Bristol Public Schools

Office of Teaching & Learning

Department	Mathematics
Department Philosophy	*Students learn by doing math, solving problems in mathematical and real-world contexts, and constructing arguments using precise language.* The Bristol mathematics curricula embeds this *learn-by-doing* philosophy by focusing on high expectations for all students and providing students with opportunities that build conceptual understanding, computational and procedural fluency, and problem solving through the use of a variety of strategies, tools, and technologies. The mathematics curriculum is responsive to the individual needs of students, while providing a structure tied to the Common Core State Standards in Connecticut. The *learn-by-doing* philosophy develops mathematically literate and productive students who can effectively and efficiently apply mathematics in their lives to make informed decisions about the world around them by doing math. To be mathematically literate, one must understand major mathematics concepts, possess computational facility, and have the ability to apply these understandings to situations in daily life. Making connections between mathematics and other disciplines is key to the appropriate application of mathematics skills and concepts to solve problems. The ability to read, discuss, and write within the discipline of mathematics is an integral skill that supports mathematical understanding, reasoning and communication. The opportunity to think critically and creatively to solve problems is important to deepen mathematical knowledge and foster innovation. A rich hands-on mathematical experience is essential to provide the foundational knowledge and skills that prepare students to be mathematically literate, productive citizens.
Course	AP Statistics
Course Description for Program of Studies	This course is equivalent to a one-semester, introductory, non-calculus based, and college course in statistics. 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, including exploring data, sampling and experimentation, anticipating patterns, and statistical inference. Students who successfully complete the course and exam may receive credit, advanced placement, or both for a one-semester introductory college statistics course.
Grade Level	11-12
Pre-requisites	Grade 11 students may take AP Statistics if they are concurrently enrolled in Precalculus accelerated with a grade of “83” or better in Algebra 2 Accelerated and teacher recommendation.

	Grade 12 students may enroll in AP Statistics with a grade of "83" or better in Algebra 2 Accelerated and teacher recommendation.
Credit (if applicable)	1.0

Table of Contents

District Learning Expectations and Standards	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
1.A Identify the question to be answered or problem to be solved (not assessed).	x	x	x	x	x	x	x	x	x
1.B Identify key and relevant information to answer a question or solve a problem.	x	x	x	x	x	x	x	x	x
1.C Describe an appropriate method for gathering and representing data.	x	x	x			x	x	x	x
1.D Identify an appropriate method for confidence intervals.						x	x		x
1.E Identify an appropriate inference method for significance tests.						x	x	x	x
1.F Identify null and alternative hypotheses.						x	x	x	x
2.A Describe data presented numerically or graphically.	x	x							x
2.B Construct numerical or graphical representations of distributions.	x	x							
2.C Calculate summary statistics, relative positions of points within a distribution, correlation and predicted response.	x	x							
2.D Compare distributions or relative positions of points within a distribution.	x	x							
3.A Determine relative frequencies, proportions or probabilities using simulation or calculations.	x			x					
3.B Determine parameters for probability distributions.				x					

3.C Describe probability distributions.				x					
3.D Construct a confidence interval, provided conditions for inference are met.						x	x		x
3.E Calculate a test statistic and find a p-value, provided conditions for inference are met.						x	x	x	x
4.A Make an appropriate claim or draw an appropriate conclusion.			x			x	x	x	x
4.B Interpret statistical calculations and findings to assign meaning or assess a claim.						x	x	x	x
4.C Verify that inference procedures apply in a given situation.						x	x	x	x
4.D Justify a claim based on a confidence interval.						x	x		x
4.E Justify a claim using a decision based on significance tests.						x	x	x	x

AP Statistics: Course Skills		
UNWRAPPED STANDARDS/Course Skills		
Course Skill Category	**Elements of Course Skill**	**Academic Vocabulary (Standard Based)**
Selecting Statistical Methods: Select methods for collecting and/or analyzing data for statistical inference.	Skills: 1.A Identify the question to be answered or problem to be solved (not assessed). 1.B Identify key and relevant information to answer a question or solve a problem. 1.C Describe an appropriate method for gathering and representing data. Inference: 1.D Identify an appropriate method for confidence intervals. 1.E Identify an appropriate inference method for significance tests. 1.F Identify null and alternative hypotheses.	• Experiment • Observational study • Random sampling • Randomization • Scope of inference • Inference method • Confidence intervals • Significance tests • Null hypothesis • Alternative hypothesis
Data Analysis: Describe patterns, trends, associations, and relationships in data.	Skills: 2.A Describe data presented numerically or graphically. 2.B Construct numerical or graphical representations of distributions. 2.C Calculate summary statistics, relative positions of points within a distribution, correlation and predicted response. 2.D Compare distributions or relative positions of points within a distribution.	• Median • Mean • Variability • Range • Interquartile range • Standard deviation • First quartile • Third quartile • Symmetric • Skewed • Normal • Bimodal • Uniform • Outliers • Correlation • Influential points • Quantitative variables • Qualitative variables • Dotplot • Stemplot • Histogram • Boxplot

		• Ogive • Scatterplot
Using Probability and Simulation: Explore random phenomena.	Skills: 3.A Determine relative frequencies, proportions or probabilities using simulation or calculations. 3.B Determine parameters for probability distributions. 3.C Describe probability distributions. Inference: 3.D Construct a confidence interval, provided conditions for inference are met. 3.E Calculate a test statistic and find a p-value, provided conditions for inference are met.	Probability • Law of large numbers • Simulation • Probability models • Sample space • Complement • Mutually exclusive (disjoint) • Venn diagram • Intersection • Union • Conditional probability • Independent events • Discrete random variable • Mean • Standard deviation • Variance • Continuous random variable • Binomial random variable • Geometric random variable • Inference: • Point estimate • Confidence interval • Confidence level • Margin of error • Critical value • Standard error • Conditions Inference • P-value • Significance level • Statistically significant • Type I error • Type II error • Degrees of freedom
Statistical Argumentation: Develop an explanation or justify a conclusion using evidence from data, definitions, or statistical inference.	Skills: 4.A Make an appropriate claim or draw an appropriate conclusion. 4.B Interpret statistical calculations and findings to assign meaning or assess a claim.	• Conditions • Inference • P-value • Significance level • Statistically significant

	Inference: 4.C Verify that inference procedures apply in a given situation. 4.D Justify a claim based on a confidence interval. 4.E Justify a claim using a decision based on significance tests.	• Type I error • Type II error •

UNIT 1: Exploring One-Variable Data

- Big Idea 1: Variation and Distribution: Is my cat old, compared to other cats?
- Big Idea 2: Patterns and Uncertainty: How certain are we that what seems to be a pattern is not just a coincidence?

SAT Skills #	Learning Targets: I can	Assessment Strategy SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	Essential Knowledge	Common Learning Experiences
1.A, 2.A **Pacing:**	What can we learn from Data? • I can identify questions to be answered, based on variation in one-variable data. (SR) • I can identify variables in a set of data. (SR) • I can classify types of variables. (CR)		• Numbers may convey meaningful information, when placed in context. • A variable is a characteristic that changes from one individual to another. • A categorical variable takes on values that are category names or group labels. • A quantitative variable is one that takes on numerical values for a measured or counted quantity.	**Topics 1.1, 1.2**
2.A, 2.B, 2.C, 2.D, 4.B **Pacing:**	How can we represent and describe data? • I can represent categorical data using frequency or relative frequency tables. (P) • I can describe categorical data represented in frequency or relative tables. (CR) • I can represent and describe categorical data graphically. (P) • I can compare multiple sets of categorical data. (CR) • I can classify types of quantitative variables. (CR) • I can represent quantitative data graphically. (O) • I can describe the characteristics of quantitative data distributions. (CR) • I can calculate measures of center and position for quantitative data. (P) • I can represent summary statistics for quantitative data graphically. (P) • I can describe summary statistics of quantitative data represented graphically. (CR) • I can compare the graphical representations and summary statistics		• A frequency table gives the number of cases falling in each category. A relative frequency table gives the proportion. • Percentages, relative frequencies and rates all provide the same information as proportions. • Counts and relative frequencies of categorical data reveal information that can be used to justify claims in context. • Bar charts (or bar graphs) are used to display frequencies or relative frequencies for categorical data. • Graphical representations of a categorical variable reveal information that can be used to justify claims. • Frequency tables, bar graphs or other representations can be used to compare two or more data sets in terms of the same categorical variable. • A discrete variable can take on a countable number of values. • In a histogram, the height of each bar shows the number or proportion within an interval. • In a stem and leaf plot, each data value is split into a "stem" (the first digit or digits) and a "leaf" (usually the last digit). • Descriptions of the distribution of quantitative data include	**Topics 1.3-1.9**

	for multiple sets of quantitative data. (CR)	shape, center, and variability (spread), as well as any unusual features such as outliers, gaps, clusters or multiple peaks. ● Statistics are numerical summaries of sample data. Measures include mean, median, quartiles, percentiles, range and standard deviation. ● Outliers can be calculated two ways and will impact some, but not all, measures. ● A boxplot is a graphical representation of the five-number summary. ● Summary statistics can be used to justify claims about data. ● The relative location of median and mean is determined by the shape of the associated graph. ● Any graphical representations or summary statistics can be used to compare two or more independent samples.	
2.D, 3.A **Pacing:**	What is the normal distribution? ● I can compare a data distribution to the normal distribution model. (CR) ● I can determine proportions and percentiles from a normal distribution. (P) ● I can compare measures of relative position in data sets. (CR)	● A parameter is a numerical summary of a population ● Some sets of data may be described as approximately normally distributed. A normal curve is mound-shaped and symmetric. ● For a normal distribution, approximately 68% of the observations are within 1 standard deviation of the mean, approximately 95% of observations are within 2 standard deviations and approximately 99.7% of observations are within 3 standard deviations. This is called the empirical rule. ● Many variables can be modeled by a normal distribution. ● A standardized score for a particular data value is calculated as (data value-mean)/(standard deviation) and measures the number of standard deviations a data value falls above or below the mean. ● An example of a standardized score is a z-score, which measures how many standard deviations a data value is from the mean. ● Percentiles and z-scores may be used to compare relative positions within a data set or between data sets.	**Topic 1.10**

ADDITIONAL CONSIDERATIONS

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT
● Students tend to misuse statistical terms (confusing mean and median) or not use specific enough language when describing and comparing distributions. ● Students describe distributions in general terms, without providing context based on the problem. ● Students compare frequencies instead of relative frequencies when comparing categorical data. ● Students use normal and symmetric interchangeably; while all normal distributions are symmetric, not all symmetric distributions are normal.	List standards in the unit and link to achieve the core coherence map for each standard https://achievethecore.org/coherence-map/HS/S ● HS.S-ID.A.1: Represent data with plots on the real number line (dot plots, histograms, and box plots). ● HS.S-ID.A.2:Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets ● HS.S-ID.A.3:Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ● HS.S-ID.A.4: Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.		

RESOURCES

UNIT 2: Exploring Two-Variable Data

- Big Idea 1: Variation & Distribution: Does the fact that the number of shark attacks increases with ice cream sales necessarily mean that ice cream sales cause shark attacks?
- Big Idea 2: Patterns & Uncertainty: How might you represent incomes of individuals with and without a college degree to help describe similarities and/or differences between the two groups?
- Big Idea 3: Data-Based Predictions, Decisions and Conclusions: How can you determine the effectiveness of a linear model that uses the number of cricket chirps per minute to predict temperature?

SAT Skills #	Learning Targets: I can	Assessment Strategy SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	Essential Knowledge	Common Learning Experiences
1.A	How do we know if variables are related?		• Apparent patterns and associations in data may be random or not.	**Topic 2.1**
Pacing:	• I can identify questions to be answered about possible relationships in data. (SR)			
2.C, 2.D	How do we represent two variable data?		• Side-by-side bar graphs, segmented bar graphs and mosaic plots are examples of bar graphs for one categorical variable, broken down by categories of another categorical variable. • Graphical representations of two categorical variables can be used to compare distributions and/or determine if variables are associated. • A two-way table is used to summarize two categorical variables. The entries in the cells can be frequency counts or relative frequencies. • A joint relative frequency is a cell frequency divided by the total for the entire table. • The marginal relative frequencies are the row and column totals in a two-way table divided by the total for the entire table. • A conditional relative frequency is a relative frequency for a specific part of the contingency table. • Summary statistics for two categorical variables can be used to compare distributions and/or determine if variables are associated.	**Topics 2.2 & 2.3**
Pacing:	• I can compare numerical and graphical representations for two categorical variables. (CR) • I can calculate and compare statistics for two categorical variables. (P)			

2.A, 2.B, 2.C, 4.B **Pacing:**	How do we represent the relationships between variables? • I can represent bivariate quantitative data using scatterplots. (P) • I can describe the characteristics of a scatter plot. (CR) • I can determine the correlation for a linear relationship. (P) • Interpret the correlation for a linear relationship. • I can calculate a predicted response value using a linear regression model. (P) • I can represent differences between measures and predicted responses using residual plots. (P) • I can describe the form of association of bivariate data using residual plots. (CR) • I can estimate parameters for the least-squares regression line model. (P) • I can interpret coefficients for the least-squares regression line model. (CR) • I can identify influential points in regression. (SR) • I can calculate a predicted response using a least-squares regression line for a transformed data set. (P)	• A bivariate quantitative data set consists of observations of two different variables made on individuals in a sample or population. • A scatterplot shows two numeric values for each observation, one corresponding to the value on the x-axis and one corresponding to the value on the y-axis. • An explanatory variable is a variable whose values are used to explain or predict corresponding values for the response variable. • Scatter plots can be described using form, direction, strength, association, and unusual features. • The correlation gives the direction and quantifies the strength of the linear association. • A correlation coefficient, calculated using the formula or technology, close to 1 or -1 does not necessarily mean that a linear model is appropriate. • The correlation, r, is unit-free and always between -1 and 1, inclusive. A value of r=0 indicates that there is no linear association. The value of r=1 or r=-1 indicates that there is a perfect linear association. • Correlation does not necessarily imply causation. • A simple linear regression model is an equation that uses an explanatory variable, x, to predict the response variable, y. • Extrapolation is predicting a response value using a value for the explanatory variable that is beyond the interval of x-values used to determine the regression line. • The residual is the difference between the actual value and the predicted value. • Residual plots can be used to investigate the appropriateness of a selected model. • The least-squares regression model minimizes the sum of the squares of the residuals. • The coefficients of the least-squares model are the estimated slope and y-intercept. • An outlier in regression is a point that does not follow the general trend shown in the rest of the data and has a large residual when the Least Squares Regression Line is calculated. • An influential point in regression is any point that, if removed, changes the relationship substantially. Examples include much different slope, y-intercept, correlation and/or outliers.	**Topics 2.4-2.9**

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT
● Students do not provide context when describing a scatter plot. ● Students mistakenly think that correlation equals causation prior to unit 3. ● Students get the order wrong when subtracting to find a residual. ● Students do not use words like "expected" or "predicted" when interpreting the slope or intercept of a least-squares regression line.	● HS.S-ID.B.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. ● HS.S-ID.B.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. ● HS.S-ID.B.6.b: Informally assess the fit of a function by plotting and analyzing residuals. ● HS.S-ID.B.6.c: Fit a linear function for a scatter plot that suggests a linear association. ● HS.S-ID.C.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. ● HS.S-ID.C.8: Compute (using technology) and interpret the correlation coefficient of a linear fit. ● HS.S-ID.C.9: Distinguish between correlation and causation. ●		

RESOURCES

UNIT 3: Collecting Data				
● Big Idea 1: Variation and Distribution: What does our data tell us? ● Big Idea 3: Data-Based Predictions, Decisions and Conclusions: Why might the data we collected not be valid for drawing conclusions about an entire population?				
SAT Skills #	**Learning Targets:** I can	**Assessment Strategy** SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	**Essential Knowledge**	**Common Learning Experiences**
1.A **Pacing:**	Does the Data We Collected Tell the Truth? ● I can identify questions to be answered about data collection methods. (SR)		● Methods for data collection that do now rely on chance result in untrustworthy conclusions.	**Topics 3.1**
1.C, 4.A **Pacing:**	How do we appropriately sample? ● I can identify the type of a study. (SR) ● I can identify appropriate generalizations and determinations based on observational studies. (SR) ● I can identify a sampling method, given a description of a study. (SR) ● I can explain why a particular sampling method is or is not appropriate for a given situation. (CR) ● I can identify potential sources of bias in sampling methods. (CR)		● A population consists of all items or subjects of interest, a sample is a subset of the population. ● In an observational study, treatments are not imposed. A sample survey is a type of observational study. ● In an experiment, different conditions are assigned to experimental units. ● It is only appropriate to make generalizations about a population based on samples that are randomly selected or otherwise representative of that population. ● A sample is only generalizable to the population from which the sample was selected. ● It is not possible to determine causal relationships between variables using data collected in an observational study. ● When an item from a population can be selected only once, this is called sampling without replacement. When an item can be selected more than once, this is called a sampling with replacement. ● A simple random sample (SRS) is a sample in which every group of a given size has an equal chance of being chosen. ● Stratified random samples, cluster samples and systematic samples can also be utilized. ● A census selects all items/subjects in a population. ● There are advantages and disadvantages for each sampling method depending upon the question that is to be answered	**Topics: 3.2-3.4**

		and the population from which the sample will be drawn. ● Potential sources of bias include voluntary response, nonresponsive, question wording and self-reported responses. ● Non-random sampling methods introduce potential for bias because they do not use chance to select the individuals.	
1.C, 1.B, 4.B **Pacing:**	How do we design an experiment and use its findings? ● I can identify the components of an experiment. (P) ● I can describe the elements of a well-designed experiment. (CR) ● I can compare experimental designs and methods. (CR) ● I can explain why a particular experimental design is appropriate. (CR) ● I can interpret the results of a well-designed experiment. (CR)	● The experimental units are the individuals that are assigned treatments. ● An explanatory variable in an experiment is a variable whose levels are manipulated intentionally. The levels or combination of levels of the explanatory variable(s) are called treatments. ● A response variable in an experiment is an outcome from the experimental units that is measured after the treatments have been administered. ● A confounding variable in an experiment is a variable that is related to the explanatory variable and influences the response variable and may create a false sense of association. ● A well designed experiment contains comparisons of at least two treatment groups including a control group, random assignment of treatments, replication and control of potential confounding variables. ● Methods include single-blind, double-blind, control group, placebo use, random assignment, randomized complete design block, matched pairs, etc. ● Statistical inference attributes conclusions based on data to the distribution from which the data were collected. ● Random assignment of treatments allows researchers to conclude that some observed changes are so large as to be unlikely to have occurred by chance. These are said to be statistically significant. ● Statistically significant differences between or among experimental treatment groups are evidence that the treatments caused the effects. ● If the experimental units used in an experiment are representative of some large group of units, the results of the experiment can be generalized to the larger group.	**Topics: 3.5-3.7**

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT
● Students mistakenly think that	List standards in the unit and link to		

correlation equals causation ● Students confuse bias and variability. ● Students are not specific enough when writing about confounding variables; they think any variable that might be related to the response variable might be a confounding variable, even if it is not related to the explanatory variable. ● Students misuse statistical terms or use terms without explanation, specifically terms like bias and confounding. ● Students can identify sources of bias, but they do not initially go far enough in describing the consequences or direction of the bias. ● Students think that replication means doing a study multiple times instead of using many subjects to reduce variability. ● Students confuse stratified and cluster sampling, and even confuse stratified sampling with block design experiments.	achieve the core coherence map for each standard		
RESOURCES			

UNIT 4: Probability, Random Variables & Probability Distributions

- Big Idea 1: Variation & Distribution: How can an event be both random and predictable?
- Big Idea 2: Patterns & Uncertainty: About how many rolls of a fair six-sided die would we anticipate it taking to get three 1's?

SAT Skills #	**Learning Targets:** I can	**Assessment Strategy** SR-Selected Response CR-Constructed Response	**Essential Knowledge**	**Common Learning Experiences**

		P-Performance O-Observation (behavioral)		
1.A	How can we find patterns in data?		● Patterns in data do not necessarily mean that variation is not random.	**Topics: 4.1**
Pacing:	● I can identify questions suggested by patterns in data. (CR)			
3.A	How do we use simulations to make predictions?		● A random process generates results that are determined by choice. ● An outcome is the result of a trial of a random process. ● An event is a collection of outcomes. ● Simulation is a way to model random events, such that simulated outcomes closely match real world outcomes. ● The relative frequency of an outcome or event in simulated or empirical data can be used to estimate the probability of that outcome or event. ● The law of large numbers states that simulated (empirical) probabilities tend to get closer to the true probability as the number of trials increases.	**Topics: 4.2**
Pacing:	● I can estimate probabilities using simulations. (P)			
3.A, 4.B	How do we make predictions with different kinds of events?		● The sample space of a random process is the set of all possible non-overlapping outcomes. ● If all outcomes in the sample space are equally likely, then the probability an event E will occur is defined as the fraction. ● The probability of an event is a number between 0 and 1, inclusive. ● Probabilities of events in repeatable situations can be interpreted as the relative frequency with which the event will occur in the long run. ● The probability that events A and B will both occur is the probability of the intersection of A and B. ● Two events are mutually exclusive or disjoint if they cannot occur at the same time. ● The probability that event A will occur given that event B has occurred is called a conditional probability. ● The multiplication rule states that the probability that events A and B both will occur is equal to the probability that event A will occur multiplied by the probability that event B will occur, given that A has occurred. ● Events A and B are independent if, and only if, knowing whether event A has occurred (or will occur) does not change the probability that event B will occur. ● The probability that event A or event B (or both) will occur is the	**Topics: 4.3, 4.4, 4.5, 4.6**
Pacing:	● I can calculate probabilities for events and their complements. (P) ● I can interpret probabilities for events. (CR) ● I can explain why two events are (or are not) mutually exclusive. (CR) ● I can calculate conditional probabilities. (P) ● I can calculate probabilities for independent events and for the union of two events. (P)			

		probability of the union of A and B. ● The addition rule states that the probability that event A or event B or both will occur is equal to the probability that event A will occur plus the probability that event B will occur minus the probability that both events A and B will occur.	
2.B, 3.B, 4.B, 3.C **Pacing:**	What is the impact of random variables? ● I can represent the probability for a discrete random variable. (O) ● I can interpret a probability distribution. (P) ● I can calculate the parameters for a discrete random variable. (P) ● I can interpret parameters for a discrete random variable. (CR) ● I can calculate parameters for linear combinations of random variables. (P) ● I can describe the effects of linear transformations of parameters of random variables. (CR)	● The values of a random variable are the numerical outcomes of random behavior ● A discrete random variable is a variable that can only take a countable number of values. Each value has a probability associated with it. The sum of the probabilities over all of the possible values must be 1. ● A probability distribution can be represented as a graph, table, or function showing the probabilities associated with values of a random variable. ● A cumulative probability distribution can be represented as a table or function showing the probability of being less than or equal to each value of the random variable. ● An interpretation of a probability distribution provides information about the shape, center, and spread of a population and allows one to make conclusions about the population of interest. ● A numerical value measuring a characteristic of a population or the distribution of a random variable is known as a parameter, which is a single, fixed value. ● Parameters for a discrete random variable should be interpreted using appropriate units and within the context of a specific population. ● Two random variables are independent if knowing information about one of them does not change the probability distribution of the other.	**Topics: 4.7, 4.8, 4.9**
3.A, 3.B, 4.B **Pacing:**	How do we use probabilistic reasoning to anticipate patterns in data? ● I can estimate probabilities of binomial random variables using data from a simulation. (CR) ● I can calculate probabilities for a binomial distribution. (P) ● I can calculate and interpret probabilities and parameters for a binomial distribution. (P) ● I can calculate probabilities for geometric random variables. (P) ● I can calculate parameters of a geometric distribution. (P) ● I can interpret probabilities and parameters for a geometric	● A probability distribution can be constructed using the rules of probability or estimated with a simulation using random number generators. ● A binomial random variable, X, counts the number of successes in n repeated independent trials, each trial having two possible outcomes (success or failure), with the probability of success p and the probability of failure 1 – p. ● Probabilities and parameters for a binomial distribution should be interpreted using appropriate units and within the context of a specific population or situation. ● Probabilities and parameters for a geometric distribution should be	**Topics: 4.10, 4.11, 4.12**

	distribution. (CR)	interpreted using appropriate units and within the context of a specific population or situation.	

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT
● Students confuse mutually exclusive events and independent events. ● Students don't always realize when to use the conditional probability formula. ● Students do not provide enough evidence when determining whether or not two events are independent. ● Students add standard deviations, rather than adding variances and then taking the square root of the variance. ● Students do no define variables and parameters well enough for random variables ● Students struggle to learn the calculator commands for binomial calculations.	● HS.S-ID.B.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.		
RESOURCES			

UNIT 5: Sampling Distributions

- Big Idea 1: Variation & Distribution: How likely is it to get a value this large just by change?
- Big Idea 2: Patterns & Uncertainty: How can we anticipate patterns in the values of a statistic from one sample to another?

SAT Skills #	Learning Targets: I can	Assessment Strategy SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	Essential Knowledge	Common Learning Experiences
1.A	Why are conclusions uncertain?		● Variation in statistics for samples taken from the same population may be random or not.	**Topics: 5.1**
Pacing:	● I can identify questions suggested by variation in statistics for samples collected from the same population. (SR)			
3.A, 3.C	Why is the normal distribution used to model variation?		● A continuous random variable is a variable that can take on any value within a specified domain. Every interval within the domain has a probability associated with it. ● A continuous random variable with a normal distribution is commonly used to describe populations. The distribution of a normal random variable can be described by a normal, or "bell-shaped," curve. ● The area under a normal curve over a given interval represents the probability that a particular value lies in that interval. ● The boundaries of an interval associated with a given area in a normal distribution can be determined using z-scores or technology, such as a calculator, a standard normal table, or computer-generated output. ● Intervals associated with a given area in a normal distribution can be determined by assigning appropriate inequalities to the boundaries of the intervals. ● Normal distributions are symmetrical and "bell-shaped." As a result, normal distributions can be used to approximate distributions with similar characteristics.	**Topics: 5.2**
Pacing:	● I can calculate the probability that a particular value lies in a given interval of a normal distribution. (P) ● I can determine the interval associated with a given area in a normal distribution. (CR) ● I can determine the appropriateness of using the normal distribution to approximate probabilities for unknown distributions. (CR)			
3.C, 4.B, 3.B	How does probabilistic reasoning allow us to anticipate patterns in data?		● A sampling distribution of a statistic is the distribution of values for the statistic for all possible samples of a given size from a given population. ● The central limit theorem (CLT) states that when the sample size is sufficiently large, a sampling distribution of the mean of a random variable will be approximately normally distributed. ● The central limit theorem requires that the sample values are independent of each other and that n is sufficiently large. ● A randomization distribution is a collection of statistics generated by simulation assuming known values for the parameters. For a randomized experiment, this means repeatedly randomly reallocating/reassigning the response values to treatment groups. ● The sampling distribution of a statistic can be simulated by	**Topics: 5.3-5.8**
Pacing:	● I can estimate sampling distributions using simulations. (P) ● I can explain why an estimator is or is not biased. (CR) ● I can calculate estimates for a population parameter. (P) ● I can determine parameters of a sampling distribution for a sample of proportions. (P) ● I can determine whether a sampling distribution for a sample proportion can be described as approximately normal. (P) ● I can interpret probabilities and parameters for a sampling distribution for a sample proportion. (CR) ● I can determine parameters of a sampling distribution for a			

	difference in sample proportions. (SR) ● I can determine whether a sampling distribution for a difference of sample proportions can be described as approximately normal. (SR) ● I can interpret probabilities and parameters for a sampling distribution for a difference in proportions. (CR) ● I can determine and interpret parameters for a sample distribution for sample means. (P) ● I can determine whether a sampling distribution of a sample mean can be described as approximately normal. (P) ● I can determine parameters of a sampling distribution for a difference in sample means. (P) ● I can interpret probabilities and parameters for a sampling distribution for a difference in sample means.(P)	generating repeated random samples from a population. ● When estimating a population parameter, an estimator is unbiased if, on average, the value of the estimator is equal to the population parameter. ● When estimating a population parameter, an estimator exhibits variability that can be modeled using probability. ● A sample statistic is a point estimator of the corresponding population parameter. ● If sampling without replacement, the standard deviation of the sample proportion is smaller than what is given by the formula above. If the sample size is less than 10% of the population size, the difference is negligible ● For a categorical variable, the sampling distribution of the sample proportion, pˆ, will have an approximate normal distribution, provided the sample size is large enough: np ≥10 and n(1− ≥ p) 10 ● Probabilities and parameters for a sampling distribution for a sample proportion should be interpreted using appropriate units and within the context of a specific population. ● For a numerical variable, if the population distribution can be modeled with a normal distribution, the sampling distribution of the sample mean, x, can be modeled with a normal distribution. ● For a numerical variable, if the population distribution cannot be modeled with a normal distribution, the sampling distribution of the sample mean, x, can be modeled approximately by a normal distribution, provided the sample size is large enough, e.g., greater than or equal to 30.	

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT

RESOURCES

UNIT 6: Inference for Categorical Data: Proportions				

- Big Idea 1: Variation & Distribution: When can we use a normal distribution to perform inference calculations involving population proportions?
- Big Idea 2: Patterns & Uncertainty: How can we narrow the width of a confidence interval?
- Big Idea 3: Data-Based Predictions, Decisions, and Conclusions: If the proportion of subjects who experience serious side effects when taking a new drug is smaller than the proportion of subjects who experience serious side effects when taking a placebo, how can we determine if the difference is statistically significant?

SAT Skills #	**Learning Targets:** I can	**Assessment Strategy** SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	**Essential Knowledge**	**Common Learning Experiences**
1.A	How do we know conclusions are uncertain?		• Variation in shapes of data distributions may be random or not.	**Topics: 6.1**
Pacing:	• I can identify questions suggested by variation in the shapes of distributions of samples taken from the same population. (SR)			
4.A, 4.B, 4.D	How do we use intervals of values to account for uncertainty?		• The appropriate confidence interval procedure for a one-sample proportion for one categorical variable is a one sample z-interval for a proportion. • In order to make assumptions necessary for inference on population proportions, means, and slopes, we must check for independence in data collection methods and for selection of the appropriate sampling distribution. • In order to calculate a confidence interval to estimate a population proportion, p, we must check for independence and that the sampling distribution is approximately normal • Based on sample data, the standard error of a statistic is an estimate for the standard deviation for the statistic. • A margin of error gives how much a value of a sample statistic is likely to vary from the value of the corresponding population parameter. • The formula for margin of error can be rearranged to solve for n, the minimum sample size needed to achieve a given margin of error. For this purpose, use a guess for $\hat{p}$ or use $\hat{p} = 0.5$ in order to find an upper bound for the sample size that will result in a given margin of error. • Critical values represent the boundaries encompassing the middle C%	**Topics: 6.2, 6.3**
Pacing:	• I can identify an appropriate confidence interval procedure for a population proportion. (P) • I can verify the conditions for calculating confidence intervals for a population proportion. (P) • I can determine the margin of error for a given sample size and an estimate for the sample size that will result in a given margin of error for a population proportion. (P) • I can calculate an appropriate confidence interval for a population proportion. (P) • I can calculate an interval estimate based on a confidence interval for a population proportion. (P) • I can interpret a confidence interval for a population proportion. (CR) • I can justify a claim based on a confidence interval for a population proportion. (CR) • I can identify the relationships between sample size, width of a confidence interval, confidence level, and margin of error for a population proportion. (CR)			

		of the standard normal distribution, where C% is an approximate confidence level for a proportion. ● Confidence intervals for population proportions can be used to calculate interval estimates with specified units. ● A confidence interval for a population proportion either contains the population proportion or it does not, because each interval is based on random sample data, which varies from sample to sample. ● We are C% confident that the confidence interval for a population proportion captures the population proportion. ● In repeated random sampling with the same sample size, approximately C% of confidence intervals created will capture the population proportion. ● Interpreting a confidence interval for a one sample proportion should include a reference to the sample taken and details about the population it represents. ● For a given sample, the width of the confidence interval for a population proportion increases as the confidence level increases. ● The width of a confidence interval for a population proportion is exactly twice the margin of error.	
1.F, 1.E, 4.C **Pacing:**	When is the normal distribution used? ● I can identify the null and alternative hypotheses for a population proportion. (P) ● I can identify an appropriate testing method for a population proportion. (SR) ● I can verify the conditions for making statistical inferences when testing a population proportion. (P) ● I can calculate an appropriate test statistic and p-value for a population proportion. (P) ● I can interpret the p-value of a significance test for a population proportion. (CR)	● The null hypothesis is the situation that is assumed to be correct unless evidence suggests otherwise, and the alternative hypothesis is the situation for which evidence is being collected. ● For hypotheses about parameters, the null hypothesis contains an equality reference (=, ≥, or ≤), while the alternative hypothesis contains a strict inequality (<, >, or ≠). The type of inequality in the alternative hypothesis is based on the question of interest. Alternative hypotheses with < or > are called one-sided, and alternative hypotheses with ≠ are called two sided. Although the null hypothesis for a one sided test may include an inequality symbol, it is still tested at the boundary of equality ● For a one-sample z-test for a population proportion, the null hypothesis specifies a value for the population proportion, usually one indicating no difference or effect. ● For a single categorical variable, the appropriate testing method for a population proportion is a one-sample z-test for a population proportion. ● In order to make statistical inferences when testing a population proportion, we must check for independence and that the sampling distribution is approximately normal. ● The distribution of the test statistic assuming the null hypothesis is true (null distribution) can be either a randomization distribution or when a probability model is assumed to be true, a theoretical	**Topics: 6.4, 6.5**

		distribution (z). ● A p-value is the probability of obtaining a test statistic as extreme or more extreme than the observed test statistic when the null hypothesis and probability model are assumed to be true. The significance level may be given or determined by the researcher. ● An interpretation of the p-value of a significance test for a one-sample proportion should recognize that the p-value is computed by assuming that the probability model and null hypothesis are true, i.e., by assuming that the true population proportion is equal to the particular value stated in the null hypothesis.	
Hyperlink standard code **Pacing:**	How does significance testing allow us to make decisions? ● I can justify a claim about the population based on the results of a significance test for a population proportion. (CR)	● The significance level,, is the predetermined probability of rejecting the null hypothesis given that it is true. ● Rejecting the null hypothesis means there is sufficient statistical evidence to support the alternative hypothesis. Failing to reject the null means there is insufficient statistical evidence to support the alternative hypothesis. ● The conclusion about the alternative hypothesis must be stated in context. ● A significance test can lead to rejecting or not rejecting the null hypothesis, but can never lead to concluding or proving that the null hypothesis is true. Lack of statistical evidence for the alternative hypothesis is not the same as evidence for the null hypothesis. ● Small p-values indicate that the observed value of the test statistic would be unusual if the null hypothesis and probability model were true, and so provide evidence for the alternative. The lower the p-value, the more convincing the statistical evidence for the alternative hypothesis. ● p-values that are not small indicate that the observed value of the test statistic would not be unusual if the null hypothesis and probability model were true, so do not provide convincing statistical evidence for the alternative hypothesis nor do they provide evidence that the null hypothesis is true. ● The results of a significance test for a population proportion can serve as the statistical reasoning to support the answer to a research question about the population that was sampled.	**Topics: 6.6**
3.A, 4.A, 4.B **Pacing:**	How do probabilities of type I and type II errors influence inference. ● I can identify type I and type II errors (CR) ● I can calculate the probability of type I and type II errors. (P) ● I can identify factors that affect the probability of errors in significance testing. (P)	● A Type I error occurs when the null hypothesis is true and is rejected (false positive). ● A Type II error occurs when the null hypothesis is false and is not rejected (false negative). ● The significance level,, is the probability of making a Type I error, if the null hypothesis is true.	**Topics:6.7**

	• I can interpret type I and type II errors. (CR)	• The power of a test is the probability that a test will correctly reject a false null hypothesis. • The probability of making a Type II error = −1 power. • The probability of a Type II error decreases when any of the following occurs, provided the others do not change: i. Sample size(s) increases. ii. Significance level () of a test increases. iii. Standard error decreases. iv. True parameter value is farther from the null. • Whether a Type I or a Type II error is more consequential depends upon the situation. • Since the significance level,, is the probability of a Type I error, the consequences of a Type I error influence decisions about a significance level.	
1.D, 4.C, 3.D **Pacing:**	How does an interval of values account for uncertainty? • I can identify an appropriate confidence interval procedure for a comparison of population proportions. (CR) • I can verify the conditions for calculating confidence intervals for a difference between population proportions. (CR) • I can calculate an appropriate confidence interval for a comparison of population proportions. (P) • I can calculate an interval estimate based on a confidence interval for a difference of proportions. (P) • I can interpret a confidence interval for a difference of proportions. (P) • I can justify a claim based on a confidence interval. (CR)	• The appropriate confidence interval procedure for a two-sample comparison of proportions for one categorical variable is a two-sample z-interval for a difference between population proportions. • In order to calculate confidence intervals to estimate a difference between proportions, we must check for independence and that the sampling distribution is approximately normal. • Confidence intervals for a difference in proportions can be used to calculate interval estimates with specified units.	**Topics: 6.8, 6.9**
1.F, 1.E, 4.C Pacing	How can the normal distribution used to model variation? • I can identify the null and alternative hypotheses for a difference of two population proportions. (SR) • I can identify an appropriate testing method for the difference of two population proportions. (CR) • I can verify the conditions for making statistical inferences when testing a difference of two population proportions. (CR) • I can calculate an appropriate test statistic for the difference of two population proportions. (CR)	• For a two-sample test for a difference of two proportions, the null hypothesis specifies a value of 0 for the difference in population proportions, indicating no difference or effect. • For a single categorical variable, the appropriate testing method for the difference of two population proportions is a two-sample z-test for a difference between two population proportions. • In order to make statistical inferences when testing a difference between population proportions, we must check for independence and that the sampling distribution is approximately normal.	**Topics: 6.10. 6.11**

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	List standards in the unit and link to achieve the core coherence map for each standard		
RESOURCES			

UNIT 7: Inference for Quantitative Data: Means

- Big Idea 1: Variation & Distribution: How do we know whether to use a t-test or a z-test for inference with means?
- Big Idea 2: Patterns & Uncertainty: How can we make sure that samples are independent?
- Big Idea 3: Data-Based Predictions, Decisions and Conclusions: Why is it inappropriate to accept a hypothesis as true based on the results of statistical inference testing?

SAT Skills #	Learning Targets: I can	Assessment Strategy SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	Essential Knowledge	Common Learning Experiences
1.A	Why are conclusions uncertain?		• Random variation may result in errors in statistical inference.	**Topic: 7.1**
Pacing:	• I can identify questions suggested by probabilities of errors in statistical inference. (SR)			
3.C, 1.D, 4.C, 3.D	How is the t-distribution used?		• When s is used instead of to calculate a test statistic, the corresponding distribution, known as the t-distribution, varies from the normal distribution in shape, in that more of the area is allocated to the tails of the density curve than in a normal distribution. • As the degrees of freedom increase, the area in the tails of a t-distribution decreases	**Topics: 7.2**
Pacing:	• I can describe t-distributions. (CR) • I can identify an appropriate confidence interval procedure for a population mean, including the mean difference between values in matched pairs. (CR) • I can verify the conditions for calculating confidence intervals for a			

	population mean, including the mean difference between values in matched pairs.(P) ● I can determine the margin of error for a given sample size for a one-sample t-interval. (P) ● I can calculate an appropriate confidence interval for a population mean, including the mean difference between values in matched pairs. (P)	● Because σ is typically not known for distributions of quantitative variables, the appropriate confidence interval procedure for estimating the population mean of one quantitative variable for one sample is a one-sample t-interval for a mean. ● Matched pairs can be thought of as one sample of pairs. Once differences between pairs of values are found, inference for confidence intervals proceeds as for a population mean. ● In order to calculate confidence intervals to estimate a population mean, we must check for independence and that the sampling distribution is approximately normal.	
4.B, 4.D, 4.A **Pacing:**	How are intervals of values used to estimate parameters? ● I can interpret a confidence interval for a population mean, including the mean difference between values in matched pairs. (CR) ● I can justify a claim based on a confidence interval for a population mean, including the mean difference between values in matched pairs. (CR) ● I can identify the relationships between sample size, width of a confidence interval, confidence level, and margin of error for a population mean. (SR)	● A confidence interval for a population mean either contains the population mean or it does not, because each interval is based on data from a random sample, which varies from sample to sample. ● We are C% confident that the confidence interval for a population mean captures the population mean. ● An interpretation of a confidence interval for a population mean includes a reference to the sample taken and details about the population it represents. ● A confidence interval for a population mean provides an interval of values that may provide sufficient evidence to support a particular claim in context. ● When all other things remain the same, the width of a confidence interval for a population mean tends to decrease as the sample size increases. ● For a given sample, the width of the confidence interval for a population mean increases as the confidence level increases.	**Topics: 7.3**
1.E, 1.F, 4.C **Pacing:**	How is the t-distribution used to model variation? ● I can identify an appropriate testing method for a population mean with unknown σ , including the mean difference between values in matched pairs. (SR) ● I can identify the null and alternative hypotheses for a population mean with unknown σ , including the mean difference between values in matched pairs. (SR) ● I can verify the conditions for the test for a population mena, including the mean difference between values in matched pairs. (CR)	● The appropriate test for a population mean with unknown σ is a one-sample t-test for a population mean. ● Matched pairs can be thought of as one sample of pairs. Once differences between pairs of values are found, inference for significance testing proceeds as for a population mean. ● When finding the mean difference, μd , between values in a matched pair, it is important to define the order of subtraction.	**Topics: 7.4**
3.E,	What does significance testing allow?	● An interpretation of the p-value of a significance test for a	**Topics:7.5**

4.B, 4.E **Pacing:**	● I can calculate an appropriate test statistic for a population mean, including the mean difference between values in matched pairs. (P) ● I can interpret the p-value of a significance test for a population mean, including the mean difference between values in matched pairs. (CR) ● I can justify a claim about the population based on the results of a significance test for a population mean. (CR)	population mean should recognize that the p-value is computed by assuming that the null hypothesis is true, i.e., by assuming that the true population mean is equal to the particular value stated in the null hypothesis. ● The results of a significance test for a population mean can serve as the statistical reasoning to support the answer to a research question about the population that was sampled.	
1.D, 4.C, 3.D, 4.A, 4.D **Pacing:**	Why are intervals of values used to estimate parameters? ● I can identify an appropriate confidence interval procedure for a difference of two population means. (SR) ● I can verify the conditions to calculate confidence intervals for the difference of two population means. (CR) ● I can determine the margin of error for the difference of two population means. (P) ● I can calculate an appropriate confidence interval for a difference of two population means. (P) ● I can interpret a confidence interval for a difference of population means. (CR) ● I can justify a claim based on a confidence interval for a difference of population means. (CR) ● I can identify the effects of sample size on the width of a confidence interval for the difference of two means. (CR)	● The appropriate confidence interval procedure for one quantitative variable for t two independent samples is a two-sample -interval for a difference between population means. ● For the difference of two sample means, the margin of error is the critical value (*t) times the standard error (SE) of the difference of two means. ● In order to calculate confidence intervals to estimate a difference of population means, we must check for independence and that the sampling distribution is approximately normal. ● The point estimate for the difference of two population means is the difference in sample means ● An interpretation for a confidence interval for the difference of two population means should include a reference to the samples taken and details about the populations they represent. ● A confidence interval for a difference of population means provides an interval of values that may provide sufficient evidence to support a particular claim in context ● When all other things remain the same, the width of the confidence interval for the difference of two means tends to decrease as the sample sizes increase.	**Topics: 7.6, 7.7**
1.E, 1.F, 4.C **Pacing:**	How is the t-distribution used to model variation? ● I can identify an appropriate selection of a testing method for a difference of two population means. (CR) ● I can identify the null and alternative hypothesis for a difference of two population means. (SR) ● I can verify the conditions for the significance test for the difference of two population means. (P) ● I can calculate an appropriate test statistic for a difference of two means. (P) ● I can interpret the p-value of a significance test for a difference of	● For a quantitative variable, the appropriate test for a difference of two population means is a two-sample t-test for a difference of two population means. ● In order to make statistical inferences when testing a difference between population means, we must check for independence and that the sampling distribution is approximately normal. ● An interpretation of the p-value of a significance test for a two-sample difference of population means should recognize that the p-value is computed by assuming that the null hypothesis is true, i.e., by assuming that the true population means are equal to each other.	**Topics:7.8-7.10**

	population means. (CR) ● I can justify a claim about the population based on the results of a significance test for a difference of two population means in context. (CR)	● The results of a significance test for a two-sample test for a difference between two population means can serve as the statistical reasoning to support the answer to a research question about the populations that were sampled.	

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	List standards in the unit and link to achieve the core coherence map for each standard		
RESOURCES			

UNIT 8: Inference for Quantitative Data: Chi-Squares

- Big Idea 1: Variation & Data: How does increasing the degrees of freedom influence the shape of the chi-square distribution?
- Big Idea 3: Data-Based Predictions, Decisions and Conclusions: Why is it inappropriate to use statistical inference to justify a claim that there is no association between variables?

SAT Skills #	Learning Targets: I can	Assessment Strategy SR-Selected Response CR-Constructed Response P-Performance O-Observation (behavioral)	Essential Knowledge	Common Learning Experiences
1.A	Why are conclusions uncertain?		● Variations between what we find and what we expect to find may be random or not.	**Topics: 8.1**
Pacing:	● I can identify questions suggested by variation between			

	observed and expected counts in categorical data. (CR)		
3.C, 1.F, 1.E, 3.A, 4.C **Pacing:**	How does the chi-square distribution model variation? ● I can describe the chi-square distributions. (CR) ● I can identify the null and alternative hypotheses in a test for a distribution of proportions in a set of categorical data. (SR) ● I can identify an appropriate testing method for a distribution of proportions in a set of categorical data. (SR) ● I can calculate expected counts for the chi-square test for goodness of fit. (P) ● I can verify the conditions for making statistical inferences when testing goodness of fit for a chi-square distribution. (P)	● Expected counts of categorical data are counts consistent with the null hypothesis. In general, an expected count is a sample size times a probability. ● The chi-square statistic measures the distance between observed and expected counts relative to expected counts. ● Chi-square distributions have positive values and are skewed right. Within a family of density curves, the skew becomes less pronounced with increasing degrees of freedom. ● For a chi-square goodness-of-fit test, the null hypothesis specifies null proportions for each category, and the alternative hypothesis is that at least one of these proportions is not as specified in the null hypothesis. ● When considering a distribution of proportions for one categorical variable, the appropriate test is the chi-square test for goodness of fit. ● Expected counts for a chi-square goodness-of-fit test are (sample size) (null proportion).	**Topics: 8.2**
3.E, 4.B, 4.E **Pacing:**	How does significance testing allow us to make decisions? ● I can calculate the appropriate statistic for the chi-square test for goodness of fit. (P) ● I can determine the p-value for the chi-square test for goodness of fit significance test. (P) ● I can interpret the p-value for the chi-square test for goodness of fit.(CR) ● I can justify a claim about the population based on the results of a chi-square test for goodness of fit. (CR)	● The distribution of the test statistic assuming the null hypothesis is true (null distribution) can be either a randomization distribution or, when a probability model is assumed to be true, a theoretical distribution (chi-square). ● The p-value for a chi-square test for goodness of fit for a number of degrees of freedom is found using the appropriate table or computer generated output. ● An interpretation of the p-value for the chi-square test for goodness of fit is the probability, given the null hypothesis and probability model are true, of obtaining a test statistic as, or more, extreme than the observed value. ● A decision to either reject or fail to reject the null hypothesis is based on comparison of the p-value to the significance level. ● The results of a chi-square test for goodness of fit can serve as the statistical reasoning to support the answer to a research question about the population that was sampled.	**Topics: 8.3**
3.A, 1.F, 1.E, 4.C **Pacing:**	How does the chi-square distribution model variation? ● I can calculate expected counts for two-way tables of categorical data. (P) ● I can identify the null and alternative hypotheses for a chi-square test for homogeneity or independence. (CR)	● The expected count in a particular cell of a two-way table of categorical data can be calculated using the appropriate formula. ● The appropriate hypotheses for a chi-square test for homogeneity are: H0: There is no difference in distributions of a categorical variable across populations or treatments. Ha : There is a difference in distributions of a categorical variable across populations or	**Topics: 8.4, 8.5**

	● I can identify an appropriate testing method for comparing distributions in two-way tables of categorical data. (CR) ● I can verify the conditions for making statistical inferences when testing a chi-square distribution for independence or homogeneity. (CR)	treatments. ● The appropriate hypotheses for a chi-square test for independence are: H0: There is no association between two categorical variables in a given population or the two categorical variables are independent. Ha : Two categorical variables in a population are associated or dependent. ● When comparing distributions to determine whether proportions in each category for categorical data collected from different populations are the same, the appropriate test is the chi-square test for homogeneity. ● To determine whether row and column variables in a two-way table of categorical data might be associated in the population from which the data were sampled, the appropriate	
3.E, 4.B, 4.E **Pacing:**	How does significance testing allow us to make decisions? ● I can calculate the appropriate statistic for a chi-square test for homogeneity or independence. (P) ● I can determine the p-value for a chi-square significance test for independence or homogeneity. (SR) ● I can interpret the p-value for the chi-square test for homogeneity or independence. (CR) ● I can justify a claim about the population based on the results of a chi-square test for homogeneity or independence. (CR)	● The p-value for a chi-square test for independence or homogeneity for a number of degrees of freedom is found using the appropriate table or technology. ● For a test of independence or homogeneity for a two-way table, the p-value is the proportion of values in a chi-square distribution with appropriate degrees of freedom that are equal to or larger than the test statistic. ● A decision to either reject or fail to reject the null hypothesis for a chi-square test for homogeneity or independence is based on comparison of the p-value to the significance level. ● The results of a chi-square test for homogeneity or independence can serve as the statistical reasoning to support the answer to a research question about the population that was sampled (independence) or the populations that were sampled (homogeneity).	**Topics: 8.6**

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	List standards in the unit and link to achieve the core coherence map for each standard		
RESOURCES			

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UNIT 9: Inference for Quantitative Data: Slopes

- Big Idea 1: Variation and Distribution: How can there be variability in slope if the slope statistic is uniquely determined for a line of best fit?
- Big Idea 2: Patterns and Uncertainty: When is it appropriate to perform inference about the slope of a population regression line based on sample data?
- Big Idea 3: Data-Based Predictions, Decisions, and Conclusions: Why do we not conclude that there is no correlation between two variables based on the results of a statistical inference for slopes?

SAT Skills #	**Learning Targets:** I can	**Assessment Strategy** SR-Selected Response	**Essential Knowledge**	**Common Learning**

		CR-Constructed Response P-Performance O-Observation (behavioral)		**Experiences**
1.A **Pacing:**	Why are conclusions uncertain? ● I can identify questions suggested by variation in scatter plots. (SR)		● Variation in points' positions relative to a theoretical line may be random or non-random.	**Topics: 9.1**
1.D, 4.C, 3.D, 4.B, 4.D, 4.A, **Pacing:**	How do intervals of values account for uncertainty? ● I can identify an appropriate confidence interval procedure for a slope of a regression model. (SR) ● I can verify the conditions to calculate confidence intervals for the slope of a regression model. (CR) ● I can determine the given margin of error for the slope of a regression model. (CR) ● I can calculate an appropriate confidence interval for the slope of a regression model. (P) ● I can interpret a confidence interval for the slope of a regression model. (CR) ● I can justify a claim based on a confidence interval for the slope of a regression model. (CR) ● Identify the effects of sample size on the width of a confidence interval for the slope of a regression model. (CR)		● The appropriate confidence interval for the slope of a regression model is a t-interval for the slope. ● In order to calculate a confidence interval to estimate the slope of a regression line, we must check the following: a. The true relationship between x and y is linear. Analysis of residuals may be used to verify linearity. b. The standard deviation for y, y , does not vary with x. Analysis of residuals may be used to check for approximately equal standard deviations for all x. c. To check for independence: i. Data should be collected using a random sample or a randomized experiment. ii. When sampling without replacement, check that n N ≤10% . d. For a particular value of x, the responses (y-values) are approximately normally distributed. Analysis of graphical representations of residuals may be used to check for normality. i. If the observed distribution is skewed, n should be greater than 30. ● The point estimate for the slope of a regression model is the slope of the line of best fit, b. ● An interpretation for a confidence interval for the slope of a regression line should include a reference to the sample taken and details about the population it represents. ● A confidence interval for the slope of a regression model provides an interval of values that may provide sufficient evidence to support a particular claim in context. ● When all other things remain the same, the width of the confidence interval for the slope of a regression model tends to decrease as the sample size increases.	**Topics: 9.2, 9.3**
1.E, 1.F, 4.C **Pacing:**	How does the t-distribution model variation? ● I can identify the appropriate selection of a testing method for a slope of a regression model. (SR) ● I can identify appropriate null and alternative hypotheses for a slope of a regression model. (SR) ● I can verify the conditions for the significance test for the slope of a		● The appropriate test for the slope of a regression model is a t-test for a slope. ● In order to make statistical inferences when testing for the slope of a regression model, we must check the following: a. The true relationship between x and y is linear. Analysis of residuals may be used to verify linearity. b. The standard deviation for y, y , does not vary with x. Analysis of residuals may be used to check	**Topics: 9.4**

	regression model. (CR)	for approximately equal standard deviations for all x. c. To check for independence: i. Data should be collected using a random sample or a randomized experiment. ii. When sampling without replacement, check that n N ≤10% . d. For a particular value of x, the responses (y-values) are approximately normally distributed. Analysis of graphical representations of residuals may be used to check for normality. i. If the observed distribution is skewed, n should be greater than 30. ii. If the sample size is less than 30, the distribution of the sample data should be free from strong skewness and outliers.	
3.E, 4.B, 4.E **Pacing:**	How does significance testing allow us to make decisions? ● I can calculate an appropriate test statistic for the slope of a regression model. (P) ● I can interpret the p-value of a significance test for the slope of a regression model. (CR) ● I can justify a claim about the population based on the results of a significance test for the slope of a regression model. (CR)	● The distribution of the slope of a regression model assuming all conditions are satisfied and the null hypothesis is true (null distribution) is a t-distribution. ● An interpretation of the p-value of a significance test for the slope of a regression model should recognize that the p-value is computed by assuming that the null hypothesis is true, i.e., by assuming that the true population slope is equal to the particular value stated in the null hypothesis. ● The results of a significance test for the slope of a regression model can serve as the statistical reasoning to support the answer to a research question about that sample.	**Topics: 9.5, 9.6**

COMMON MISCONCEPTIONS	PRIOR KNOWLEDGE NEEDED TO MASTER STANDARDS FOR THIS UNIT	ADVANCED STANDARDS FOR STUDENTS WHO HAVE DEMONSTRATED PRIOR MASTERY	OPPORTUNITIES FOR STUDENT-DIRECTED LEARNING WITHIN THE UNIT
● Students sometimes incorrectly use the values of t given in computer regression output as the critical values for a confidence interval. ● Students use n - 1 for degrees of freedom instead of n - 2. ● Students “accept” the null hypothesis rather than failing to reject it.	List standards in the unit and link to achieve the core coherence map for each standard		
RESOURCES			