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HEALTH & PHYSICAL EDUCATION

RAHWAY PUBLIC SCHOOLS

CURRICULUM & INSTRUCTION

Content Area: Mathematics

Course: Probability & Statistics

Grade Level: 11-12

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Jeffery Kurczeski,

Program Supervisor of 7-12 Math & Science and 9-12 Business & Technology

The Board acknowledges the following who contributed to the preparation of this curriculum.

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Dr. Tiffany A. Beer, Director of Curriculum and Instruction

Dr. Aleya Shoieb, Superintendent of Schools

Subject/Course Title:
Probability & Statistics
Grades 11-12

Date of Board Adoption:
August 27, 2024

RAHWAY PUBLIC SCHOOLS CURRICULUM

Probability & Statistics: Grades 11-12

PACING GUIDE

Unit	Title	Pacing
1	Exploring and Interpreting Categorical and Quantitative Data	11 weeks
2	Relationships Between Variables	9 weeks
3	Gathering Data	9 weeks
4	Randomness & The Rules of Probability	11 weeks

ACCOMMODATIONS

<p>504 Accommodations:</p> <ul style="list-style-type: none"> ● Provide scaffolded vocabulary and vocabulary lists. ● Provide extra visual and verbal cues and prompts. ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Weekly home-school communication tools (notebook, daily log, phone calls or email messages). ● Provide study sheets and teacher outlines prior to assessments. ● Quiet corner or room to calm down and relax when anxious. ● Reduction of distractions. ● Permit answers to be dictated. ● Hands-on activities. ● Use of manipulatives. ● Assign preferential seating. ● No penalty for spelling errors or sloppy handwriting. ● Follow a routine/schedule. ● Provide student with rest breaks. ● Use verbal and visual cues regarding directions and staying on task. ● Assist in maintaining agenda book. 	<p>IEP Accommodations:</p> <ul style="list-style-type: none"> ● Provide scaffolded vocabulary and vocabulary lists. ● Differentiate reading levels of texts (e.g., Newsela). ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide extra visual and verbal cues and prompts. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Provide students with additional information to supplement notes. ● Modify questioning techniques and provide a reduced number of questions or items on tests. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Provide study sheets and teacher outlines prior to assessments. ● Use of manipulatives. ● Have students work with partners or in groups for reading, presentations, assignments, and analyses. ● Assign appropriate roles in collaborative work. ● Assign preferential seating. ● Follow a routine/schedule.
<p>Gifted and Talented Accommodations:</p> <ul style="list-style-type: none"> ● Differentiate reading levels of texts (e.g., Newsela). ● Offer students additional texts with higher lexile levels. ● Provide more challenging and/or more supplemental readings and/or activities to deepen understanding. ● Allow for independent reading, research, and projects. ● Accelerate or compact the curriculum. ● Offer higher-level thinking questions for deeper analysis. ● Offer more rigorous materials/tasks/prompts. ● Increase number and complexity of sources. ● Assign group research and presentations to teach the class. ● Assign/allow for leadership roles during collaborative work and in other learning activities. 	<p>ML Accommodations:</p> <ul style="list-style-type: none"> ● Provide extended time. ● Assign preferential seating. ● Assign peer buddy who the student can work with. ● Check for understanding frequently. ● Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc...). ● Have student repeat directions. ● Make vocabulary words available during classwork and exams. ● Use study guides/checklists to organize information. ● Repeat directions. ● Increase one-on-one conferencing. ● Allow student to listen to an audio version of the text. ● Give directions in small, distinct steps. ● Allow copying from paper/book. ● Give student a copy of the class notes.

- Provide written and oral instructions.
- Differentiate reading levels of texts (e.g., Newsela).
- Shorten assignments.
- Read directions aloud to student.
- Give oral clues or prompts.
- Record or type assignments.
- Adapt worksheets/packets.
- Create alternate assignments.
- Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted.
- Allow student to resubmit assignments.
- Use small group instruction.
- Simplify language.
- Provide scaffolded vocabulary and vocabulary lists.
- Demonstrate concepts possibly through the use of visuals.
- Use manipulatives.
- Emphasize critical information by highlighting it for the student.
- Use graphic organizers.
- Pre-teach or pre-view vocabulary.
- Provide student with a list of prompts or sentence starters that they can use when completing a written assignment.
- Provide audio versions of the textbooks.
- Highlight textbooks/study guides.
- Use supplementary materials.
- Give assistance in note taking
- Use adapted/modified textbooks.
- Allow use of computer/word processor.
- Allow student to answer orally, give extended time (time-and-a-half).
- Allow tests to be given in a separate location (with the ESL teacher).
- Allow additional time to complete assignments and/or assessments.
- Read question to student to clarify.
- Provide a definition or synonym for words on a test that do not impact the validity of the exam.
- Modify the format of assessments.
- Shorten test length or require only selected test items.
- Create alternative assessments.
- On an exam other than a spelling test, don't take points off for spelling errors.

UNIT 1 OVERVIEW

Content Area: Mathematics

Unit Title: Exploring and Interpreting Categorical & Quantitative Data

Target Course/Grade Level: Probability & Statistics/Grades 11-12

Unit Summary: In this unit, students will explore different types of data, including categorical and quantitative data, and be able to summarize, represent, and interpret those types of data, whether it has one variable or two variables. Students will discover the components of experimental design, types of bias that can affect data collection and results, and sampling techniques. Making inferences and justifying conclusions from sample surveys, experiments, and observational studies will be a key component of this unit.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms and box plots).

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.

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).

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.

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.

S.ID.B.6 Represent data on two quantitative variables on a scatter plot and describe how the variables are related.

- Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.
- Informally assess the fit of a function by plotting and analyzing residuals, including with the use of tech.

S.ID.C.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.

S.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S.IC.A.2 Decide if a specified model is consistent with results from a given data-generating process, using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S.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.

Career Readiness, Life Literacies, and Key Skills:

- 9.4.12.CI.1** Demonstrate the ability to reflect, analyze and use creative skills and ideas.
- 9.4.12.CI.3** Investigate new challenges and opportunities for personal growth, advancement and transition.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.DC.6** Select information to post online that positively impacts personal image and future college and career opportunities.
- 9.4.12.IML.1** Compare search browsers and recognize features that allow for filtering of information.
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of source and relevance of information and data.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specific task.
- 9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments.

Interdisciplinary Connections and Standards:

ELA

- L.SS.11-12.1** Demonstrate command of the system and structure of the English language when writing or speaking.
- L.VL.11-12.3** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
- L.VI.11-12.4** Demonstrate understanding of figurative language, word relationships and nuances in word meanings, including connotative meanings.
- RI.IT.11-12.3** Analyze the impact of the author's choices as they develop ideas throughout the text regarding how to develop and relation elements.
- RL.MF.11-12.6** Synthesize complex information across multiple sources and formats to develop ideas and interpretations.
- W.AW.11-12.1** Write arguments to support claims in an analysis of substantive topics, using valid reasoning and relevant and sufficient evidence.
- W.WR.11-12.5** Conduct short as well as more sustained research projects to answer a question or solve a problem.
- SL.PE.11-12.1** Initiate and participate effectively in a range of collaborative discussions with peers on grades 11-12 topics, building on others' ideas and expressing their own clearly and persuasively.
- SL.PI.11-12.4** Present information, findings and supportive evidence clearly, concisely and logically.

Science

- HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of populations.
- HS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- HS-PS1-8** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
- HS-PS4-2** Evaluate questions about the advantages of using digital transmission and storage of information.

Social Studies

- 6.1.12.EconET.2.a** Analyze how technological development transformed the economy.
- 6.1.12.EconNE.3.a** Evaluate the impact of education in improving economic opportunities and in development of responsible citizens.
- 6.1.12.EconNE.6.a** Analyze the impact of money, investment, credit, savings, debt and financial institutions on the development and lives of individuals.
- 6.1.12.EconNE.9.a** Explain how economic indicators are used to evaluate the health of the economy.
- 6.1.12.EconNE.9.c** Explain how the government can adjust taxes, interest rates and other policies to restore the country's economic health.
- 6.1.12.EconEM.12.a** Assess the role of public and private sectors in promoting economic stability.

Unit Understandings

Students will understand that...

- Statistics play a large role in the complexity of our world.
- The “Five W’s” (Who, What, Where, Why, and When) are vital to our computations.
- We treat variables in two basic ways: categorical and quantitative.
- Mean and median should be used for specific purposes.

Unit Essential Questions

- How do we identify the Five Ws?
- What are the differences and similarities between categorical and quantitative variables?
- What is the difference between the variance and standard deviation?
- Why is standard deviation only appropriate for symmetric data?

Knowledge and Skills

Students will know...

- **Vocabulary** –
 - context, data, data table, case, population, sample, variable, categorical variables, and quantitative variables.
 - frequency table, distribution, pie chart, categorical data condition, contingency table, marginal distribution, conditional distribution, independence, and association.
 - histogram, gap, stem-and-leaf display, dot plot, shape, center, spread, mode, bimodal, uniform, symmetric, tails, skewed, outliers, median, range, quartile, interquartile range, percentile, s-number summary, mean, variance, standard deviation, and residuals.
 - boxplot, timeplot, and rescaling.
 - standardizing, normal model, parameter, statistic, z-score, standard normal distribution, and normal percentile.
- **Formulas** –
 - Variance
 - Standard Deviation
- Area Principle
- 65-95-99.7 Rule

Students will be able to...

- Identify the five w's of categorical and quantitative data.
- Manipulate data that summarizes categorical data.
- Create graphs/charts that summarize categorical data.
- Create graphs and two-way contingency tables that summarize categorical data.
- Represent data with plots on the real number line (dot plots, histograms and box plots).
- Create categorical questions to survey classmates.
- Compile and analyze the results of categorical surveys by constructing charts and contingency tables.
- Research an example of a real-world survey and summarize the results.
- Classify and define quantitative variables in a set of data.
- Construct histograms and stem-and-leaf displays of data sets.
- Create a quantitative survey to provide to classmates.
- Compile and analyze the results of quantitative surveys by constructing charts and tables.
- Utilize a data set's mean and standard deviation to fit it to a normal distribution.
- Analyze histograms and calculate the five number summaries.
- Describe normal models and determine the difference between standardizing two variables.
- Calculate z-scores (standard scores) of a group of values to compare it to the mean.

- Utilize statistics appropriate to the shape of the data distribution to compare the center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
- Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- Evaluate a standard deviation to determine how spread out all the data is around the mean.
- Estimate the shape of the distribution of a variable by knowing information about the data.
- Compare and contrast side-by-side histograms.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- All examples and assigned problems will involve real-world situations and data, making it easier for all students to relate to the study at hand.
- Construct and analyze graphical displays.
- Mathematical investigations.
- “What Can Go Wrong?” Activities that explain all possible pitfalls and common mistakes.
- Create a “Who, What, Why, When, Where, and How” table to identify the variable.
- Design a frequency table of NBA statistics (*Text-Stats in Your World*).
- Survey analysis of class favorites (restaurants, sports, TV shows, etc.).
- Research and analyze movie ratings and budgets (IMDB.com).
- “Comparing Distributions in Your World” Research Activity (*Text-Stats in Your World*).
- “Guess the Ages” *Laying the Foundation* Activity/Project – scatter plot, linear association.

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. practice worksheets, assessments, and writing assignments.
- Teacher’s Edition CD compiled of real data (no artificial sets).
- Teacher developed worksheets and activities.
- ESPN.com for sports statistics

- IMDB.com for movie statistics
- Microsoft Excel
- Google Sheets
- TI-83/TI-84
- Useful Websites for Teachers to Explore:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com
 - <https://www.khanacademy.org/>
 - <https://learnzillion.com/>
 - <https://www.teachingchannel.org/>
 - <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator
- Graph paper
- Rulers
- Colored Pencils/Markers

UNIT 2 OVERVIEW

Content Area: Mathematics

Unit Title: Relationships Between Variables

Target Course/Grade Level: Probability & Statistics/Grades 11-12

Unit Summary: In this unit, students will take their understanding of linear and exponential functions and distributions from their earlier mathematics courses and apply them to data sets. As the students analyze the data sets, they will come to understand and appreciate their understanding of linear and exponential distributions and help apply it to real-life situations and problems. As the students look at these sets of data and distributions, they will be able to identify, label, and make sense of the strength and form of the distributions and what more they can tell us about the data and the information behind the data. Throughout the unit, the students will also look at scatter plots and can summarize and analyze the data within those plots.

Approximate Length of Unit: 9 weeks

LEARNING TARGETS

NJ Student Learning Standards:

- 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.
- 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).
- 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.
- S.ID.B.6** Represent data on two quantitative variables on a scatter plot and describe how the variables are related.
- Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.
 - Informally assess the fit of a function by plotting and analyzing residuals, including with the use of tech.
 - Fit a linear function for a scatterplot that suggests a linear association.
- S.ID.C.7 1** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- S.ID.C.8** Compute (using technology) and interpret the correlation coefficient of a linear fit.
- S.ID.C.9** Distinguish between correlation and causation.
- S.IC.A.1** Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

- S.IC.A.2** Decide if a specified model is consistent with results from a given data-generating process, using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?
- S.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.

Career Readiness, Life Literacies, and Key Skills:

- 9.4.12.CI.1** Demonstrate the ability to reflect, analyze and use creative skills and ideas.
- 9.4.12.CI.3** Investigate new challenges and opportunities for personal growth, advancement and transition.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.DC.6** Select information to post online that positively impacts personal image and future college and career opportunities.
- 9.4.12.IML.1** Compare search browsers and recognize features that allow for filtering of information
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of source and relevance of information and data.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specific task.
- 9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments.

Interdisciplinary Connections and Standards:

ELA

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- RI.IT.11-12.3** Analyze the impact of the author's choices as they develop ideas throughout the text regarding how to develop and relation elements.
- RL.MF.11-12.6** Synthesize complex information across multiple sources and formats to develop ideas and interpretations.
- W.AW.11-12.1** Write arguments to support claims in an analysis of substantive topics, using valid reasoning and relevant and sufficient evidence.
- W.WR.11-12.5** Conduct short as well as more sustained research projects to answer a question or solve a problem.
- SL.PE.11-12.1** Initiate and participate effectively in a range of collaborative discussions with peers on grades 11-12 topics, building on others' ideas and expressing their own clearly and persuasively.
- SL.PI.11-12.4** Present information, findings and supportive evidence clearly, concisely and logically.

Science

- HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of populations.
- HS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
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- HS-PS4-2** Evaluate questions about the advantages of using digital transmission and storage of information.

Social Studies

- 6.1.12EconET.2.a** Analyze how technological development transformed the economy.
- 6.1.12.EconNE.3.a** Evaluate the impact of education in improving economic opportunities and in development of responsible citizens.

6.1.12.EconNE.6.a Analyze the impact of money, investment, credit, savings, debt and financial institutions on the development and lives of individuals.

6.1.12.EconNE.9.a Explain how economic indicators are used to evaluate the health of the economy.

6.1.12.EconNE.9.c Explain how the government can adjust taxes, interest rates and other policies to restore the country's economic health.

6.1.12.EconEM.12.a Assess the role of public and private sectors in promoting economic stability.

Unit Understandings:

Students will understand that...

- The direction and form of scatterplots are needed to identify possible linear relationships.
- There are differences between correlation and causation.
- Extrapolations can push you beyond your model and become untrustworthy.
- Not all models are linear.

Unit Essential Questions:

- What are the essential correlation properties?
- When would we use exponential models?
- Why is a high correlation not evidence of a cause-and-effect relationship? (lurking variables)
- How do residuals affect our model?
- What does the correlation tell us about the regression?

Knowledge and Skills:

Students will know...

- **Vocabulary** –
 - scatterplots, association, outlier, response variable, explanatory variable, correlation coefficient, and regression.
 - model, linear, predicted value, residuals, least squares, regression line, intercept, regression to the mean, extrapolation, and lurking variable.
 - exponential model.
 - power model.
- **Formulas** –
 - Correlation coefficient
 - Residuals
 - Slope
 - Exponential Model
 - Power Model
- Straight Enough Condition
- Outlier Condition

Students will be able to...

- Distinguish between correlation and causation.
- Interpret differences in shape, center, and spread in the context of the data sets.
- Utilize a data set's means and standard deviation to fit it to a normal distribution.
- Assess the fit of a function by plotting and analyzing residuals.
- Interpret relative frequencies in the context of the data.
- Evaluate the conditions for correlation and how to check them
- Justify that correlation has no units.
- Describe the direction, form, and strength of a scatter plot.
- Utilize a linear model to predict a value for x and y.
- Discuss possible lurking variables in real-life situations.
- Justify their choice of model based on a data set.

- Solve real-life problems using the slope and intercept of a linear system.
- Compare exponential and linear distributions.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- All examples and assigned problems will involve real-world situations and data, making it easier for all students to relate to the study at hand.
- Construct and analyze graphical displays.
- Mathematical investigations.
- “What Can Go Wrong?” Activities that explain all possible pitfalls and common mistakes.
- Create a “Who, What, Why, When, Where, and How” table to identify the variable.
- Steroids and MLB Statistics (Text-Stats in Your World).
- SAT Scores and Success in College Research.
- Braking Distance of Cars (Video/Website).

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. Practice worksheets, assessments, and writing assignments.
- Teacher’s Edition CD compiled of real data (no artificial sets).
- Teacher developed worksheets and activities.
- ESPN.com for sports statistics.
- Microsoft Excel
- Google Sheets
- TI-83/TI-84
- Useful Websites for Teachers to Explore:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>

- www.kutasoftware.com
- <https://www.khanacademy.org/>
- <https://learnzillion.com/>
- <https://www.teachingchannel.org/>
- <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator
- Graph paper
- Rulers
- Colored Pencils/Markers

UNIT 3 OVERVIEW

Content Area: Mathematics

Unit Title: Gathering Data

Target Course/Grade Level: Probability & Statistics/Grades 11-12

Unit Summary: In this unit, the students will examine how populations can be samples and how data are collected without introducing bias. A random sample is defined. Students are introduced to experiments and observational studies, and they analyze experimental designs. Students will make inferences and justify conclusions from sample surveys, experiments, and observational studies. The students will start to be introduced to the idea of probability (which will be covered more in-depth in the next unit) so they can evaluate the outcomes of decisions.

Approximate Length of Unit: 9 weeks

LEARNING TARGETS

NJ Student Learning Standards:

S.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S.IC.A.2 Decide if a specified model is consistent with results from a given data-generating process, using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S.IC.B.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S.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.

S.IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S.IC.B.6 Evaluate reports based on data (e.g. interrogate study design, data sources, randomization, the way the data are analyzed and displayed, inferences drawn and methods used; identify and explain misleading uses of data; recognize when arguments based on data are flawed).

S.MD.A.3 Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

S.MD.B.6 Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

S.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).

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze and use creative skills and ideas.

- 9.4.12.CI.3** Investigate new challenges and opportunities for personal growth, advancement and transition.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.DC.6** Select information to post online that positively impacts personal image and future college and career opportunities.
- 9.4.12.IML.1** Compare search browsers and recognize features that allow for filtering of information.
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of source and relevance of information and data.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specific task.
- 9.4.12.TL.2** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3** Analyze the effectiveness of the process and quality of collaborative environments.

Interdisciplinary Connections and Standards:

ELA

- L.SS.11-12.1** Demonstrate command of the system and structure of the English language when writing or speaking.
- L.VL.11-12.3** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
- L.VI.11-12.4** Demonstrate understanding of figurative language, word relationships and nuances in word meanings, including connotative meanings.
- RI.IT.11-12.3** Analyze the impact of the author's choices as they develop ideas throughout the text regarding how to develop and relation elements.
- RL.MF.11-12.6** Synthesize complex information across multiple sources and formats to develop ideas and interpretations.
- W.AW.11-12.1** Write arguments to support claims in an analysis of substantive topics, using valid reasoning and relevant and sufficient evidence.
- W.WR.11-12.5** Conduct short as well as more sustained research projects to answer a question or solve a problem.
- SL.PE.11-12.1** Initiate and participate effectively in a range of collaborative discussions with peers on grades 11-12 topics, building on others' ideas and expressing their own clearly and persuasively.
- SL.PI.11-12.4** Present information, findings and supportive evidence clearly, concisely and logically.

Science

- HS-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of populations.
- HS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- HS-PS1-8** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
- HS-PS4-2** Evaluate questions about the advantages of using digital transmission and storage of information.

Social Studies

- 6.1.12EconET.2.a** Analyze how technological development transformed the economy.
- 6.1.12.EconNE.3.a** Evaluate the impact of education in improving economic opportunities and in development of responsible citizens.
- 6.1.12.EconNE.6.a** Analyze the impact of money, investment, credit, savings, debt and financial institutions on the development and lives of individuals.
- 6.1.12.EconNE.9.a** Explain how economic indicators are used to evaluate the health of the economy.
- 6.1.12.EconNE.9.c** Explain how the government can adjust taxes, interest rates and other policies to restore the country's economic health.
- 6.1.12.EconEM.12.a** Assess the role of public and private sectors in promoting economic stability.

Unit Understandings:

Students will understand that...

- Bias must always be avoided during sampling.
- There are advantages and disadvantages to sample surveys, observational studies, and randomized experiments.
- Control groups are beneficial to experiments.
- Simulations can help us when experimentation is too difficult.

Unit Essential Questions:

- How do you choose a sample at random?
- When can a simulation be useful to model random behavior?
- What are the three basic principles of a sound experimental design?
- How does bias destroy our results?

Knowledge and Skills:

Students will know...

- **Vocabulary** –
 - bias, randomization, sample size, census, population parameter, representative, simple random sample (SRS), sampling frame, stratified random sample, cluster sample, multistage sample, systematic sample, pilot, voluntary response bias, convenience samples, undercoverage, nonresponse bias, and response bias.
 - experiment, random assignment, factor, response, experimental units, level, treatment, control group, blinding, single-blind, double-blind, placebo, placebo effect, blocking, matching, designs, and confounding.
 - simulation, simulation component, trial, response variable, and statistical significance.
- Principles of Experimental Design – *Control, Randomize, Replicate*

Students will be able to...

- Utilize probabilities to make fair decisions.
- Analyze decisions and strategies using probability concepts.
- Evaluate the value of randomization as a defense against bias.
- Design a randomized experiment to test the effect of a single factor.
- Predict random outcomes in a real-world situation.
- Research how to randomly assign subjects to experimental treatments.
- Explain different methods for collecting data.
- Analyze the accuracy of a hypothesis using simulations.
- Determine the margin of error for surveys.
- Assess the validity of an experiment's results.
- Utilize resampling to make inferences about a treatment.
- Discover probabilities in distributions.
- Describe bias in sampling and survey questions.
- Analyze the varying methods of collecting data.
- Make inferences from sample surveys and experiments.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, and PearDeck, Freckle, Geogebra, Gimkit, Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- All examples and assigned problems will involve real-world situations and data, making it easier for all students to relate to the study at hand.
- Construct and analyze graphical displays.
- Mathematical investigations.
- “What Can Go Wrong?” Activities that explain all possible pitfalls and common mistakes.
- Create a “Who, What, Why, When, Where, and How” table to identify the variable.
- Unfair Coins (Internet Activity).
 - Discussion of double-sided (penny taped to the back of a nickel or quarter) coins and their effects on experiments.
- Analyze News Article: “Facebook and Low Grades- A Dangerous Mix?”.
- Research historical experiments.
- Ethical experiment responses (*Stats in Your World exercise*).

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. Practice worksheets, assessments, and writing assignments.
- Teacher’s Edition CD compiled of real data (no artificial sets).
- Teacher developed worksheets and activities.
- Microsoft Excel
- Google Sheets
- TI-83/TI-84
- Useful Websites for Teachers to Explore:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com

- <https://www.khanacademy.org/>
- <https://learnzillion.com/>
- <https://www.teachingchannel.org/>
- <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator
- Graph paper
- Rulers
- Colored Pencils/Markers
- Dice
- Decks of Cards
- Coins

UNIT 4 OVERVIEW

Content Area: Mathematics

Unit Title: Randomness & The Rules of Probability

Target Course/Grade Level: Probability & Statistics/Grades 11-12

Unit Summary: In this unit, the students will gain an understanding of independent probability and conditional probability, use them to interpret data, and use probability rules to find probabilities of compound events. The unit will start with the students finding sample spaces for a variety of classic probability experiments and using two-way tables to find relative and conditional relative frequencies. The students will then focus on finding conditional probabilities and probabilities of independent, dependent, and compound events. Permutations and combinations are introduced so students can use them to find probabilities of compound events.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

- S.CP.A.1** Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).
- S.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.
- S.CP.A.3** Understand the conditional probability of A given B as $\frac{P(A \text{ and } B)}{P(B)}$, 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.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.
- S.CP.B.7** Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.
- S.CP.B.8** Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$ and interpret the answer in terms of the model.
- S.CP.B.9** Use permutations and combinations to compute probabilities of compound events and solve problems.
- S.IC.B.6** Evaluate reports based on data (e.g. interrogate study design, data sources, randomization, the way the data are analyzed and displayed, inferences drawn and methods used; identify and explain misleading uses of data; recognize when arguments based on data are flawed).
- S.MD.A.2** Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
- S.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. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected

number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

S.MD.B.5 Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. For example, find the forecasted value of an investment.

a. Find the expected payoff for a game of chance. For example, find the expected winnings from a game at a fast food restaurant.

b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

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6.1.12.EconNE.9.c Explain how the government can adjust taxes, interest rates and other policies to restore the country's economic health.

6.1.12.EconEM.12.a Assess the role of public and private sectors in promoting economic stability.

Unit Understandings:

Students will understand that...

- Combinations can be used to find a probability.
- The Law of Large Numbers and the “Law of Averages” are not identical.
- There are several rules for combining probabilities of outcomes for more complex events.
- Two events could be either independent or disjoint, but not both.
- Not everything is “normal”.

Unit Essential Questions:

- What is the Law of Large Numbers?
- What is the Probability Assignment Rule?
- What is the expected value and how is it used?
- How is the Binomial Model used in statistics?
- What is the meaning of statistical significance?

Knowledge and Skills:

Students will know...

- **Vocabulary** –
 - random phenomenon, probability, independence, permutation, and combinations.
 - disjoint legitimate probability assignments, and independence assumption.
 - tree diagram and conditional probability.
 - random variable, probability model, expected value, variance, standard deviation, binomial probability model, 10% condition, success condition, and failure condition.
- Law of Large Numbers (LNN)
- “Law of Averages”
- Equally Likely Condition
- Fundamental Counting Principle
- Probability Assignment Rule
- Complement Rule
- Addition Rule
- Multiplication Rule

Students will be able to...

- Define and discover ways to use theoretical and experimental probability.
- Utilize two-way tables to find probabilities.
- Compare independent and dependent events.
- Conduct and interpret probability and binomial distributions.
- Utilize conditional relative frequencies to find probabilities.
- Make decisions using probabilities to solve real-life problems.
- Calculate probabilities of independent and dependent events.

- Solve real-life problems using more than one probability rule.
- Argue how disjoint events and overlapping events are different.
- Assess probabilities using permutations and combinations.
- Construct and interpret probability distributions.

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- Construct and analyze graphical displays.
- Mathematical investigations.
- “What Can Go Wrong?” Activities that explain all possible pitfalls and common mistakes.
- Create a “Who, What, Why, When, Where, and How” table to identify the variable.
- “Spam Messages in Your Inbox” (*Text-Stats in Your World*).
- Insurance policies/payouts distribution.
- Carnival game probability models.
- Basketball percentage models.

RESOURCES

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