Statistics Honors Course Overview

Content Area: **Math**
Course(s): **STATISTICS H**
Time Period:
Length: **Full Year**
Status: **Published**

Cover

EAST BRUNSWICK PUBLIC SCHOOLS

East Brunswick New Jersey

Superintendent of Schools

Dr. Victor P. Valeski

Mathematics

Statistics Honors-Course Number: 1180

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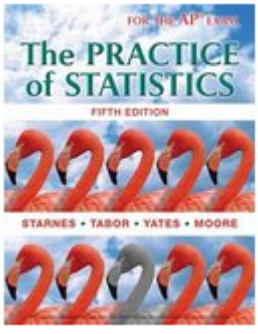
Course Overview

COURSE DESCRIPTION:

This course will familiarize students with mathematical models that occur in more advanced courses and in professions through the use of exploratory data analysis and statistical methods. Topics include descriptive statistics, probability, regression, confidence intervals and an introduction to hypothesis testing. Upon completion of this course, students will be able to critically analyze the use and misuse of statistics in social and scientific issues, to display data and analyze frequency distributions, to calculate and interpret measures of central tendency and dispersion, to use simple probability to interpret distributions, to use technology to explore regression and correlation and to calculate a confidence interval to determine the strength of a statistical claim. This course allows students to further their study of mathematics.

Textbooks and other resources

Textbook: The Practice of Statistics 5th Edition; Starnes, Tabor, Yates and Moore; W. H. Freeman Company; copyright 2015; adopted 2016



Websites, TI-84 graphing calculator with related applications and programs.

Scope and Sequence

UNIT	LEARNING GOALS	MARKING PERIOD
EXPLORING/MODELING DATA	**Learning Goals: Chapter 1** • SWBAT Display categorical data with a bar graph, dot plot, stem plot • SWBAT Identify what makes some graphs of categorical data deceptive • SWBAT Display quantitative data with histogram and boxplot • SWBAT Describe the overall pattern (SOCS) • SWBAT Calculate and display the marginal distribution and condition distribution of a categorical variable from a two-way table • SWBAT Describe the association between two categorical variables by comparing appropriate conditional distributions • SWBAT Calculate and interpret measures of spread, variance and standard deviation • SWBAT Choose the most appropriate graph, measure of center, and spread for distributions of quantitative variables • SWBAT Utilize appropriate technology **Learning Goals: Chapter 2** • SWBAT Find and interpret the percentile for an individual value • SWBAT Estimating percentiles and individual values using an ogive • SWBAT Finding and interpreting a z-score • SWBAT Describing the effect of add, subtract, multiply and divide by a constant on the shape, center, and spread • SWBAT Use the 68-95-99.7 rule to estimate area, probability in a normal distribution • SWBAT Estimate the relative locations of	MP 1

	mean and median on a density curve • SWBAT Use z-score tables to find proportions/probabilities • SWBAT Determine if a distribution of data is approximately normal • SWBAT Utilize appropriate technology	
MODELING DATA	**Learning Goals: Chapter 3** • SWBAT Identify explanatory and response variables in two variable data • SWBAT Make a scatterplot to explain the relationship between two variables • SWBAT Describe direction, form, and strength of a linear relationship • SWBAT Recognize outliers • SWBAT Interpret the correlation coefficient • SWBAT Explain why association does not imply causation • SWBAT Interpret the slope and y-intercept of an LSRL • SWBAT Use the LSRL to predict y given an x • SWBAT Explain dangers of extrapolation • SWBAT Calculate, construct, and interpret residuals and their plots to assess linearity • SWBAT Interpret coefficient of determination • SWBAT Describe how slope, y-intercept, and residual and coefficient of determination are influenced by outliers • SWBAT Students will be able to use technology in transform involving powers and roots to find a power model • SWBAT Students will be able to use technology in transform involving powers and roots to find a exponential model. • SWBAT Use both models to make predictions and to determine which best represents the data • SWBAT Utilize appropriate technology	MP 2
PROBABILITY	**Learning Goals: Chapter 5** • SWBAT Interpret probability as a long run relative frequency • SWBAT Use simulation to model chance behavior • SWBAT Determine a probability model for	MP 3

	a chance process • SWBAT Use basic probability rules including complement, addition for mutually exclusive, and multiplication for independence • SWBAT Use a two-way table or a venn diagram to model chance process and calculate probabilities • SWBAT Calculate and interpret conditional probabilities • SWBAT Use tree diagrams to model a chance process and calculate probabilities • SWBAT Utilize appropriate technology **Learning Goals: Chapter 6** • SWBAT Use a discrete random variable probability distribution to calculate probabilities and interpret the mean (expected value), calculate standard deviation • SWBAT Use a continuous random variable probability distribution to calculate probabilities and interpret the mean (expected value), calculate standard deviation • SWBAT Describe the effects of transforming a random variable by adding, subtracting, multiplying and dividing • SWBAT Find the mean, standard deviation and probability of the sum or difference of independent random variables • SWBAT Determine the conditions, compute and interpret probabilities, calculate and interpret the mean and standard for a binomial distribution • SWBAT Determine the conditions, compute and interpret probabilities, calculate and interpret the mean and standard for a geometric distribution • SWBAT Utilize appropriate technology	
SAMPLING DISTRIBUTIONS, CONFIDENCE INTERVALS & HYPOTHESIS TESTING	**Learning Goals: Chapter 7** • SWBAT Distinguish between parameter and statistics • SWBAT Distinguish among the distribution of a population, sample, and the sampling distribution of a statistic • SWBATInfer a parameter from a sampling	MP 4

distribution of a statistic
- SWBAT Determine whether a statistic is an unbiased estimator of the population parameter
- SWBAT Describe the relationship between sample size and the variability of the statistic
- SWBAT Find the mean and standard deviation for Sampling distribution of mu and checking their conditions
- SWBAT Find the mean and standard deviation for Sampling distribution of p hat and checking their conditions
- SWBAT Calculate probabilities when the sampling distribution is normal (mu & p hat)
- SWBAT Utilize appropriate technology

Learning Goals: Chapter 8

Looking for the population parameter mean when sigma is known...

- SWBAT nterpret a confidence interval and level in context
- SWBAT Calculate the point estimate and margin of error for the confidence interval
- SWBAT Describe how the sample size affects the length of the confidence interval
- SWBAT Determine the critical values for calculating the confidence interval for a population mean using a table or technology.
- SWBAT Utilize appropriate technology

Looking for population parameter proportion when sigma is known..… (Optional)

- SWBAT Interpret a confidence interval and level in context
- SWBAT Calculate the point estimate and margin of error for the confidence interval
- SWBAT Describe how the sample size affects the length of the confidence interval
- SWBAT Determine the critical values for calculating the confidence interval for a population mean using a table or technology.
- SWBAT Utilize appropriate technology

Learning Goals: Chapter 9

Looking for the population parameter mean when sigma is known...

- SWBAT State the null and alternate hypothesis for a significance test
- SWBAT Interpret a P-value in context
- SWBAT Determine if the results of a study are statistically significant and draw an appropriate conclusion using a significance level
- SWBAT Use a confidence interval to draw a conclusion for a two-sided significance test about a population parameter mean
- SWBAT Utilize appropriate technology

(Optional) Survays, Experiments, Study

Learning Goals: Chapter 4

(Surveys, Experiments, Study)

- SWBAT Identify the population and sample in a statistical study
- SWBAT Identify voluntary response samples and convenience samples
- SWBAT Describe how to obtain to a random sample using slips of paper, technology, or a table of random digits
- SWBAT Distinguish a simple random sample from a stratified random sample and a clustered random sample
- SWBAT Explain how undercoverage, nonresponse, question wording and other aspects of a sample survey can lead to bias.
- SWBAT Distinguish between an observational study, survey, and experiment
- SWBAT Explain the concept of confounding
- SWBAT Identify experimental units, explanatory and response variables, and treatments for a randomized block design
- SWBAT Explain the purpose of

MP 4

comparison, random assignment, control, and replication in an experiment
- SWBAT Describe the placebo effect and the purpose of blinding in an experiment (single and double)
- SWBAT Explain the purpose of blocking in an experiment
- SWBAT Describe a randomized block design or a matched pairs design for an experiment
- SWBAT Utilize appropriate technology

NJ Student Learning Standards

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MA.S-CP	Conditional Probability and the Rules of Probability
MA.S-CP.A	Understand independence and conditional probability and use them to interpret data
MA.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").
MA.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.
MA.S-CP.A.3	Understand the conditional probability of A given B as $P(A\ and\ B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
MA.S-CP.A.4	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.
MA.S-CP.A.5	Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
MA.S-CP.B	Use the rules of probability to compute probabilities of compound events in a uniform probability model
MA.S-CP.B.6	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.
MA.S-CP.B.7	Apply the Addition Rule, $P(A\ or\ B) = P(A) + P(B) - P(A\ and\ B)$, and interpret the answer in terms of the model.
MA.S-CP.B.8	Apply the general Multiplication Rule in a uniform probability model, $P(A\ and\ B) = [P(A)] \times [P(B\,|\,A)] = [P(B)] \times [P(A\,|\,B)]$, and interpret the answer in terms of the model.

MA.S-CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
MA.S-IC	Making Inferences and Justifying Conclusions
MA.S-IC.A	Understand and evaluate random processes underlying statistical experiments
MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MA.S-IC.A.2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
MA.S-IC.B	Make inferences and justify conclusions from sample surveys, experiments, and observational studies
MA.S-IC.B.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
MA.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.
MA.S-IC.B.5	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
MA.S-IC.B.6	Evaluate reports based on data.
MA.S-ID	Interpreting Categorical and Quantitative Data
MA.S-ID.A	Summarize, represent, and interpret data on a single count or measurement variable
MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
MA.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.
MA.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).
MA.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.
MA.S-ID.B	Summarize, represent, and interpret data on two categorical and quantitative variables
MA.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.
MA.S-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
MA.S-ID.B.6a	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.
MA.S-ID.B.6b	Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology.
MA.S-ID.B.6c	Fit a linear function for a scatter plot that suggests a linear association.
MA.S-ID.C	Interpret linear models
MA.S-ID.C.7	Interpret the slope (rate of change) and the intercept (constant term) of a linear

	model in the context of the data.
MA.S-ID.C.8	Compute (using technology) and interpret the correlation coefficient of a linear fit.
MA.S-ID.C.9	Distinguish between correlation and causation.
MA.S-MD	Using Probability to Make Decisions
MA.S-MD.A	Calculate expected values and use them to solve problems
MA.S-MD.A.1	Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.
MA.S-MD.A.2	Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
MA.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.
MA.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.
MA.S-MD.B	Use probability to evaluate outcomes of decisions
MA.S-MD.B.5	Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.
MA.S-MD.B.6	Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
MA.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).
MA.S-MD.B.5a	Find the expected payoff for a game of chance.
MA.S-MD.B.5b	Evaluate and compare strategies on the basis of expected values. 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. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results. 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? For example, find the expected winnings from a state lottery ticket or a game at a fast food restaurant. 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. 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. 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?

Standards for Mathematical Practices

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.

Grading and Evaluation Guidelines

GRADING GUIDELINES:

As per Math Department Policy, grades will be determined by a variety of assessment strategies, including Major Assessments, Minor Assessments, and Performance Assessments. In addition to tests and quizzes, students will be evaluated on a combination of performance assessment instruments, including homework completions, cooperative group participation, note-taking, open ended question responses, lab reports and/or supplemental projects.

GRADING PROCEDURES:

Grading procedures must be described in sufficient detail so that a pupil will understand, the minimal to advanced proficiency, expected of him/her as the outcome of each unit, for the marking period and for the course as a whole. Benchmark level assessments associated with the course also need to be identified. While assessments of proficiency levels must be valid and reliable they do not need be the same for all students. Other criteria to be considered in grading must be identified and the degree to which such criteria will be considered in a grade. Each pupil must receive a copy of the grading procedures, proficiencies and criteria for each unit and/or marking period.

COURSE EVALUATION:

Course achievement will be evaluated as the percent of all pupils who achieve the minimum level of proficiency (final average grade) in the course. Student achievement levels above minimum proficiency will also be reported. Final grades, and where relevant mid-term and final exams, will be analyzed by staff for the total cohort and for sub-groups of students to determine course areas requiring greater support or modification.

In terms of proficiency the East Brunswick grades are as follows:

A	**Excellent**	**Advanced Proficient**
B	**Good**	**Above Average Proficient**
C	**Fair**	**Proficient**
D	**Poor**	**Minimally Proficient**
F	**Failing**	**Partially Proficient**

In this course the goal is that a minimum of 95% of the pupil's will meet at least the minimum proficiency level (D or better) set for the course. The department will analyze the achievement of students on Unit Assessments, Mid-term and Final Exams and Final Course Grades, and for Final Course Grades the achievement of sub-groups identified by the state to determine if modifications in the curriculum and instructional methods are needed.

Course evaluation requires the answering of the following questions:
1. Are course content, instruction and assessments aligned with the required NJSLS? 2. Is instruction sufficient for students to achieve the Standards? 3. Do all students achieve the set proficiencies/benchmarks set for the course?

Other Details

Mathematics (AAAN)

Statistics Honors

Course No. 1043 (1180)

SCED

02202 Inferential Probability and Statistics

Probability and Statistics courses focus on descriptive statistics, with an introduction to inferential statistics. Topics typically include event probability, normal probability distribution, collection and description of data, frequency tables and graphs, measures of central tendency and variability, random variables, and random sampling. Course topics may also include covariance and correlation, central limit theorem, confidence intervals, and hypothesis testing.