AP Statistics Audit Syllabus

Purpose:

According to the College Board, AP Statistics is designed to introduce students to four broad themes: 1) exploring data, 2) sampling and experimentation, 3) anticipating patterns, and 4) statistical inference. Throughout the course, students will develop strategies for collecting and analyzing data, they will be required to draw appropriate conclusions from their analyses, and to communicate those conclusions in context. Class will be structured in such a way as to facilitate this work. Some time will be spent in lecture, but much of class time will be utilized working on activities and investigations. Students will be encouraged to communicate their thought processes both orally in class discussion and in writing. Students are exposed to released AP Statistics free response questions throughout the year. They work on them as homework assignments and spend significant time in class discussing and evaluating their responses based on the released rubrics. Emphasis is placed on statistical accuracy and effective communication of statistical concepts.

Technology:

Throughout the course, students will use a variety of technological tools to investigate concepts from the course syllabus including, but not limited to, graphical analysis, simulation, calculation of test statistics, regression, central limit theorem, etc. Tools used will include graphing calculators (ex. TI-83/84, TI-Nspire, etc.), Fathom, web-based applets, and other statistical software.

Text:

Yates, Moore, & Starnes. *The Practice of Statistics.* 4 ed., W.H. Freeman & Co., 2011

Course Outline:

Overview: What is Statistics?

Chapter 1: Exploring Data (12 days)

Chapter Sections: *Introduction Data Analysis: Making Sense of Data*
1.1 Analyzing Categorical Data
1.2 Displaying Quantitative Data with Graphs
1.3 Describing Quantitative Data with Numbers

Chapter Objectives: *Identify the individuals and variables in a set of data.*
Classify variables as categorical or quantitative.
Make and interpret bar graphs, pie charts, dot plots, stem plots, and histograms of distributions of a categorical variable.

Using graphical displays like those listed above, describe the overall pattern (shape, center, spread) of a distribution and identify any symmetry, skewness, or major departures from the pattern (like outliers).

Use appropriate graphs and numerical summaries to compare distributions of quantitative variables and the relationships between categorical variables.

From a two-way table of counts, answer questions involving marginal and conditional distributions.

Identify outliers using the 1.5 x IQR rule.

Calculate and interpret measures of center (mean, median) and measures of spread (IQR, standard deviation).

Select appropriate measures of center and spread.

Chapter Activities:

M&M Activity: Data Collection

opening day activity to introduce students to the themes of AP Statistics

Activity: Hiring Discrimination

this activity models the components of the statistical problem solving process: research question, data analysis, probability model, and inference

Class Activity: Data Collection

--students survey characteristics of one another (ex. number of phone contacts, number of siblings, height, etc) and create several types of displays of that data
--class discussion describing shape, outliers, center, spread

Technology: Making Histograms on the Calculator

Technology: Mean and Median Applet (on textbook website)

M&M Activity: Mean and Standard Deviation

activity designed to develop the concepts behind the calculation for standard deviation

Technology: Making Boxplots on the Calculator
Computing Numerical Summaries on the Calculator

FRAPPY (FRQ 2006 #1)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 2: Modeling Distributions of Data (11 days)

Chapter Sections:

2.1 Describing Location in a Distribution

2.2 Normal Distributions

Chapter Objectives:

Use percentiles to locate individual values within distributions of data.

Describe the effect of adding, subtracting, multiplying by, or dividing by a constant on the shape, center, and spread of a distribution of data.

Interpret a cumulative relative frequency graph.

Find and interpret the standardized value (z-score) of an observation in context.

Approximate the median and mean on a density curve.

Use tables to find the percentile of a value from any normal distribution and vice versa.

Make an appropriate graph to determine if a distribution is bell-shaped.

Assess the normality of a data set using the 68-95-99.7 rule.

Interpret a normal probability plot.

Chapter Activities:

Activity: Where do I stand?

introduces concepts of position within a distribution and the effects of transformations on measures of center, spread, and position

Technology: Fathom Demonstration...Normal Distribution

Technology: Normal Probability Plots on the Calculator

FRAPPY (FRQ 2006B #1)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 3: Describing Relationships (12 days)

Chapter Sections:

3.1 Scatterplots and Correlation

3.2 Least-Squares Regression

Chapter Objectives:

Identify explanatory and response variables.

Make a scatterplot to display the relationship between two quantitative variables.

Describe the direction, form, and strength of the overall pattern of a scatter plot.

Recognize outliers in a scatterplot.

Explain how correlation r *and recognize how* r^2*, slope, y-intercept, and standard deviation of the residuals are all influenced by extreme observations.*

Calculate and interpret correlation and residuals in context.

Explain the concept of least squares and use technology to find a least-squares regression line (LSRL).

Interpret the slope and y*-intercept of the LSRL in context.*

Construct and interpret residual plots to assess if a linear model is appropriate.

Use the standard deviation of the residuals and r^2 to assess how well the line fits the data.

Use computer output to identify the equation of the LSRL.

Interpret the standard deviation of the residuals and r^2 in context.

Chapter Activities:

Activity: The Case of the Missing M&Ms
used to lay groundwork for discussion of explanatory and response variables and the concept of correlation

Technology: Scatterplots on the Calculator

Technology: Correlation and Regression Applet (on textbook website)

Technology: Least-Squares Regression Lines on the Calculator

Technology: Fifty Fathoms...Least Squares.ftm

Technology: Residual Plots on the Calculator

Technology: Interpret Least-Squares Regression Output from Minitab, JMP, and other software

Class Activity: Data Exploration
--students explore numerical summaries of data and compare conclusions based on these summaries to the more informed conclusions based on plots of the data
--class discussion of some of the erroneous conclusions resulting from not plotting data

FRAPPY (FRQ 2005 #3)
individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 4: Designing Studies (16 days)

Chapter Sections:

4.1 Sampling and Surveys

4.2 Experiments

4.3 Using Studies Wisely

Chapter Objectives:

Identify the population and sample in a sample survey.

Identify voluntary response samples and convenience samples and explain how these methods can lead to bias.

Distinguish between simple random samples, stratified random samples, and cluster samples.

Give advantages and disadvantages of each sampling method.

Explain how undercoverage, nonresponse, and question wording can lead to bias in a sample survey.

Distinguish between an observational study and an experiment.

Explain how a lurking variable can lead to confounding.

Identify the experimental units, explanatory variables, treatments, and response variables in an experiment.

Explain why random assignment is an important experimental design principle.

Describe a completely randomized design for an experiment and distinguish it from a randomized block design.

Describe how to avoid the placebo effect and explain the meaning and purpose of blinding in an experiment.

Know when a matched pairs experimental design is appropriate and how to implement such a design.

Determine the scope of inference for a statistical study.

Chapter Activities:

Activity: Random Rectangles

this activity is used to compare convenience sampling and random sampling

Technology: Choosing an SRS using a Calculator

Activity: Rolling Down the River

--this activity is used to illustrate the differences between simple random sampling and stratified random sampling
--students discuss the impact each has on the variability of the parameter of interest

Project: Response Bias

(see project information on page 13)

Activity: Distracted Driving

activity that explores the concepts of statistical significance

Class Activity: Designing Mini-Experiments

--small groups are each given a situation and asked to develop an experiment to investigate
--groups describe their designs to the rest of the class and discuss and modification that may be necessary

FRAPPY (FRQ 2004 #2)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 5: Probability: What are the Chances? (10 days)

Chapter Sections:

5.1 Randomness, Probability, and Simulation

5.2 Probability Rules

5.3 Conditional Probability and Independence

Chapter Objectives: *Interpret probability as a long-run relative frequency in context.*

Use simulation to model chance behavior.

Use basic probability rules, including the complement rule, the addition rule, and the multiplication rule to solve probability questions.

Use Venn diagrams and tree diagrams to model chance behavior.

Determine whether two events are independent.

Find the probability that an event occurs using a two-way table.

Compute conditional probabilities.

Chapter Activities: *Activity:* Whose Book is This?

brief activity designing and conducting a simple simulation

Activity: Investigating randomness

--brief activity investigating the idea of runs in chance processes
--discussion springboard into short vs. long-run regularity

FRAPPY (FRQ 2003B #2)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 6: Random Variables (11 days)

Chapter Sections: *6.1 Discrete and Continuous Random Variables*

6.2 Transforming and Combining Random Variables

6.3 Binomial and Geometric Random Variables

Chapter Objectives: *Calculate the mean and standard deviation of a discrete random variable.*

Interpret the mean and standard deviation of a random variable in context.

Describe the effects of transforming a random variable by adding or subtracting a constant and multiplying or dividing by a constant.

Determine whether two random variables are independent.

Find the mean and standard deviation of the sum or difference of independent random variables.

Find probabilities involving the sum or difference of independent Normal random variables.

Determine whether the conditions for a binomial random variable are met.

Compute and interpret probabilities involving binomial and geometric distributions.

Calculate the mean and standard deviation of a binomial random variable. Interpret these values in context.

Chapter Activities: *Technology:* Binomial Probabilities on the Calculator

Technology: Geometric Probabilities on the Calculator

FRAPPY (FRQ 2003 #3)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Review for Semester Exam (4 days)
Semester 1 Exam (2 days)

Chapter 7: Sampling Distributions (9 days)

Chapter Sections: *7.1 What is a Sampling Distribution?*

7.2 Sample Proportions

7.3 Sample Means

Chapter Objectives: *Distinguish between a parameter and a statistic.*

Distinguish between population distribution, sampling distribution, and the distribution of sample data.

Determine whether a statistic is an unbiased estimator of a population parameter.

Understand the relationship between sample size and the variability of an estimator.

Find the mean and standard deviation of the sampling distribution of a sample proportion p-hat for an SRS of size n *from a population having proportion* p *of success.*

Find the mean and standard deviation of the sampling distribution of a sample mean x-bar from an SRS of size n*.*

Check whether the 10% and Normal conditions are met in a given setting.

Use Normal approximation to calculate probabilities involving p-hat.

Use the sampling distribution of p-hat to evaluate a claim about a population proportion.

Calculate probabilities involving a sample mean x-bar when the population distribution is Normal.

Explain how the shape of the sampling distribution of x-bar is related to the shape of the population distribution.

Use the central limit theorem to help find probabilities involving a sample mean x-bar.

Chapter Activities: *Activity:* German Tanks

Technology: Using Fathom to Simulate Sampling Distributions

Activity: The Candy Machine

--introduces concepts related to sampling distributions of p-hat
--uses an applet to simulate the distribution of p-hat

Activity: Penny for Your Thoughts

Technology: Using an Applet to Simulate the distribution of x-bar (for Normal and non-Normal populations)

FRAPPY (FRQ 2009 #2)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 8: Estimating with Confidence (10 days)

Chapter Sections: *8.1 Confidence intervals: the Basics*

8.2 Estimating a Population Proportion

8.3 Estimating a Population Mean

Chapter Objectives: *Interpret a confidence level and a confidence interval in context.*

Understand that a confidence interval gives a range of plausible values for the parameter.

Understand why each of the three inference conditions -- Random, Normal, and Independent -- is important.

Explain how practical issues like nonresponse, undercoverage, and response bias can affect the interpretation of a confidence interval.

Construct and interpret a confidence interval for a population proportion and for a population mean.

Determine critical values for calculating a confidence interval using a table or a calculator.

Carry out the steps in constructing a confidence interval for a population proportion and for a population mean: define the parameter; check conditions; perform calculations; interpret results in context.

Determine the sample size required to obtain a level C *confidence interval for a population proportion and a population mean with a specified margin of error.*

Understand how the margin of error of a confidence interval changes with the sample size and the level of confidence C*.*

Determine sample statistics from a confidence interval.

Chapter Activities: *Activity:* The mystery mean

introduces how information from a sample can be used to estimate a population parameter

Technology Activity: The Confidence Interval Applet

investigates the notion of confidence level and the relationship between confidence level and confidence interval

Technology: Confidence Intervals for p on the Calculator

Activity: Calculator Bingo
introduces t-distribution

Technology: Confidence Intervals for population means on the Calculator

Class Activity: Data Exploration
--students use chapter concepts to analyze a data set from a random sample
--class discussion summarizing findings

FRAPPY (FRQ)
individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 9: Testing a Claim (11 days)

Chapter Sections: *9.1 Significance Tests: the Basics*

9.2 Tests and a Population Proportion

9.3 Tests about a Population Mean

Chapter Objectives: *State correct hypotheses for a significance test about a population proportion or mean.*

Interpret P-values in context.

interpret a Type I error and a Type II error in context, and give the consequences of each.

Understand the relationship between the significance level of a test, P(Type II error), and power.

Check conditions for carrying out a test about a population proportion and if met, conduct a significance test.

Check conditions for carrying out a test about a population mean and if met, conduct a one-sample t*-test.*

Use a confidence interval to draw a conclusion for a two-sided test about a population proportion and a population mean.

Recognize paired data and use one-sample t *procedures to perform significance tests for such data.*

Chapter Activities: *Activity:* I'm a Great Free-Throw Shooter
introduces the notion of testing a claim

Technology: Investigating Power with an Applet

Technology: One-proportion z Test on the Calculator

Technology: Tests and Confidence Intervals using Statistical Software

Technology: One-sample t Test on the Calculator

Class Activity: Data Exploration

--students explore a set of paired data analyzing the mean difference for statistical significance

FRAPPY (FRQ)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 10: Comparing Two Populations or Groups (10 days)

Chapter Sections: *10.1 Comparing Two Proportions*

10.2 Comparing Two Means

Chapter Objectives: *Describe the characteristics of and calculate probabilities using the sampling distribution of p_1-hat - p_2-hat.*

Determine whether the conditions for performing inference are met

Construct and interpret a confidence interval to compare two proportions.

Perform a significance test to compare two proportions and to compare two means.

Interpret the results of inference procedures in a randomized experiment.

Describe the characteristics of and calculate probabilities using the sampling distribution of x_1-bar - x_2-bar.

Use two-sample t *procedures to compare two means based on summary statistics.*

Use two-sample t procedures to compare two means from raw data.

Interpret standard computer output for two-sample t *procedures.*

Check conditions for using two-sample t *procedures in a randomized experiment*

Determine the proper inference procedure to use in a given setting.

Chapter Activities: *Activity:* Is Yawning Contagious?

introduces the process of comparing two proportions

Technology: Confidence Intervals for a difference in proportions on the calculator

Technology: Significance test for a difference in proportions on the calculator

Activity: Does polyester decay?

uses simulation to introduce the comparison of two means

Technology: Two-sample t intervals on the calculator

Technology: Two-sample t tests with computer software and calculators

Class Activity: Data Exploration - Do Magnets Help Reduce Pain?

--students explore this data using appropriate statistical evidence

FRAPPY (FRQ)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 11: Inference for Distributions of Categorical Data (8 days)

Chapter Sections: *11.1 Chi-Square Goodness-of-Fit Test*

11.2 Inference for Two-Way Tables

Chapter Objectives: *Know how to compute expected counts, conditional distributions, and contributions to the chi-square statistic.*

Check the Random, Large sample size, and Independent conditions before performing a chi-square test.

Use a chi-square goodness-of-fit test to determine whether sample data are consistent with a specified distribution of a categorical variable.

Examine individual components of the chi-square statistic as part of a follow-up analysis

Use a chi-square test for homogeneity to determine whether the distribution of a categorical variable differs for several populations or treatments.

Interpret computer output for a chi-square test based on a two-way table.

Show that the two-sample z *test for comparing two proportions and the chi-square test for a 2-by-2 two-way table give equivalent results.*

Use a chi-square test of association/independence to determine whether there is convincing evidence of an association between two categorical variables.

Distinguish between the three types of chi-square tests.

Chapter Activities: *M&M Activity:* Goodness of Fit

students explore this data using appropriate statistical evidence

Technology: Finding p-values for chi-square tests on the calculator

Technology: Chi-square goodness-of-fit test on the calculator

Technology: Chi-square tests for two-way tables with computer software and the calculator

Class Activity: Data Exploration - Do Magnets Help Reduce Pain?

--students explore the fact that the two-sample z test for two proportions and the chi-square test for a two-way table give equivalent results

--students write up a brief report summarizing the results found

FRAPPY (FRQ)

individual and whole class work on, discussion and analysis of AP free response question and student responses

Chapter 12: More on Regression (9 days)

Chapter Sections: *12.1 Inference for Linear Regression*

12.2 Nonlinear relationships: Transforming to Achieve Linearity

Chapter Objectives: *Check conditions for performing inference about the slope β of the population regression line.*

Interpret computer output from a least-squares regression analysis.

Construct and interpret a confidence interval for the slope β of the population regression line.

Perform a significance test about the slope β of a population regression line.

Use transformations involving powers and roots to achieve linearity for a relationship between two variables.

Make predictions from a least-squares regression line involving transformed data.

Use transformations involving logarithms to achieve linearity for a relationship between two variables.

Determine which of several transformations does a better job of producing a linear relationship.

Chapter Activities: *Activity:* The Helicopter Experiment

introduction into inference about the slope of the LSRL

Technology: Regression Inference using computer software and calculators

Technology: Transforming to Achieve Linearity on the Calculator

Class Activity: Data Exploration - Do Magnets Help Reduce Pain?

--students explore transformations of insurance premium data

FRAPPY (FRQ)

individual and whole class work on, discussion and analysis of AP free response question and student responses

AP Exam Review (10 days)

Practice AP Free Response Questions
Choosing the Correct Inference Procedure
Mock grading sessions
Practice Multiple Choice Questions

AP Statistics Exam (1 day)

Bias in Surveys Project

The Project: Working in groups of two, you will design and conduct an experiment to investigate the effects of response bias in surveys. You may choose the topic for your surveys, but you must design your experiment so that it can answer at least one of the following questions.

- **A.** Can the wording of a question create response bias?
- **B.** Do the characteristics of the interviewer crease response bias?
- **C.** Does anonymity change the responses to sensitive questions?
- **D.** Does providing extra information affect the responses?

This project consists of 3 parts and is worth 50 test points. (In other words, it is weighted at about half a test)

Proposal (10 points): Your group must submit a complete project proposal form that outlines your survey question and the details of your experimental design. The proposal is worth 20% of the total grade so don't treat it casually. The proposal form will be provided and is due Tuesday, November 2nd.

The written report (20 points): The report is due Monday, November 15th and should include the following sections (clearly labeled).

- **A.** Introduction: What form of response bias were you investigating? What is your topic and why did you choose this topic? What results do you expect?
- **B.** Methodology: Describe how you conducted your experiment and why you think your design was effective. Note: This section should be very similar to your proposal.
- **C.** Results: Present the data in both tables and/or graphs in such a way that conclusions can be easily made. Make sure to label the graphs/tables clearly and consistently.
- **D.** Conclusions: What conclusions can be drawn from your experiment? Be specific. Were the results as you had anticipated? Did you encounter any problems during your project? would you do anything different if you were to repeat your experiment? What did you learn from this project?

The written report must be typed and graphs should be done on the computer. If you need assistance with this, please let me know.

Poster (20 points): The poster is due Monday, November 22nd. That day posters will be displayed in the classroom (and perhaps elsewhere in the building?) for classmates to read. The poster should completely summarize your project yet be simple and straight-forward enough to be understood by someone who has not had a statistics course. Your poster should include:

- **A.** Title and objective: the type of response bias investigated and the survey questions.
- **B.** Data Collection methods: how you used control, blocking, randomization, etc.
- **C.** At least 2 visuals: experimental design schematic (required), graphs, tables, digital photos.
- **D.** Results and conclusions.

Note: All work is due at the beginning of the period, even if you or your partner are absent. Significant points will be deducted for late work (20% per day).

Examples of Projects:

Milk vs. Orange Juice
1. Which do you prefer, mild or orange juice, as a breakfast drink? (milk: 14%)
2. Mile contains high levels of vitamin D and calcium. Do you prefer milk or orange juice as a breakfast drink? (milk: 64%)

Cheating
1. Do you cheat in class? (anonymous: 47% would)
2. Do you cheat in class? (not anonymous: 15% would)

Make-Up (all questions asked to males)
1. Do you find females who wear makeup attractive? (wearing makeup: 75% yes)
2. Do you find females who wear makeup attractive? (without wearing makeup: 30% yes)

Time Online
1. On average, how many hours do you spend online each week: 0-5, 6-10, 11-16, 17-25, 26-35, or more?
2. On average, how many hours do you spend online each week: 0-5, 6-10, 11-16, or more?
(For this question, the students anticipated that subjects would be embarrassed to say "more". In the first question, 50% answers over 17 hours, but in the second question, 0% did.)

Rough Scoring Rubric
(more details to come later)

The written report will be score for AP appropriate content and accuracy.

Introduction - Form of Response Bias Identify topic choice & reasoning and survey questions used	3 points
Methodology - Setup of completely randomized experiment Appropriate use of randomization, replication and control Appropriately labeled experimental design diagram	7 points
Results - Data collection results displayed in appropriate tables and graphs	3 points
Conclusion - Interpret results back to original form of response bias What was learned Discussion of problems encountered Changes that would be made if experiment was repeated	7 points

The poster will be scored for clarity, communication and visual appeal.

Title and Objective - survey questions and type of response bias	2 points
Data Collection Methods - brief discussion of how the experiment was carried out	5 points
Visual Aids - experimental design diagram, graphs, pictures	6 points
Results and Conclusions - clear and concise	3 points
Visual Appeal - make it clean, professional and fun to look at	4 points

Post AP Exam: Final Project

Purpose: The purpose of this project is for you to actually do statistics. You are to form a hypothesis, design a study, conduct the study, collect the data, describe the data, and make conclusions using the data. You are going to do it all!!

Topics: You may do your study on any topic, but you must be able to do all 6 steps listed above. Make it interesting and note that degree of difficulty is part of the grade.

Group Size: You may work alone or with a partner for this project.

Proposal: To get your project approved, you must be able to demonstrate how your study will meet the requirements of the project. In other words, you need to clearly and completely communicate your hypotheses, your explanatory and response variables, the test/interval you will use to analyze the results, and how you will collect the data so the conditions for inference will be satisfied. You must also make sure that your study will be safe and ethical if you are using human subjects. This should be typed. If your proposal isn't approved, you must resubmit the proposal for partial credit until it is approved.

Poster:
The key to a good statistical poster is communication and organization. Make sure all components of the poster are focused on answering the question of interest and that statistical vocabulary is used correctly. The poster should include:

- Title (in the form of a question).
- Introduction. In the introduction you should discuss what question you are trying to answer, why you chose this topic, what your hypotheses are, and how you will analyze your data.
- Data Collection. In this section you will describe how you obtained your data. Be specific.
- Graphs, Summary Statistics and the Raw Data (if numerical). Make sure the graphs are well labeled, easy to compare, and *help answer the question of interest.* You should include a brief discussion of the graphs and interpretations of the summary statistics.
- Discussion and Conclusions. In this section, you will state your conclusion (with the name of the test, test statistic and *P*-value) and you should discuss why your inference procedure is valid. You should also discuss any errors you made, what you could do to improve the study next time, and any other critical reflections
- Live action pictures of your data collection in progress.

Presentation: Each individual will be required to give a 5 minute oral presentation to the class.