MIDDLETOWN TOWNSHIP PUBLIC SCHOOLS

Probability & Statistics - Grades 11 & 12
(Full year course)

Adopted by the Board of Education on May 23, 2018 (Anticipated)

Written by:

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MIDDLETOWN TOWNSHIP BOARD OF EDUCATION
EQUAL OPPORTUNITY POLICIES

The Middletown Township Board of Education affirms its responsibilities to ensure all students in the public schools of this township equal educational opportunity regardless of race, color, creed, religion, sex, ancestry, national origin or social or economic status. Lack of English language skills will not be a deterrent to admission to any program. No otherwise qualified handicapped individuals shall solely by reason of their handicap be denied the benefits of or subjected to discrimination in any activity.
The school system's Affirmative Action Plans for School/Classroom Practices are on file in the Superintendent's office.

AFFIRMATIVE ACTION GRIEVANCE PROCEDURE

The Board of Education has established a procedure for staff, students or parents on a student's behalf to follow in filing a complaint dealing with alleged violation, misinterpretation or inequitable application of the policies and practices of the school district relative to provisions of Federal and State anti-discrimination legislation. Details of the grievance procedures are included in the school district's policy manual under Policy #4111.

The Building Principal or designee serves as the first step of this grievance procedure.

The District Affirmative Action Officer is:

Kimberly Pickus
Middletown Township Board of Education
August T. Miner Administrative Offices
Second Floor
834 Leonardville Road
Middletown, New Jersey 07737
(732) 671-3850

The District 504 Compliance Officer is:

Robert Dunn
Middletown Township Board of Education
August T. Miner Administrative Offices
Second Floor
834 Leonardville Road
Middletown, New Jersey 07737
(732) 671-3850

DISTRICT PHILOSOPHY OF INSTRUCTION

In order to prepare our students for the ever-increasing demand for a literate, technology-oriented workforce, Middletown Township Public School District embraces an instructional philosophy that is student-centered, inquiry-based, and that differentiates instruction based on student's individual abilities.

Teachers, as facilitators of lifelong learning, challenge students by providing an environment in which the students become active participants engaged in working together on projects and in solving problems that involve or simulate authentic data and events.

Students learn to value a variety of different approaches and are taught to take responsibility for their own meaningful learning as they become more adept at communicating their reasoning and in asking questions to help clarify their thinking and that of their classmates.

PROBABILITY & STATISTICS COURSE PHILOSOPHY

The Probability & Statistics course lends itself naturally to a mode of teaching that engages students in constructing their own knowledge. For example, students working individually or in small groups can plan and perform data collection and analysis where the teacher acts as a facilitator, rather than a director. This approach gives students ample opportunity to think through problems, make decisions, and share questions and conclusions with other students as well as with the teacher.

Important components of the course include the use of technology, projects, cooperative group problem-solving, and writing as part of concept-oriented instruction and assessment. This approach to teaching Probability and Statistics will allow students to build interdisciplinary connections with other subjects and with their world outside school. The Probability and Statistics course depends heavily on the availability of technology suitable for the interactive, investigative aspects of data analysis.

INTRODUCTION

The purpose of Probability and Statistics is to introduce students to tools for collecting, analyzing and drawing conclusions from data. Students are exposed to four broad conceptual themes:

1. Exploring Data: Describing patterns and departures from patterns
2. Sampling and Experimentation: Planning and conducting a study
3. Anticipating Patterns: Exploring random phenomena using probability and simulation
4. Statistical Inference: Estimating population parameters and testing hypotheses

On the following pages the recommended activities section includes activities for the purpose of differentiating instruction to meet the needs of special education students, English language learners, students at risk of school failure and gifted students.

Adopted Textbook

Rossman, Chance; *Workshop Statistics; Discovery with Data, 4th ed.,* John Wiley and Sons, Inc., © 2018

Recommended Time Frame and Sequence

(Including Quarterly Assessments)

1st Semester:

MP1: **Unit 1 - Collecting Data and Drawing Conclusions (Workshop Unit #1)**

Topic 1: Data and Variables	2 Blocks
Topic 2: Data and Distributions	2 Blocks
Topic 3: Drawing Conclusions from Studies	2 Blocks
Topic 4: Random Sampling	2 Blocks
Topic 5: Designing Experiments	2 Blocks

Unit 2 - Summarizing Data (Workshop Unit #2)

Topic 6: Two-Way Tables	2 Blocks
Topic 7: Displaying and Describing Distributions	2 Blocks
Marking Period 1 Assessments	5 Blocks
First Marking Period Quarterly Exam	4 Blocks (Analyzing flights/two way)

MP2: **Unit 2 - Summarizing Data (Workshop Unit #2)**

Topic 8: Measures of Center	2 Blocks
Topic 9: Measures of Spread	2 Blocks
Topic 10: More Summary Measures and Graphs	2 Blocks

Unit 3 - Relationships in Data (Workshop Unit # 7)

Topic 26: Graphical Displays of Associations	2 Blocks
Topic 27: Correlation Coefficient	2 Blocks
Topic 28: Least Squares Regression	2 Blocks
Marking Period 2 Assessments	5 Blocks

	Second Marking Period Quarterly Exam	4 Blocks (Scatter Plot)

2nd Semester: MP3: **Unit 4 - Randomness in Data (Workshop Unit #3)**

Topic 11: Probability	2 Blocks
Topic 30: Probability Rules (unit is online only)	2 Blocks
Topic 12: Normal Distribution	2 Blocks
Topic 13: Sampling Distributions: Proportions	2 Blocks
Topic 14: Sampling Distributions: Means	2 Blocks
Topic 15: Central Limit Theorem and Statistical Inference	2 Blocks

Marking Period 3 Assessments	5 Blocks	
	Third Marking Period Quarterly Exam	4 Blocks (Games of Chance Lab)

MP4: **Unit 5 - Inference from Data: Principles (Workshop Unit #4)**

Topic 16: Confidence Intervals: Proportions	2 Blocks
Topic 17: Tests of Significance: Proportions	2 Blocks
Topic 18: More Inference Considerations	2 Blocks
Topic 19: Confidence Intervals: Means	2 Blocks
Topic 20: Tests of Significance: Means	2 Blocks

Marking Period 4 Assessments	5 Blocks	
	Fourth Marking Period Project & Quarterly Exam	7 Blocks (Census at School)

Additional Activities

MP 1 - M&M Intro Activity, M&M Sampling Activity, Sampling & Bias Mini Project, Friend or Foe Lab
MP 2 - Basketball Scatterplot Activity, M&M Distribution, Memorizing Letters Lab, Backpack Weighing You Down? Lab
MP 3 - Casino Lab, Lottery Expected Value, Sampling Cell Phone Use
MP 4 - Box Office Confidence Interval, Sleepless Nights

UNIT # 1: Collecting Data & Drawing Conclusions (Workshop Unit 1)

Essential Questions	Enduring Understandings
● How do we collect data? ● What are the different ways in which data can be summarized? ● How can variability be minimized through randomization? ● What factors influence whether we determine that a cause-and-effect relationship may exist between two variables? ● What is the scope of conclusions that can be drawn from statistical studies?	● Careful planning is essential in order to avoid bias and obtain valid data that allow for useful comparison between groups. Sophisticated tools for data analysis cannot compensate for poor data collection. ● Data can be summarized both graphically and numerically. ● Randomization is an essential part of all good sampling methods and experiments. ● Well-designed experiments can be used to establish causation. ● Statistics can be generalized to a larger population when random sampling has occurred.

OBJECTIVES:	ACTIVITIES:	ALIGNMENT TO NJSLS:	MATERIAL/RESOURCES:
1. Identify the population and sample in a statistical study. 2. Identify voluntary response samples and convenience samples and how this can lead to bias. 3. Describe how to obtain a random sample using technology or a table of random digits. 4. Distinguish a simple random sample from a stratified random sample or cluster sample. Give advantages and disadvantages of each sampling method. 5. Explain how undercoverage, nonresponse, and wording can lead to bias. 6. Distinguish between an observational study and an experiment. 7. Explain the concept of confounding and how it limits the ability to make cause and effect conclusions. 8. Identify the experimental units, explanatory variables, treatments, and response variables in an experiment. 9. Describe a completely randomized design for an experiment. 10. Describe & identify the Placebo Effect 11. Explain the meaning and the purpose of blinding and double blind in an experiment. 12. Explain in context what "statistically significant" means. 13. Explain the purpose of blocking in an experiment. 14. Describe a randomized block design or matched pairs design for an experiment.	● M&M Intro to Data Collection* ● M&M Random Sampling Activity* ● Cell Phone Calls ● Student Data ● Variables of State ● Studies from *Blink* ● A Nurse Accused ● Penny Thoughts ● Hand Washing ● Student Travels ● Buckle Up! ● February Temperatures ● Sporting Examples ● Elvis Presley and Alf Landon ● Self-Injuries ● Home Court Disadvantage? ● Candy & Longevity ● Childhood Obesity & Sleep ● Sampling Words ● Back to Sleep ● Testing Strength Shoes ● Botox for Back Pain ● Memorizing Letters ● Nicotine Lozenge * Optional	● S-IC3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. ● S-IC4. 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. ● S-IC5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. ● S-IC6. Evaluate reports based on data.	● Applets via Rossman Chance http://www.rossmanchance.com/applets Randomization of Subjects, Sampling Words ● Refer to folder in shared drive for materials and resources for the additional activities.

UNIT # 2: Summarizing Data (Workshop Unit 2)

Essential Questions	Enduring Understandings
● How do we best display a particular set of data? ● How do we best summarize a particular set of data? ● How are the numerical summaries of categorical and quantitative different? How are they similar?	● Categorical and quantitative data are each summarized using different visual displays in order to realize patterns. ● A distribution of quantitative data is described using shape, outliers, center, spread. ● Proportions are the numeric summary of categorical data. ● Quantitative data are each summarized using measures of center and spread.

OBJECTIVES:	**ACTIVITIES:**	**ALIGNMENT TO NJSLS:**	**MATERIAL/RESOURCES:**
1. Identify the individuals and variables in a set of data. 2. Classify variables as categorical or quantitative. 3. Display categorical data with a bar graph. 4. Decide when it would be appropriate to make a pie chart based on data. 5. Identify what makes some graphs deceptive. 6. From a two-way table of counts, answer questions involving marginal and conditional distributions. 7. Describe the relationship between two categorical variables by computing appropriate conditional distributions. 8. Construct bar graphs to display the relationship between two categorical variables. 9. Make and interpret dot plots and stem plots of quantitative data. 10. Describe and compare the overall pattern (shape, center, spread) of distribution(s) and identify any major departures from the pattern (like outliers). 11. Identify the shape of a distribution from a graph as roughly symmetric or skewed. 12. Make and interpret a histogram with a reasonable choice of classes. 13. Calculate and interpret measures of center (mean, median). 14. Identify outliers using the 1.5*IQR rule. 15. Make a boxplot. 16. Calculate and interpret measures of spread (range, IQR, standard deviation). 17. Select the most appropriate measures of center and spread in a given setting. 18. Find and interpret the standardized score (z-score) of an individual value within a distribution of data.	● Feeling Rushed ● AZT and HIV ● Lifetime Achievements ● Graduate Admissions Discrimination ● Back to Sleep ● Matching Game ● Rowers' Weights ● Famous Poets' Poems ● Population Growth ● Diabetes Diagnoses ● Go Take a Hike ● Debating Speeds ● Buckle Up! ● Questionable Conclusions ● Readability of Cancer Pamphlets ● Developing Life Expectancies Value of Statistics ● Placements of Exam Scores ● SAT's and ACT's ● Marriage Age's ● Natural Selection ● Roller Coaster ● Ice Cream Calories ● Fan Cost Index Digital Cameras	● S-ID1. Represent data with plots on the real number line (dot plots, histograms, and box plots). ● S-ID2. 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. ● S-ID3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ● S-ID4. 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. ● SID5. 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.	● Applets via Rossman Chance http://www.rossmanchance.com/applets DotPlot Summaries, Histogram Bin Width, Randomization Test, Sampling Words, Two-Way Test Table Simulation ● Refer to folder in shared drive for materials and resources for the additional activities.

UNIT # 3: Relationships in Data (Workshop Unit 7)

Essential Questions	Enduring Understandings
● How can the association between two quantitative variables be graphically displayed? ● What is, and how do you interpret, the correlation coefficient? ● How can you judge the effectiveness of linear regression? ● Are there limitations to the use of linear regression model?	● Scatterplots are visual displays of two quantitative variables to identify associations. ● The correlation coefficient can be used to identify the strength, form, and direction of an association between two quantitative variables. ● Coefficient of determination and residual plots can be used to determine the strength and accuracy of a linear model. ● There are limitations to the usefulness of mathematical representation and modeling such as extrapolation.

OBJECTIVES:	**ACTIVITIES:**	**ALIGNMENT TO NJSLS:**	**MATERIAL/RESOURCES:**
1. Identify explanatory and response variables in situations where one variable helps to explain or influences the other. 2. Make a scatterplot to display the relationship between two quantitative variables. 3. Describe the direction, form, and strength of a relationship displayed in a scatterplot and identify outliers in a scatterplot. 4. Understand the basic properties of correlation. 5. Calculate (using technology) and interpret correlation. 6. Interpret the slope and y intercept of a least-squares regression line. 7. Use the least-squares regression line to predict the y-value for a given x-value. 8. Explain the dangers of extrapolation. 9. Interpret residuals. 10. Determine the equation of a least-squares regression line using technology or computer output. 11. Interpret residual plots to assess if a linear model is appropriate.	● House Prices ● Birth and Death Rates- ● Car Data ● Marriage Ages ● Heights, Handspans, and Foot Lengths ● Television & Life Expectancy ● Kentucky Derby Times ● Governor's Salaries ● Guess the Correlation ● Exam Score Improvements ● Draft Lotter ● Animal Trotting Speeds ● Textbook Prices	● S-ID6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. ● S-ID7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. ● S-ID8. Compute (using technology) and interpret the correlation coefficient of a linear fit. ● S-ID9. Distinguish between correlation and causation.	● Applets via Rossman Chance http://www.rossmanchance.com/applets Guess the Correlation, Least Squares Regression, Sampling Regression

UNIT # 4: Randomness in Data (Workshop Unit 3)

Essential Questions	Enduring Understandings
● How do we account for randomness? ● What is expected value? ● What does a normal distribution imply about the spread of data? ● Why is the normal distribution essential to the study of statistics?	● Probability is a long-run property of repeatable events. ● Expected value refers to the long-run average value of a random numeric process. ● The normal distribution is a density curve, used to mimic the probability that describes the overall pattern of a distribution that describes the center and standard deviation of a given data set. ● Normal distributions and empirical rule are good descriptions for some real world data, and are good approximations for the results of many chance outcomes and most importantly, are the basis for many statistical inference procedures.

OBJECTIVES:	ACTIVITIES:	ALIGNMENT TO NJSLS:	MATERIAL/RESOURCES:
1. Interpret probability as a long-run relative frequency. 2. Use simulation to model chance behavior. 3. Describe a probability model for a chance process. 4. Use basic probability rules, including the complement rule and the addition rule for mutually exclusive events. 5. Use general addition rule to calculate probabilities. 6. Use a tree diagram to model a chance process and calculate probabilities involving two or more events. 7. Use the general multiplication rule to calculate probabilities. 8. Calculate and interpret conditional probabilities. 9. Calculate and interpret the mean (expected value) of a discrete random variable. 10. Use the 68–95–99.7 rule to estimate areas (proportions of values) in a Normal distribution. 11. Use technology to find the proportion of values in a specific interval, or the values that correspond to a given percentile in any Normal distribution. 12. Distinguish between a parameter and a statistic. 13. Use the sampling distribution of a statistic to evaluate a claim about a parameter. 14. Find the mean and standard deviation of the sampling distribution of a sample proportion $\hat{p}$. 15. Check the 10% condition before calculating $\hat{p}$. 16. Determine if the sampling proportion of $\hat{p}$ is approximately Normal. 17. Use Normal approximation to calculate probabilities involving $\hat{p}$. 18. Find the mean and standard deviation of the sampling distribution of a sample mean. 19. Check the 10% condition before calculating x-bar.	● Who Sends the Most Text Messages ● Random Babies ● Family Births ● Jury Selection ● Treatment Groups ● Body Temperature and Jury Selection ● Birth Weights ● Blood Pressure and Pulse Rate ● Criminal Footprints ● Candy Colors ● Smoking Rates ● Coin Ages ● Capsized Tour Boat ● Kissing Couples ● Christmas Shopping ● Solitaire - Workshop Statistics ● Looking Up CEOs	● S-ID4. 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. ● S-IC1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. ● S-CP3. 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. ● S-CP6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model. ● S-CP7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model. ● S-CP8. Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.	● Applets via Rossman Chance http://www.rossmanchance.com/applets Normal Probability Calculator, Random Babies, Reese's Pieces, Sampling Pennies, Sampling Words ● Who Sends the Most Text Messages Activity in shared folder

20. Calculate probabilities involving a sample mean x-bar when the population distribution is Normal. 21. Understand and apply the Central Limit Theorem for proportions and means.			

UNIT # 5: Inference From Data: Principles (Workshop Unit 4)

Essential Questions	Enduring Understandings
● What does it mean to make an inference? ● What is a confidence interval? ● What does it mean to test for significance? ● What is a significance test? ● How does one distinguish among the various tests of significance?	● Inference is a tool for estimating an unknown population parameter. ● A confidence interval contains two parts: the point estimate and margin of error, used to estimate a population parameter. ● A significance test is used in making a conclusion about a claim for population parameter based on sample data. ● Significance tests vary depending on whether the population proportion or mean is being estimated.

OBJECTIVES:	**RECOMMENDED ACTIVITIES:**	**ALIGNMENT TO NJSLS:**	**MATERIAL/RESOURCES:**
1. Interpret a confidence level in context. 2. Interpret a confidence interval in context. 3. Determine the margin of error from a confidence interval. 4. Describe how the sample size and confidence level affect the length of a confidence interval. 5. State and check the Random, 10%, and Large Counts condition for constructing a confidence interval for a population proportion and mean. 6. Construct and interpret a confidence interval for a population proportion. 7. Construct and interpret a confidence interval for a population mean. 8. State the null and alternate hypotheses for a significance test about a population proportion or mean. 9. Interpret p-values in context. 10. Determine whether the results of a study are statistically significant and make an appropriate conclusion using a significance level. 11. Interpret a Type I error and a Type II error in context. 12. State and check the Random, 10%, and Large Counts conditions for performing a significance test about a population proportion and mean. 13. Perform a significance test about a population proportion. 14. Perform a significance test about a population mean.	● Generation M ● Candy Colors ● Kissing Couples ● Flat Tires ● Baseball “Big Bang” ● Pet Ownership ● Racquet Spinning ● Hypothetical Baseball Improvements ● M & M Consumption ● Sleeping Times ● Backpack Weights ● Golden Ratio ● Children’s Television Viewing	● S-IC1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. ● S-IC2. Decide if a specified model is consistent with results from a given data-generating process. ● S-IC4. 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. ● S-IC6. Evaluate reports based on data.	● Applets via Rossman Chance http://www.rossmanchance.com/applets Coin Tossing, Power Simulation, Simulating Confidence Intervals, Testing Significance Calculator

Program Evaluation Form - Probability and Statistics

Please complete this form and return to Director of Mathematics K-12 no later than the last week of May 2019. Thank you.

On a scale of 1 to 5 (with 1 being the lowest and 5 being the highest), please indicate your response with regard to each of the following:

1. Based on your experience this year, to what extent does this guide used in conjunction with *Workshop Statistics* (Fourth Edition) by Rossman, Chance:

- engage student interest in comparison to previous programs? N/A 1 2 3 4 5

- facilitate student discussion and communication of their ideas with teacher as facilitator (giving feedback & asking questions)? N/A 1 2 3 4 5

- provide resources to assist the teacher in allowing students to work on activities of their choice? N/A 1 2 3 4 5

- promote higher level thinking on the part of the students? N/A 1 2 3 4 5

- promote active student involvement? N/A 1 2 3 4 5

2. To what extent does this program meet the needs of students of varying levels of ability? N/A 1 2 3 4 5

3. Do you feel there is a need for in-service for the teachers of this course? If so, please be specific.

COMMENTS: (Please expand on any of the items above as appropriate. Use back of form if necessary.)

Name (optional): _____