### AP Statistics

**Course Essential Questions:** How can the discipline of statistics be used to search for patterns and relationships in real-life?

**Unit 1: Exploring Data: describing patterns and departures from patterns - Exploring Data**

<table>
<thead>
<tr>
<th>Essential Questions:</th>
<th>Essential Understanding:</th>
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</thead>
<tbody>
<tr>
<td>● What is statistics and why should we study it?</td>
<td>● Statistics is the science of learning from data.</td>
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<td>● How is data analysis used to explore categorical data?</td>
<td>● Statistics gives us a language for talking about uncertainty that is understood by statistically literate people everywhere.</td>
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<td>● What are different ways to display the distribution of a variable and how do you determine which is the best to use?</td>
<td>● The most important information about any statistical study is how the data were produced.</td>
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<td>● How do we use and interpret statistical summaries to describe quantitative data?</td>
<td>● A carefully chosen graph is often more instructive than a bunch of numbers.</td>
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<td>● How do we identify where a value is located in a distribution?</td>
<td>● Percentiles are used to locate a value in a distribution.</td>
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<td>● What role does the Normal curve play into approximating distributions of data?</td>
<td>● Correlation is a numerical summary that provides the strength of a linear association.</td>
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<td>● What are the important characteristics that describe the association between two variables in a scatterplot?</td>
<td>● A least-square regression line models the relationship between variables in a scatter plot.</td>
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### Curriculum Standards- DOK noted where applicable with Standards

I. Exploring Data
   - Constructing and interpreting graphical displays of distributions of univariate data
   - Summarizing distributions of univariate data
   - Comparing distributions of univariate data
   - Exploring bivariate
   - Exploring categorical data

III. Anticipating Patterns
   - The Normal distribution

### LEARNING TARGETS

<table>
<thead>
<tr>
<th>Knowledge/Content</th>
<th>Skills/Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Know ...</td>
<td>I Can ...</td>
</tr>
</tbody>
</table>
- **Individuals** are the objects described by a set of data.
- A **variable** is any characteristic of an individual.
- A **categorical** variable places an individual into one of several groups or categories.
- A **quantitative** variable takes a numerical values for which it makes sense to find an average.
- That the **distribution** of a variable tells us what values the variable takes and how often it takes these values.
- That a **frequency table** displays the counts of a variable.
- The components of a **bar graph**.
- The components of a **histogram**.
- The components of a **pie chart**.
- The components of a **stemplot**.
- The **marginal distribution** of one of the categorical variables in a two-way table of counts is the distribution of values of that variable among all individuals described by the table.
- A **conditional distribution** of a variables describes the value of that variable among individuals who have a specific value of another variable.
- That there is an **association** between two variables if knowing the value of one variable helps predict the value of the other.
- That when you examine the distribution of a quantitative variable you should look for the overall pattern and for striking departures.
- You can describe the **overall pattern** can be described as shape, center, and spread.
- An important kind of departure is an **outlier**, an individual value that falls outside the overall pattern.
- The measures of center. ([Mean], [Median], [Mode])
- The different shapes of distributions. ([left skewed], [right skewed], [uniform], [symmetric])
- The different measures of spread. ([range], [standard deviation], [variation])
- When to use which measure of center to represent a data set.
- The components of a boxplot
- The process for calculating the **quartiles** and interquartiles.
- What makes up the **5-number summary**.
- That a **percentile** represents the value with p percent of the observations less than it.
- Identify the individuals and variables in a set of data (intro)
- Classify variables as categorical or quantitative (intro)
- Display categorical data with a bar graph. 1.1
- Decide whether it would be appropriate to make a pie chart 1.1
- Identify what makes some graphs of categorical data deceptive 1.1
- Calculate and display the marginal distributions of a categorical variable from a two-way table. 1.1
- Calculate and display the conditional distribution of a categorical variable for a particular value of the other categorical variable in a two-way table 1.1
- Describe the association between two categorical variables by comparing appropriate conditional distributions 1.1
- Make and interpret dotplots and stemplots of quantitative data. 1.2
- Describe the overall pattern of a distribution and identify any major departures from the pattern 1.2
- Identify the shape of a distribution from a graph as roughly symmetric or skewed 1.2
- Make and interpret histograms or quantitative data 1.2
- Compare distributions of quantitative data using dotplots, stemplots, or histograms 1.2
- Calculate measures of center 1.3
- Calculate and interpret measures of spread 1.3
- Choose the most appropriate measure of center and spread in a given setting 1.3
- Identify outliers using the 1.5 X IQR rule 1.3
- Make and interpret boxplots or quantitative data 1.3
- Use appropriate graphs and numerical summaries to compare distributions of quantitative variables. 1.3
- Find and Interpret the percentile of an individual value within a distribution of data. 2.1
- Estimate percentiles and individual values using a cumulative relative frequency graph 2.1
- Find and interpret the standardized score of an individual value within a distribution of data 2.1
- Describe the effect of adding, subtracting, multiplying by, or dividing by a constant on the shape, center, and spread of a distribution of data. 2.1
- Estimate the relative locations of the median and mean on a density curve 2.2
- The components of a cumulative relative frequency graph.
- How the mean, median, and mode are located depending on the different shapes of the density curves.
- That the z-score tells us how many standard deviations from the mean an observation falls, and in what direction.
- The process for computing the z-score.
- How adding, subtracting, multiplying by, or dividing by a constant will affect the shape, center, and spread of a distribution of data.
- What a density curve is and characteristics of it.
- A Normal distribution is described by a Normal Density curve.
- Why Normal distributions are important in Statistics.
- The 68-95-99.7 rule
- A response variable measures an outcome of a study.
- An explanatory variable may help explain or predict changes in a response variable.
- A scatterplot shows the relationship between two quantitative variables measured on the same individuals.
- The basic properties of correlation, including how the correlation is influenced by outliers.
- A regression line is a line that describes how a response variable changes as an explanatory variables changes.
- Extrapolation is the use of a regression line for prediction far outside the interval of values of the explanatory variable x used to obtain the regression line.
- A residual is the difference between an observed value of the response variable and the value predicted by the regression line.
- The least-squares regression line of the response variable on the explanatory variable is the line that makes the sum of the squared residuals as small as possible.
- The components for a residual plots and the process to assess whether a linear model is appropriate.
- The dangers of extrapolation.
- How the slope, y intercept, standard deviation of the residuals, and r squared are influenced by outliers.
- Why association does not imply causation between an explanatory and response variable.

<p>| Use the 68-95-99.7 rule to estimate areas in a Normal distribution 2.2 |
| Find the proportion of z-values in a specified interval 2.2 |
| Find a z-score from a percentile in the standard Normal distribution 2.2 |
| Determine whether a distribution of data is approximately Normal from graphical and numerical evidence 2.2 |
| Find the areas in any normal distribution using Table A or technology 2.2 |
| Find values from areas in any normal distribution using Table A or technology. 2.2 |
| Identify explanatory and response variables in situations where one variable helps to explain or influences the other. 3.1 |
| Make a scatterplot to display the relationship between two quantitative variables 3.1 |
| Describe the direction, form, and strength of a relationship displayed in a scatterplot and recognize outliers in a scatterplot. 3.1 |
| Interpret the correlation 3.1 |
| Use technology to calculate correlation 3.1 |
| Explain why association does not imply causation 3.1 |
| Interpret the slope and y intercept of a least-squares regression line 3.2 |
| Use the least-squares regression line to predict y for a given x. 3.2 |
| Explain the dangers of extrapolation. 3.2 |
| Calculate and interpret residuals 3.2 |
| Explain the concept of least squares 3.2 |
| Determine the equation of a least-squares regression line using technology. 3.2 |
| Construct and interpret residual plots to assess whether a linear model is appropriate 3.2 |
| Interpret the standard deviation of the residuals and r square. 3.2 |
| Use the residuals and r square to assess how well the least-squares regression line models the relationship between two variables. 3.2 |
| Describe how the slope, y intercept, standard deviation of the residuals, and r squared are influenced by outliers. 3.2 |
| Find the slope and y intercept of the least squares regression line from the means and standard deviations of x and y and their correlation. 3.2 |</p>
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Unit 2: Sampling and experimentation: Planning and conducting a study

Essential Questions:
- What is the difference between a population and a sample?
- What are unbiased methods of sampling and describe the appropriateness of each?
- What characteristics make up a well-designed experiment?
- How does the data produced in a study determine the different conclusions that can be made?

Essential Understanding:
- Because a census is almost always infeasible, it is important for a researcher to understand what multiple methods are and when to use them for gathering data.
- Well-designed experiments should contain a comparison, random assignment, control, and replication.
- Depending on the data that is collected, one could make inferences about populations or conclude cause and effect.

Curriculum Standards- DOK noted where applicable with Standards

II. Sampling and Experimentation
- Planning and conducting surveys and experiments using appropriate methods of data collection
- Generalizability of results and types of conclusions that can be drawn from observational studies, experiments, and surveys

LEARNING TARGETS

Knowledge/Content
I Know …
- The **population** in a statistical study is the entire group of individuals we want information about.
- A **census** collects data from every individual in the population.
- A **sample** is a subset of individuals in the population from which we actually collect data.
- Ways to sample badly: Convenience and voluntary response samples.
- Ways to sample well: Random sampling, Simple Random Sampling.
- The steps in choosing a simple random sample with technology.
- Other random sampling methods and the advantages and disadvantages of each. (ex: cluster, simple random, stratified, systematic)
- The design of a statistical study shows **bias** if it would consistently underestimate or consistently overestimate the value you want to know.

Skills/Processes
I Can …
- Identify the population and sample in a statistical study **4.1**
- Identify voluntary response samples and convenience samples. **4.1**
- Explain how sampling methods can lead to bias **4.1**
- Describe how to obtain a random sample using slips of paper, technology, or a table of random digits. **4.1**
- Distinguish a simple random sample from a stratified random sample or cluster sample. **4.1**
- Give the advantages and disadvantages of each sampling method. **4.1**
- Explain how undercoverage, non response, question wording, and other aspects of a sample survey can lead to bias. **4.1**
- Distinguish between an observational study and an experiment. **4.2**
• **Undercoverage** occurs when some members of the population cannot be chosen in a sample.

• **Nonresponse** occurs when an individual chosen for the sample can’t be contacted or refuses to participate.

• An **Observational study** observes individuals and measures variables of interest but does not attempt to influence the responses.

• An **experiment** deliberately imposes some treatment on individuals to measure their responses.

• **Confounding** occurs when two variables are associated in such a way that their effects on a response variable cannot be distinguished from each other.

• How confounding effects drawing conclusions.

• A specific condition applied to the individuals in an experiment is called a **treatment**.

• How to experiment badly.

• How to experiment well.

• In an experiment, **random assignment** means that experimental units are assigned to treatments using a chance process.

• Know the difference between explanatory and response variables.

• The Principles of an experimental design.
  (Comparison, Random assignment, Control, Replication)

• In statistics, replication means “use enough subjects.”

• In a **completely randomized design**, the experimental units are assigned to the treatments completely by chance.

• What the purpose of a control group in an experiment is.

• The **placebo effect** is the response to a dummy treatment and its purpose in experiments.

• In a **double blind experiment**, neither the subjects nor those who interact with them and measure the response variable know which treatment a subject received.

• An observed effect so large that it would rarely occur by chance is called **statistically significant**.

• A **block** is a group of experimental units that are known before the experiment to be similar in some way that is expected to affect the response to the treatments.

• Explain the concept of confounding and how it limits the ability to make cause-and-effect conclusions. 4.2

• Identify the experimental units, explanatory and response variables, and treatments in an experiment. 4.2

• Explain the purpose of comparison, random assignment, control, and replication in an experiment. 4.2

• Describe a completely randomized design for an experiment. 4.2

• Describe the placebo effect and the purpose of blinding in an experiment 4.2

• Interpret the meaning of statistically significant in the context of an experiment. 4.2

• Explain the purpose of blocking in an experiment. 4.3

• Describe a randomized block design or a matched pairs design for an experiment 4.3

• Describe the scope of inference that is appropriate in a statistical study. 4.3
- In a **randomized block design**, the random assignment of experimental units to treatments is carried out separately within each block.
- The process for creating a randomized block design.
- A **matched pairs design** is a common form of blocking for comparing just two treatments.
- The basic data ethics. (institutional review, informed consent, and confidentiality)

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Unit 3: Anticipating patterns: exploring random phenomena using probability and simulation.

Essential Questions:
- How does probability play into the role of bridging designing a study and drawing conclusions from them?
- How can the way that probability distributions are displayed aid in their interpretation?
- What is the difference between discrete and continuous variables?
- What are the two most common types of discrete random variables and what does each count?
- What is the difference between a statistic and a parameter?
- What is the difference between the distribution of the population, the distribution of the sample, and the sampling distribution of a sample statistic?
- How does the size of the sample affect the variability and shape of a distribution?

Essential Understanding:
- The probability of an outcome in a chance process describes the proportion of times the outcome would occur in the long run.
- Binomial random variables count the number of successes in a fixed number of trials, while geometric random variables count the number of trials needed to achieve a single success.
- A parameter is a number that describes some characteristics of a population. A statistic estimates the value of a parameter using a sample from the population.
- Statistics vary.
- To adequately describe a sampling distribution, one needs to address shape, center, and spread.

Curriculum Standards- DOK noted where applicable with Standards

III. Anticipating Patterns
- Probability
- Combining independent random variables
- The Normal distribution
- Sampling distributions

LEARNING TARGETS

Knowledge/Content I Know …

- The probability of any outcome of a chance process is a number between 0 and 1.
- **Probability** describes the proportion of times the outcome would occur in a very long series of repetitions.
- The steps for performing a simulation.
- The **sample space** of a chance process is the set of all possible outcomes.
- A **probability model** is a description of some chance process that consists of two parts: a

Skills/Processes I Can …

- Interpret probability as a long-run relative frequency. 5.1
- Use simulation to model chance behavior. 5.1
- Describe a probability model for a chance process 5.2
- Use the complement rule. 5.2
- Use the addition rule for mutually exclusive events. 5.2
sample space and a probability for each outcome.

- An **event** is any collection of outcomes from some chance process.
- Two events are **mutually exclusive** if they have no outcomes in common and so can never occur together.
- The complement rule.
- The addition rule for mutually exclusive events.
- The general addition rule for calculating probabilities for two events.
- The probability that one event happens given that another event is already known to have happened is called a **conditional probability**.
- The formulas for computing conditional probabilities.
- The general multiplication rule for probabilities.
- Two events are **independent** if the occurrence of one event does not change the probability that the other event will happen.
- The multiplication rule for independent events.
- A **random variable** takes numerical values that describe the outcomes of some chance process.
- The **probability distribution** of a random variable gives its possible values and their probabilities.
- The process for computing the expected value of a discrete random variable.
- How to use a probability distribution to compute probabilities of discrete and continuous random variables.
- Discrete random variables arise from counting something.
- A **continuous random variable** arises from measuring something, takes all values in an interval of numbers and the probability distribution of it is described by a density curve.
- A **binomial setting** arises when we perform several independent trials of the same chance process and record the number of times that a particular outcome occurs.
- The conditions for using a binomial distribution known as BINS but also including the 10% and large count condition.
- The binomial probability formula.
- The steps for finding binomial probabilities.
- The key strokes for computing a binomial probability on the calculator.
- Use a two-way table or Venn diagram to model a chance process and calculate probabilities involving two events. **5.2**
- Use the general addition rule to calculate probabilities. **5.2**
- Calculate and interpret conditional probabilities. **5.3**
- Use the general multiplication rule to calculate probabilities **5.3**
- Use tree diagrams to model a chance process and calculate probabilities involving two or more events. **5.3**
- Determine if two events are independent. **5.3**
- When appropriate, use the multiplication rule for independent events to compute probabilities. **5.3**
- Compute probabilities using the probability distribution of a discrete random variable. **6.1**
- Calculate and interpret the mean (expected value) of a discrete random variable. **6.1**
- Calculate and interpret the standard deviation of a discrete random variable. **6.1**
- Compute probabilities using the probability distribution of certain continuous random variables. **6.1**
- Describe the effects of transforming a random variable by adding and subtracting a constant and multiplying or dividing by a constant. **6.2**
- Find the mean and standard deviation of the sum or difference of independent random variables. **6.2**
- Find probabilities involving the sum or difference of independent Normal random variables. **6.2**
- Determine whether the conditions for using a binomial random variable are met. **6.3**
- Computer and interpret probabilities involving binomial distributions. **6.3**
- Calculate the mean and standard deviation of a binomial random variable. **6.3**
- Interpret the mean and standard deviation in context. **6.3**
- Find probabilities involving geometric random variables **6.3**
- When appropriate, use Normal approximation to the binomial distribution to calculate probabilities. **6.3**
- Distinguish between a parameter and a statistic.
- Use the sampling distribution of a statistic to evaluate a claim about a parameter. **7.1**
<table>
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<th><strong>Phase III Textbook/Materials</strong></th>
<th><strong>Phase IV Summative Assessment Evidence</strong></th>
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Essential Questions:
- What conditions do you need to check when calculating a confidence interval for a population proportion?
- How do you determine the appropriate sample size when planning a study?
- What are the steps of conducting a significance test?
- How are confidence intervals and significance tests used to compare two proportions or two means?

Essential Understanding:
- A point estimate is the single best guess for the value of a population parameter.
- A confidence interval is an interval of plausible values for a parameter.
- The Four step process is ideally suited for confidence interval questions and should be used each time one calculates and interprets a confidence interval.
- The difference between two sample proportions varies due to the chance involved in random selection is essential for drawing conclusions based on an observed difference in proportions in a study.
- The chi-square statistic is a way to measure the difference between an observed distribution and a hypothesized distribution of categorical data.

Curriculum Standards- DOK noted where applicable with Standards

IV. Statistical Inference
- Estimating population parameters and testing hypotheses
- Tests of significance

LEARNING TARGETS

Knowledge/Content I Know ...
- A point estimator is a statistic that provides an estimate of a population parameter.
- A confidence interval gives an interval of plausible values for a parameter.
- How the sample size and confidence level affect the length of a confidence interval.
- How practical issues can affect the interpretation of a confidence interval.
- The conditions for constructing a confidence interval for a population mean.
- The four step process for creating a confidence interval. (State, Plan, Do, Conclude)
- Conditions for constructing a confidence interval about a proportion.

Skills/Processes I Can ...
- Determine the point estimate and margin of error from a confidence interval. 8.1
- Interpret a confidence interval in context. 8.1
- Interpret a confidence level in context. 8.1
- Describe how the sample size and confidence level affect the length of a confidence interval. 8.1
- Explain how practical issues can affect the interpretation of a confidence interval. 8.1
- State and check the Random, 10%, and Large Counts conditions for constructing a confidence interval for a population proportion. 8.2
- Determine critical values for calculating a Confidence interval for a population proportion. 8.2
- When the standard deviation of a statistic is estimated from data, the result is called the **standard error** of the statistic.
- The formula for computing a one-sample z-interval for a population proportion.
- The formula for determining the necessary sample size that will yield a specific confidence interval.
- How the t distributions are different from the standard Normal distribution.
- Why it is necessary to use a t distribution when calculating a confidence interval for a population mean.
- The formula for computing the standard error of the sample mean.
- The process for choosing sample size for a desired margin of error when estimating the population mean.
- The claim we weigh evidence against in a statistical test is called the null hypothesis.
- The claim about the population that we are trying to find evidence for is the alternative hypothesis.
- The difference between Type 1 and Type 2 errors and how they affect our inference about a hypothesis.
- The conditions for performing a significance test about a population parameter.
- What factors affect the power of a test.
- The relationship among the probability of a Type 1 error, the probability of a Type 2 error, and the power of a test.
- The conditions for doing inference about sample proportions.
- The conditions for doing inference about the difference of sample means.
- When it is appropriate to use two-sample t procedures versus paired t procedures.
- A **Chi-Square statistic** is a measure of how far the observed counts are from the expected counts.
- The conditions for performing a chi-square test for goodness of fit.
- The process for computing the chi-square statistic, degrees of freedom, and P-value for a chi-square test for goodness of fit.
- The conditions for performing inference about the slope of the population regression line.

- Construct and interpret a confidence interval for a population proportion. **8.2**
- Determine the sample size required to obtain a C% confidence interval for a population proportion with a specified margin of error. **8.2**
- State and check the conditions for constructing a confidence interval for a population mean. **8.3**
- Explain how the t distributions are different from the standard Normal distribution. **8.3**
- Explain why it is necessary to use a t distribution when calculating a confidence interval for a population mean. **8.3**
- Determine critical values for calculating a confidence interval for a population mean using a table or technology. **8.3**
- Construct and interpret a confidence interval for a population mean. **8.3**
- State the null and alternative hypotheses for a significance test about a population parameter. **9.1**
- Interpret a P-value in context. **9.1**
- Determine whether the results of a study are statistically significant and make an appropriate conclusion using a significant level. **9.1**
- Interpret a Type 1 and Type 2 error in context and give a consequence of each. **9.1**
- State and check the conditions for performing a significance test about a population parameter. **9.2**
- Perform a significance test about a population proportion. **9.2**
- Interpret the power of a test and describe what factors affect the power of a test. **9.2**
- Describe the relationship among the probability of a Type 1 error, the probability of a Type 2 error, and the power of a test. **9.2**
- State and check the conditions for performing a significant test about a population mean. **9.3**
- Perform a significance test about a population mean. **9.3**
- Use a confidence interval to draw a conclusion for a two-sided test about a population parameter. **9.3**
- Perform a significance test about a mean difference using paired data. **9.3**
- Determine the shape, center, and spread of the sampling distribution of the difference of sample proportions. **10.1**
<table>
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<th>Phase III Textbook/Materials</th>
</tr>
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<tbody>
<tr>
<td>Phase IV Summative Assessment Evidence</td>
</tr>
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- The formula for finding the sampling distribution of a slope.
- The formula for calculating the t interval for the slope.
- The t test for the slope.

- Determine whether the conditions are met for doing inference about sample proportions. 10.1
- Construct and interpret a confidence interval to compare two proportions. 10.1
- Perform a significance test to compare two proportions. 10.1
- Describe the shape, center, and spread of the sampling distribution of the difference of sample means. 10.2
- Determine whether the conditions are met for doing inference about the difference of sample means. 10.2
- Construct and interpret a confidence interval to compare two means. 10.2
- Perform a significance test to compare two means. 10.2
- Determine when it is appropriate to use two-sample t procedures versus paired t procedures. 10.2
- State appropriate hypotheses and compute expected counts for a chi-square test for goodness of fit. 11.1
- Calculate the chi-square statistic, degrees of freedom, and P-value for a chi-square test for goodness of fit. 11.1
- Perform a chi-square test for goodness of fit. 11.1
- Conduct a follow-up analysis when the results of a chi-square test are statistically significant. 11.1
- Check the conditions for performing inference about the slope of the population regression line. 12.1
- Interpret the values of a, b, s, SEb, and r square in context. 12.1
- Determine the values of a, b, s, SEb, and r square from a computer output. 12.1
- Construct and interpret a confidence interval for the slope of the population regression line. 12.1
- Perform a significance test about the slope of the population regression line. 12.1
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