Randolph Township Schools
Randolph High School

Statistics Outside the Classroom
Curriculum

“Facts are stubborn, but statistics are more pliable.”
- Mark Twain

Department of
Science, Technology, Engineering, and Math
Michael Cascione
Supervisor

Curriculum Committee
Ryan Casey
Sean Altis

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July 2013

Board APPROVAL
September 10, 2013
Name change October 17, 2017
Randolph Township Schools  
Department of Science, Technology, Engineering, and Math  

Statistical Measures  

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Randolph Township Schools

Mission Statement

We commit to inspiring and empowering all students in Randolph Schools to reach their full potential as unique, responsible and educated members of a global society.

Randolph Township Schools
Affirmative Action Statement

Equality and Equity in Curriculum

The Randolph Township School district ensures that the district’s curriculum and instruction are aligned to the state’s standards. The curriculum addresses the elimination of discrimination and the achievement gap, as identified by underperforming school-level AYP reports for state assessments. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972
RANDOLPH TOWNSHIP BOARD OF EDUCATION
EDUCATIONAL GOALS
VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:
• The needs of the child come first
• Mutual respect and trust are the cornerstones of a learning community
• The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
• A successful learning community communicates honestly and openly in a non-threatening environment
• Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
• Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
• Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth
Randolph Township Schools
Department of Science, Technology, Engineering, and Math

Introduction

Randolph Township Schools is committed to excellence. We believe that all children are entitled to an education that will equip them to become productive citizens of the 21st century. We believe that an education grounded in the fundamental principles of science, technology, engineering, and math (STEM) will provide students with the skills and content necessary to become future leaders and lifelong learners.

A sound STEM education is grounded in the principles of inquiry, rigor, and relevance. Students will be actively engaged in learning as they use real-world STEM skills to construct knowledge. They will have ample opportunities to manipulate materials and solve problems in ways that are developmentally appropriate to their age. They will work in an environment that encourages them to take risks, think critically, build models, observe patterns, and recognize anomalies in those patterns. Students will be encouraged to ask questions, not just the “how” and the “what” of observed phenomena, but also the “why”. They will develop the ability, confidence, and motivation to succeed academically and personally.

STEM literacy requires understandings and habits of mind that enable students to make sense of how our world works. As described in Project 2061’s Benchmarks in Science Literacy, The Standards for Technological Literacy, and Professional Standards for Teaching Mathematics, literacy in these subject areas enables people to think critically and independently. Scientifically and technologically literate citizens deal sensibly with problems that involve mathematics, evidence, patterns, logical arguments, uncertainty, and problem-solving.

Statistical Measures

Introduction

Statistical Measures is an elective course in the STEM department for seniors who have completed Algebra II. It introduces students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Students will become familiar with the vocabulary, methods, and meaning of the statistics, which exist in the world around them. Through this course, students will also become critical consumers of published conclusions based on statistical analysis, and become aware of the ways in which statistics can be improperly used to mislead, confuse, or distort the truth. The course provides a strong basis for students to continue the study of statistics at the college level.

The course makes use of technology to analyze and present real data. Students are encouraged to incorporate their knowledge of and interest in other disciplines into project work. In addition to gaining skills necessary to produce, analyze, model and draw conclusions from data, students will develop skills required to produce convincing oral and written statistical arguments, using appropriate terminology.
<table>
<thead>
<tr>
<th>SUGGESTED TIME ALLOTMENT</th>
<th>UNIT NUMBER</th>
<th>CONTENT - UNIT OF STUDY</th>
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<tbody>
<tr>
<td>5 weeks</td>
<td>I</td>
<td>Descriptive Statistics</td>
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<td>3 weeks</td>
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<td>3 weeks</td>
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<td>3 weeks</td>
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<td>Statistical Inference</td>
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</table>
## ENDURING UNDERSTANDINGS

- Data needs to be summarized and displayed in an appropriate way in order to extract meaning from it.
- It is important to understand how data was collected in order to draw valid conclusions from it.
- Statistical analysis and data displays often reveal patterns that may not be obvious.

## ESSENTIAL QUESTIONS

- How should we summarize and display a particular set of data to understand what is “says?”
- What does it mean to “lie” with statistics? How can statistics be misleading, and to what extent?
- How does the “bell curve” relate to the real world?

## KNOWLEDGE

**Students will know:**

The 5 W’s of data collection.

Distributions (the set of possible values a variable can take and the frequency with which those values occur) can be summarized in frequency tables and characterized by their shape, center, spread and outliers.

## SKILLS

**Students will be able to:**

- Identify the 5 W’s of how data is collected:
  - Who it is collected about (the observational units)
  - What variables are represented, and their data types (quantitative or categorical, binary)
  - When is the data collected
  - Where is it collected
  - Why it is collected

For quantitative data:

- Describe the shape, center and spread of a distribution from a graph.
- Identify outliers, if present, and their effect on the shape, center and spread of the distribution.

For categorical data:

- Construct and interpret two-way (contingency) tables
- Calculate and interpret probabilities, conditional probabilities and marginal probabilities.

Choose appropriate summaries and displays:

- Choose graphical displays based on whether a variable is quantitative or categorical, and the purpose of the display.
- Choose appropriate numerical summaries based on whether

## CCSS

- HSS-ID.1
- HSS-ID.2
- HSS-ID.3
- HSS-ID.4
- HSS-ID.5
- HSS-IC.6
- HSS-CP.4
- SMP.1
- SMP.2
- SMP.3
- SMP.4
- SMP.5
- SMP.7
- ELA.RST.11-12.3
- ELA.RST.11-12.4
- ELA.RST.11-12.7
- ELA.RST.11-12.8
- ELA.RST.11-12.9
- ELA.WHST.11-12.2
- ELA.WHST.11-12.4
- ELA.WHST.11-12.7
- ELA.WHST.11-12.9
The Normal distribution is a useful family of models that describes many symmetric, real-world data sets.

- the data is symmetric or skewed.

Create graphical displays:
- for categorical data – pie chart, bar graph
- for quantitative data – dot plot, stem-and-leaf plot, histogram, boxplot

Calculate numeric measures:
- center - mean, median
- spread - standard deviation, interquartile range, range
- quartiles, five number summary
- upper and lower bounds for outliers

Recognize the symmetric, unimodal, bell-shaped Normal curve.

Compute and interpret z-scores, and apply the 68-95-99.7% Rule in order to:
- understand how many standard deviations above or below the mean a value is, and
- compare values from different Normal distributions
<table>
<thead>
<tr>
<th>SUGGESTED TIME ALLOTMENT</th>
<th>CONTENT – UNIT OF STUDY</th>
<th>SUPPLEMENTAL UNIT RESOURCES</th>
</tr>
</thead>
</table>
| 5 weeks                  | Unit I – Descriptive Statistics  
  o Observational units and types of variables  
  o Graphical displays  
  o Numeric summaries  
  o Normal models | Textbook: Chapters 1 – 5, first half of Chapter 6  
Workbook Topics 1 - 7  
Data for use with Fathom: [http://www.keycurriculum.com/resources/fathom-resources/free-activities-and-resources/more-data](http://www.keycurriculum.com/resources/fathom-resources/free-activities-and-resources/more-data)  
Census at School: [http://www.amstat.org/censusatschool/](http://www.amstat.org/censusatschool/)  
Applet to demonstrate the effect of bin width on the analysis of data using a histogram [http://www.stat.sc.edu/~west/javahtml/Histogram.html](http://www.stat.sc.edu/~west/javahtml/Histogram.html)  
Data and Story Library [http://lib.stat.cmu.edu/DASL/](http://lib.stat.cmu.edu/DASL/)  
### ENDURING UNDERSTANDINGS

- Mathematical models, created using techniques of linear regression, can be useful for making predictions about the future.
- High correlation between two quantitative variables does not necessarily imply a cause-and-effect relationship between them.
- There are limitations to the usefulness of mathematical representation and modeling. What makes a mathematical model good or not good for a particular real-world scenario?

### ESSENTIAL QUESTIONS

- Is linear regression an appropriate technique to model all data? Why?
- If two quantities are highly correlated, then a change in one should cause a change in the other. Why is this not true?
- What makes a mathematical model good or not good for a particular real-world scenario?

### KNOWLEDGE

**Students will know:**

- Bivariate data can be represented graphically in a scatterplot.
- Least squares regression lines can be found with and without technology and are used to make predictions.
- Methods to analyze the meaning and effectiveness of a linear regression model.

### SKILLS

**Students will be able to:**

- Create scatterplots.
- Describe the form, direction, and strength of the relationship between two quantitative variables, as shown in a scatterplot.
- Find the equation of the least squares regression line for a given set of data both with and without technology.
- Use the least squares regression line to make predictions and find residuals.
- Calculate or create, interpret (in the context of the data), and use (to assess the effectiveness of the model):
  - slope and intercept
  - correlation coefficient
  - coefficient of determination
  - outliers
  - influential points
  - residual plot

### CCSS

- HSS-ID.6
- HSS-ID.6.a
- HSS-ID.6.b
- HSS-ID.6.c
- HSS-ID.8
- HSS-ID.9
- HSS-IC.6
- SMP.2
- SMP.3
- SMP.4
- SMP.5
- ELA.RST.11-12.3
- ELA.RST.11-12.4
- ELA.RST.11-12.7
- ELA.RST.11-12.8
- ELA.RST.11-12.9
- ELA.WHST.11-12.2
- ELA.WHST.11-12.4
- ELA.WHST.11-12.7
- ELA.WHST.11-12.9
<table>
<thead>
<tr>
<th>SUGGESTED TIME ALLOTMENT</th>
<th>CONTENT – UNIT OF STUDY</th>
<th>SUPPLEMENTAL UNIT RESOURCES</th>
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<tbody>
<tr>
<td>3 weeks</td>
<td>Unit II – Linear Regression</td>
<td>Textbook: Chapters 7, 8</td>
</tr>
<tr>
<td></td>
<td>o Scatterplots</td>
<td>Workbook and associated data files: Topics 8 - 11</td>
</tr>
<tr>
<td></td>
<td>o Using and interpreting the LSRL</td>
<td><a href="http://www.stat.tamu.edu/~west/ph/coreye.html">http://www.stat.tamu.edu/~west/ph/coreye.html</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applet to demonstrate the effect of influential points <a href="http://www.stat.sc.edu/~west/javahtml/Regression.html">http://www.stat.sc.edu/~west/javahtml/Regression.html</a></td>
</tr>
</tbody>
</table>
### ENDURING UNDERSTANDINGS

<table>
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<tr>
<th>ENDURING UNDERSTANDINGS</th>
<th>ESSENTIAL QUESTIONS</th>
<th>CCSS</th>
</tr>
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<tr>
<td>Careful planning is essential in order to avoid bias and obtain valid data that allows for useful comparison between groups.</td>
<td>• How do we make sure there is no bias in the data we collect?</td>
<td>HSS-IC.1</td>
</tr>
<tr>
<td>Randomization is an essential part of all good sampling methods and experiments.</td>
<td>• How can we make sure a sample is truly random?</td>
<td>HSS-IC.2</td>
</tr>
<tr>
<td>Well-designed experiments can be used to establish causation.</td>
<td>• Why would someone purposely want to collect biased data?</td>
<td>SMP.1</td>
</tr>
</tbody>
</table>

### KNOWLEDGE

**Students will know:**

- Simulations can be carried out to answer questions involving probability and outcomes of many random events.
- Different methods of data collection and their effectiveness in different situations.
- Techniques for planning and conducting a survey.

### SKILLS

**Students will be able to:**

- Design, implement and interpret simulations using various sources of random numbers.
- Identify an appropriate data collection method for a given scenario:
  - Census
  - Sample Survey
  - Experiments
- Identify populations and samples and their associated parameters and statistics.
- Recognize sources of bias in sampling and surveys:
  - voluntary response
  - undercoverage
  - response bias
  - nonresponse bias
- Recognize and apply sampling methods:
  - simple random sample
  - stratified random sample
  - cluster sample
  - systematic sample
  - convenience sample

### CCSS

- HSS-IC.1
- HSS-IC.2
- SMP.1
- SMP.2
- SMP.3
- SMP.4
- ELA.RST.11-12.3
- ELA.RST.11-12.4
- ELA.RST.11-12.7
- ELA.RST.11-12.8
- ELA.RST.11-12.9
- ELA.WHST.11-12.2
- ELA.WHST.11-12.4
- ELA.WHST.11-12.7
- ELA.WHST.11-12.9
Techniques for analyzing, planning and conducting experiments.

- voluntary response sample

Document the design of an experiment with a diagram showing treatment groups and sizes, randomization, blocking and measurement of a response variable.

Identify:
- factors, levels, treatments, response variable
- blocks, control groups
- use of placebos and blinding

Analyze and discuss results of an experiment.
<table>
<thead>
<tr>
<th>SUGGESTED TIME ALLOTMENT</th>
<th>CONTENT – UNIT OF STUDY</th>
<th>SUPPLEMENTAL UNIT RESOURCES</th>
</tr>
</thead>
</table>
| 3 weeks                  | Unit III – Surveys, Sampling and Experiments  
  o Simulations  
  o Sampling methods  
  o Survey design  
  o Experimental design | Textbook Chapters 10 – 12  
  Workbook and associated data files: Topics 12, 13  
  Worksheets, modified  
  Jelly Blubbers, a hands-on introduction to simple random samples and the importance of sample size  
  http://exploringdata.net/sampling.htm  
  An activity to conduct an experiment using Tangrams  
  http://web.grinnell.edu/individuals/kuipers/stat2labs/Tangrams.html |
## ENDURING UNDERSTANDINGS

| Random phenomena are unpredictable in the short term but show long-run regularity. |
| The probability of an event is the proportion of times the event will occur over many trials. |
| Probability is the basis for statistical inference. |

## ESSENTIAL QUESTIONS

| Why do those who win at a casino end up losing what they won and more if they continue to play? |
| Why is it that a fair coin may be flipped ten times and heads is the result all ten times? |
| How can we confidently base decisions on chance? |

## KNOWLEDGE

| Students will know: |
| Types of probability. |
| Formal rules of probability. |
| Rules for calculating probabilities of compound events. |

## SKILLS

| Students will be able to: |
| Identify types of probability: |
| - Theoretical |
| - Empirical |
| - Subjective |
| When an experiment is performed, identify and calculate: |
| - Sample space |
| - Probability of a simple event |
| - Upper and lower limits on probability |
| - Complement of an event |
| Identify independent or mutually exclusive events. |
| Calculate probabilities of compound events using: |
| - Addition Rule (or) |
| - Multiplication Rule (and) |
| - Venn diagrams |
| Interpret and calculate conditional probabilities using formulas and tree diagrams. |
| Identify type of random variable: |
| - Discrete |
| - Continuous |

## CCSS

<p>| 9-12.CP.1 |
| 9-12.CP.2 |
| 9-12.CP.3 |
| 9-12.CP.5 |
| 9-12.CP.6 |
| 9-12.CP.7 |
| 9-12.CP.8 |
| 9-12.MD.1 |
| 9-12.MD.2 |
| 9-12.MD.3 |
| 9-12.MD.4 |
| 9-12.MD.5.a |
| 9-12.MD.5.b |
| SMP.1 |
| SMP.2 |
| SMP.3 |
| SMP.4 |
| SMP.6 |
| SMP.7 |
| ELA.RST.11-12.3 |
| ELA.RST.11-12.4 |
| ELA.RST.11-12.7 |
| ELA.RST.11-12.8 |
| ELA.RST.11-12.9 |</p>
<table>
<thead>
<tr>
<th>How probability distributions are defined to represent random variables.</th>
<th>Write, interpret and use the following to make decisions:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- discrete probability distributions</td>
</tr>
<tr>
<td></td>
<td>- expected value</td>
</tr>
<tr>
<td></td>
<td>- variance and standard deviation</td>
</tr>
</tbody>
</table>

ELA.WHST.11-12.2
ELA.WHST.11-12.4
ELA.WHST.11-12.7
ELA.WHST.11-12.9
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<th>SUGGESTED TIME ALLOTMENT</th>
<th>CONTENT – UNIT OF STUDY</th>
<th>SUPPLEMENTAL UNIT RESOURCES</th>
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</thead>
</table>
| 4 weeks                  | Unit IV – Probability and Random Variables  
  o Calculating probabilities  
  o Random variables        | Textbook  
  Second half of Chapter 6  
  Chapters 14, 15  
  First half of Chapter 16  
  Workbook Topic 14  
  Worksheets, modified  
  Applet to demonstrate conditional probability using the Monty Hall problem  
  [http://www.stat.sc.edu/~west/javahtml/LetsMakeaDeal.html](http://www.stat.sc.edu/~west/javahtml/LetsMakeaDeal.html)  
  Casino Lab  
  [http://apstatsmonkey.com/StatsMonkey/Probability_files/Casino%20Lab%202008.pdf](http://apstatsmonkey.com/StatsMonkey/Probability_files/Casino%20Lab%202008.pdf) |
### ENDURING UNDERSTANDINGS

| Inference is a process by which we draw conclusions about a population based on sample data. | • In what way are hypothesis tests like the American legal system, where a defendant is found to be guilty or not guilty, but never proven innocent? |
| Tests of significance and confidence intervals drive decision-making in our world. | • How much evidence is required to convince you that a claim is true, and does that vary according to the situation? |
| Hypothesis testing determines whether results are statistically significant or are likely to have occurred due to chance. | • When are we convinced that statistical results are significant or likely to have occurred due to chance? |

### ESSENTIAL QUESTIONS

- In what way are hypothesis tests like the American legal system, where a defendant is found to be guilty or not guilty, but never proven innocent?
- How much evidence is required to convince you that a claim is true, and does that vary according to the situation?
- When are we convinced that statistical results are significant or likely to have occurred due to chance?

### KNOWLEDGE

**Students will know:**

A confidence interval estimates the range of values, which is likely to include an unknown population parameter.

### SKILLS

**Students will be able to:**

- Calculate confidence intervals for a proportion and for means (standard deviation known):
  - standard error
  - critical value
  - margin of error
  - confidence interval
- Interpret and explain confidence intervals in the context of the problem.
- Set up and carry out hypothesis tests regarding a proportion, or means (standard deviation known).
  - Left-tailed, right-tailed, two-tailed
  - Null and alternate hypotheses
  - Standard error
  - z-statistic
  - p-value
  - Decision to reject or fail to reject the null hypothesis
- Interpret the results of a hypothesis test in the context of the problem.

### CCSS

- HSS-IC.4
- HSS-IC.5
- HSS-IC.6
- SMP.2
- SMP.3
- SMP.4
- SMP.6
- ELA.RST.11-12.3
- ELA.RST.11-12.4
- ELA.RST.11-12.7
- ELA.RST.11-12.8
- ELA.RST.11-12.9
- ELA.WHST.11-12.2
- ELA.WHST.11-12.4
- ELA.WHST.11-12.7
- ELA.WHST.11-12.9
<p>| Types of errors that can be made as a result of hypothesis tests. | Describe Type I and Type II errors in the context of a particular hypothesis test. |   |</p>
<table>
<thead>
<tr>
<th>SUGGESTED TIME ALLOTMENT</th>
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<th>SUPPLEMENTAL UNIT RESOURCES</th>
</tr>
</thead>
</table>
| 3 weeks                  | Unit V – Statistical Inference  
  o Confidence intervals for a single proportion or mean (standard deviation known)  
  o Hypothesis tests for a single proportion or mean (standard deviation known)  
  o Confidence intervals and hypothesis tests for two proportions | Textbook Chapters 17, 18, 20  
  Workbook Topics 19 – 25  
  Worksheets, modified http://www.mastermathmentor.com/apstat/ap_manual5.ashx  
  One-proportion hypothesis tests based on online games (Memory, Shapesplosion) http://web.grinnell.edu/individuals/kuipers/stat2labs/Handouts/Memorathon%20Introduction%20to%20hypothesis%20tests.pdf http://web.grinnell.edu/individuals/kuipers/stat2labs/Handouts/Shapesplosion%20Regression.pdf  
  Confidence interval based on tossing objects http://serc.carleton.edu/sp/cause/conjecture/examples/18162.html |
RESOURCES:

Textbook:
Stats: Modeling the World
Authors: Bock, Velleman, De Veaux
ISBN: 0201737353
Copyright 2004 Pearson Education, Inc.

Class set of workbooks and associated data files:
Workshop Statistics, Discovery with Data and Fathom
Authors: Rossman, Chance, Lock
Copyright 2002 Key College Publishing

Other Textbooks:
Statistics Through Applications
Authors: Starnes, Yates, and Moore
Copyright 2011 WH Freeman and Co.

The Practice of Statistics
Authors: Starnes, Yates, and Moore
Copyright 2012 WH Freeman and Co.

Technology:
- Software capable of statistical analysis in the educational environment such as Fathom
- Spreadsheet software such as Excel
- Word processor software such as Word
- Presentation software such as Powerpoint
- Graphing calculator
Web addresses:
Curriculum support materials for teachers of introductory statistics, R. Boggs, Glenmore State High School, Rockhampton, Australia: http://exploringdata.net/
Dartmouth-developed materials to support a course in quantitative literacy: http://www.dartmouth.edu/~chance/
Statistics teaching materials, M. Krummel, Howard County Public School, Maryland: http://mrskrummel.com/teachersapstat.html
Consortium for the Advancement of Undergraduate Statistics Education: http://www.causeweb.org/
Statistics @ SUNY Oswego: http://www.oswego.edu/~srp/stats/index.htm

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Statistics

APPENDIX B

ASSESSMENT:

- Quiz
- Test
- Individual Projects
- Group Projects
- Homework
- Online Resources
Opportunities exist for interdisciplinary units with courses such as Animal Behavior, Marine Biology and other science electives.
It is assumed that the student has successfully completed Algebra I, Geometry and Algebra II, or the equivalent.