Summit Public Schools

Summit, New Jersey

Grade Level: 12th / Content Area: Mathematics

Length of Course: Full Academic Year

AP Statistics

Submitted by:

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Curriculum

Course Description:

Statistics is the science of data. The purpose of this course is to introduce the students to the major concepts and tools needed for collecting, analyzing, and drawing conclusions from data. This course concentrates on four broad conceptual themes: exploring data, planning a study (collecting data), probability (anticipating patterns in data), and statistical inference based on data.

This course is an active learning experience. Students analyze data with calculators and computers. They conduct classroom experiments, carry out individual and group projects, and perform stimulations involving probability concepts. Students are required to write a statistical report reporting their conclusions based on their data.

Course Overview:

AP Statistics at our school is equivalent to a one-semester college course in introductory statistics. To develop effective statistical communication skills, students are required to prepare frequent written and oral analyses of real data.

Early in the year, students observe the effects of random phenomena. Students are taught both elementary probability theory and combinatorial theory, but the emphasis for the probability section is placed on probability modeling. Students use graphical and numerical techniques to study patterns and departures from patterns. They use descriptive statistics to illustrate characteristics of data sets and from observing these characteristics the student makes informed speculations about the relationship of variables.

A clear difference between association and causation is developed by many examples encountered with these problems. The students analyze sample surveys and experiments to further clarify the difference between association and causation.

Learners hypothesize about a population parameter, create their own surveys and experiments, observe the effects of bias and determine the best inference procedures. Once the population parameter is chosen, and inference model selected, students work using probability modeling to determine if their acquired statistics provide enough evidence to make conclusions about the respected populations.

The statistics course will teach students to communicate methods, results, and interpretations using the vocabulary of statistics.

Use of Technology

Graphing calculators and Chromebooks are used throughout the course of the program to assist students in solving problems, interpreting output, visualizing distributions, and observe random behavior. Programs utilized are Microsoft Excel and Google Sheets. Students observe Minitab statistical software output and use various applets, i.e. Normal Distributions, to observe statistical theory in action. The school provides each student with a TI-84 plus for use during the academic year. Students are expected to bring their calculators and individual Chromebook to all classes and be proficient with their use and graphing capabilities, along with quickly entering and analyzing data entered into a shared Google Sheet for the classroom data collection.

Primary Textbook

Yates, Daniel S.; Moore, David S.; Starnes, Daren S. *The Practice of Statistics 4th edition*. New York, New York: W. H. Freeman and Co., 2003

Quarter 1: Units 1-3, maybe a little Unit 4

Unit 1 – Ch. 1: Exploring Data

Topic	Time Frame
First Day of School	1
1.1 Analyzing Categorical Data	1.5
1.2 Displaying Quantitative Data with Graphs	1.5
Wrap 1.1&1.2; Quiz 1.1-1.2	1
1.3 Describing Quantitative Data with Numbers	1
Review	1
Test Chapter 1	1
Total	8

Unit 2 – Ch. 2: Modeling Distributions of Data

Topic	Time Frame
2.1 Describing Location in a Distribution, including quiz	2.5
2.2 Normal Distributions, including quiz	2.5
Review	1
Test Chapter 2	1
Total	7

Unit 3 – Ch. 3, (also 12.2): Describing Relationships

Topic	Time Frame
3.1 Scatterplots and Correlation	1
3.2 Least-Squares Regression	3
Quiz 3.1-3.2	0.5
Linear correlation project work time	2

12.2 Transforming to Achieve Linearity	1.5
Review Unit 3	1
Review previous units;	1
Test Chapter 3, 12.2 + older topics; enrichment including logistic regression in time remaining after testing	2
Total	12

This is almost the end of Quarter 1; We did 4 days of Unit 4 before the official end

Quarter 2: Units 4-7

Unit 4 – Ch. 4: Designing Studies

Topic	Time Frame
4.1 Sampling and Surveying , including Quiz	3
4.2 Experiments	2.5
4.3 Using Studies Wisely (Scope of Inference)	0.5
Review	1
Test Chapter 4	1
Total	8

Unit 5 – Ch. 5: Basic Probability

Topic	Time Frame
5.1 Randomness, Probability, and Simulation	1
5.2 Probability Rules	1
Chapter 5 Quiz	0.5
5.3 Conditional Probability and Independence	2
Review	0.5
Test Chapter 5	1
Total	6

Unit 6 – Random Variables

Topic	Time Frame
6.1 Discrete and Continuous Random Variables	3
6.2 Transforming and Combining Random Variables	2
Quiz 6.1-6.2	0.5
6.3 Binomial and Geometric Random Variables	2
Review	1
Test Chapter 6	1
Enrichment project: Casino Game project planning	2.5
Enrichment activity: Casino Day	2
Total	14

Unit 7 – Ch. 7: Sampling Distributions

Topic	Time Frame
7.1 What is a Sampling Distribution?	1
7.2 Sample Proportions	1
Quiz 7.1-7.2	0.5
7.3 Sample Means	1.5
Review	1
Test Chapter 7	1
Total	6

Midterm review should be 2 or 3 days

Quarter 3: Units 8-10

Unit 8 – Ch. 8: Estimating With Confidence

Topic	Time Frame
8.1 Confidence Interval Basics	1
8.2 Estimating a Population Proportion	2
Quiz 8.1-8.2	0.5

Enrichment Project: Brainstorm Survey Questions and Logistics	1.5
8.3 Estimating a Population Mean	1
Enrichment Project: Collect SHS survey data and enter data in	1.5
Review	1
Test Chapter 8	1
Enrichment Project: SHS survey results project work day	1
Total	10.5

Unit 9 – Ch. 9: Testing a Claim

Topic	Time Frame
9.1 Significance Test Basics	2
9.2 Tests About a Population Proportion	2
Quiz 9.1-9.2	0.5
9.3 Tests About a Population Mean	1.5
Review	1
Test Chapter 9	1
Total	8

Unit 10 – Ch. 10 (Comparing Two Populations), Ch. 11 (Inference for Distributions of Categorical Data) and 12.1 (Inference for Linear Regression)

Topic	Time Frame
10.1 Comparing Two Proportions	1.5
10.2 Comparing Two Means	1.5
Review and Quiz 10.1-10.2	1
11.1 Chi-Square Goodness-of-Fit Tests	2
11.2 Inference for Relationships	2
Quiz 11.1-11.2	0.5
Review Ch. 10-11	1.5
Test Chapters 10-11	1
12.1 Inference for Linear Regression	2
Total	13

Sometimes Quarter 4 starts with the 12.1 material. The last grade of Quarter 3 should be the Chapter 10-11 Test

Quarter 4: AP Review and Enrichment Projects

Unit 11 – AP Review

Topic	Time Frame
Regression Review (Ch3&12)and Quiz	3
Probability Review (Ch5&6) and Quiz	3
Displaying/Describing Data (Ch1&2), Designing Studies (Ch4) and going over practice tests	4
Chapters 7-11 Review and Quiz	3
Miscellaneous Practice/Review	3
AP Test	1
Total	17

About one week of miscellaneous activities teaching ANOVA test, assorted discrete math topics and going over Free Response Questions (once released) from the AP Test.

Unit 12 – Enrichment Project: Pick any one or two variables that you wish to study and compare. Survey a random sample from your desired population and run a significance test on the data to come to a conclusion and offer insight into the chosen topic.

Topic	Time Frame
Project work time	7
Project presentations	1
Miscellaneous activities and significance tests from student-collected data	3

Exploring Data and Describing Patterns (Units 1-3)

Standards: Interpreting Categorical and Quantitative Data (S-ID)

All students will be able to summarize, construct and interpret graphical displays of univariate data, bivariate data and categorical data

Big Ideas: *Course Objectives / Content Statement(s)*

- Create/analyze histograms, boxplots, stem plots and dot plots for univariate data.
- Create/analyze scatterplots and least squares regression lines for bivariate data.
- Create/analyze frequency tables, bar graphs and pie charts for categorical data.
- Describe measures of center, location and dispersion for univariate data.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
	Students will understand that…
How do we represent univariate data?	Histograms, boxplots, stemplots and dot plots are methods to display and compare distributions
How do we compare two distributions?	Every distribution's shape, center and spread should be thoroughly analyzed, and similarities/differences can be gleaned from those measures of center and spread and location of data points.
How do we analyze two different sets of data using standardized z-scores?	A z-score helps make comparisons possible between differing sets of data with unique means and standard deviations, and percentiles can be calculated.
How do we determine if a set of data can fit a normal distribution, and how do we make conclusions about the approximately normal data?	The 68-95-99.7 Empirical Rule for Normal distributions allows for predictions to be made and conclusions drawn for percentages, means and standard deviations for a population.
How do we analyze and display bivariate data, and how do we determine if a linear function is the most appropriate regression model for the set of data?	A scatterplot can be constructed and analyzed for a set of two quantitative variables. A least squares regression line can be calculated, and the correlation coefficient, along with the residual plot help determine if a linear model is the most appropriate regression model.

Areas of Focus: Proficiencies **(Cumulative Progress Indicators)**	**Examples, Outcomes, Assessments**
Students will: (S-ID-A1) Represent data with plots (S-ID-A2) Use measures of shape, center and spread to describe a distribution (S-ID-A3) Interpret differences in two distributions' shape, center, spread and effects of outliers (S-ID-A4) Use the mean and standard deviation of a set of data to fit it to a normal distribution and estimate population percentages (S-ID-B5) Summarize categorical data with two-way frequency tables and recognize possible associations and trends. (S-ID-B6) Represent data for two quantitative variables on a scatter plots, fit a least squares regression line, assess the fit of the function by analyzing residuals and determining if a linear or exponential curve is best (S-ID-C7) Interpret the slope and y-intercept of the least squares regression line in the context of the data (S-ID-C8) Compute and interpret the correlation coefficient for a linear regression (S-ID-C9) Distinguish between correlation and causation	Instructional Focus: 1. Measures of center (mean, median, mode) 2. Measures of spread (standard deviation, range, interquartile range) 3. Shape (skewed, symmetric approximately Normal) of a distribution 4. Outliers, percentiles and points of location 5. Correlation coefficient and least squares regression line 6. Residual plots 7. Creating/analyzing all univariate and bivariate graphs Sample Assessments: See hard copy versions of assessments in the AP Stat binder in office 110/112 Technology Integration: Students will use a graphing calculator to find all descriptive statistics for a set of univariate data, along with how to display boxplots, histograms and normal probability plots for the set of univariate data. Students will use a graphing calculator and Google Sheets to enter data into lists/spreadsheets, create scatter plots, calculate least squares regression lines, find residuals and residual plots for a set of bivariate data. Global Perspectives: Students will be able to compare two prospective college applicants' ACT to SAT scores, display sets of data that compare different gender's pulse rates, and do a project that compares any two quantitative variables in an effort to determine the strength of its linear relationship (For example: Median household income and unemployment rate for all 50 US states.)

Planning and Conducting a Study (Unit 4)

Standards: Making Inferences and Justifying Conclusions (S-IC)

All students will be able to evaluate and describe procedures for obtaining random sampling through surveys, observational studies and experiments.

Big Ideas: *Course Objectives / Content Statement(s)*

- Describe the differences and pros/cons of various data collection methods: census, sample survey, experiments and observational studies
- Describe and conduct different sampling methods to distribute a survey
- Describe and conduct different types of experiments
- Determine what conclusions can be made from the sampling or experimenting depending on the study design

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
How do we obtain a random sample when distributing a survey?	Students will understand that… Obtaining a simple random sample (SRS), stratified random sample, cluster sample, systematic sample and multi-stage sample is necessary when distributing a survey
How do we conduct an experiment?	A comparative experiment can include a block design or a matched pairs design in order to reduce confounding variables in an experiment's results; and random assignment of treatments is necessary for an experiment
What are the benefits of specific experiment designs?	Providing a control group, accounting for the placebo effect, making studies single-blind or double-blind and using replication all have important aspects that make an experiment more reliable and well-designed.
What inferences can be drawn based on a study's design?	Causal relationships can only be determined by conducting an experiment that randomly assigns treatments, while inferences about an entire population can be made if the study's sample was randomly obtained from the population being studied.
Areas of Focus: Proficiencies	**Examples, Outcomes, Assessments**

(Cumulative Progress Indicators)	
Students will: (S-IC-B3) Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each (S-IC-B5) Use data from a randomized experiment to compare two treatments	Instructional Focus: 1. Sampling and surveys: SRS, cluster, stratified 2. Biases in sampling: convenience, voluntary response, undercoverage, measurement, etc. 3. Experiment designs, including block design and matched pairs 4. Reducing confounding variables with control groups, placebos, double-blind, replication and other experiment designs 5. Inferences from studies, as relating to cause and effect and the scope of inference pertaining to the sample or population Sample Assessments: See hard copy versions of assessments in the AP Stat binder in office 110/112 Technology Integration: Students will use Google Forms to distribute surveys, Google Sheets to record results for the surveys and for the in-class experiments, along with using their calculators to randomly generate numbers in order to obtain a random collection of subjects and treatments being assigned. Global Perspectives: Students will be able to evaluate the flaws in surveys and studies published in the media, pertaining to social issues, politics, etc. Students will be able to conduct experiments. For example, determine the effect of a treatment such as listening to music while working versus no music while working.

Exploring Random Phenomena Using Probability and Simulation (Units 5-6)

Standards: Conditional Probability and the Rules of Probability (S-CP) and Using Probability to Make Decisions (S-MD) All students will be able to model situations and calculate the probability of a variety of different types of events.
Big Ideas: *Course Objectives / Content Statement(s)* ● Calculate the probability of independent events. ● Calculate conditional probability.

- Combine independent random variables and determine expected values and probabilities.
- Calculate probability for a variety of discrete, continuous, geometric and binomial random variables

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
How do we calculate the probability of independent events?	Students will understand that… Learn fundamental rules of probability relating to multiplying the probability of events.
How do we create a model for determining the number of possible outcomes, assisting us in calculating probability?	A sample space can be created using tree diagrams, a systematic list, or Venn diagrams.
How do we calculate the union of two events?	Adding probabilities helps find the union of two events, while subtracting the intersection if the events are not disjoint.
How do we calculate conditional probability?	A tree diagram can assist, as can algebraic expressions, to determine the probability of an event A and an event B, given that A has happened (learning proper notation for conditional probability). Creating a probability distribution table will help when finding expected values by multiplying the values with the probability of that event.
How do we assign values for discrete random variables and determine the expected value for a scenario?	The mean values of each random variable can be added, but the combined standard deviation for a sum or difference is the square root of the sum of the variances of each random variable
How do we combine random variables?	The distinguishing characteristics of each random variable will be learned, along with the formulas and calculator techniques for finding the probability for each event.

How do we determine if a random variable is discrete, continuous, geometric or binomial and how do we calculate the probability of the desired event?	
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will:	Instructional Focus: 1. How to create a sample space and calculate possible outcomes 2. How to add/subtract/multiply the probability of events 3. How to calculate the complement of an event 4. How to create diagrams that assist in calculating probability 5. How to determine what type of random variable is appropriate for a given situation, and how to calculate the probability for it. 6. How to assign values to a discrete random variable, and calculate the mean and standard deviation for the random variable 7. How to transform random variables and combine random variables, and what their new means and standard deviations would be for the combined random variable.
(S-CP-A1) Describe events as subset of a sample space for unions, intersections or complements of other events.	
(S-CP-A2) Understand if two events A and B are independent and know how to show their independence mathematically.	
(S-CP-A3) Understand how to calculate conditional probability	
(S-CP-A4) Construct two-way frequency tables to calculate conditional probability and determine if events are independent.	
(S-CP-B6) Use the rules of probability to compute probabilities of compound events in a uniform probability model for conditional probability	
(S-CP-B7) Apply the additional rule	
(S-CP-B8) Apply the general multiplication rule	Sample Assessments: See hard copy versions of assessments in the AP Stat binder in office 110/112
(S-MD-A1) Define a random variable and graph the corresponding probability distribution	Technology Integration: Students will use a graphing calculator to calculate probabilities, along with using the calculator to model distributions and make calculations for discrete, continuous, geometric and binomial random variables. Students will use the calculator and Chromebooks, along with Google Sheets to randomly generate numbers and simulate probability settings using empirical data.
(S-MD-A2) Calculate the expected value of a random variable	
(S-MD-A3) Develop a probability distribution for a random variable in which theoretical probabilities can be calculated. (S-MD-A4) Develop a probability distribution for a random variable in which empirical probabilities can be assigned.	Global Perspectives: Students will be able calculate the probability of events happening that help inform product testing, business budgeting, medical testing, likelihood of events happening regarding finances, sports and weather. Students will also work in groups on a project that puts probability into context by creating a game of

(S-MD-B) Use probability to evaluate outcomes of decisions.	chance that pays "play money" out to contestants at a slightly lower rate than the chance of winning, thus creating a negative expected value for the customer. This will be put to the test during a class-wide Casino Day using play money to see how probabilities and unfair odds cause people to lose at games of chance.

Statistical Inference: Estimating Population Parameters and Testing Hypotheses (Units 7-10)

Standards: Making Inferences and Justifying Conclusions (S-IC)

All students will be able to estimate population parameters, calculate and interpret confidence intervals and test hypotheses through a variety of significance tests.

Big Ideas: *Course Objectives / Content Statement(s)*

- Describe the key characteristics of a sampling distribution
- Calculate and interpret confidence intervals for estimating population proportions and means
- Calculate the p-value of a significance test and determine what can concluded for a certain hypotheses
- Understand Type I and II errors, power and other contextual criteria that determine how to create appropriate hypotheses and calculate and run an appropriate significance test for one and two sample situations.

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
	Students will understand that…
How do we determine the shape, center and spread of a sampling distribution?	Using given formulas and enough context, we can calculate the mean and standard deviation of a sampling distribution, along with determining if it's approximately Normal.
How do we calculate and interpret confidence intervals?	Using given formulas, we can estimate a population parameter (for both a population mean and proportion) to a certain confidence level. Given a scenario, and being able to correctly write a set of hypotheses, the students should be able to identify

What are Type I and Type II errors? How do we create a set of hypotheses and calculate and interpret a p-value for one- and two-sample z- and t-tests, along with Chi-Square tests? How do we determine what test is appropriate to run given the real-world context of the problem?	Type I and Type II errors in the context of the real-world problem. Using given formulas and enough context from the problem, students should be able to set up hypotheses, identify all needed conditions, calculate the p-value and make an appropriate conclusion for a variety of significance tests. When it's appropriate and how to calculate one-sample and two-sample z-tests and t-tests, including matched pairs t-tests, along with Chi-Square Goodness of Fit tests, and Chi-Square tests for association and for homogeneity, as well as a significance test for the slope of a regression line.
Areas of Focus: Proficiencies **(Cumulative Progress Indicators)**	**Examples, Outcomes, Assessments**
Students will: (S-IC-A1) Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (S-IC-A2) Decide if a specified model is consistent with results from a given data-generating process such as simulation (S-IC-B4) 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.	Instructional Focus: 1. Calculating mean, standard deviation and determining shape of a sampling distribution. 2. Understanding the difference between sample data and population data, and how sample data helps inform us about characteristics and estimating .parameters of the population 3. Confidence intervals for proportions and means. 4. Significance tests for one-sample and two-sample proportions and means 5. Type I, Type II errors and power – how it informs our significance level and how it relates to modern science, technology and other sectors. 6. Knowing the four-step process of hypothesis writing, testing conditions, calculating the p-value and making conclusions in context for a given situation for all types of significance tests.

	Sample Assessments: See hard copy versions of assessments in the AP Stat binder in office 110/112 Technology Integration: Students will use Google Forms to distribute surveys, Google Sheets to record results for the surveys and will ultimately use their calculators to estimate certain population parameters for Summit High School, through a data driven approach using data they collected. Students will use their calculators to find p-values and make appropriate conclusions for all types of significance tests. Global Perspectives: Students will conduct a project that uses margin of error and confidence intervals, along with using sample data to estimate population parameters for a variety of topics in their randomly distributed multi-stage survey given to find out details about Summit High School, such as how many students play a school sport, are bilingual, receive private tutoring in at least one academic subject. It's the culmination of everything they've done in Statistics up to that point, and mimics what real polling companies do when determining unemployment rate, forecasting political races, etc. Students will understand how margin of error can affect political election predictions in the context of recent elections. Students will also understand Type I and Type II errors along with conducting significance tests in the context of trying to determine statistically significant results that could inform product testing, medical testing (false-positives and second-opinions), technological advances, experiment results and a variety of other problems all relevant to the world we live in.