DELAWARE VALLEY SCHOOL DISTRICT

PLANNED INSTRUCTION

A PLANNED COURSE FOR:

Introductory Statistics

Curriculum Writing Committee:

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Grade Level: 10-12

Date of Board Approval: ____2020_____

DELAWARE VALLEY SCHOOL DISTRICT

Introductory Statistics Grading Policy Target Points

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Total Points	**455**	**460**	**370**	**435**	**100%**
Tests	**200**	**300**	**200**	**200**	**52%**
Quizzes	**150**	**130**	**140**	**145**	**33%**
Homework/ Classwork	**30**	**30**	**30**	**30**	**7%**
Project	**75**	**0**	**0**	**60**	**8%**

Curriculum Map

Overview:

This elective course is designed to introduce students to the concepts of statistics as they apply to many other fields of study. Major topics will include elementary data analysis with both graphical and numerical approaches; the design of experiments, sampling, and surveys, probability, and methods of inference. The course may be taken concurrently with Algebra II and Trigonometry but not in lieu of that course.

Time/Credit for the Course:

FULL YEAR, 1 CREDIT, 1 PERIOD/DAY

Goals:

Unit One - Understanding of: **60 days**

- Graphs to display distributions.
- Measures of central tendency and Interquartile Range.
- Identifying Outliers.
- Standard Deviation, Z-scores, and the Normal Curve.
- Graphical abuses and how to find them within line graphs and pictograms.
- Scatter Plots, Correlations, and Least-Squares Regression Line.
- Residual Plots and interpreting r-squared.

- Reasons for relationships, including causation, confounding, and common response.

Unit Two - Understanding of: 35 days

- Bias and simple random sample in conducting a statistical study.
- Parameters and test statistics of samples.
- Margin of Error and Confidence Statements.
- Sampling Errors and Non-Sampling Errors.
- The effect of wording in a sample question.
- Subjects and treatments when conducting an experiment.
- Placebo group and control groups.
- Sampling Surveys in the real world.
- Logic of experimental design.
- Differences in blind and double-blind experiments.
- Randomized experimental design.
- Block Designing Experiments.
- Experiments in the real world.
- Ethics in conducting experiments.

Unit Three - Understanding of: 40 days

- Finding Probability and Simulating data.
- Independent events.
- Probability models and sample space.
- Using Venn Diagrams for Probability.
- Rules for mutually exclusive events and conditional probability.
- Random variables and probability distributions.
- Law of large numbers and Sampling Distribution.
- Factorials, Permutations, and Combinations.
- Binomial Distribution and the Binomial Theorem.

Unit Four - Understanding of: 45 days

- Confidence intervals and sample proportions.
- Hypothesis Testing, one-sided or two-sided.
- Misuses of inference in the real world.
- Chi-square tests for Goodness of Fit and Two-Way Tables.
- T-scores and p-values.
- Inference about a Population Mean

DELAWARE VALLEY SCHOOL DISTRICT

Big Ideas:

BIG IDEA 1: VARIATION AND DISTRIBUTION (VAR)
The distribution of measures for individuals within a sample or population describes variation. The value of a statistic varies from sample to sample. How can we determine whether differences between measures represent random variation or meaningful distinctions? Statistical methods based on probabilistic reasoning provide the basis for shared understandings about variation and about the likelihood that variation between and among measures, samples, and populations is random or meaningful.

BIG IDEA 2: PATTERNS AND UNCERTAINTY (UNC) Statistical tools allow us to represent and describe patterns in data and to classify departures from patterns. Simulation and probabilistic reasoning allow us to anticipate patterns in data and to determine the likelihood of errors in inference.

BIG IDEA 3: DATA-BASED PREDICTIONS, DECISIONS, AND CONCLUSIONS (DAT) Data-based regression models describe relationships between variables and are a tool for making predictions for values of a response variable. Collecting data using random sampling or randomized experimental design means that findings may be generalized to the part of the population from which the selection was made. Statistical inference allows us to make data-based decisions.

Textbook and Supplemental Resources:

Name of Textbook: Statistics through Applications, Second Edition

Textbook ISBN #: 9-781-4292-1974-7

Textbook Publisher & Year of Publication: W.H. Freeman, 2011

Supplemental Resources:

- Fathom
- https://www.stapplet.com/
- Graphing calculator
- Online Applets available at http://www.rossmanchance.com/applets/
- "Against All Odds" video series and worksheets, Videos 1 - 13 https://www.learner.org/resources/series65.html#
- https://www.statsmedic.com/
- http://www.artofstat.com/

DELAWARE VALLEY SCHOOL DISTRICT

Unit:1: Elementary Data Analysis **Time Range in Days:** 60 days

Standard(s): College Board Advanced Placement Statistics Course Description
https://apcentral.collegeboard.org/pdf/ap-statistics-course-and-exam-description.pdf

Standards Addressed:
College Board AP Stat: AP Stat – IA (A,C,D), IB (A,B,C,D,E) , IC (A,C,D), ID (A,B,C,D) , IE (A,B,C,D)

Eligible Content:

- Identify the question to be answered or problem to be solved.
- Identify key and relevant information to answer a question or solve a problem.
- Describe an appropriate method for gathering and representing data
- Describe data presented numerically or graphically
- Construct numerical or graphical representations of distributions
- Calculate summary statistics, relative positions of points within a distribution, correlation, and predicted response.
- Compare distributions or relative positions of points within a distribution.
- Determine relative frequencies, proportions, or probabilities using simulation or calculations.

Objectives:

- Create a stemplot, dotplot, or histogram of the distribution of a quantitative variable. (DOK – Level 1,2)
- Assess and analyze the shape of a distribution. (DOK – Level 3,4)
- Describe the pattern of a set of data using measures of center and spread. (DOK – Level 1,2,3)
- Apply knowledge of the difference between measures of center and spread to use the appropriate measures to assess center and spread and identify outliers. (DOK – Level 2,3)
- Calculate means, medians, standard deviations, IQRs, and ranges for sets of data. Analyze the results within the context of the data. (DOK – Level 1,2,3,4)
- Use graphs, numerical summaries, and or boxplots to compare categorical or quantitative variables. (DOK – Level 1,2)
- Assess the standardized score (z-score) of an observation and interpret those scores in context. (DOK – Level 3)

- Express individual values in terms of their percentiles, and critique those percentiles in context. (DOK – Level 3,4)
- Summarize the properties of a density curve, and locate its approximate mean, median, and mode. Compare the mean and median for a given density curve. (DOK – Level 2,3)
- Describe the shape of normal curves and estimate both the mean and the standard deviation of a Normal density curve. (DOK – Level 1,2)
- Summarize the 68-95-99.7 rule and symmetry to estimate the proportion of observations between two points lying at one, two, or three standard deviations on either side of the mean. (DOK – Level 2)
- Assess the standard normal distribution to calculate the proportion of values between two points, and to determine a z-score from a percentile, using a table and/or a graphing calculator. (DOK – Level 1,2,3)
- Calculate the point having a given proportion of values above or below it in a Normal distribution with given mean and standard deviation, and interpret the result. (DOK – Level 1,2)
- Classify variables as quantitative or categorical, and identify explanatory and response variables in bivariate data sets when one variable explains or influences another. (DOK – Level 1,2)
- Construct a scatterplot to display the association between quantitative variables. Further analyze the relationship by adding a categorical variable using different symbols in a scatterplot. (DOK – Level 1,2,3,4)
- Describe the association between quantitative variables in terms of its direction, form and strength in context. Identify outliers. (DOK – Level 1,2)
- Use technology to calculate and interpret the correlation coefficient between two quantitative variables. (DOK – Level 1,2)
- Describe the properties of r, the correlation coefficient. (DOK – Level 1,2)
- Define, calculate and interpret the Least Squares Regression Line (LSRL). (DOK – Level 2)
- Interpret the slope and y-intercept of the LSRL in context. (DOK – Level 2)
- Interpret the value of the coefficient of determination (r-squared) for a LSRL in context. (DOK – Level 2)
- Use the regression line to predict a value of y from a given value of x. Recognize extrapolation and critique the validity of a prediction involving extrapolation.(DOK – Level 2,3,4)
- Calculate a residual for a given observation and interpret in context. (DOK – Level 1,2)

- Assess the quality of a linear model by constructing a residual plot. (DOK – Level 3)
- Identify outliers and influential observations in an association between quantitative variables. (DOK – Level 1,2)
- Give plausible explanations for an observed association between two variables: direct cause and effect, the influence of lurking variables, or both (DOK – Level 2)
- Assess the strength of statistical evidence for a claim of causation, especially when experiments are not possible. (DOK – Level 3)

Core Activities and Corresponding Instructional Methods:

1. Students select a set of 8 to 10 variables to observe and record data among members of the class. They classify the variables as categorical or quantitative, and in teams select what they believe to be the most interesting ones to analyze using a graph. They construct appropriate graphs, and describe the distributions, compare the distributions across a binary variable, and describe associations in context.
2. When discussing the "statistical process" in Chapter 1, have students create their own statistical process. In groups, they will come up with their own question of interest, how they plan to gather data (observational study or experiment), what the variables/subject are, what type of graph they will use to analyze the data, and finally they will draw conclusions from their "hypothetical" study. This gets students thinking about each part of the process and why certain parts are done before others. It's also engaging because students are creating their own study and implementing their own interests into the activity.
3. Use stapplet.com to demonstrate how to make bar graphs and pie graphs using technology. Gather data from the class to make it more engaging. This can be anything from favorite color to favorite pizza place or favorite sports team.
4. Students will use stapplet.com to make dot plots and histograms on the Chromebooks. This will include real life data involving "celebrity salaries" to show how female movie stars are paid insignificantly less than their male counterparts. Discussions will include lurking variables such as the type of movie that the actor was in and how males are cast in higher paying roles. The dot plot will show various supermodels and their respective BMI's. Students will compare this dot plot to the "average woman" BMI and discussions can be had from what they observe from the data.
5. Students use Fathom software to explore a set of data and evaluate how far an individual value must differ from the rest before it is identified as an outlier.
6. Students use a data set to create a box-plot on the board. Students will alter the data set while maintaining a constant mean to visualize how the mean acts as a balancing

point. Use this applet to demonstrate how the mean and median are affected by outliers: https://digitalfirst.bfwpub.com/stats_applet/stats_applet_6_meanmed.html

7. Students will use test or quiz scores to see how the effect of adjusting test scores by adding or multiplying by a constant. Students describe the effect of these linear transformations on the shape, center, and spread of the distribution of data. Use stapplet.com to show these two box plots side by side. One should be the original and the other should be when you add or multiply by a constant. Students can visually see how the box plot shifts with a side by side comparison.
8. Students will discover and explain misuses of statistics by evaluating real life claims using pictograms, statistics with missing information, incorrect arithmetic, or implausible numbers.
9. Show students the most recent SAT percentile and score Rankings. Found at https://blog.prepscholar.com/sat-percentiles-and-score-rankings. This can be done in conjunction with Ch. 3 when discussing percentiles. This coincides with seniors getting their SAT back and taking their SAT's for the last time.
10. In an effort to help students understand how the 68-95-99.7 rule works, gather a random sample of songs with their song lengths from any pop artist (this activity involves Taylor Swift). You need at least 30 songs. Have students find the average and standard deviation of the song lengths (you can again use calculators or stapplet.com). Have a worksheet of all the song lengths listed from least to greatest. Have students set up the bell curve with the mean/standard deviation from what was calculated. Then, students will count the songs within 1 SD, within 2 SD and within 3 SD. They will need to calculate the percentages for each. If done correctly, the percentages will be close to but not exactly 68-95-99.7%. Then discuss why they might not be exact but they came close.
11. Students will use the Normal Curve Applet to visualize properties of the Normal Curve, area under the curve, and the 68-95-99.7 rule.
    https://homepage.divms.uiowa.edu/~mbognar/applets/normal.html
12. Students will collect data such as height and shoe size to create a scatter plot on a graphing calculator, calculate least-squares-residual line, and correlation factor. Students can also do this on chromebooks using stapplet.com if another form of technology is preferred. Add some celebrity height/shoe sizes to increase engagement. Danny Devito is a great outlier to use for this particular scatterplot.
13. Use the "Guess the Correlation Coefficient Applet"
    https://www.rossmanchance.com/applets/GuessCorrelation.html
    This helps students understand what the correlation coefficient does and they become better at understanding the ranges from -1 to 1.

14. Use this applet to demonstrate the "Least Square Regression Line" https://phet.colorado.edu/sims/html/least-squares-regression/latest/least-squares-regression_en.html. Students can interactively try to guess the slope and the y-int as well as the correlation coefficient.
15. Students can investigate real life correlations between "Poverty and Obesity Rates" by state. This scatterplot can be done on stapplet.com. Data can be found on the US Census website. Gather poverty rates by state and obesity rates by state. Students can input the data into the app and investigate the relationship. Great discussions can be had in terms of the correlation coefficient and lurking variables. Other observations can be made by looking at which states are the highest vs. lowest and if there are any outliers.
16. Students can also investigate correlations by using a knock-off "EHarmony" friendship compatible profile. Students will answer a set of 10 questions on various things they prefer (pizza vs Chinese food, rap music vs country, etc.). They will use a sliding scale to determine how strongly they prefer the 1st choice to the 2nd choice. For instance, if someone strongly prefers the 1st choice they will use a -5 and 5 will be used for the 2nd choice. A 0 will indicate no preference for either. Students will then match up their responses with a friend. This will create coordinates with their friend's answers. Students will plot a scatter plot of this data. They then can calculate the correlation coefficient to see how well "matched" they are as friends.
17. Students can learn all the objectives of linear regression through a Barbie bungee jumping activity via https://www.statsmedic.com/introstats-chapter-2
    There are daily activities building up to the finale of having Barbie bungee jump and making predictions on the amount of rubber bands needed so Barbie can have an enjoyable experience and most importantly survive the jump.
18. In a cumulative assignment, students in pairs will use statistics in a meaningful manner to determine the Greatest Yankee Home Run hitter of all time. Students will be provided data on four legendary former Yankees. Each pair will determine three sets of related data to compare the four players using box plots. Students will consider the shape, center, and spread and determine the existence of any outliers. Students will use their data to support their ranking of the four players.
19. An alternative project to #18 is the "Comparing Nutritional Values Project". Students will gather data on 3 fast food places: McDonalds, Wendy's, and Burger King. They will record the calories of at least 10 burgers from each restaurant. Students will make 3 box plots for each restaurant to show the distribution of calories. Then they will do this again with chicken sandwiches. In total, students should have 6 box plots. This will all be done in stapplet.com. Students will consider the shape, center, and spread and determine the existence of any outliers. Students will use their data to determine which

fast food place is the “healthiest” choice based on calories (if someone was counting calories, which place would be the best choice). Part 2 of the project consists of students finding a misleading graph on the internet. Students must provide the source of the image, explain what is misleading from the graph (using information from class) and then explain how they would fix the graph to make it more suitable for others to interpret.

Assessments:

Diagnostic:

- Teacher prepared diagnostic test, teacher questioning and observation

Formative:

- Teacher observations, questioning techniques
- Group activities
- Homework – example problems from the textbook for each section.
- Quizzes/graded assignments from chapters 1-4

Summative:

- Common Assessment Chapter Exams 1-4 (Consists of both Multiple Choice and Free Response Questions).

DELAWARE VALLEY SCHOOL DISTRICT

Unit: **2: Data Production** **Time Range in Days:** 35 days

Standard(s): College Board Advanced Placement Statistics Course Description
https://apcentral.collegeboard.org/pdf/ap-statistics-course-and-exam-description.pdf

Standards Addressed:
CB AP Stat: AP Stat – IIA , IIB , IIC, IID, IIE

Eligible Content:

- Identify the question to be answered or problem to be solved
- Identify key and relevant information to answer a question or solve a problem.
- Describe an appropriate method for gathering and representing data.

Objectives:

- Identify and distinguish between the population and parameter of interest. (DOK – 1,2)
- Identify and distinguish between the parameter and statistic in a given scenario. (DOK – 1,2)
- Recognize and classify types and causes of bias due to voluntary response samples, convenience samples, and other inferior sampling practices. (DOK – 1,2)
- Use a table of random digits to select a simple random sample (SRS) from a population. (DOK – 1)
- Explain how sample surveys deal with bias and variability in their conclusions. (DOK – 3)
- Explain in simple language what the margin of error is for 95% confidence. (DOK – 3)
- Understand and compare the difference between sampling errors and non-sampling errors. (DOK – 1,2,3)
- Recognize the presence of under-coverage and nonresponse as sources of error in a random sample. (DOK – 1)
- Explain how sampling and non-sampling errors can create bias in a given sample (DOK-3)
- Recognize the effect of the wording of questions on the responses and critique the appropriateness of the wording on the responses desired. (DOK -1,2,3)
- Use random digits to select a stratified random sample from a population when the strata are identified. (DOK – 1)

- Understand the difference between simple random sampling and stratified sampling (DOK - 1,2)
- Identify the explanatory variables, treatments, response variables, and subjects in an experiment (DOK – 1)
- Explain the key difference between an observational study and experiment and why experiments are better predictors of cause and effect than observational studies. (DOK - 3)
- Recognize and classify bias due to confounding of explanatory variables with lurking variables in either an observational study or an experiment. (DOK - 1,2)
- Outline the design of a completely randomized experiment using a diagram. (DOK – 2)
- Use a table of random digits to carry out random assignment of subjects to groups in a completely randomized experiment. (DOK – 1)
- Outline the design of a matched pairs experiment or other block designs when appropriate. (DOK - 2)
- Recognize the placebo effect. (DOK - 1)
- Recognize when the double-blind technique should be used and relate its use to the effect it has on bias. (DOK – 1,2)
- Explain why a randomized comparative experiment can give good evidence for cause and effect relationships. (DOK – 3)
- Design and implement a matched pairs experiment in the classroom using name brand food and generic food. Students will decide how to create an experiment that is free from bias and which uses a single blind experimental outline (DOK -4)
- Discuss why we have institutional review boards that oversee ethical guidelines for experiments done in the scientific community. (DOK – 3)

Core Activities and Corresponding Instructional Methods:

1. Activity 5.1 A from textbook, pg 202. Students will use a sampling technique called “tagging”. This is a real-life sampling technique that is used by wildlife conservatives who take a sample of fish, tag them, and then re-sample to estimate the population of fish in a lake. This activity can be used with goldfish and “colored” goldfish to simulate the tagging experience.
2. Students will watch a video on the Vietnam war draft. They will be shown the dire consequences of what happens when a sample is not truly “random”. https://youtu.be/VJO-NI07yLs. They will look at both a scatter plot and boxplot which shows that December birthdays had significantly lower Draft numbers than all other

birthdays. We will discuss the implications of such a mistake and also how statisticians fixed this grave error for future drafts.

3. Students will use a table of random digits to choose a random sample. The random digit table is shown in their textbook. http://people.uncw.edu/chenc/STT215/ips6e_table-b.pdf
4. Activity 5.1B from text book, pg 211. Using an SRS applet to investigate what happens in a SRS. https://homepage.divms.uiowa.edu/~mbognar/applets/srs.html
5. Students will use a graphing calculator to generate random numbers. The RAND(int) function is used for producing random digits. http://studenthelp.cpm.org/m/TI-84/l/95350-ti-84-generating-random-numbers
6. Activity 5.2 from textbook, pg 219. Use a known population proportion for a group of 100 people. Perform 10 SRS of 10 samples each to calculate how your results compare to the true population proportion.
7. https://www.statsmedic.com/intro-day37 Help students understand the concept of margin of error with this lesson from the statsmedic.
8. Lesson plan from the stat medic: https://www.statsmedic.com/intro-day35 Students will "choose" a sample of 5 words from the Gettysburg Address and calculate the average word length. Students will make a dot plot of everyone's number and we will try to "estimate" the population parameter. Students repeat this process, but will "randomly" generate 5 digits from their calculators. They will then calculate the average word length of those 5 words. The purpose of this is to show students that "choosing" words create bias which does a poor job at estimating "p". Random sampling does a better job at estimating the population parameter.
9. Lesson Plan from the stat medic: https://www.statsmedic.com/intro-day36
   This is the same activity from above, but it investigates what happens when we increase our sampling size to 10 words. This activity is designed to help students understand sampling variability and how larger samples estimate the population parameter better than smaller samples.
10. The same activity for #7 and #8 can be done using Beyonce Lyrics "Crazy in Love" https://www.statsmedic.com/post/does-beyonce-write-her-own-lyrics
11. Application 5.3 from the textbook, pg 249. Students will extrapolate from a survey about which math classes students should take in high school to help them in college.
12. Students will understand and explain how sampling and non-sampling errors can create bias in samples/surveys: https://www.statsmedic.com/intro-day39
13. Using **surveymonkey.com**, create two surveys. One should be straight forward, "non-biased" questions (these could be anything of student interest). Then, create a similar survey with "biased" questions - questions should be similar in nature but worded in biased ways. Students will take both surveys. This is best if each survey is spread out

over time so they forget their answers to the 1st survey. Compare the results of both surveys to see if biased wording affected the responses.

14. Have students perform the "ESP" activity from the textbook. Students will randomly generate numbers 1-4 each associate with a suite from a deck of cards. Students will try to have their partner "read their mind" to decide what card they are holding. They will record how many cards were answered correctly. The entire class will share their data. This experiment is designed to show students that "intuition" is not a viable way to understand or perform statistics.
15. Lesson from the stat medic: https://www.statsmedic.com/downloads-intro-day41. Students will design a "good" experiment that uses a randomized comparative design.
16. Application 6.1 from textbook, pg 270. Students will examine various clinical studies to find out how the experiment was conducted.
17. Activity 6.2A from textbook, pg 273. Students will conduct an experiment to see the effect of listening to classical music while performing a maze task.
18. An alternative activity to #16 could be creating an experiment to see if giving students a "blank" map of the United States would help them remember all 50 states better than just writing them down on a piece of paper. Randomly divide the class into two groups. Both groups will be shown the names of all 50 states for about 2 minutes. Group 1 will get a blank map and group 2 will have to write all 50 on a piece of paper. Each group will get 5 minutes to write down as many as they can remember. Compare numbers of both groups at the end.
19. Lesson from stat medic: https://www.statsmedic.com/downloads-intro-day40. Students will be able to explain the concept of a placebo and blinded studies. Students will watch a video on the placebo effect.
20. Have students set up blocking designs for various examples found in the textbook. Students should be shown a variety of blocking designs that block for gender, age, weight, and other lurking variables.
21. Set up a "real life" matching experiment in the classroom. This can be done with any food or beverage of your choice. Have students "taste-test" name brand and generic food brands. This could be cereal, cookies, potato chips, etc. Drink ideas could be Coke vs. Pepsi or different brands of ice tea. Discuss the importance of making this experiment single blind (subjects should not know which food is which). Also discuss this important of randomizing which food is eaten first by using a coin flip for each trial.
22. For Section 6.3 Ethical Experiments, a variety of videos can be shown to show students the importance of an institutional review board and why we have ethical guidelines in place. The following Youtube videos can be shown:

    - A Class Divided (full film) | FRONTLINE https://youtu.be/1mcCLm_LwpE

- There are a variety of videos from this website that can be used to show older experiments were unethical and why review boards are necessary: https://www.mentalfloss.com/article/52787/10-famous-psychological-experiments-could-never-happen-today
- Volunteers Become Human Guinea Pigs For Medical Research https://youtu.be/lSZ6yYsni0Q
- Some Popular Surgeries Are Just Placebos, Here's Why They Still Exist https://youtu.be/tFTDNotO0Hs

Assessments:

Diagnostic:

- Teacher prepared diagnostic test, teacher questioning and observation

Formative:

- Teacher observations, questioning techniques
- Group activities - See core activities above
- Homework – example problems from the textbook for each section, worksheets made by teacher, or worksheets from statsmedic.com
- Quizzes/graded assignments from chapters 5 and 6

Summative:

- Common Assessment Chapter Exams 5 and 6 (Consists of both Multiple Choice and Free Response Questions).

DELAWARE VALLEY SCHOOL DISTRICT

Unit: **3: Probability/Anticipating Patterns** **Time Range in Days:** 40 days

Standard(s): College Board Advanced Placement Statistics Course Description
https://apcentral.collegeboard.org/pdf/ap-statistics-course-and-exam-description.pdf

Standards Addressed:
CB AP Stat: AP Stat – IIIA, IIIC

Eligible Content:

- Identify the question to be answered or problem to be solved
- Identify key and relevant information to answer a question or solve a problem.
- Describe data presented numerically or graphically.
- Construct numerical or graphical representations of distributions.
- Calculate summary statistics, relative positions of points within a distribution, correlation, and predicted response.
- Determine relative frequencies, proportions, or probabilities using simulation or calculations
- Determine parameters for probability distributions
- Describe probability distributions.

Objectives:

- Recognize that some phenomena are random. Predict the long-run regularity of random phenomena (DOK - 1,2)
- Understand that the probability of an event as the proportion of times the event occurs in very many repetitions of a random phenomenon. (DOK – 1)
- Recognize that the short runs of random phenomena do not display the regularity described by probability. Accept that randomness is unpredictable in the short run, and avoid seeking cause and effect explanations for random occurrences. (DOK – 1,2)
- Design a simulation using random digits to model chance behavior. (DOK – 4)
- Estimate a probability by repeating a simulation many times. (DOK – 2)
- Collect and display the probability of an event by adding the probabilities of the outcomes that make it up. (DOK – 1)
- Use probability rules to find the probabilities of events that are formed from other events, including unions, intersections, complements, and conditional probabilities. (DOK – 1)
- Construct Venn Diagrams, two-way tables, and tree diagrams to model chance behavior and draw conclusions from the diagram. (DOK – 2,3)

- Compute probabilities using information provided from Venn diagrams, two-way tables, and tree diagrams. (DOK – 2)
- Explain the idea of expected value as the average of numerical outcomes in many repetitions of a random phenomenon. (DOK – 3)
- Find and interpret the expected value of a random variable from a probability distribution. (DOK – 1,2)
- Estimate an expected value by repeating a simulation many times. (DOK – 2)
- Find the probability under a normal curve. (DOK -1)
- Use multiplication counting principle to determine the number of possible outcomes of a chance process involving multiple steps. (DOK – 1,2)
- Count the number of district arrangements of a group of individuals using permutations. (DOK – 1)
- Count the number of distinct selections of a group of individuals using combinations. (DOK – 1)
- Distinguish counting situations in which order matters from those where order doesn't matter. (DOK – 2)
- Solve probability problems using multiplication counting principle, permutation, and combinations. (DOK – 3)
- Determine whether a given chance process describes a binomial setting. (DOK – 2)
- Use the binomial theorem to calculate probabilities involving a binomial distribution. (DOK – 1)
- Compute the expected value of a binomial distribution. (DOK - 2)

Core Activities and Corresponding Instructional Methods:

1. Students use dice, coins, or cards to demonstrate probability as long term relative frequency. (Such as rolling a die 30 times and keeping a running tally on excel to show that as the number of trials increase the probability gets closer to ⅙)
2. Students will simulate claims about probability such as Rock-Paper-Scissors. Is the probability of winning ⅓ for each type of throw you make. Students will perform many trials of rock-paper-scissors and record how often they throw each move and how often they win.
3. Students will calculate the probability of events in casino games such as craps and roulette. They will demonstrate how the casino has the advantage to win in the long run for each game.

4. Students will investigate the chance involving various lottery problems. They will investigate myths of strategies from multiple lottery winners.
5. Students will perform simulations to estimate probability. (Activities like The Office Secret Santa or finding the probability of landing on orange in Monopoly)
6. Activity 7.1B from text book, pg 314. Does flipping a thumbtack have the same probability of flipping a coin? This probability is unknown. By performing simulations many times we can approximate the probability.
7. Investigate the Monty Hall Problem. Should students stay with their first choice or switch their choice after one choice has been eliminated. Students will perform many simulations then determine why it is the case. http://www.rossmanchance.com/applets/MontyHall/Monty04.html
8. Perform various probability experiments with M & M candies.
9. Students will decide if events are independent, dependent, and or mutually exclusive. Students will look at various situations and formalize rules for how to tell if it fits its key term.
10. Application 7.3 from textbook, pg 362. Estimating probability from a chart.
11. Conduct probability experiments with dice to determine a probability distribution.
12. Use fathom to help describe probability distributions.
13. Students will create a venn diagram from a two-way table and vice versa.
14. Students will determine the probability under a normal curve.
15. Activity 8.2 from textbook, pg 387. An investigation into the Deal or No Deal game with expected values.
16. Application 8.2 from textbook, pg 397. Calculating a playlist from an iPod.
17. Introduce the Binomial Theorem with stats medic activity on making free throws at the end of a basketball game. https://www.statsmedic.com/intro-day65
18. Stats medic activity https://www.statsmedic.com/intro-day66 to build a binomial distribution by having students take a multiple-choice test by just blind guesses. What is the probability of getting 0-5 questions correct on a 5 question quiz if you are just guessing.
19. 60 minutes video on how a retired couple won millions using a lottery loophole. The couple used the idea of expected value to know when to play and not to play. They used the law of large numbers to cover any losses by making a large amount of bets. https://www.cbsnews.com/video/jerry-and-marge-selbee-how-a-retired-couple-won-millions-using-a-lottery-loophole-60-minutes/
20. Demonstrate strategies in blackjack for hitting or staying using conditional probabilities.

21. The movie “21” or ``Breaking Vegas: The true story of the MIT blackjack team”

22. Use Plinko Applet to demonstrate how the binomial distribution approaches a normal curve. Understanding that probabilities on the ends are more likely to be skewed the values in the middle. http://phet.colorado.edu/sims/html/plinko-probability/latest/plinko-probability_en.html

Assessments:

Diagnostic:

- Teacher prepared diagnostic test, teacher questioning and observation

Formative:

- Teacher observations, questioning techniques
- Group activities
- Homework – example problems from the textbook for each section.
- Quizzes/graded assignments from chapters 7 and 8.

Summative:

- Common Assessment Chapter Exams 7 and 8 (Consists of both Multiple Choice and Free Response Questions).

DELAWARE VALLEY SCHOOL DISTRICT

Unit: **4: Statistical Inference** **Time Range in Days:** 45 days

Standard(s): College Board Advanced Placement Statistics Course Description
https://apcentral.collegeboard.org/pdf/ap-statistics-course-and-exam-description.pdf

Standards Addressed:
CB AP Stat: AP Stat – IVA , IVB

Eligible Content:

- Identify an appropriate inference method for confidence intervals.
- Identify an appropriate inference method for significance tests.
- Identify null and alternative hypotheses.
- Construct a confidence interval, provided conditions for inference are met.
- Calculate a test statistic and find a p-value, provided conditions for inference are met.
- Make an appropriate claim or draw an appropriate conclusion.
- Interpret statistical calculations and findings to assign meaning or assess a claim.
- Justify a claim using a decision based on significance tests
- Justify a claim based on a confidence interval.

Objectives:

- Explain the idea of a sampling distribution. (DOK - 3)
- Interpret the normal sampling distribution of a sample proportion and the 68-95-99.7 rule to find probabilities involving p-hat. (DOK – 1,2)
- Explain the idea of a confidence interval. (DOK – 3)
- Explain in nontechnical language what is meant by “95% confidence” and other level of confidence in statistical reports. (DOK – 3)
- Make an appropriate 95% confidence statement making a conclusion about a population parameter. (DOK – 2,3)
- Assess how the margin of error of a confidence interval changes with the same size and the level of confidence (DOK-3)
- Detect major mistakes in applying inference, such as improper data production, selecting the best of many outcomes, ignoring high nonresponse and outliers. (DOK – 2)
- Explain the idea of a significance test. (DOK – 3)
- State the null and alternative hypothesis in a testing situation when the parameter is a population proportion, p. (DOK – 3)

- Explain the meaning of a p-value when you are given the numerical value of p for a test. (DOK – 3)
- Explain the meaning of "statically significant at the 5% level" and other statements of significance. (DOK – 3)
- Explain why significance at a specific level such as 5% is less informative than a p-value. (DOK – 3)
- Recognize that significance testing does not measure the size or importance of effect. (DOK -1)
- Recognize and explain the effect of small and large samples on the significance of an outcome. (DOK - 1,3)
- Explain what null hypothesis the chi-square goodness of fit statistic tests in a specific setting. (DOK – 3)
- Calculate expected cell counts, the chi-square statistic, and its degrees of freedom from the data. (DOK – 1)
- Use percents and bar graphs to describe the relationship between any two categorical variables starting from the counts in a two-way table. (DOK -2)
- Explain what null hypothesis the chi-square statistic tests for a specific two-way table. (DOK – 3)
- Calculate expected cell counts, the chi-square statistic, and its degrees of freedom from a two-way table. (DOK – 1)
- Assess the normal sampling distributions of a sample mean to find probabilities involving x-bar. (DOK -2)
- Hypothesize one-sided and two-sided tests about a population mean. (DOK – 3)

Core Activities and Corresponding Instructional Methods:

1. Activity 9.1A from text book, pg 420. An applet to investigate the sample to sample variability in the proportion of candies dispensed by a machine. http://www.rossmanchance.com/applets/OneProp/OneProp.htm?candy=1
2. Build a sampling distribution of means via a large population. Show how the shape, center, and spread change as the sample size increases.
3. Activity 9.1B from text book. An applet to construct confidence intervals from different random samples, pg 427. https://istats.shinyapps.io/Inference_prop
4. Students will learn how to do confidence intervals on their calculators (Stat - Calc - 1 prop Z Int) to calculate an interval and interpret it.

5. Data Exploration from our textbook, pg 434, on No Child Left behind. This exploration looks into how schools created wiggle room by having their results as samples of the population.
6. Application 9.1 from our textbook, pg 436. Students select a sample of beads to calculate a 95% confidence interval for the proportion of beads.
7. Activity 9.2 from our textbook, pg 438. Testing whether a deck of cards is fair. How long until you are convinced that a deck is unfair? Teacher will rig a deck of cards to have all black or all red. Shuffle the cards and have a student pick a card. How many cards will it take to start questioning whether the deck is legitimate. This corresponds to the idea of p-value.
8. Activity 9.2B from our textbook, pg 442. An applet to investigate what happens in a significance test.
   http://digitalfirst.bfwpub.com/stats_applet/stats_applet_15_reasoning.html
9. Students write hypothesis statements from a question prompt. Students determine which direction the alternate hypothesis points.

10. Application 9.3 from our textbook, pg 462. Testing null hypothesis for proportions
11. Students will use a sample of M & Ms to determine claims about the color distribution while performing a chi-square goodness of fit test.
12. Students will calculate the color distribution of cars in the DVHS parking lot to determine if it fits in the distribution of car colors in the USA.
13. Students will research how the Guinness Brewery attributed to the t-distribution.
    https://www.youtube.com/watch?v=U9Wr7VEPGXA

Assessments:

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DELAWARE VALLEY SCHOOL DISTRICT

Summative:

- Common Assessment Chapter Exams 9 and 10(Consists of both Multiple Choice and Free Response Questions).
- FInal Project Options:
    - Perform an experiment on the effect of bias in surveys. Students will create two surveys, one with direct questions and one with wording bias to lead the respondent towards an opinion. Students will distribute the survey to classrooms and compare the results.
    - Alternative Final Project: Students will research a career that interests them after highschool. They will look up the “average salary” for that career in the area where they will “live”. Have students look up various statistics on costs of living (rent, utilities, car insurance, car payments, etc.) Have students build their own income/debt chart to see how they will balance the cost of living after they graduate college/trade school or start working immediately after highschool.

DELAWARE VALLEY SCHOOL DISTRICT

Checklist to Complete and Submit with Curriculum:

__X___ Copy of the curriculum using The template entitled "Planned Instruction," available on the district website

__X___ **The primary textbook form(s)**

___X__ The appropriate payment form, in compliance with the maximum curriculum writing hours noted on the first page of this document

Each principal and/or department chair has a schedule of First and Second Readers/Reviewers. Each Reader/Reviewer must sign & date below.

First Reader/Reviewer Printed Name Christine Marcial

First Reader/Reviewer Signature Christine Marcial Date May 7, 2020

Second Reader/Reviewer Printed Name_____

Second Reader/Reviewer Signature _____ Date_____