

Course Title:	Advanced Placement Statistics
Grade(s):	10, 11, & 12

Course Description
The purpose of the AP course in statistics is to introduce students to the major concepts and tools for collecting, analyzing and drawing conclusions from data. Students are exposed to four broad conceptual themes: • Exploring Data: Describing patterns and departures from patterns • Sampling and Experimentation: Planning and conducting a study • Anticipating Patterns: Exploring random phenomena using probability and simulations • Statistical Inference: Estimating population parameters and testing hypotheses Advanced Placement (AP) AP classes are college-level courses requiring an exceptional amount of study on the part of the student who is expected to take the College Board Advanced Placement Examination in the second semester. A passing grade (typically 3 or better on a scale of 1 to 5) may earn college credit depending on the requirements of the individual colleges and universities students plan to attend. Students should expect to reach an advanced scope of skills compared to the standard or honors class: a higher reading stamina, the aptitude to think critically, and the propensity to finish complex tasks in a timely manner. Students taking an AP class have demonstrated the ability to take responsibility for their own learning, work fluidly both independently and collaboratively. The expectation is that the students will exemplify self-advocacy and time/stress management, as there are several demanding tests involved in the AP Curriculum. These classes are recommended to students by teachers who have evaluated a student's past practice and achievement. Course Units: 1. Exploring Data 2. Modeling Distributions of Data 3. Describing Relationships 4. Designing Studies and Collecting Data 5. Probability - What are the Chances 6. Random Variables 7. Sampling Distributions 8. Estimating with Confidence

9. Testing a Claim
10. Comparing Two Populations or Groups
11. Inference for Distributions of Categorical Data
12. More about Regression
13. Project

Approved Curricular Materials/Textbook(s)

The Practice of Statistics (sixth edition) by Starnes/Tabor

Unit Title	Unit Description (Include Unit Objectives)	Unit Pacing
Unit 1: EXPLORING DATA	In this introductory unit, students move beyond simple numbers to understand the "story" behind data. We begin by defining the difference between categorical and quantitative variables and mastering the concept of a distribution. Students will learn to identify relationships between variables, construct meaningful visual displays, and provide precise numerical summaries that reveal the underlying patterns in a dataset. Unit Topics Include: ● Analyzing Categorical Data - Frequency and relative frequency tables - Visualizing data with bar charts and pie charts - Exploring relationships between two categorical variables ● Displaying Quantitative Data with Graphs - Constructing dotplots, stemplots, and histograms - Identifying the "shape" of data (Symmetry vs. Skewness) - Comparing distributions across different groups ● Describing Quantitative Data with Numbers - Measuring center: Mean vs. Median - Measuring variability: Range, Standard Deviation and Interquartile Range (IQR)	2 weeks (August - September)

	- Identifying mathematical outliers	
Unit 2: MODELING DISTRIBUTIONS OF DATA	In this unit, we shift from describing entire datasets to pinpointing an individual's relative standing within a distribution. We begin by calculating percentiles and z-scores to answer the question, "Where do I stand?" Students will explore how mathematical transformations (like shifting or scaling) affect a distribution's shape, center, and spread. Finally, we introduce density curves, focusing specifically on the Normal Distribution—a symmetric, bell-shaped model used to estimate percentiles and probabilities for a wide variety of real-world variables. Unit Topics Include: • Describing Location in a Distribution - Calculating and interpreting Percentiles and Cumulative Relative Frequency graphs - Standardizing values using z-scores - Analyzing the effects of transforming data (adding, subtracting, multiplying, or dividing by a constant) • Density Curves and Normal Distributions - Transitioning from histograms to smooth Density Curves (where the total area = 1) - Identifying the Mean and Standard Deviation of a density curve - Applying the 68-95-99.7 Rule (The Empirical Rule) - Calculating areas under the Normal curve and finding values from known percentiles (Inverse Normal)	2 weeks (September)
Unit 3: DESCRIBING RELATIONSHIPS	In this unit, we shift our focus from analyzing single variables to exploring the relationships between two quantitative variables. Students will learn to visualize these connections using scatterplots and quantify the strength and direction of their association through correlation (r). The core of the unit involves constructing and interpreting the Least-Squares Regression Line - a mathematical model used to predict outcomes and analyze how well a linear trend fits the observed data.	2 weeks (September - October)

	Unit Topics Include: • Scatterplots and Correlation - Identifying Explanatory vs. Response variables - Describing patterns using Direction, Form, Strength, and Outliers - Interpreting the Correlation Coefficient (r) and its properties • Least-Squares Regression - Constructing the regression equation: $y = a + bx$ - Interpreting the slope and y-intercept in context - Calculating and interpreting residuals (Observed - Predicted) - Using the model to make predictions and avoiding extrapolation • Assessing the Fit of a Regression Line - Analyzing Residual Plots to determine if a linear model is appropriate - Interpreting the Standard Deviation of the Residuals - Interpreting the Coefficient of Determination (r^2) - Identifying the impact of outliers and influential points on the regression line	
Unit 4: DESIGNING STUDIES & COLLECTING DATA	In this unit, we explore the critical methods used to gather reliable data through surveys, observational studies, and experiments. Students will learn that "how" data is collected determines "what" conclusions can be drawn. We will focus on the principles of randomization to reduce bias and the specific structures of well-designed experiments. Finally, we will analyze the scope of inference, distinguishing between when we can generalize results to a population versus when we can establish a true cause-and-effect relationship. Unit Topics Include: • Sampling and Surveys - Identifying Population vs. Sample - Mastering sampling methods: Simple Random Sample (SRS), Stratified, Cluster, and Systematic - Recognizing Bias: Undercoverage, Nonresponse, and Response Bias	2 weeks (October)

	• Experiments - Distinguishing between Observational Studies and Experiments - The Four Principles of Experimental Design: Comparison, Random Assignment, Control, and Replication - Advanced designs: Randomized Block Design and Matched Pairs - The role of Placebos and Blinding (Single vs. Double) • Using Studies Wisely - Scope of Inference: Determining if results apply to a population or prove causation - The ethics of data collection - Understanding Confounding Variables and how they impact study results	
Unit 5: PROBABILITY: WHAT ARE THE CHANCES	In this unit, we move from data analysis to the mathematics of chance. We begin by using simulations to estimate probabilities and understand the "Law of Large Numbers." Students will develop formal probability models and master the fundamental rules of addition and multiplication. By revisiting two-way tables and introducing Venn diagrams and tree diagrams, we will explore the critical concepts of conditional probability and independence—tools that allow us to determine if the occurrence of one event truly changes the likelihood of another. Unit Topics Include • Randomness, Probability, and Simulation - Interpreting probability as a long-run relative frequency - Designing and conducting simulations to estimate outcomes - Understanding the "Law of Large Numbers" vs. the "Law of Averages" myth • Probability Rules - Defining a Sample Space and Probability Models - Mastering the Basic Rules: Complement rule, Addition rule for Mutually Exclusive events, and General Addition rule - Using Venn Diagrams to visualize intersections ($\cap$) and unions ($\cup$) • Conditional Probability and Independence - Calculating Conditional Probability: $P(A B) = \frac{P(A \cap B)}{P(B)}$	3 weeks (October - November)

	- Using The General Multiplication Rule and Tree Diagrams for multi-stage events - Proving Independence: Determining if $P(A B) = P(A)$ - Multiplication rule for independent events	
Unit 6: RANDOM VARIABLES	This unit is the bridge between probability theory and the "Big Picture" of statistical inference. You are moving from calculating the odds of a single event to understanding the behavior of entire distributions. In this unit, we transition from basic probability to the study of Random Variables—numerical outcomes determined by chance processes. A random variable is a numerical outcome of a chance process, such as the height of a randomly selected student, the number of heads in three flips of a coin, or the difference between the diameter of a randomly chosen cup and the diameter of a randomly chosen lid. We will analyze the "personality" of these variables by examining their probability distributions, specifically focusing on their shape, center, and spread. This unit serves as the essential preparation for statistical inference; understanding how random variables (like sample proportions and means) behave under repeated sampling is the key to building confidence intervals and performing significance tests later in statistics courses. Unit Topics Include: • Foundations of Random Variables - Distinguishing between Discrete (countable) and Continuous (measured) variables - Constructing and interpreting probability histograms - Measuring Center: Calculating the Expected Value - Measuring Variability: Calculating Variance and Standard Deviation • Transformations & Combinations - Understanding how linear transformations (adding/multiplying constants) affect the mean and standard deviation - Combining independent random variables: Rules for adding/subtracting means and adding variances • Binomial and Geometric Random Variables - Binomial Distributions and Shape	4 weeks (November - December)

	- Calculating Binomial probabilities using formulas and technology - Geometric Distributions: Modeling the number of trials to get the first success	
Unit 7: SAMPLING DISTRIBUTIONS	In this unit, we move from analyzing individual data points to analyzing the behavior of sample statistics ($\hat{p}$ and $\bar{x}$). We explore the concept of a Sampling Distribution: the distribution of values taken by a statistic in all possible samples of the same size from the same population. Students will learn how to describe the center and variability of these distributions and master the Central Limit Theorem, which allows us to use Normal models to make predictions about means even when the underlying population is not Normal. Unit Topics Include • What is a Sampling Distribution? - Distinguishing between a Parameter (population) and a Statistic (sample) - Understanding the concept of "Repeated Sampling" - Defining Bias and Variability in the context of sampling • Sampling Distributions: Center and Variability - Identifying an Unbiased Estimator (when the mean of the sampling distribution equals the true parameter) - Understanding how Sample Size (n) affects the spread (variability) of the distribution - The 10% Condition: When it is safe to calculate the standard deviation • Sample Proportions ($\hat{p}$) - Calculating the mean ($\mu_{\hat{p}} = p$) and standard deviation $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$. - Checking the Large Counts Condition ($np \geq 10$ and $n(1 - p) \geq 10$) to ensure a Normal shape • Sample Means ($\bar{x}$) - Calculating the mean ($\mu_{\bar{x}} = \mu$) and standard deviation ($\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$) - Analyzing how the shape of the sampling distribution changes as n increases	2 weeks (December - January)

	• The Central Limit Theorem (CLT) - Understanding that for a large enough sample size (usually $n \geq 30$), the sampling distribution of $\bar{x}$ is approximately Normal, regardless of the population's shape - Applying the CLT to calculate probabilities involving sample means	
Unit 8: ESTIMATING WITH CONFIDENCE	This unit marks the formal transition into statistical inference, shifting from theoretical probability to practical estimation. While previous studies focused on the behavior of statistics when parameters were known, this unit addresses the real-world scenario where the "truth" about a population is unknown. We introduce the confidence interval as a foundational tool for determining a range of plausible values for a population parameter based on sample data. By mastering the construction and interpretation of these intervals for both proportions and means, students develop the critical framework necessary for all subsequent inferential procedures, including comparative studies and regression analysis. Unit Topics Include: • Define the Logic of Confidence: Distinguish between a point estimate and an interval estimate, and explain the relationship between the margin of error and the confidence level (C) • Interpret Confidence Levels and Intervals: Correctly communicate the meaning of "confidence" in context, focusing on the long-run success rate of the estimation method • Calculate Critical Values: Use the standard Normal distribution (z^*) for proportions and the Student's t-distribution (t^*) for means to determine appropriate multipliers for a given confidence level • Verify Inferential Conditions: Validate the Random, 10%, and Normal/Large Counts conditions to ensure the sampling distribution of the estimator is approximately Normal and the standard deviation formula is applicable • Construct One-Sample z-intervals for Proportions: Apply the formula $\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ to estimate population parameters for categorical data • Construct One-Sample t-intervals for Means: Utilize the t-distribution when	3 weeks (January - February)

	the population standard deviation is unknown, calculating the correct degrees of freedom for quantitative data Analyze Precision and Sample Size: Determine how changes in confidence level, sample size (n), and standard deviation impact the width of an interval, and calculate the minimum sample size required to achieve a specific margin of error	
Unit 9: TESTING A CLAIM	This unit introduces the formal logic and mathematical framework of Significance Testing, a cornerstone of statistical inference used to evaluate claims about population parameters. Students will transition from intuitive decision-making to a rigorous four-step process—State, Plan, Do, Conclude—to determine if observed sample data provides convincing evidence against a null hypothesis. We will focus on one-sample tests for both proportions and means, exploring the critical relationship between P-values, significance levels (α), and the potential for errors in judgment. By mastering these procedures, students will gain the ability to distinguish between results that are truly statistically significant and those that can be attributed to mere sampling variability. Unit Topics Include: - Master the Logic of Hypothesis Testing: Define the Null (H_0) and Alternative (H_a) hypotheses and explain the reasoning behind the "proof by contradiction" approach used in significance tests - Interpret P-values and Significance: Explain the meaning of a P-value as a conditional probability and use it to make informed decisions regarding the strength of evidence against the null hypothesis - Identify and Analyze Errors: Distinguish between Type I errors (false positives) and Type II errors (false negatives), and understand how the power of a test relates to sample size and effect size - Perform One-Sample z-Tests for Proportions: Execute the full four-step inference process for categorical data, ensuring conditions for Normality (Large Counts) and Independence are met - Perform One-Sample t-Tests for Means: Apply the t-distribution when the population standard deviation is unknown and utilize the correct degrees of freedom for quantitative data	2 weeks (February - March)

	• Conduct Two-Sided Tests and Relate to Confidence Intervals: Demonstrate the mathematical duality between two-sided significance tests and confidence intervals to provide a range of plausible values for a parameter • Analyze Paired Data: Identify dependent sampling structures and perform matched-pairs t-tests by analyzing the distribution of differences	
Unit 10: COMPARING TWO POPULATIONS OR GROUPS	In this unit, we transition from analyzing single samples to the more complex task of comparing two distinct populations or experimental treatment groups. This "two-sample" framework allows us to investigate differences between population parameters—specifically proportions and means—to determine if observed variations are statistically significant or merely the result of sampling variability. We will explore the critical distinction between independent samples and paired data while mastering the construction of confidence intervals for the difference between parameters. By the end of this unit, students will be able to perform robust hypothesis tests and accurately interpret the results of comparative studies in various scientific and social contexts. Unit Topics Include: • Distinguish Between Study Designs: Identify whether a study uses independent samples or a matched-pairs (dependent) design to select the correct inferential procedure • Construct Confidence Intervals for Differences: Estimate the magnitude of the difference between two population proportions or two population means with a specified level of confidence • Perform Two-Sample Significance Tests: Conduct hypothesis tests to evaluate claims about the difference between two parameters • Verify Inferential Conditions: Validate the "Random, 10%, and Normal/Large Counts" conditions specifically for two-sample settings, ensuring both samples independently meet the requirements • Master the t-Distribution for Two Means: Calculate the appropriate degrees of freedom • Analyze Effect Size and Practical Significance: Move beyond P-values to interpret the practical importance of a found difference using the calculated	2 weeks (March)

	confidence interval	
Unit 11: INFERENCE FOR DISTRIBUTIONS OF CATEGORICAL DATA	This unit introduces the Chi-Square (χ^2) family of tests, providing a robust framework for analyzing categorical data across one or more populations. Unlike the z and t procedures used for means and proportions, Chi-Square tests evaluate the discrepancy between observed counts and the counts we would expect to see if a specific null hypothesis were true. Students will master three distinct inferential procedures: 1. The Goodness of Fit test for single distributions. The chi-square test for goodness of fit is used to determine whether the distribution of a single categorical variable differs from a hypothesized distribution in some population. 2. The Test for Homogeneity for comparing multiple groups. The chi-square test for homogeneity is used to compare the distribution of a single categorical variable for two or more populations or treatments. 3. The Test for Independence for exploring associations between two variables. The chi-square test for independence is used to investigate the relationship between two categorical variables in a single population This unit emphasizes the unique nature of Chi-Square inference, where hypotheses are typically stated in prose, and tests are inherently many-sided, focusing on whether a model fits the data rather than the direction of a specific difference. Chi-square tests differ from the other significance tests we have learned in several ways. First, we usually state the hypothesis in words rather than symbols. Second, there are no one-sided alternative hypotheses. Essentially, the alternative hypothesis is always “the null hypothesis isn’t true.” Unit Topics Include: • Identify Appropriate Procedures: Distinguish between Goodness of Fit, Homogeneity, and Independence based on the study design and the number of populations or variables involved • Formulate Null and Alternative Hypotheses: State hypotheses in the	2 weeks (March)

	context of the research question, recognizing that χ^2 tests are always "not equal to" or many-sided by nature • Calculate Expected Counts: Determine the theoretical counts for each category under the assumption that the null hypothesis is true • Verify Mathematical Conditions: Ensure the data meets the requirements for Chi-Square inference, specifically that the data comes from a random process and that all Expected Counts are at least 5 • Compute the Chi-Square Statistic: Calculate the test statistic $\chi^2 = \sum \frac{(Observed - Expected)^2}{Expected}$ and determine the appropriate degrees of freedom • Interpret P-values and Follow-up Analysis: Use the χ^2 distribution to find P-values and perform a "component analysis" to identify which specific categories contributed most to a statistically significant result	
Unit 12: MORE ABOUT REGRESSION	This final unit focuses on advanced linear modeling and the techniques used to analyze non-linear relationships. Students will move beyond simple descriptive regression to perform formal statistical inference on the slope of a least-squares regression line, allowing for the estimation of population parameters and the testing of theoretical claims. Additionally, the unit addresses how to handle data that does not follow a linear trend by applying mathematical transformations, such as logarithms and power functions, to achieve linearity and expand the utility of regression models. Unit Topics Include: • Perform Inference for Regression: Construct and interpret confidence intervals for the slope of a population regression line to estimate the strength of a linear relationship • Conduct Significance Tests: Perform hypothesis tests to determine if there is a statistically significant linear association between two quantitative variables • Evaluate Model Assumptions: Verify the necessary conditions for regression inference, including linearity, independence, normality, and equal variance (LINER) • Analyze Non-linear Relationships: Identify curved patterns in scatterplots	2 weeks (April)

	and determine when a linear model is inappropriate • Apply Data Transformations: Utilize powers and logarithms to transform variables, effectively "straightening" non-linear data to allow for least-squares regression modeling • Interpret Transformed Models: Back-transform and interpret the results of non-linear models to make predictions in the original context of the data	
AP EXAM & REVIEW	During this time, students will engage in focused review and additional practice designed to strengthen both their conceptual understanding and their ability to apply statistics in a variety of contexts. Students will work with authentic AP exam questions from previous years, helping them become familiar with the format, rigor, and expectations of the exam. Students will also have opportunities to complete full-length practice exams, allowing them to develop effective time management strategies and build confidence in their problem-solving abilities. These practice experiences will help students identify areas for improvement, reflect on their progress, and assess their readiness for the AP Statistics exam.	1 week - 2 weeks (April - May)
Unit 13: PROJECTS	In this culminating unit, students transition from learners to researchers by designing and executing an original statistical study. Working individually or in small groups, students will identify a meaningful, school-appropriate topic and develop their own research questions for data collection, design a rigorous data-collection plan, analyze the data using appropriate statistical tools mastered throughout the year, and present their findings in a clear, visual, and engaging format. This project emphasizes real-world application, creativity, and student leadership, requiring a "soup-to-nuts" approach—from the initial hypothesis to a final, polished presentation of data-driven conclusions. To successfully complete this project, students are expected to: • Identify a Topic: Select a school-appropriate topic and formulate a clear, testable hypothesis • Design a Data Collection Plan: Develop a method (survey, observational study, or experiment) that minimizes bias and utilizes proper sampling or	3 weeks (May - June)

	assignment techniques • Execute Data Collection: Gather raw data while maintaining ethical standards and documenting the process • Perform Descriptive Analysis: Create appropriate graphical representations (histograms, boxplots, scatterplots) and calculate numerical summaries • Apply Inferential Reasoning: Select and conduct the correct inference procedure (Confidence Interval, T-Test, or Chi-Square) to determine the significance of the findings • Communicate Results: Produce a final report or visual presentation that translates complex calculations into clear, accessible conclusions for a general audience • Reflect on Limitations: Critically evaluate the study's design, identifying potential confounding variables or errors that may have impacted the results	
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