or Competencies**:
**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**
 I. Formulate Question
    Students can make the statistics question distinction.
    Students pose their own questions of interest.

Questions seek generalization.

III. Analyze Data

Understand and use distributions in analysis as a global concept.

Measure variability within a group; measure variability between groups.

IV. Interpret Results

Generalize from sample to population.

Aware of the effect of randomization on the results of experiments.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations

Achievement Standard: Apply basic mathematical operations to solve problems.

Number Relationships and Operations

Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.

Statistics and Probability

Achievement Standard: Analyze and interpret data using common statistical procedures.

Problem-Solving Applications

Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| Aligned Washington State Academic Standards | |
| --- | --- |
| **Mathematics: Common Core** | HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |

| **Unit 12:** Significance Tests in Practice | **Total Learning Hours for Unit:** 10 |
| --- | --- |
| **Unit Summary**:<br>In this unit, competencies include: | |

- Construct and interpret a one-sample *t*-test.
- Construct and interpret a one-sample *t*-test for matched pairs data.
- Construct and interpret a one-proportion *z*-test.
- Differentiate between the one-sample confidence interval for a population proportion and a one-sample significance test for a population proportion.
- Understand and state the assumptions and conditions that verify the appropriateness of a one-sample *t*-test and a one-proportion *z*-test.
- Recognize the importance of the design of the study, outliers, and skewness of a distribution with respect to a *t*-test.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Use a hypothesis to state confidence by completing the *Is One Side of a Coin Heavier* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Use a hypothesis to state confidence by completing the *Is One Side of a Coin Heavier* activity.
     4.A.2 Evaluate information critically and competently
     6.A.1 Use technology as a tool to research, organize, evaluate and communicate information

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

 I. Formulate Question

   Students can make the statistics question

   distinction.  Students pose their own questions of

   interest.

   Questions seek generalization.

 III. Analyze Data

   Understand and use distributions in analysis as a global concept.

   Measure variability within a group; measure variability between

   groups.

 IV. Interpret Results

   Generalize from sample to population.

   Aware of the effect of randomization on the results of experiments.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations

   Achievement Standard: Apply basic mathematical operations to solve problems.

Number Relationships and Operations

| | |
|---|---|
| Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions. | |
| Statistics and Probability | |
|    Achievement Standard: Analyze and interpret data using common statistical procedures. | |
| Problem-Solving Applications | |
|    Achievement Standard: Use mathematical procedures to analyze and solve business problems. | |

## Aligned Washington State Academic Standards

| | |
|---|---|
| **Mathematics: Common Core** | HS.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.<br>HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.<br>HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.<br>HS.S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).<br>HS.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.<br>HS.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).<br>HS.S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.<br>HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.<br>HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.<br>HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.<br>HS.S.IC.6 Evaluate reports based on data. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them.<br>MP2 Reason abstractly and quantitatively.<br>MP3 Construct viable arguments and critique the reasoning of others.<br>MP4 Model with mathematics.<br>MP5 Use appropriate tools strategically.<br>MP6 Attend to precision.<br>MP7 Look for and make use of structure.<br>MP8 Look for and express regularity in repeated reasoning. |

| **Unit 13:** Comparing Two Population Parameters | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:

In this unit, competencies include:
- Construct and interpret a two-sample $t$-test for a significance test for the difference between population means.
- Construct and interpret a two-sample $t$-interval for the difference between population means.
- Construct and interpret a two-proportion $z$-test for a significance test for the difference between population proportions.
- Construct and interpret a two-proportion $z$-interval for the difference between population proportions.
- Understand the interpretation of a two-sample t-interval and two-proportion $z$-interval approximate the magnitude of the difference between the parameters.
- Use technology to calculate the two-sample $t$-tests and $t$-intervals.
- Use technology to calculate the two-proportion $z$-tests and $z$-intervals.
- Verify the conditions are met to perform the two-sample $t$-tests and t-intervals as well as the two-proportion $z$-tests and $z$-intervals.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:
- Compare two populations by completing the *Paper Airplane Build-Off* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*
- Compare two populations by completing the *Paper Airplane Build-Off* activity.
    2.A.1 Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

**Industry Standards and/or Competencies**:

 **The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question

   Students can make the statistics question distinction.

   Students pose their own questions of interest.

   Questions seek generalization.

II. Collect Data

   Students make design for differences.

III. Analyze Data

   Understand and use distributions in analysis as a global concept.

   Measure variability within a group; measure variability between groups.

   Compare group to group using displays and measures of variability.

IV. Interpret Results

   Generalize from sample to population.

   Aware of the effect of randomization on the results of experiments.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations
   Achievement Standard: Apply basic mathematical operations to solve problems.
Number Relationships and Operations
   Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.
Statistics and Probability
   Achievement Standard: Analyze and interpret data using common statistical procedures.
Problem-Solving Applications
   Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| **Aligned Washington State Academic Standards** | |
|---|---|
| **Mathematics: Common Core** | HS.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. <br> HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. <br> HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <br> HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. <br> HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. <br> HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. <br> HS.S.IC.6 Evaluate reports based on data. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them. <br> MP2 Reason abstractly and quantitatively. <br> MP3 Construct viable arguments and critique the reasoning of others. <br> MP4 Model with mathematics. <br> MP5 Use appropriate tools strategically. <br> MP6 Attend to precision. <br> MP7 Look for and make use of structure. <br> MP8 Look for and express regularity in repeated reasoning. |

| **Unit 14:** Inference for Distribution of Categorical Variables: Chi-Square Procedures | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:
In this unit, competencies include:

- Explain when a chi-square test is for goodness of fit, a test of independence, or a test of homogeneity.
- Construct and interpret a chi-square test of goodness of fit.
- Construct and interpret a chi-square test of independence.
- Construct and interpret a chi-square test of homogeneity.
- Use technology to calculate a chi-square test.
- Verify the conditions are met to perform a chi-square test.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:
- Investigate the color distribution of samples of M&Ms compared with the advertised distribution using the *Chi-Square M&Ms* activity.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*
- Investigate the color distribution of samples of M&Ms compared with the advertised distribution using the *Chi-Square M&Ms* activity.

    5.A.2 Examine how individuals interpret messages differently, how values and points of view are included or excluded, and how media can influence beliefs and behaviors

    6.A.1 Use technology as a tool to research, organize, evaluate and communicate information

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question

    Students can make the statistics question distinction.

    Questions seek generalization.

II. Collect Data

    Students make design for differences.

III. Analyze Data

    Understand and use distributions in analysis as a global concept.

    Measure variability within a group; measure variability between groups.

    Compare group to group using displays and measures of variability.

    Quantification of association; fitting of models for association.

IV. Interpret Results

    Students are able to look beyond the data in some contexts.

    Generalize from sample to population.

    Aware of the effect of randomization on the results of experiments.

    Understand the difference between observational studies and experiments.

    Interpret measures of strength of association.

    Interpret models of association.

Distinguish between conclusions from association studies and experiments.

**National Business Education Association (NBEA) Computation Standards:**
Mathematical Foundations
    Achievement Standard: Apply basic mathematical operations to solve problems.
Number Relationships and Operations
    Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.
Statistics and Probability
    Achievement Standard: Analyze and interpret data using common statistical procedures.
Problem-Solving Applications
    Achievement Standard: Use mathematical procedures to analyze and solve business problems

| Aligned Washington State Academic Standards | |
|---|---|
| **Mathematics: Common Core** | HS.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. <br> HS.N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. <br> HS.N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <br> HS.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. <br> HS.S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. <br> HS.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. <br> HS.S.ID.6b Informally assess the fit of a function by plotting and analyzing residuals. <br> HS.S.ID.6c Fit a linear function for a scatter plot that suggests a linear association. <br> HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. <br> HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. <br> HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. <br> HS.S.IC.6 Evaluate reports based on data. |
| **Mathematical Practices** | Practice 1: Make sense of problems and persevere in solving them. <br> Practice 2: Reason abstractly and quantitatively. |

| | Practice 3: Construct viable arguments and critique the reasoning of others. |
|---|---|
| | Practice 4: Model with mathematics. |
| | Practice 5: Use appropriate tools strategically. |
| | Practice 6: Attend to precision. |
| | Practice 7: Look for and make use of structure. |
| | Practice 8: Look for and express regularity in repeated reasoning. |

| **Unit 15:** Inference for Regression | **Total Learning Hours for Unit:** 10 |
|---|---|

**Unit Summary**:

In this unit, competencies include:

- Construct and interpret a test of the hypothesis that the slope of the regression line is 0 in the population.
- Use technology to construct a *t*-test for slope of the regression line.
- Verify the conditions and assumptions are met in order to construct a *t*-test for slope of the regression line.
- Explain and interpret the meaning of the standard error about the least-squares regression line.

**Performance Assessments**: (Districts to complete for each unit)

*Example assessments for this unit include:*

It is expected that students:

- Complete a case study: Three pointers in college basketball—inference vs. regression.

**Leadership Alignment**: (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*

*Example:*

- Complete a case study: Three pointers in college basketball—inference vs. regression.
    4.A.1 Access information efficiently (time) and effectively (sources)
    4.A.2 Evaluate information critically and competently

**Industry Standards and/or Competencies**:

**The Guidelines for Assessment and Instruction in Statistics Education (GAISE):**

I. Formulate Question

    Students can make the statistics question distinction.

    Students pose their own questions of interest.

    Questions seek generalization.

III. Analyze Data

    Understand and use distributions in analysis as a global concept.

    Measure variability within a group; measure variability between groups.

    Quantification of association; fitting of models for association.

 IV. Interpret Results

Students are able to look beyond the data in some contexts.

Generalize from sample to population.

Aware of the effect of randomization on the results of experiments.

Interpret measures of strength of association.

Interpret models of association.

Distinguish between conclusions from association studies and experiments.

**National Business Education Association (NBEA) Computation Standards:**

Mathematical Foundations

Achievement Standard: Apply basic mathematical operations to solve problems.

Number Relationships and Operations

Achievement Standard: Solve problems involving whole numbers, decimals, fractions, percentages, ratios, averages, and proportions.

Statistics and Probability

Achievement Standard: Analyze and interpret data using common statistical procedures.

Problem-Solving Applications

Achievement Standard: Use mathematical procedures to analyze and solve business problems.

| Aligned Washington State Academic Standards | |
|---|---|
| **Mathematics: Common Core** | HS.N.RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.<br>HS.N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. Use properties of rational and irrational numbers.<br>HS.N.RN.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.<br>HS.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.<br>HS.A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.<br>HS.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.<br>HS.A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.<br>HS.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 |

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|---|---|
| | 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.* |
| | HS.F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. |
| | HS.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.* |
| | HS.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. |
| | HS.F.BF.4 Find inverse functions. |
| | HS.F.BF.4a 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. |
| | HS.F.BF.4b (+) Verify by composition that one function is the inverse of another. |
| | HS.F.BF.4c (+) Read values of an inverse function from a graph or a table, given that the function has an inverse. |
| | HS.F.BF.4d (+) Produce an invertible function from a non-invertible function by restricting the domain. |
| | HS.F.BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. |
| | HS.F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. |
| | HS.F.LE.1a Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. |
| | HS.F.LE.1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. |
| | HS.F.LE.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. |
| | HS.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). |
| | HS.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. |
| | HS.F.LE.4 For exponential models, express as a logarithm the solution to abct = d where a, c, and dare numbers and the base b is 2, 10, or e; evaluate the logarithm using technology. |
| | HS.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. |

| | HS.S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. |
|---|---|
| | HS.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. |
| | HS.S.ID.6b Informally assess the fit of a function by plotting and analyzing residuals. |
| | HS.S.ID.6c Fit a linear function for a scatter plot that suggests a linear association. |
| | HS.S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. |
| | HS.S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit. |
| | HS.S.ID.9 Distinguish between correlation and causation. |
| | HS.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. |
| | HS.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. |
| | HS.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. |
| | HS.S.IC.6 Evaluate reports based on data. |
| **Mathematical Practices** | MP1 Make sense of problems and persevere in solving them. |
| | MP2 Reason abstractly and quantitatively. |
| | MP3 Construct viable arguments and critique the reasoning of others. |
| | MP4 Model with mathematics. |
| | MP5 Use appropriate tools strategically. |
| | MP6 Attend to precision. |
| | MP7 Look for and make use of structure. |
| | MP8 Look for and express regularity in repeated reasoning. |