Pequea Valley School District
Math

Course: Statistics **Grade**: 10-12

Unit 1: Categorical and Quantitative Variables

Unit Essential Question: **How do you identify and differentiate between types of variables? How do you determine appropriate analytical tools?**

CONCEPT	CONCEPT	CONCEPT	CONCEPT
Describing Data	**Analyzing Categorical Data**	**Analyzing Quantitative Data**	**Comparing Distributions**
VOCABULARY	**VOCABULARY**	**VOCABULARY**	**VOCABULARY**
Who, What, Where, When, Why, Context, Data, Data Table, Cases, Sample, Population, Variables, Categorical, Quantitative, Units	Frequency, Frequency Table, Relative Frequency, Relative Frequency Table, Distribution, Area Principle, Bar Chart, Pie Chart, Categorical Data Condition, Contingency Table, Marginal Distribution, Conditional Distribution, Independence, Association	Quantitative Data Condition, Distribution, Histogram, Relative Frequency Histogram, Gap, Stem-and-Leaf Plot, Dotplot, Shape, Center, Spread, Mode, Unimodal, Bimodal, Multimodal, Uniform, Symmetric, Tails, Skewed, Outliers, Median, Range, Quartile, Interquartile Range, Percentile, Five-number Summary, Mean, Variance, Standard Deviation	Boxplot, Shifting, Rescaling, Timeplot, Outlier Rule

KNOW	KNOW	KNOW	KNOW
• Be able to identify the Who, What, When, Where, Why, and How of data, or recognize when some of this information has not been provided. • Be able to identify the cases and variables in any data set. • Be able to identify the population from which a sample was chosen.	• Be able to recognize when a variable is categorical and choose an appropriate display for it. • Understand how to examine the association between categorical variables by comparing conditional and marginal percentages.	• Be able to identify an appropriate display for any quantitative variable. • Be able to guess the shape of the distribution of a variable by knowing something about the data. • Be able to select a suitable measure of center and a suitable measure of spread for a variable based on information about its distribution. • Know the basic properties of the median: The median divides the data into the half of the data values that are below the median and the half that are above. • Know the basic properties of the mean: The mean is the point at which the histogram balances. • Know that the standard deviation summarizes how spread out all the data are around the mean. • Understand that the median and IQR resist the effects of outliers, while the mean and standard deviation do not. • Understand that in a skewed distribution, the mean is pulled in the direction of the skewness (toward the longer tail) relative to the median.	• Be able to select a suitable display for comparing groups. Understand that histograms show distributions well, but are difficult to use when comparing more than two or three groups. Boxplots are more effective for comparing several groups. • Understand that how you group data can affect what kinds of patterns and relationships you are likely to see. Know how to select groupings to show the information that is important for your analysis. • Be aware of the effects of skewness and outliers on measures of center and spread. Know how to select appropriate measures for comparing groups based on their displayed distributions. • Understand that outliers, whatever their source, deserve special attention. • Recognize when it is appropriate to make a timeplot. • Understand how adding (subtracting) a constant or multiplying (dividing) by a constant changes the center and/or spread of a variable.
UNDERSTAND	**UNDERSTAND**	**UNDERSTAND**	**UNDERSTAND**

• How to classify a variable as categorical or quantitative, depending on its use. • How to identify the units in which the variable has been measured (or note that they have not been provided).	• How to summarize the distribution of a categorical variable with a frequency table. • How to display the distribution of a categorical variable with a bar chart or pie chart. • How to make and interpret a contingency table. • How to make and interpret displays of the conditional distributions of one variable for two or more groups.	• How to display the distribution of a quantitative variable with a stem-and- leaf display (drawn by hand for smaller data sets), a dotplot, or a histogram (made by computer for larger data sets). • How to compute the median and IQR of a set of data. • How to compute the mean and standard deviation of a set of data.	• How to make side-by-side histograms on comparable scales to compare the distributions of two groups. • How to make side-by-side boxplots to compare the distributions of two or more groups. • How to describe differences among groups in terms of patterns and changes in their center, spread, shape, and unusual values. • How to make a timeplot of data that have been measured over time. • How to compare the distributions of two or more groups by comparing their shapes, centers, and spreads. Be prepared to explain your choice of measures of center and spread for comparing the groups.
LEARNING OUTCOME	**LEARNING OUTCOME**	**LEARNING OUTCOME**	**LEARNING OUTCOME**
• Learners will be able to describe a variable in terms of its Who, What, When, Where, Why, and How (and be prepared to remark when that information is not provided).	• Learners will be able to describe the distribution of a categorical variable in terms of its possible values and relative frequencies. • Learners will be able to describe and discuss patterns and associations found in a contingency table and displays of conditional distributions.	• Learners will be able to describe the distribution of a quantitative variable in terms of its shape, center, and spread. • Learners will be able to describe any unusual features revealed by the display of a variable. • Learners will be able to describe summary statistics in a sentence using appropriate units.	• Learners will be able to describe trends and patterns in the centers and spreads of groups—especially if there is a natural order to the groups, such as a time order. • Learners will be able to discuss patterns in a timeplot in terms of both the general trend of the data and the changes in how spread out the pattern is. • Learners will be able to describe any anomalies or extraordinary features revealed by the display of a variable.

			• Learners will be able to compare the distributions of two or more groups by comparing their shapes, centers, and spreads. • Learners will be able to to discuss any outliers in the data, noting how they deviate from the overall pattern of the data.

Pa Core Standards:

Assessments: Unit Assessment, SUV Comparison Project,

Pacing: 33 days (including assessments)

Resources: Schoology, *Stats in Your World* by Bock & Mariano

Pequea Valley School District
Math

Course: Statistics Grade: 10-12

Unit 2: Normal Distribution

Unit Essential Question: How do you apply the properties of a Normal Distribution to analyze real-world data sets?

CONCEPT	CONCEPT	CONCEPT	CONCEPT
z-scores	**Standard Normal Model**	**Percentiles**	**Inverse Normal**
VOCABULARY	**VOCABULARY**	**VOCABULARY**	**VOCABULARY**
Standardizing, Standardized Value, Statistic, z-score	Normal Model, Parameter, Statistic, Standard Normal Model, Nearly Normal Condition	68-95-99.7 Rule (aka Empirical Rule), Normal Percentiles, normalcdf (calculator function)	Inverse, invNorm (calculator function)
KNOW	**KNOW**	**KNOW**	**KNOW**
• Recognize when standardization can be used to compare values. • Understand that standardizing uses the standard deviation as a ruler.	• Recognize when a Normal model is appropriate.	• z-scores correspond with percentile rankings. • 50th percentile is the median/mean of a Normal model. • Calculator's "normalcdf" or Z-Table is necessary for this conversion.	• Percentiles can be used to determine necessary value of a statistic. • Calculator's "invNorm" function is necessary for this conversion.
UNDERSTAND	**UNDERSTAND**	**UNDERSTAND**	**UNDERSTAND**
• How to calculate the z-score of an observation. • How to compare values of two different variables using their z-scores.	• How to determine the approximate standard deviation from a population • How to distinguish between a parameter and a statistic	• How to identify the upper and lower limits of a Normal model calculation • How to interpret a percentile	• How to identify the area under the Normal curve that corresponds with a given percentile • How to solve the z-score formula for the sample statistic given a z-score value

LEARNING OUTCOME	LEARNING OUTCOME	LEARNING OUTCOME	LEARNING OUTCOME
• Learners will be able to explain what z-scores mean. • Learners will be able to explain how extraordinary a standardized value may be by using a Normal model.	• Learners will be able to check whether a variable satisfies the Nearly Normal Condition by making a histogram.	• Learners will be able to use Normal models and the 68–95–99.7 Rule to estimate the percentage of observations falling within 1, 2, or 3 standard deviations of the mean. • Learners will be able to find the percentage of observations falling below any value in a Normal model using a Normal table or appropriate technology.	• Learners will be able to determine the value of a statistic given a percentile. • Learners will be able to interpret the likelihood of such an event occurring in real-world situations.

Pa Core Standards:

Assessments: Unit Assessment

Pacing: 14 days (including assessments)

Resources: Schoology, *Stats in Your World* by Bock & Mariano

Pequea Valley School District Math Department

Course: Statistics Grade: 10-12

Unit 3: Exploring Relationships Between Variables

Unit Essential Question: How do appropriately analyze, interpret, and describe the relationship between two variables?

CONCEPT
Bivariate Associations
VOCABULARY
Scatterplots, Association, Direction, Form, Strength, Outlier, Response Variable, Explanatory Variable, Correlation, Correlation Coefficient, Lurking Variable, Causation
KNOW
• Recognize when interest in the pattern of a possible relationship between two quantitative variables suggests making a scatterplot. • Know the conditions for correlation and how to check them. Know that correlations are between -1 and +1, and that each extreme indicates a perfect linear association. • Understand how the magnitude of the correlation reflects the strength of a linear association as viewed in a scatterplot. • Know that correlation has no units. Know that the correlation

CONCEPT
Linear Models
VOCABULARY
Model, Linear Model, Straight Enough Condition, Predicted Value, Residuals, Least Squares, Regression Line, Line of Best Fit, Slope, y-Intercept, Regression to the Mean, Interpolation, Extrapolation
KNOW
• Be able to identify response (y) and explanatory (x) variables in context. • Understand how a linear equation summarizes the relationship between two variables. • Recognize when a regression model should be used to summarize a linear relationship between two quantitative variables. • Know that residuals are the differences between the data values and the corresponding values predicted by the line and

CONCEPT
Non-linear Models
VOCABULARY
Exponential Model, Power Model
KNOW
• Recognize when a curved model may be appropriate. • Use the context of the relationship to get clues about what model to try. • Recognize when the pattern of the data indicates that no simple model will work.

coefficient is not changed by changing the center or scale of either variable.
- Understand that causation cannot be demonstrated by a scatterplot or correlation.

UNDERSTAND

- How to identify the roles of the variables and that you should place the response variable on the y-axis and the explanatory variable on the x-axis.
- How to make a scatter plot by hand (for a small set of data) or with technology.
- How to compute the correlation of two variables (using technology).

that the least squares criterion finds the line that minimizes the sum of the squared residuals.
- Know the danger of extrapolating beyond the range of the x-values used to find the linear model, especially when the extrapolation tries to predict into the future.
- Look for lurking variables whenever you consider the association between two variables.
- Understand that a strong association does not mean that the variables are causally related.

UNDERSTAND

- How to examine your data for violations of the Straight Enough Condition that would make it inappropriate to use a linear model.
- How to use a plot of residuals to check the Straight Enough Condition and the Outlier Condition.
- How to find a regression equation from the summary statistics for each variable and the correlation between the variables.
- How to find a regression equation using your calculator or statistics software and how to find the slope and intercept values in the regression output.
- How to use a linear model to predict a value of y for a given x.
- How to compute the residual for

UNDERSTAND

- How to fit both exponential and power models using technology.
- How to check the residuals plot to see if your model is useful.
- How to use the model to make predictions.

LEARNING OUTCOME
• Learners will be able to describe the direction, form, and strength of a scatter plot. • Learners will be able to identify and describe points that deviate from the overall pattern. • Learners will be able to use correlation as part of the description of a scatter plot. Be alert to misinterpretations of correlation. • Learners will be able to find a correlation between two variables and explain that it does not indicate a causal relationship between them. • Learners will be able to describe the dangers of suggesting causal relationships when describing correlations.

each data value and how to plot the residuals.
LEARNING OUTCOME
• Learners will be able to write a sentence explaining what a linear equation says about the relationship between y and x, basing it on the fact that the slope is given in y-units per x-unit. • Learners will be able to describe a prediction made from a regression model, relating the predicted value to the specified x-value. • Learners will be able to include appropriate cautions about extrapolation when reporting predictions from a linear model. • Learners will be able to discuss possible lurking variables.

LEARNING OUTCOME
• Learners will be able to justify their choice of the model. • Learners will be able to describe and interpret their model.

Pa Core Standards:

Assessments: Unit Assessment

Pacing: 28 days (including assessments)

Resources: Schoology, *Stats in Your World* by Bock & Mariano

Pequea Valley School District
Math

Course: Statistics **Grade**: 10-12

Unit 4: Gathering Data

Unit Essential Question: **How do we gather data that is representative of the population and use that data to make informed decisions?**

CONCEPT
Samples
VOCABULARY
Sample, Population, Sample Survey, Bias, Randomization, Sample Size, Census, Population Parameter, Sample Statistic, Representative, Simple Random Sample (SRS), Sampling Frame, Sampling Variability, Stratified Random Sample, Cluster Sample, Multistage Sample, Systematic Sample, Pilot, Voluntary Response Bias, Convenience Sample, Undercoverage, Nonresponse Bias, Response Bias

CONCEPT
Observational Studies and Experiments
VOCABULARY
Observational Study, Retrospective Study, Prospective Study, Experiment, Random Assignment, Factor, Response, Experimental Units, Subjects, Participants, Level, Treatment, Control, Randomize, Replicate, Statistically Significant, Control Group, Blinding, Single-Blind, Double-Blind, Placebo, Placebo Effect, Blocking, Matching, Experimental Design, Confounding

CONCEPT
Using Randomness
VOCABULARY
Random, Generating Random Numbers, Simulation, Simulation Component, Trial, Response Variable, Statistical Significance

KNOW

- Know the basic concepts and terminology of sampling.
- Recognize population parameters in descriptions of populations and samples.
- Understand the value of randomization as a defense against bias.
- Understand the value of sampling to estimate population parameters from statistics calculated on representative samples drawn from the population.
- Understand that the size of the sample (not the fraction of the population) determines the precision of estimates.

UNDERSTAND

- How to draw a simple random sample from a master list of a population, using a calculator, a computer, and a table of random numbers.

KNOW

- Recognize when an observational study would be appropriate.
- Know the three basic principles of sound experimental design—control, randomize, replicate.
- Recognize the factors, the treatments, and the response variable in a description of a designed experiment.
- Understand the essential importance of randomization in assigning treatments to experimental units.
- Understand the importance of replication in generalizing conclusions.
- Understand the value of blocking so that variability due to differences in attributes of the subjects can be removed.
- Understand the importance of a control group and the need for a placebo treatment in some studies.
- Understand the importance of blinding and double-blinding in studies on human subjects, and be able to identify blinding and the need for blinding in experiments.
- Understand the value of a placebo in experiments with human participants.

UNDERSTAND

- How to use graphical displays to compare responses for different treatment groups.
- How to report the results of an observational study. Identify the subjects, how the data were gathered, and any potential biases or flaws you may be aware of. Identify the factors

KNOW

- Recognize random outcomes in a real-world situation.
- Recognize when a simulation might usefully model random behavior in the real world.

UNDERSTAND

- How to use random numbers or some other source of random values, such as dice, a spinner, or a table of random numbers.
- How to choose a sample at random.
- How to randomly assign subjects to experimental treatments.
- How to simulate real-world

	known and those that might have been revealed by the study. • How to compare the responses in different treatment groups to assess whether the differences are larger than could be reasonably expected from ordinary sampling variability. • How to report the results of an experiment. Tell who the subjects are and how their assignment to treatments was determined. Report how and in what units the response variable was measured.	outcomes.
LEARNING OUTCOME	**LEARNING OUTCOME**	**LEARNING OUTCOME**
• Learners will be able to report about a sample as part of the statistical analysis. • Learners will be able to report possible sources of bias in sampling methods. • Learners will be able to recognize voluntary response and nonresponse as sources of bias in a sample survey.	• Learners will be able to identify observational studies as retrospective or prospective, and understand the strengths and weaknesses of each method. • Learners will be able to design a completely randomized experiment to test the effect of a single factor. • Learners will be able to report on the statistical significance of the result in terms of whether the observed group-to-group differences are larger than could be expected from chance alone.	• Learners will be able to describe a randomization process or a simulation so that others can repeat it. • Learners will be able to discuss the results of a simulation study and draw conclusions about the question being investigated.

Pa Core Standards:

Assessments: Unit Assessment
Pacing: 25 days (including assessments)
Resources: Schoology, *Stats in Your World* by Bock & Mariano

Pequea Valley School District
Math

Course: Statistics Grade: 10-12

Unit 5: Randomness and Probability

Unit Essential Question: How do we determine the likelihood of real-world events?

CONCEPT	CONCEPT	CONCEPT	CONCEPT
Determining Number of Possible Outcomes	**Chances and Odds**	**Probability Rules**	**Probability Models**
VOCABULARY	**VOCABULARY**	**VOCABULARY**	**VOCABULARY**
Random Phenomenon, Law of Large Numbers, Probability, Independence, Trial, Outcome, Event, Sample Space, Fundamental Counting Principle, Permutations, Combinations, Equally Likely Condition	Probability Assignment Rule, Complement Rule, Disjoint, Mutually Exclusive, Addition Rule, Legitimate Probability Assignment, Multiplication Rule, Independence Assumption	General Addition Rule, Conditional Probability, Independence, General Multiplication Rule, Tree Diagram	Random Variable, Probability Model, Expected Value, Variance, Standard Deviation, Bernoulli Trials, Binomial Probability Model, 10% Condition, Success/Failure Condition
KNOW	**KNOW**	**KNOW**	**KNOW**
• Understand that random phenomena are unpredictable in the short term but show long-run regularity. • Know that the relative frequency of a random event settles down to a value called the probability. • Know that this is guaranteed for independent events by the Law of Large Numbers. • Recognize when outcomes in a	• Know the rules of probability. • Recognize when events are disjoint and when events are independent. • Understand the difference and that disjoint events cannot be independent.	• Know the concept of conditional probability as redefining the Who to consider only the event that is given. • Know the concept of independence.	• Recognize random variables. • Know the conditions necessary for creating a probability model. • Recognize the impact of insufficient trials.

sample space are equally likely. • Recognize the difference between permutations (arrangements) and combinations (selections).			
UNDERSTAND	**UNDERSTAND**	**UNDERSTAND**	**UNDERSTAND**
• How to create a sample space for a random phenomenon. • How many outcomes an event may have using the Fundamental Counting Principle, permutations, or combinations. • How to use lists or counts of equally likely outcomes to find the probability of an event.	• How to and when to apply the Addition Rule. Know that events must be disjoint for the Addition Rule to work. • How to and when to apply the Multiplication Rule. Know that events must be independent for the Multiplication Rule to work. • How to use the Complement Rule to make calculating probabilities simpler. Recognize that probabilities of "at least . . ." are likely to be easier to find this way.	• How to and when to apply the General Addition Rule. • How to find probabilities for using a Venn diagram, a two-way table, or a tree diagram. • How to determine whether events are independent. • How to and when to apply the General Multiplication Rule.	• How to find the mean (expected value) and the variance of a random Variable. • How to use the proper notation for these population parameters: m or E1X2 for the mean, and s or SD1X2 when discussing variability. • How to tell if a situation involves Bernoulli trials. • How to find the mean and standard deviation of a Binomial model.
LEARNING OUTCOME	**LEARNING OUTCOME**	**LEARNING OUTCOME**	**LEARNING OUTCOME**
• Learners will be able to recognize random outcomes in a real-world situation. • Learners will be able to use the terms "sample space," "outcomes," and "events" correctly. • Learners will be able to use statements about probability in describing a random phenomenon. • Learners will be able to use probability as evidence that an observed outcome may be unusual (statistically significant).	• Learners will be able to use the facts about probability to determine whether an assignment of probabilities is legitimate. Each probability must be a number between 0 and 1, and the sum of the probabilities assigned to all possible outcomes must be 1. • Learners will be able to use statements about probability in describing a random phenomenon. • Learners will be able to use the terms "disjoint events" and "independent events"	• Learners will be able to make a clear statement about a conditional probability that shows how the condition affects the probability. • Learners will be able to avoid making statements that assume independence of events when there is no clear evidence that they are in fact independent.	• Learners will be able to find the probability model for a random variable. • Learners will be able to interpret the meaning of the expected value and standard deviation of a random variable in the proper context. • Learners will be able to choose when to use a Binomial model for a random variable involving Bernoulli trials. • Learners will be able to calculate Binomial probabilities approximating with a Normal model.

	correctly.		

Pa Core Standards:

Assessments: Unit Assessment

Pacing: 31 days (including assessments)

Resources: Schoology, *Stats in Your World* by Bock & Mariano

Pequea Valley School District
Math

Course: Statistics Grade: 10-12

Unit 6: From the Data at Hand to the World at Large

Unit Essential Question: How do we utilize a sample of data to make predictions about a population?

CONCEPT	CONCEPT	CONCEPT	CONCEPT
Confidence Intervals	**Hypothesis Testing**	**Inferences About a Mean**	**Comparing Proportions or Means**
VOCABULARY	**VOCABULARY**	**VOCABULARY**	**VOCABULARY**
Sampling Distribution Model, Sampling Variability, Sampling Error, Sampling Distribution, Standard Error, Confidence Interval, Margin of Error, Critical Value	Null Hypothesis, Alternative Hypothesis, Two-tailed Alternative, One-tailed Alternative, One-proportion z-Test, The Rule of 2, Statistically Significant, Type I Error, Type II Error, Significance Level, Alpha Level, P-value	Central Limit Theorem, Student's t Distribution, Degrees of Freedom, Critical Value, One-Sample t-Interval for Mean, One-Sample t-Test for Mean, Paired Data, Paired t-Test, Paired-t Confidence Interval	Pythagorean Theorem of Statistics, Sampling Distribution of the Difference Between Two Proportions, Two-Proportion z-Interval, Two-Proportion z-Test, Two-Sample t-Interval, Two-Sample t-Test
KNOW	**KNOW**	**KNOW**	**KNOW**
• Understand that the variability of a statistic depends on the size of the sample. Statistics based on larger samples are less variable. • Understand confidence intervals as a balance between the precision and the certainty of a statement about a model parameter. • Understand that the margin of error of a confidence interval	• Know the conditions that must be true for a one-proportion z-test to be appropriate, and know how to examine your data for violations of those conditions. • Know that we do not "accept" a null hypothesis if we cannot reject it but, rather, that we can only "fail to reject" the hypothesis for lack of evidence against it.	• Know that the variability of a statistic (as measured by the standard deviation of its sampling distribution) depends on the size of the sample. Statistics based on larger samples are less variable. • Know that the Central Limit Theorem gives the sampling distribution model of the mean for sufficiently large samples regardless of the	• Know the null and alternative hypotheses for testing the difference between two population proportions or two population means. • Know how to examine your data for violations of conditions that would make inference unwise or invalid. • Understand that the formula for the standard error of the difference between two independent sample

for a proportion changes with the sample size and the level of confidence.		underlying population. • Know the assumptions required for t-tests and t-based confidence intervals.	proportions or means is based on the principle that when finding the sum or difference of two independent random variables, their variances add.
UNDERSTAND	**UNDERSTAND**	**UNDERSTAND**	**UNDERSTAND**
• How to examine your data for violations of conditions that would make inference about a population proportion unwise or invalid.	• How to state the null and alternative hypotheses for a one-proportion z-test. • How to write a sentence interpreting the results of a one-proportion z-test.	• How to examine your data for violations of conditions that would make inference about the population mean unwise or invalid. • How to recognize whether a design that compares two groups is paired.	• How to find a confidence interval for the difference between two proportions or means. • How to perform a significance test of the natural null hypothesis that two population proportions or means are equal.
LEARNING OUTCOME	**LEARNING OUTCOME**	**LEARNING OUTCOME**	**LEARNING OUTCOME**
• Learners will be able to use a sampling distribution model to make simple statements about the variability of proportions from sample to sample. • Learners will be able to construct a 95% confidence interval for a proportion. • Learners will be able to interpret a sampling model as describing the distribution of sample proportions from all possible samples. • Learners will be able to interpret a 95% confidence interval for a proportion in a simple sentence or two.	• Learners will be able to identify and use the alternative hypothesis when testing hypotheses. Understand how to choose between a one-tailed and two-tailed alternative hypothesis. • Learners will be able to perform a one-proportion z-test and make a decision based on the Rule of 2.	• Learners will be able to use a sampling distribution model to make simple statements about the distribution of a mean under repeated sampling. • Learners will be able to compute and interpret a t-test for the population mean. • Learners will be able to compute and interpret a t-based confidence interval for the population mean. • Learners will be able to find a paired confidence interval. • Learners will be able to perform a paired t-test, recognizing that it is mechanically equivalent to a one-sample t-test applied to the differences.	• Learners will be able to write a sentence describing what is said about the difference between two population proportions or means by a confidence interval. • Learners will be able to to write a sentence interpreting the results of a significance test of the null hypothesis that two population proportions or means are equal. • Learners will be able to interpret the meaning of a P-value in context. Know that we do not “accept” a null hypothesis if we fail to reject it.

Pa Core Standards:

Assessments: Unit Assessment

Pacing: 30 days (including assessments)

Resources: Schoology, *Stats in Your World* by Bock & Mariano