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| **Grade(s):** | **11-12** |
| **Discipline/Course:** | **Mathematics** |
| **Course Title:** | **Probability & Statistics** |
| **Prerequisite(s):** | Algebra-2 |
| **Course Description:**<br>*Program of Studies* | Probability and statistics is recommended for those who want an elective that will be beneficial to many academic, medical, social science, and business careers. Statistics topics studied include: describing data with graphs, distributions, histograms and other graphical techniques, and measures of center and spread. Probability topics include: probability rules, probability distributions – discrete and normal. Additional topics include: sampling design, experimental design, sampling distributions, linear regression, and an introduction to inference testing and confidence intervals. Probability & Statistics is an excellent option for students anticipating statistics requirements in college.<br>1. Unit one focuses on acquiring data, understanding measurement, and critiquing data. Students will learn good sampling techniques to conduct experiments and studies to give results about a given population that is as accurate as possible. In choosing a sampling method it is important to avoid bias and other sources of error by properly using random sampling and through careful design of a sample survey. A properly designed and executed experiment can give good evidence for causation. Control and randomization are the most important aspects of the statistical design of experiments, without them, data collected can be misleading and lead to invalid results.<br>2. In unit two, the student will be able to describe patterns of univariate and bivariate data as well as observations that do not fit those patterns. Students will learn to organize sets of data into graphs, calculate numerical summaries, and then critically analyze data by describing, interpreting, and comparing important features. Choosing the most appropriate data display and quantitative description of data is an important skill in correctly analyzing and comparing data.<br>3. In this third unit, the students will apply probability principles to calculate likelihoods, to build probability models, and to calculate expected values. Students will apply the multiplication |

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| | principle, counting techniques, tree diagrams, simulations, and other probability rules. Differentiation will be made between discrete and continuous random variables and the rules and properties that apply to both.<br>4. In the fourth unit, students will be introduced to hypothesis testing and confidence intervals and they will use this concept to estimate population parameters and draw conclusions about situations. |
| **Course Essential Questions:** | ● How can collecting, validating, organizing and displaying data help us analyze information and make reasonable predictions and informed decisions? |
| **Course Enduring Understandings:** | ● Observe and describe patterns and departures from patterns.<br>● Plan and conduct a study using samples, experiments, and simulations.<br>● Explore random phenomena using the normal distribution, probability, and simulation.<br>● Use statistical inference to make conclusions with confidence.<br>● Estimate population parameters and test hypotheses. |
| **Duration:** | One year |
| **Course Materials/Resources:** | *Statistics and Probability with Applications* (Starnes & Tabor) |

***Note: Topics listed in the units may evolve over time based on adaptations to implementation. However, the overall content of the entire course will not change**

| Academic Expectations<br>The Fairfield Public Schools describe a variety of cross curricular expectations that all students should exemplify during their time within the schooling experience. This page gives examples of what the practice standards look like at the specified grade level. Students are expected to: | | |
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| Standards | Explanations | Example |
| 1. Exploring and Understanding [MP1] | When students engage in problem solving situations, they should be able to understand the problem, determine relevant information, and ask relevant additional questions. | Students should be able to answer the following questions when approaching a problem:<br>1. Do you understand all the words used in stating the problem?<br>2. What are you asked to find or show?<br>3. Can you restate the problem in your own words?<br>4. Can you think of a picture or diagram that might help you understand the problem? |
| 2. Synthesizing and Evaluating | Engaging in a problem solving situation, students should be able to analyze the most efficient approach, and reflect on the process used to solve the problem. | Students should be able to answer the following questions when analyzing how to approach a problem, and also reflect on the result:<br>1. Is there enough information to enable you to find a solution? If not, what additional information is needed?<br>2. Are there multiple ways to complete the task? Which approach do you think is most efficient, and why?<br>3. Do you know a related problem? Look at the unknown and try to think of a familiar problem having the same or similar unknown. Can you use it?<br>4. Was your strategy effective? What worked? What didn't?<br>5. Was there another approach that could have been more efficient?<br>6. Is your answer reasonable? How do you know?<br>7. Was your presentation approach effective? If not, what would you change?<br>8. How did the communication tools allow you to get the message across to the intended audience? |

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| 3. Creating and Constructing | Engaged in a problem solving situation, students should implement a plan. | Students should be able to answer the following question to implementing their plan to solve a problem:<br>1. What strategy will you use to complete the task? |
| 4. Conveying Ideas | Students should be able to use correct mathematical language, logically display their work for the desired problem. | Students should be able to answer the following questions to convey their mathematical thinking to solve a problem:<br>1. How will you present your information to your intended audience?<br>2. Does your response illustrate the correct terms and work to the problem? |
| 5. Using Communication Tools | Students should be able to choose the correct tools to illustrate their mathematical work to solve a specific problem. | Students should be able to answer the following question to use specific communication tools to solve a problem:<br>1. If applicable, what communication tools will you use to convey your ideas and solution? |
| 6. Collaborating Strategically | Students should be able to work collaboratively to solve problems. | Students should be able to answer the following question to collaboratively solve problems:<br>1. In what ways did you work together to help solve the desired problem? |

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| **Unit Number and Title:** | Unit 1: Producing Data, |
| **Duration:** | 9 weeks |
| **Resource(s):** | *Statistics and Probability with Applications* (Starnes & Tabor) |
| **Learning Goals** | |
| **Standard(s):** | N/A |
| **Essential Question(s):** | ● How do you design and carry out an experiment to allow valid conclusion of causation?<br>● How do you design and carry out a survey to minimize bias and random error?<br>● How do you characterize the results of a study to reflect both the basic findings and appropriate qualifications? |
| **Enduring Understanding(s):** | ● Observational studies and controlled experiments allow conclusions regarding the population based on data from a carefully selected group of subjects.<br>● Well-designed observational studies can provide information about the characteristics of the population whereas randomized controlled experiments can provide information about treatment effects on the population. |
| **Learning Goal(s):** *Students will be able to use their learning to:* | 1. Understand different methods of data collection; for example a census, sample survey, experiment and observational study.<br>2. Critique the reliability, validity, accuracy of measurements.<br>3. Design, conduct and interpret surveys and experiments.<br>4. Differentiate between the many sources of bias in sampling and surveys and determine how to avoid them.<br>5. Summarize survey results with a confidence statement.<br>6. Determine the sample size corresponding to a given margin of error for a 95% confidence level using the $1/\sqrt{n}$ approximation. |

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| | 7. Distinguish between different sampling methods including simple random sampling, stratified random sampling, and other methods.<br>8. Apply the terms of treatments, control groups, and subjects.<br><br>9. Understand the principles of good experimental design: control of variables, random assignments, and replication.<br>10. Apply techniques for addressing bias and confounding, including placebos and blinding in experiments.<br>11. Differentiate between a basic completely randomized design and other designs.<br>12. Understand the limitations on generalizing results and the types of conclusions that can be drawn from observational studies, experiments, and surveys.<br>13. Critique ethical issues involved in the design of a study. |

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| **Unit Number and Title:** | Unit 2: Organizing Data |
| **Duration:** | 11 Weeks |
| **Resource(s):** | *Statistics and Probability with Applications* (Starnes & Tabor) |
| **Learning Goals** | |
| **Standard(s):** | N/A |
| **Essential Question(s):** | • Which calculations provide the most appropriate characterization of distribution?<br>• How do you fully describe a data set in context, using appropriate terminology, calculations, and graphs?<br>• How can technology display and create models?<br>• How do you create a model for bivariate data and how do you describe, interpret and analyze the model?<br>• How can you use the properties of a normal distribution to analyze a data set? |
| **Enduring Understanding(s):** | • Complete analysis of data makes use of correct terminology, varied graphs and appropriate numerical techniques to study patterns and departures from patterns. |
| **Learning Goal(s):** *Students will be able to use their learning to:* | 1. Know the definitions of the mean, median, and mode of distribution of data and how to compute each of them in particular situations using formulas and/or technology.<br>2. Organize and compare univariate data.<br>a. Organize data using a number of different methods, including frequency tables, histograms, standard line graphs and bar graphs, stem-and-leaf displays, and box plots.<br>b. Describe the center, shape, spread and unusual features (outliers) of univariate data.<br>c. Graphically compare distributions of univariate data.<br>3. Explore categorical data using bar charts, pie charts, and frequency tables.<br>4. Determine the mean and the standard deviation of a normally distributed random variable. |

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| | 5. Understand the meaning of the standard deviation of a distribution of data and compute it using technology.<br>6. Describe the form, strength, and direction of bivariate data as displayed in a scatterplot.<br>7. Find the line of best fit to a given distribution of data by using least squares regression.<br>8. Analyze the relationship characterized by a least squares regression, discussing possible relationships of variables and interpreting intercept, slope, $r$, and $r^2$.<br>9. Understand properties of the normal distribution and how to use, 68-95-99.7 rule, tables, and technology to solve problems. |

**Unit Template**

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| **Unit Number and Title:** | Unit 3: Probability |
| **Duration:** | 9 weeks |
| **Resource(s):** | *Statistics and Probability with Applications* (Starnes & Tabor) |
| **Learning Goals** | |
| **Standard(s):** | N/A |
| **Essential Question(s):** | ● How do you use probability rules to evaluate chance behavior in real world contexts?<br>● How can you use expected value for decision making?<br>● How can simulation be used to calculate expected values and probabilities?<br>● How can technology be applied to create and interpret models? |
| **Enduring Understanding(s):** | ● Probability is the tool used for anticipating future outcomes based on past events, theoretic speculation, or simulation.<br>● Expected value is a key tool for rational decision making.<br>● Simulation allows us to overcome difficulties with other means of calculating probabilities and expected values.<br>● The normal distribution can be applied to many real life situations to solve probability problems. |
| **Learning Goal(s):**<br>*Students will be able to use their learning to:* | 1. Identify a random process.<br>2. Calculate a probability based on observed proportions, simulation, or theoretical analysis.<br>3. Solve probability problems using the rules for addition (“or”) and multiplication (“and”) rules.<br>4. Understand properties of the normal distribution and how to use tables and technology to solve probability problems.<br>5. Know the role of the “Law of Large Numbers” in improving estimates of probabilities.<br>6. Know the definition of the mean (expected value) of a discrete random variable and determine |

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| | the mean for a particular set of random events.<br>7. Understand and differentiate probability distributions.<br>8. Design and execute simulations to calculate probabilities and expected values. |

**Unit Template**

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| **Unit Number and Title:** | Unit 4: Inference |
| **Duration:** | 7 weeks |
| **Resource(s):** | *Statistics and Probability with Applications* (Starnes & Tabor) |
| **Learning Goals** | |
| **Standard(s):** | N/A |
| **Essential Question(s):** | • How do you use inferential models to draw statistically significant conclusions from data and make inferences about populations?<br>• How can the language of statistics be used to communicate mathematical ideas coherently and precisely?<br>• How can technology be applied to create and interpret models?<br>• How can improperly applied inference procedures lead to bad conclusions? |
| **Enduring Understanding(s):** | • The foundation of an inference procedure is the hypotheses, null and alternative, which are determined by carefully considering the question of interest.<br>• The p-value determines acceptance of the null hypothesis or rejection of it in favor of the alternative hypothesis based on the likelihood of the observed result.<br>• There are many inference procedures to select from based on the nature of the problem at hand. |
| **Learning Goal(s):**<br>*Students will be able to use their learning to:* | 1. Formulate appropriate null and alternative hypotheses and properly choose a test to conduct in order to reach a conclusion regarding the null and alternative.<br>  a. State hypotheses using proper notation.<br>  b. Determine whether the test is one-sided or two-sided based on the problem setting.<br>2. Select an appropriate testing procedure (i.e. confidence interval or z-test)<br>3. Determine and interpret confidence intervals on proportions and means. |

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| | a. Determine confidence intervals for a simple random sample from a normal distribution of data.<br>b. Determine the sample size required for a desired margin of error.<br>c. Interpret confidence intervals in context of a given situation.<br>4. Use a z-procedure to determine the p-value for a proportion or mean for a simple random sample from a normal distribution.<br>a. Use the p-value to draw a conclusion about the null and alternative hypothesis.<br>b. Interpret the conclusion in context of a given situation.<br>5. Critique an application of inference procedures. |