Livermore Valley Joint Unified School District

Course Title:	Statistics A/B
Grade Level(s):	10 – 12
Length of Course:	One semester or equivalent term
Credit:	10 units
Prerequisite:	Completion of Algebra II with a C- or better or consent from instructor
Co-requisite:	none

Course Overview:
In *Statistics A/B* students will be introduced to the study of statistics in a wide variety of areas. Topics discussed include displaying and describing data, the normal curve, regression, probability, statistical inference, confidence intervals, and hypothesis tests with applications in the real world. This course covers the four themes of introductory statistics: producing data, analyzing data, probability, and inference. Students will develop a basic understanding of statistics that will prepare them to solve problems that involve collecting and analyzing meaningful data. This includes the study of measures of central tendency, measures of variation, graphical representation of data, least squares regression, correlation, probability distributions, sampling techniques, parameter estimation, and hypothesis testing. Technology and statistical literacy will be integrated throughout the course.

Schools Offering:	Del Valle High School Granada High School Livermore High School Vineyard High School
Meets University of California Entrance Requirements:	*Update seeking* "c" Approval Prior UC Approval June 11, 2017
Board Approval:	*Update Pending Board Approval* Prior Board Approval May 9, 2006
Course Materials:	*Statistics and Probability with Applications, 3rd edition;* Starnes, Daren and Tabor, Josh; Bedford, Freeman & Worth, 2017 ISBN: 978-1-4641-2216-3 http://www.highschool.bfwpub.com
Supplemental Materials:	none

STATISTICS A/B

COURSE CONTENT:

Unit 1: Analyzing One-Variable Data

In this unit, students learn how to organize and visually display data from a single variable. Students then analyze data using numerical and graphical summaries. Students also learn how to calculate and describe the location of an individual within the distribution of a quantitative variable using the numerical data. They also use graphical models of density curves, including the normal distribution, to estimate an individual's location in a distribution.

Summary of Key Assignments and/or Activities

Students will complete an assignment called "Does hand sanitizer work?" For this activity, students will examine an experiment performed using 30 identical petri dishes. Each petri dish was randomly assigned to 10 students to press their hand in a dish after washing with soap, 10 students to press one hand in a dish after using hand sanitizer, and 10 students to press on hand in a dish after using nothing. Students will then examine, compare, and contrast the numerical summaries and visual representations of each group of 10. Topics addressed will include how many variables were recorded and of what type, constructing appropriate graphical displays and describing them, and accurately comparing distributions.

Unit 2: Analyzing Two-Variable Data

In this unit, students investigate relationships between two quantitative variables by making scatterplots of paired data. Then, students will determine the strength of the linear relationship between two variables, calculate the least-square regression equation, how well the linear model fits the data, and use the linear model to make predictions.

Summary of Key Assignments and/or Activities

The Stats Anchor problem of "When will the cherry trees blossom" students will use data taken from a Japanese cherry tree orchard. The data consists of outside temperature (Celsius) and the date of the first bloom in April for a 24-year period. Students will use technology to construct a scatter plot, calculate summary statistics such as correlation, the coefficient of determination, and Least Squares Regression Line (LSRL) for each set of variables. Then, students will use the regression model to predict what is the best day to visit Japan and see the cherry blossoms.

Unit 3: Collecting Data

In this unit, students learn how to identify populations and samples, good and bad sampling methods for observational studies, and how to take a simple random sample. They expand their knowledge to other random sampling methods and how sampling errors and non-sampling errors can occur. Students then learn good and bad methods of experimentation, how to identify the experimental units and treatments and methods of random allocation to treatment groups. They finish by learning how to use studies wisely.

Summary of Key Assignments and/or Activities

A key assignment within the unit is called, "How can we prevent malaria?" This assignment is key to help students understand the value of randomization while sampling data. Also learning that you can only derive cause and effect results from a well-designed experiment. Students are expected to design an experiment to determine the proportion of children that have negative effects because of

screening for Malaria. Using the techniques learned in this unit students will evaluate the effectiveness of malaria screening in Africa.

Unit 4: Probability

Unit 4 introduces probability as a long-run relative frequency of some chance event and uses simulation to build this understanding as well as estimate probabilities of chance events. Students will learn what a probability model is and basic probability rules. Additionally, they will learn how to organize information in a sample space including the use of two-way tables, Venn diagrams, and tree diagrams. Finally, students will learn the concepts and calculations for conditional probability, mutually exclusive and independent events, counting methods and probability through the multiplication principle, permutations, and combinations.

Summary of Key Assignments and/or Activities

The Stats Applied anchor problem is "Should a student athlete who fails a drug test be suspended?" Students will learn and apply the concepts of probability rules, conditional probability, mutually exclusive, and independent events, organize information in two-way tables or Venn diagrams and tree diagrams to help calculate probabilities and answer several questions leading to a conclusion for answering the main question by the end of the unit. This directly relates to the 2020 COVID-19 pandemic and the probabilities of true and false positives and negatives in testing for the disease. These concepts will be learned and emphasized in focused application problems at the end of each lesson and the anchor activity will be referred to throughout the unit and finally solved at the end of the unit. A Key activity is "What is probability?" a computer simulation developing the understanding of probability as a long-run relative frequency by drawing a line graph of the simulation results. StatsMedic activities will also be used to emphasize concepts and will wrap up with the "FRAME Routine" in which students outline the thought process to distinguish between union ("or" statements) and intersection ("and" statements) and their calculations.

Unit 5: Random Variables

In this unit, students will discuss two types of random variables, discrete and continuous, and their properties. Emphasized are the binomial random variable and the binomial distribution as well as continuous random variables that follow the Normal distribution. Methods of probability calculations for both distributions related to formulas and tables along with using technology to make these probability calculations are the culminating objectives of this unit.

Summary of Key Assignments and/or Activities

The Stats Applied anchor problem is "How did that vending machine go wrong?" The concepts to solve this problem will be learned, related to the problem, and revisited to solve the problem to conclude the unit. Key activities will be learning how to use the TI-84 calculator and stapplet.com to make probability calculations for the binomial and normal distributions with technology. These skills will then be applied to the activity "Pop quiz!" in which students find the probabilities of guessing on multiple choice quiz with "n" questions and "c" choices for each question. The concepts learned will then be applied to all binomial settings. The other key activity is "What's so special about the normal distribution?" in which the students learn the 68-95-99.7 empirical rule and how to use the visual representation of normal probability calculations using the online applet.

Unit 6: Sampling Distributions

In this unit, students will learn what a sampling distribution of a statistic is and how the sample size affects the shape and variation of the sampling distribution. They will learn how to determine the mean and standard deviation of sampling distributions for sample proportions and sample means as

well as how to interpret the standard deviation of a sampling distribution. If the sampling distribution can be approximated by the Normal distribution, then the students will make probability calculations based on that Normal distribution. The culminating concept is the Central Limit Theorem and how it applies to the sampling distribution of a sample mean.

Summary of Key Assignments and/or Activities
The opening activity of this unit "A penny for your thoughts?" is the anchor activity that will link all the concepts together throughout the unit. Students will generate data from the dates on a sample of pennies from a very large population of pennies. They will make note of the mean date minted and the proportion of pennies from the 2000s. They will then make posters of class dotplots for the sample proportions and sample means for different sized samples. These posters will be revisited throughout the unit, and added to, up to when the students work on a final activity about the Central limit theorem. From this opening activity to mid-unit activities and through the final activity student will get a full understanding of how sample size affects the shape and center of the sampling distribution and how the sampling distribution relates to the population distribution from where the samples were drawn. They will then use computer simulation and sketch the shapes of sampling distributions of different sizes from different shaped parent populations and write summaries of how these sampling distributions relate to the concepts that they have learned throughout the unit.

Unit 7: Estimating a Parameter
Students will learn how to calculate and interpret confidence intervals for estimating population proportions and population means. To do this, they will use previous knowledge of calculating the standard deviation of a sampling distribution, area under the curve for a Normal distribution, and combine that with new knowledge about how to calculate a margin of error. Students will then learn to check conditions for constructing confidence intervals and whether they can use their confidence interval for inference purposes as well as what the margin of error does and does not cover. They will then put all that together to construct and interpret confidence intervals along with understanding of and the ability to interpret what C% confidence means within the context of a problem.

Summary of Key Assignments and/or Activities
A key activity in this unit is "What's the mystery mean?" In this activity, the teacher will draw one sample of values from a population. From this sample the students will have to devise a plan to estimate the true population mean, only known to the teacher. Students will draw on previous knowledge, calculate number summaries and draw graphs and then come up with some plausible interval which they believe captures the true population mean. Students will informally discuss margin of error and from this they will start to develop the concept of a confidence interval. This activity will be revisited, and a poster will be made before the end of the unit to demonstrate their understanding of how to calculate a confidence interval for a mean, how to interpret the confidence interval and what C% confidence means with relation to their confidence interval. They will also learn what the margin of error does and does not cover.

Unit 8: Testing a Claim
In this unit, students will learn about a formal procedure for using observed data to decide between two competing claims (hypotheses). The claims are statements about a parameter, like the population proportion p or the population mean (Mu). Students will learn how to check conditions for constructing confidence intervals and performing significance tests for a population mean or proportions. They will also check conditions for performing a significance test and determine when

it is appropriate to use a t-procedure. Students will use formulas and tables as well as technology to calculate a test statistic and P-value when performing a significance test. After constructing C% confidence intervals or performing significance tests students will then make inferences about the population or a claim about a population mean.

Summary of Key Assignments and/or Activities
A key Activity in this unit is "What is normal body temperature?" This activity has students evaluate the common notion that normal body temperature is at 98.6 F. Students will analyze a data set that contains the body temperature of a random sample of 130 healthy men and women aged 18 to 40. Students will need to answer the question if the follow data provide convincing evidence that "normal" body temperature in the population of healthy adults 18-40 is not 98.6F

Unit 9: Comparing Two Populations or Treatments (optional unit)
In this unit, students will learn how to check conditions for constructing confidence intervals and performing significance tests for a population mean or a difference in means/ population proportion or a difference in proportions. If conditions are met, they will construct and interpret C% confidence intervals for estimating a population mean/proportion, estimating the difference between two means/proportions, and estimating a mean difference. They will also check conditions for performing a significance test and determine when it is appropriate to use paired t procedures versus two-sample t procedures. Students will use formulas and tables as well as technology to calculate a test statistic and P-value when performing a significance test about a population mean/proportion, difference between means and a mean difference. After constructing C% confidence intervals or performing significance tests students will then make inferences about the population or a claim about a population mean/proportion.

Summary of Key Assignments and/or Activities
The key assignment is "Are fast food drive-thrus fast and accurate?" Students examine the data from different fast-food restaurants. They will determine if there is a great difference between the time it took for different patrons to order and receive their food. Students will construct and interpret confidence intervals and perform a test of significance between the time of these fast-food restaurants. To determine if there was a significant difference in accuracy between the restaurants.

Unit 10: Inference for Distributions and Relationships (optional unit)
In this unit, students will state hypotheses, check conditions for and perform a chi-square test for goodness of fit for a categorical variable with two or more categories. They will state hypotheses, check conditions for and perform a chi-square test for homogeneity to determine if the distribution of a categorical variable differs for two or more populations or treatments or perform a chi-square test for independence to determine whether there is convincing evidence of an association between two categorical variables in a population. Finally, students will check conditions for and perform a t test for the slope of a least-squares regression line to determine if there is convincing evidence of a linear association between two quantitative variables.

Summary of Key Assignments and/or Activities
This key activity is "Does background music influence what customers buy?" This activity works to answer if a given data set provided convincing evidence of an association between type of background music and type of entree ordered? Through their analysis of a given two way table, students will determine whether French, Italian or no music is associated with the type food (French/Italian or other) ordered at a given restaurant.

California Content Standards and Standards for Mathematical Practice.
Higher Mathematics Standards, 2013

Standards for Mathematical Practice

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.

Statistics and Probability
Interpreting Categorical and Quantitative Data
Summarize, represent, and interpret data on a single count or measurement variable

1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
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.
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
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.

Summarize, represent, and interpret data on two categorical and quantitative variables

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.
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    a. 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.
    b. Informally assess the fit of a function by plotting and analyzing residuals.
    c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.
9. Distinguish between correlation and causation.

Making Inference and Justifying Conclusions
Understand and evaluate random processes underlying statistical experiments

1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
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.
5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
6. Evaluate reports based on data.

Conditional Probability and The Rules of Probability-

Understand independence and conditional probability and use them to interpret data

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").
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.
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.
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. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.
5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

Use the rules of probability to compute probabilities of compound events.

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.
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.
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.
9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

Calculate expected values and use them to solve problems

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.
2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
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. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.
4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

Use probability to evaluate outcomes of decisions

5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.
   a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.
   b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.
6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Instructional Methods and/or Strategies

Direct Instruction (Lecture)

- Direct instruction as an instructional method is used to provide students with clear understanding of new curriculum concepts through lecture and guided discussion. This can be used to help simplify technical language and connect current topics being learned to earlier information that has already been covered.

Flipped Classroom

- Pre-recorded videos are used to support students in one of two ways:
  1) provide students with review of previous material that will be used in the upcoming topics
  2) provide initial exposure to new material that students can/will then apply to practice/applications in upcoming classes
- Both of these options support students in successfully learning new material.

Activity based instruction

- Activity based instruction is used to help students see the topics being learned in the real world. This strategy gives students the opportunity to extend their knowledge beyond a textbook solution and problem solve using real data and collaboration with peers.

Assessment Methods and/or Tools

Practice Problem Sets

- Intent: Check understanding of small sections of curriculum on specific concept.
- Goal: The goal is to provide specific feedback on detailed skills as students are learning the material to recognize common pitfalls and avoid forming bad habits.

Lab Activities

- Intent: Show real life applications of content. Students will apply concepts learned in the course to real life situations including data that they themselves collect.
- Goal: Help students display an understanding of the content beyond a structured practice problem.

Assessments

- Intent: Provide students with a more summative assessment of their understanding using core textbooks.
- Goal: Measure student understanding and retention on larger breath of concepts than individual one at a time.

Poster Projects

- Intent: Give students an opportunity to apply what they have learned in a creative way.
- Goal: Show students how what they have learned can be applied to a topic of their choosing.