CURRICULUM

FOR

STATISTICS & PROBABILITY

GRADES 11 & 12
This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Christine H. Salcito, Director of Curriculum and Instruction
Kevin Robinson, Program Supervisor of STEM

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

Vincent Vinci

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

Date of Board Adoptions: September 18, 2012
UNIT OVERVIEW

UNIT: One

Content Area: Statistics & Probability

Unit Title: Exploring and Interpreting Categorical & Quantitative Data

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

Unit Summary:
- Summarize, represent, and interpret data on a single count or measurement variable
- Summarize, represent, and interpret data on two categorical and quantitative variables
- Interpret linear models
- Make inferences and justify conclusions from sample surveys, experiments, and observational studies

Approximate Length of Unit: 11 weeks

Primary interdisciplinary connections: Business, Economics, Social Studies, Psychology, Language Arts, and Biology

LEARNING TARGETS

<table>
<thead>
<tr>
<th>Content Area Domain</th>
<th>Content Area Cluster</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreting Categorical &amp; Quantitative Data</td>
<td>Summarize, represent, and interpret data on a single count or measurement variable</td>
<td>S-ID.1, S-ID.2, S-ID.3, S-ID.4</td>
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<td>S-IC.6</td>
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21st Century Workplace Readiness Standards

<table>
<thead>
<tr>
<th>Standard/Strand</th>
<th>Cumulative Progress Indicator</th>
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<tbody>
<tr>
<td>21st Century Life and Career Skills/Creativity and Innovation</td>
<td>Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.</td>
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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.
- Imagery and displays are useful tools for data analysis.

Unit Essential Questions

- Discover the differences and similarities between categorical and quantitative variables.
- Sketch charts (pie, bar) that show correct and incorrect usage of the Area Principle.
- Identify patterns in histograms. (uniform, symmetric, skewed, gaps).
- Find the median and mean of a batch of numbers.
- Why is standard deviation only appropriate for symmetric data?
- What is the difference between the variance and standard deviation?
- Compare groups with boxplots and histograms. For example, compare the speeds of wood and steel roller coasters.
- Why is rescaling sometimes necessary in order to be “honest” with our displays?
- Does standardizing into z-scores change the shape, center, and spread of the distribution of a variable?

Knowledge and Skills

*Students will know…*

- **Vocabulary**
  - context, data, data table, case, population, sample, variable, units, categorical variables, quantitative variable
  - frequency table, distribution, pie chart, categorical data condition, contingency table, marginal distribution, conditional distribution, independence, association
  - histogram, gap, stem-and-leaf display, dotplot, shape, center, spread, mode, bimodal, uniform, symmetric, tails, skewed, outliers, median, range, quartile, interquartile range, percentile, s-number summary, mean, variance, standard deviation
  - boxplot, timeplot, rescaling
  - standardizing, normal model, parameter, statistic, z-score, standard normal distribution, normal percentile

- **Formulas**
  - Variance
  - Standard Deviation

- Area Principle
- 65-95-99.7 Rule

*Students will be able to…*

- identify the who, what, when, where, why and how, of data
- indentify the cases and variables in any data set
- classify a variable as categorical or quantitative
- summarize the distribution of a categorical variable with a frequency table
- create and interpret a contingency table
- know the basic properties of the mean and median
- use statistics appropriate to the shape of the data distribution
- use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentage
- 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
- fit a linear function for a scatter plot that suggests a linear association
- distinguish between correlation and causation
- guess the shape of the distribution of a variable by knowing something about the data
- compute the median and IQR of a data set
- evaluate reports based on data
- compute the standard deviation and mean of a data set
- compare side-by-side histograms
- create a timeplot of data and distinguish when one is appropriate
- describe trends and patterns
- compare the distributions of two or more groups by comparing their shapes, centers, and spreads
- discuss how outliers effect the overall pattern of data
- use mathematical vocabulary fluently
- make sense of problems and persevere in solving them
- reason abstractly and quantitatively
- construct viable arguments and critique the reasoning of others
- model with mathematics
use appropriate tools strategically
attend to precision
look for and make use of structure
look for and express regularity in repeated reasoning

**EVIDENCE OF LEARNING**

**Assessment**

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

- Unit tests, quizzes, quarterly formative assessments
- Open-ended problems that involve written responses
- Daily student work
- Student/group presentations
- Daily Homework
- Long term projects

**Learning Activities**

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

- 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
- khanacademy.org – exercises and videos
- “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)
- “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. Transparencies, practice worksheets, assessments, 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
- TI-83/TI-84

**Equipment Needed:**

- ELMO Projector
- Graph paper
- Calculators
- Rulers
- Colored Pencils/Markers
- Statistics Study Card
UNIT OVERVIEW

UNIT: Two

Content Area: Statistics & Probability

Unit Title: Relationships Between Variables

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

Unit Summary:
- Summarize, represent, and interpret data on a single count or measurement variable
- Summarize, represent, and interpret data on two categorical and quantitative variables
- Interpret linear models
- Make inferences and justify conclusions from sample surveys, experiments, and observational studies

Approximate Length of Unit: 7 weeks

Primary interdisciplinary connections: Arts & Literature, Business, Health, Finance, Economics, Social Studies, Psychology, Language Arts, and Science

LEARNING TARGETS

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21st Century Workplace Readiness Standards

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<td>Develop an understanding of how science and mathematics function to provide results, answers, and algorithms for engineering activities to solve problems and issues in the real world.</td>
<td>9.4.12.O.(2).1</td>
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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
  - model, linear, predicted value, residuals, least squares, regression line, intercept, regression to the mean, extrapolation, 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...*
- interpret differences in shape, center, and spread in the context of the data sets
- use the means and standard deviation of a data set to fit it to a normal distribution
- fit a linear function for a scatter plot that suggest a linear association
- informally assess the fit of a function by plotting and analyzing residuals
- interpret relative frequencies in the context of the data
- interpret the slope and the intercept of a linear model in the context of the data
- distinguish between correlation and causation
- know the conditions for correlation and how to check them
- know that correlation has no units
- describe the direction, form, and strength of a scatterplot
- use a linear model to predict a value for x and y
- discuss possible lurking variables
- justify their choice of model
- make sense of problems and persevere in solving them
- reason abstractly and quantitatively
- construct viable arguments and critique the reasoning of others
- model with mathematics
- use appropriate tools strategically
- attend to precision
- look for and make use of structure
- look for and express regularity in repeated reasoning
EVIDENCE OF LEARNING

Assessment

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

- Unit tests, quizzes, quarterly formative assessments
- Open-ended problems that involve written responses
- Daily student work
- Student/group presentations
- Daily Homework
- Long term projects

Learning Activities

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

- 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
- khanacademy.org – exercises and videos
- “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
- Breaking Distance of Cars (Video/Website)

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. Transparencies, practice worksheets, assessments, 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
- TI-83/TI-84

Equipment Needed:

- ELMO Projector
- Graph paper
- Calculators
- Rulers
- Colored Pencils/Markers
- Statistics Study Card
UNIT OVERVIEW

UNIT: Three

Content Area: Statistics & Probability

Unit Title: Gathering Data

Target Course/Grade Level: Statistics & Probability, Grades 11\(^{th}\)/12\(^{th}\)

Unit Summary:
- Understand and evaluate random processes underlying statistical experiments
- Make inferences and justify conclusions from sample surveys, experiments, and observational studies
- Use probability to evaluate outcomes of decisions

Approximate Length of Unit: 8 weeks

Primary interdisciplinary connections: Law, Business, Finance, Economics, Social Studies, Psychology, Language Arts, Technology, and Science

LEARNING TARGETS

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<td>S-IC.1, S-IC.2</td>
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<td>Making Inferences &amp; Justifying Conclusions</td>
<td>Make inferences and justify conclusions from sample surveys, experiments, and observational studies</td>
<td>S-IC.3, S-IC.4, S-IC.5, S-IC.6</td>
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<tr>
<td>Using Probability to Make Decisions</td>
<td>Use probability to evaluate outcomes of decisions</td>
<td>S-MD.6, S-MD.7</td>
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<td>21(^{st}) Century Life and Career Skills/ Critical Thinking and Problem Solving</td>
<td>Apply critical thinking and problem-solving strategies during structured learning experiences</td>
<td>9.1.12.A.1</td>
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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, response bias
- experiment, random assignment, factor, response, experimental units, level, treatment, control group, blinding, single-blind, double-blind, placebo, placebo effect, blocking, matching, designs, confounding
- simulation, simulation component, trial, response variable, statistical significance

Principles of Experimental Design – Control, Randomize, Replicate

Students will be able to...

- understand statistics as a process for making inferences about population parameters based on a random sample for that population
- decide if a specified model is consistent with results from a given data-generating process
- recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each
- 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
- use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant
- evaluate reports based on data
- use probabilities to make fair decisions
- analyze decisions and strategies using probability concepts
- understand the value of randomization as a defense to bias
- design a randomized experiments to test the effect of a single factor
- recognize random outcomes in a real-world situation
- know how to randomly assign subjects to experimental treatments
- make sense of problems and persevere in solving them
- reason abstractly and quantitatively
- construct viable arguments and critique the reasoning of others
- model with mathematics
- use appropriate tools strategically
- attend to precision
- look for and make use of structure
- look for and express regularity in repeated reasoning

EVIDENCE OF LEARNING

Assessment

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

- Unit tests, quizzes, quarterly formative assessments
- Open-ended problems that involve written responses
- Daily student work
- Student/group presentations
- Daily Homework
- Long term projects
Learning Activities

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

- 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
- khanacademy.org – exercises and videos
- “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?”

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. Transparencies, practice worksheets, assessments, writing assignments
- Teacher’s Edition CD compiled of real data (no artificial sets)
- Teacher developed worksheets and activities
- Microsoft Excel
- TI-83/TI-84

Equipment Needed:

- Dice
- Decks of Cards
- Coins
- ELMO Projector
- Graph paper
- Calculators
- Rulers
- Colored Pencils/Markers
- Statistics Study Card
UNIT OVERVIEW

UNIT: Four
Content Area: Statistics & Probability
Unit Title: Randomness & The Rules of Probability
Target Course/Grade Level: Statistics & Probability, Grades 11th/12th
Unit Summary:
- Understand independence and conditional probability and use them to interpret data
- Use the rules of probability to compute probabilities of compound events in a uniform probability model
- Make inferences and justify conclusions from sample surveys, experiments, and observational studies
Approximate Length of Unit:
- 9 weeks
Primary interdisciplinary connections:
- Arts & Literature, Business, Health, Finance, Economics, Social Studies, Psychology, Language Arts, and Chemistry

LEARNING TARGETS

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<td>Conditional Probability &amp; the Rules of Probability</td>
<td>Understand independence and conditional probability and use them to interpret data</td>
<td>S-CP.1, S-CP.2, S-CP.3, S-CP.4, S-CP.5</td>
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<td>Conditional Probability &amp; the Rules of Probability</td>
<td>Use the rules of probability to compute probabilities of compound events in a uniform probability model</td>
<td>S-CP.6, S-CP.7, S-CP.8, S-CP.9</td>
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Unit Understandings

Students will understand that...

- Combinations can be used to find a probability
- The Law of Large Numbers and “Law of Averages” are not identical
- There are several rules for combing 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, combinations
  - disjoint legitimate probability assignments, independence assumption
  - tree diagram, conditional probability
  - random variable, probability model, expected value, variance, standard deviation, binomial probability model, 10% condition, success condition, failure condition

- Formulas –
  - 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...

- describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersection, or complements of other events
- 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
- understand the conditional probability of $A$ given $B$ as $P(A \text{ and } B)/P(B)$, 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 $B$.
- construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities
- recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations
- 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
- 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.
- 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.
- use permutations and combinations to compute probabilities of compound events and solve problems
- evaluate reports based on data
- make sense of problems and persevere in solving them
- reason abstractly and quantitatively
- construct viable arguments and critique the reasoning of others
- model with mathematics
- use appropriate tools strategically
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- look for and make use of structure
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EVIDENCE OF LEARNING

Assessment

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Learning Activities

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

- 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
- khanacademy.org – exercises and videos
- “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)

RESOURCES

Teacher Resources:

- Stats in Your World Textbook: Teachers’ Edition & accompanying resources, e.g. Transparencies, practice worksheets, assessments, writing assignments
- Teacher’s Edition CD compiled of real data (no artificial sets)
- Teacher developed worksheets and activities
- Microsoft Excel
- TI-83/TI-84

Equipment Needed:

- ELMO Projector
- Graph paper
- Calculators
- Rulers
- Colored Pencils/Markers
- Statistics Study Card