Statistics and Probability

High Priority Standards (Missouri Learning Standards, National, etc.)

CCSS.MATH.CONTENT.HSS.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).
CCSS.MATH.CONTENT.HSS.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).
CCSS.MATH.CONTENT.HSS.ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

Learning Goal	Proficiency Scale
The student will be able to explore and understand data.	**4:** Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal.
	3: Student demonstrates evidence of the learning goal by:
	- displaying and summarizing Quantitative Data - comparing Distributions - using the standard deviation as a ruler - understanding the normal model
	2: Student demonstrates overall proficiency with the objectives and essential vocabulary by - displaying and describing categorical data - understanding Distributions - recognizing and recalling specific vocabulary such as: data, data table, context, variable, sample, population, frequency table, distribution, Simpson's paradox, Histogram, stem-and-leaf display, spread, skewed, outliers, quartile, percentile, boxplot, variance, standard deviation, median, mode and range, z-score, normal model, parameter, statistic, 68-95-99.7, standardized value
	1: Student demonstrates limited proficiency with the objectives and essential vocabulary

Learning Targets

- connect the information from the data to the "Who", "What", "How".
- Analyze categorical variables and display the distributions in a pie chart, bar chart or segmented bar chart.
- Compare how two categorical variables are related by putting the counts/percentages in a contingency table.
- Summarize quantitative variables by thinking about and investigating median, mean, standard deviation and outliers.
- Compare groups and look for patterns among the groups over time.
- Organize and standardize data to understand the power that it has and use the 68-95-99.7 rule to understand distributions.

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<tr><td colspan="2" align="center">High Priority Standards (Missouri Learning Standards, National, etc.)</td></tr>
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CCSS.MATH.CONTENT.HSS.ID.C.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
CCSS.MATH.CONTENT.HSS.ID.C.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.
CCSS.MATH.CONTENT.HSS.ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
CCSS.MATH.CONTENT.HSS.ID.C.9 Distinguish between correlation and causation.

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Learning Goal

The student will be able to explore relationships between variables.

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Proficiency Scale

4: Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal.

3: Student demonstrates evidence of the learning goal by:

- understanding linear regressions
- using scatterplots to interpret data and make predictions
- interpreting graphs and understanding linear regression
- understanding correlation and causation

2: Student demonstrates overall proficiency with the objectives and essential vocabulary by:
- graphing scatterplots
- interpreting data
- recognizing and recalling specific vocabulary such as: scatterplots, outlier, correlation coefficient, response variable, explanatory variable, association, model, linear, predicted value, residuals, regression to the mean, regression line (line of the best fit), slope, standard error, extrapolation, influential point, re-expression, ladder of powers

1: Student demonstrates limited proficiency with the objectives and essential vocabulary

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Learning Targets

- Interpret scatterplots by using the correlation coefficient and look for outliers.
- Understand the relationships between quantitative variables, looking at the line of best fit, correlation and the slope of the line.
- Interpret the slope in context as predicted change in y-units per 1 unit change in x.
- Analyze groups of data using regression analysis looking for subsets that behave differently and points with large residuals.
- Understand what a good regression model is and what it isn't; don't extrapolate so far that the prediction becomes useless.

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High Priority Standards (Missouri Learning Standards, National, etc.)
CCSS.MATH.CONTENT.HSS.IC.B.3   Recognize purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. CCSS.MATH.CONTENT.HSS.CP.A.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots. CCSS.MATH.CONTENT.HSS.IC.B.3   Recognize the purposes of and differences among sample surveys, experiments, and observational studies

Learning Goal	Proficiency Scale
The student will understand the process of gathering data.	4: Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal. 3: Student demonstrates evidence of the learning goal by: ● analyzing the randomness in a sample or study ● seeing the bias in sample surveys ● making a sample survey ● doing experiments with observational studies 2: Student demonstrates overall proficiency with the objectives and essential vocabulary by: ● understanding randomness in statistics ● examine and work with sample surveys ● looking at observational studies ● recognizing and recalling specific vocabulary such as: random, simulation, trial, response variable, population, bias, sample survey, randomization, sample size, census, population parameter, cluster sample, sampling variability, pilot survey, voluntary response bias, nonresponse bias, undercoverage, response bias, observational study, retrospective study, prospective study, random assignment, principles of experimental design, statistically significant, control group, blinding, single blind double-either, placebo, placebo effect, matching, confounding 1: Student demonstrates limited proficiency with the objectives and essential vocabulary

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<u>Learning Targets</u>

- Use a simulation model to help investigate a question for which many outcomes are possible.
- Create and draw samples, using randomness to make them representative of the population of interest.
- Understand the different types of samples in a way that sees bias in them to show how accurate and trustworthy they are.
- Interpret sample surveys, observational studies and randomized comparative experiments and how they collect data.
- Recognize and understand the principles of experimental design.
- Understand the value of a control group and of using blinding and placebo controls.

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High Priority Standards (Missouri Learning Standards, National, etc.)

CCSS.MATH.CONTENT.HSS.MD.B.7   Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
CCSS.MATH.CONTENT.HSS.MD.B.5   Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.
CCSS.MATH.CONTENT.HSS.MD.A.4   Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value.
CCSS.MATH.CONTENT.HSS.MD.A.3   Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated
CCSS.MATH.CONTENT.HSS.MD.A.2   Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
CCSS.MATH.CONTENT.HSS.CP.A.2   Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
CCSS.MATH.CONTENT.HSS.CP.A.3   Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
CCSS.MATH.CONTENT.HSS.CP.B.9   Use permutations and combinations to compute probabilities of compound events and solve problems.

Learning Goal	Proficiency Scale
The student will understand randomness and probability.	4: Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal. 3: Student demonstrates evidence of the learning goal by: - describing randomness in sample spaces - making predictions using probability - finding the probability of multiple events - using the probability rules to find probability - knowing how to use standard variables to find standard deviation - analyzing probability models to make approximations 2: Student demonstrates overall proficiency with the objectives and essential vocabulary by: - defining randomness in sample spaces - finding the probability of one event - knowing the probability rules - recognizing and recalling specific vocabulary such as: - knowing the difference between the types of random variables - knowing the equations for probability models - recognizing and recalling specific vocabulary such as: random phenomenon, trial, outcome, event, sample space, law of large numbers, probability, independence, theoretical

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	probability, subjective probability, probability assignment rule, disjoint (mutually exclusive), general addition rule, conditional probability, independence, general multiplication rule, tree diagram, random variable, discrete random variable, continuous random variable, probability model, expected value, variance, standard deviation, Bernoulli trials, 10% condition, geometric probability model, binomial probability model, statistically significant
	1: Student demonstrates limited proficiency with the objectives and essential vocabulary

Learning Targets

- Understand that the Law of Large Numbers speaks only of long-run behavior.
- Apply basic probability rules and general probability rules.
- Work with independent events, random variables and conditional probabilities.
- Estimate probabilities using Bernoulii trials.

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High Priority Standards (Missouri Learning Standards, National, etc.)
CCSS.MATH.CONTENT.HSS.IC.A.1   Understand statistics as a process for making inferences about population parameters based on a random sample from that population.   CCSS.MATH.CONTENT.7.SP.A.2   Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.   CCSS.MATH.CONTENT.HSS.IC.A.2   Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.   CCSS.MATH.CONTENT.HSS.IC.B.4   Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

Learning Goal	**Proficiency Scale**

The student will understand data samples and make inferences based on data.	4: Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal.
	
	 3: Student demonstrates evidence of the learning goal by:
	     ● using sampling distribution models.
	     ● using confidence intervals for proportions.
	     ● testing hypotheses about proportions.
	     ● comparing two proportions.
	
	 2: Student demonstrates overall proficiency with the objectives and essential vocabulary by:
	     ● knowing what a sampling distribution is
	     ● defining skewed data in a sampling distribution
	     ● making hypotheses about proportions
	     ● recognizing and recalling specific vocabulary such as: sampling variability, sampling distribution, central limit theorem, standard error, confidence interval, z-interval, margin of error, critical value, null hypothesis, alternative hypothesis, p-value, z-test, effect size, statistically significant, alpha level, significance level, false positive, false negative, pooling
	 1: Student demonstrates limited proficiency with the objectives and essential vocabulary

Learning Targets
● Model the variation in statistics from sample to sample with a sampling distribution.   ● Use and find standard deviation in a sampling distribution.   ● Construct a confidence interval for a proportion as the statistic, plus and minus a margin of error.   ● Understand the relationship of sample size to both the certainty (confidence level) and precision (margin of error).   ● Use a random sample to test a hypothesis about the world.   ● Understand the statistical inference to create confidence intervals and test hypotheses about the difference in two proportions

Statistics and Probability

High Priority Standards (Missouri Learning Standards, National, etc.)

CCSS.MATH.CONTENT.HSS.CP.A.5   Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

CCSS.MATH.CONTENT.7.SP.A.2   Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

CCSS.MATH.CONTENT.HSS.IC.B.6   Evaluate reports based on data.
CCSS.MATH.CONTENT.7.SP.A.1   Understand that statistics can be used to gain information about a population by examining a sample of the population

Learning Goal	Proficiency Scale
The student will be able to use statistics to understand real world problems.	4: Student demonstrates innovation, in depth inference(s), or advanced application(s) with the learning goal. 3: Student demonstrates evidence of the learning goal by: - making inferences about means. - identifying skewed data - comparing means. - pairing samples and blocks. 2: Student demonstrates overall proficiency with the objectives and essential vocabulary by: - Using Gosset's model for inferences and means - Using tables to find t-values - know the equation for sampling distribution for the difference between two sample means - Observing tables to find paired data - recognizing and recalling specific vocabulary such as: t-models, degrees of freedom for t-distribution, normal condition, one-sample t-interval for the mean, one-sample t-test for the mean, two-sample t methods, two-sample t-test, paired data, paired t-test 1: Student demonstrates limited proficiency with the objectives and essential vocabulary

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Learning Targets

- Create confidence intervals to test hypotheses about proportions.
- Use statistical inference to compare the means of two independent groups.
- Analyze data from matched pairs using different inference procedures.
- Design a study that collects data and recognize when data are paired or matched and when they are not.