

ADVANCED PLACEMENT STATISTICS

Course Design

Statistics is unlike any math course students have taken in their high school careers. Coming up with a numerical solution to a problem is only a small part. Statistics is mostly about the process; the interpretation of a problem, choosing the correct method to solve the problem, and communicating the results in a way that people not versed in Statistics can understand. Statistics is a way of thinking not just a set of computations.

Students are exposed to a wide variety of teaching materials which include a primary textbook, activities, readings from other books, journals, magazines, newspapers, videos, computer software and calculator simulations. Students are provided with formula sheets, statistical tables, and chapter outlines to guide their reading. All students are required to have a graphing calculator with statistical capabilities. Those who do not have their own, sign one out for the duration of the course. The classroom is a math lab with twelve computers for student use. Each computer has access to Fathom dynamic Statistics Software which is used to produce graphs and charts as well as to create simulations to illustrate concepts. Computer output from a variety of sources, including Minitab, SAS, and SPSS is used to familiarize students with the different types of statistical outputs those software create.

Once the AP Examination is completed, students work on a final culminating project. The project is designed for students to apply what they have learned throughout the course by formulating a question, designing the study or experiment, collecting the data, analyzing the data, and performing appropriate inferential procedures to answer the original question of interest. Students turn in both a written report with appropriate graphical displays as well as an oral presentation in which they summarize the project and choices they made in analyzing the question.

Course Requirements

AP Statistics introduces students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Students are exposed to four broad conceptual themes:

- *Exploring Data*: Describing patterns and departures from patterns
- *Sampling and Experimentation*: Planning and conducting a study
- *Anticipating Patterns*: Exploring random phenomena using probability and simulation
- *Statistical Inference*: Estimating population parameters and testing hypotheses

Connections are drawn among all of the aspects of the statistical process, including for example, how up-front design issues affect the back-end data analysis.

AP Statistics teaches the students how to communicate methods, results, and interpretations using the proper terminology of statistics. Students are provided many opportunities to write and discuss their ideas, methods, and conclusions.

AP Statistics teaches students how to use graphing calculators and demonstrates the use of computers and different software to enhance the development of the statistical thinker through exploration, analysis/output and simulation.

Students who successfully complete this course and exam may receive college credit, advanced placement, or both for a one-semester introductory college statistics course.

Primary Textbook and Other Resources

Primary Textbook:

- Bock, David E., Velleman, Paul F., and De Veaux, Richard D. *Stats: Modeling the World*, 2nd Edition, Boston: Pearson Addison-Wesley, 2007.

Other Texts and Resources

- Bock, David E., Velleman, Paul F., and De Veaux, Richard D. *Stats: Modeling the World*, 2nd Edition, Boston: Pearson Addison-Wesley, 2007.
- Yates, Daniel S., Moore, David S., and Starnes, Darren S. *The Practice of Statistics*, 2nd Edition, New York: W.H. Freeman, 2003.
- Annenberg Media, *Against All Odds: Inside Statistics*, VHS series. COMAP.
- Texas Instruments TI83+/TI84+ Graphing Calculators.
- Key Curriculum Press: *Fathom Dynamic Statistics Software*.
- Yates, Daniel S., Moore, David S., and Starnes, Darren S. *Statistics Through Applications*, New York: W.H. Freeman, 2005.
- Scheaffer, Gnanadeskian, Watkins, Witmer. *Activity-Based Statistics*, New York: Springer-Verlag, 1996
- Bohan, James F., *AP Statistics: Preparing for the Advanced Placement Examination*, 2nd Edition. New York: AMSCO School Publications, 2006.
- College Board. *AP Statistics Free Response Problems*. New Jersey: College Board, 2006.
- Newspaper/Magazine/Internet articles to illustrate concepts currently being covered in class.

- Instructor designed activities to illustrate and develop an understanding of statistical concepts.

Assessment

Students are assigned homework at the beginning of each chapter with ten problems to be collected on the day of the quiz for that chapter. Students are expected to plan for an hour of work each night for this course. They are to complete a few problems each night so that all ten problems are complete by the quiz date. The collected problems are graded based on a four point rubric, similar to that of the AP Exam. The problems that are not collected serve the basis for our classroom discussions.

At the end of each chapter, an Investigative Task is assigned which requires the student to use the topics learned previously to dig deeper into the analysis of a data set. These require more time and writing than a regular homework problem. Most of these tasks are generated from the BVD Teacher Resource Guide.

A chapter quiz is given for each chapter in the textbook. A test is given for each of the textbook's units, which comprise of four to six chapters each. The quizzes are specific to the topics covered, whereas the tests spiral all of the material learned to date. The tests are structured similarly to the AP Examination. There are approximately ten multiple-choice questions and five open-ended questions.

A "Typical" Chapter

In most cases, studying for a new chapter begins when the previous chapter's quiz is completed. Students are given an outline to complete when reading the next chapter. The first day usually involves a discussion of the reading and notes from a Powerpoint presentation that comes with the book and is edited by the instructor. Over the next few days, there is a shift from teacher-lead lectures to small-group work and discussion, which is intended to tie the specifics to the larger concepts and themes.

In most chapters, after the initial exposure to the material, there is an activity or investigation. Sources for these can come from a Fathom file, *Statistics Through Applications*, *Activity-Based Statistics*, or some other source.

Student understanding of concepts and applications are checked daily through problems and teacher questioning. There is a quiz at the end of each chapter. The chapter finishes with an Investigative Task where the focus becomes about communicating statistical concepts effectively. This is generally a larger assignment that involves a 1-2 page written report with appropriate graphs, charts, analyses, and written communication. If the chapter is the last chapter in the current unit, there are a couple of days of review and then a major unit test.

Review for the AP Exam

The course is taught with the philosophy of AP Statistics as outlined in the Course Description and Teacher's Guide. To that end, prepping for the exam starts on the first day of class. To help students prepare what is required in terms of statistical communication and analytic writing, previous released free-response questions are assigned at various intervals throughout the course. Students do not only compose their own responses, but use the rubrics to grade each other's work. This should help them become familiar with the types of responses the AP readers are looking for when scoring responses.

All of the topics are covered at least two weeks prior to the AP Exam test date. The time leading up to the exam is spent writing free-response answers and multiple choice questions from the AMSCO review book as well as the AP Test Series Review book for Statistics. If there is enough time, students are given a timed practice exam.

Throughout the course, prior material is spiraled into homework problems and test problems. When released free-responses are assigned, some are from much earlier material so that the students are constantly exposed to earlier learned material.

Course Projects

The course projects are in the form of extended writing assignments or oral presentations. These are formal, therefore, form and technical adequacy are enforced. Some examples are given below.

- Students write up a summary of a magazine or newspaper article that involves a statistical study. They are asked to identify the key components of the study (who, what, where, why, how, etc.) and look for examples of misrepresentations or poor reasoning. More stock is put into their writing as they have just scratched the surface of the course material.
- Nielsen Data Project. Students input the Nielsen ratings from the current week of television shows. They use Fathom to create appropriate charts, graphs, and summary statistics. They then write a paper comparing the viewership of the different television networks. Students then create a five minute presentation to an advertising executive to tell what stations, shows, times, or days of week bring in the most viewers.
- Students are to design a taste test. They are expected to incorporate all stages of the design process from design (randomization, blindness, etc.) to data collection to a descriptive report of the results.
- Casino Lab. Students simulate different games (modified casino games). They answer questions based on the results they got from their simulation. Then they calculate the theoretical probabilities associated with the specific game.

As inference lends itself to lab work, the number and frequency of labs increase as the year progresses. My expectations regarding work quality also increase. The students are required to connect their projects into the larger scientific context.

Course Content and Outline

The following outline describes this course's content by book chapter and unit.

Unit I – Exploring and Understanding Data

Chapter 1: Statistics Starts Here

- Activity: Read an article that references some statistics or statistical study.

Chapter 2: Data

- Types of data
- Create Data Lists in the TI84+
- Activity: In-class survey analysis

Chapter 3: Displaying and Describing Categorical Data

- Frequency Tables
- Pie Charts
- Bar Charts
- Contingency Tables

Chapter 4: Displaying Quantitative Data

- Histograms
- Stemplots
- Dotplots
- Shape, Center, and Spread
- Timeplots
- Cumulative Frequency Graphs
- Re-expressing Skewed Data
- Using the TI84+
- Activity: Weighing Pennies
- Activity: Gabalot High Phone Calls (From YMS, The Practice of Statistics)
- Video: Against All Odds – “Picturing Distributions”

Chapter 5: Describing Distributions Numerically

- Describing Center: Mean and Median

- Describing Spread: Range, Interquartile Range, Standard Deviation
- Boxplots
- Outliers
- Using the TI84+
- Project: Nielsen Ratings (Described above)

Chapter 6: The Standard Deviation as a Ruler and the Normal Model

- Standardized Scores
- The 68-95-99.7 Rule
- Percentiles and quartiles
- Normal Probability Plots
- Using TI84+
- Video: Against All Odds – “Normal Distributions”

Unit I - Test

Unit II – Exploring Relationships Between Variables

Chapter 7: Scatterplots, Association, and Correlation

- Making and Describing Scatterplots
- The Correlation Coefficient
- Properties of the Correlation Coefficient
- Straightening Scatterplots
- Using the TI84+

Chapter 8: Linear Regression

- The Linear Model
- Residuals
- Least Squares Regression Line
- Regression to the Mean
- Coefficient of Determination
- Using the TI84+
- Activity: Da Vinci Activity for Linear Regression

Chapter 9: Regression Wisdom

- Looking for Groups in Data
- Extrapolating
- Unusual and Influential Points

- Lurking Variables and Causation
- Activity: BVD Wandering Point Worksheet (from Instructors Resource Guide)

Chapter 10: Re-Expressing Data: Get It Straight!

- Straightening Relationships
- Goals of Re-expression
- The Ladder of Powers
- Using the TI84+
- Activity: The Cost of a First-Class Stamp (from YMS, The Practice of Statistics)

Unit II Test

Unit III – Gathering Data

Chapter 11: Understanding Randomness

- Random Behavior
- Simulations
- Estimating Likelihood of Outcomes Using Simulations
- Using the TI84+ for Simulations
- Activity: The Spread of an Epidemic, Part I (From YMS, the Practice of Statistics)

Chapter 12: Sample Surveys

- Bias in Sampling
- Simple Random Samples
- Stratified Random Samples
- Cluster/Multistage Sampling
- Systematic Sampling
- Activity: The River Problem
- Activity: Random Rectangles
- Additional Reading: How Are Polls Conducted? (By Frank Newport, Lydia Saad, David Moore from Where America Stands, 1997 John Wiley & Sons, Inc.)

Chapter 13: Experiments and Observational Studies

- Observational Studies
- Completely Randomized Design
- Designing Experiments
- Control Groups
- Treatments
- Blocking
- Replication
- Blinding
- Confounding and Lurking Variables
- Video: Against All Odds – “Experimental Design”
- Video: Against All Odds – “Blocking and Sampling”
- Project: Taste Test

Unit III Test

Unit IV – Randomness and Probability

Chapter 14: From Randomness to Probability

- Definition of probability, outcomes, and events
- Law of Large Numbers
- Properties of Probabilities
- Independence
- Disjoint Events

Chapter 15: Probability Rules

- The Addition Rule
- The Multiplication Rule
- Conditional Probability
- Tree Diagrams
- Reversing the Conditions
- Activity: Casino Lab

Chapter 16: Random Variables

- Properties of Discrete Random Variables
- Expected Value of a Discrete Random Variable
- Standard Deviation of a Discrete Random Variable

- Linear Functions and Linear Combinations of Discrete Random Variables
- Properties of Continuous Random Variables
- Using the TI84+
- Activity: Game: Greed
- Project: Slot Machines – Oral Presentation Required

Midterm Exam – AP Exam Format – 25 Multiple Choice and 5 Open-Ends

Chapter 17: Probability Models

- The Geometric Model
- The Binomial Model
- Using the Normal Model to Approximate the Binomial Model
- Using the TI84+ Distribution Menu
- Activity: The Spread of an Epidemic, Part II (From YMS, the Practice of Statistics)

Unit IV Test

Unit V – From the Data Hand to the World at Large

Chapter 18: Sampling Distribution Models

- Sampling Distributions
- Sampling Distribution Model for Proportions
- Sampling Distribution Model for Means
- The Central Limit Theorem
- Standard Error
- Activity: Spinning Pennies

Chapter 19: Confidence Intervals for Proportions

- Properties of Point Estimates
- Logic of a Confidence Interval
- Meaning of Confidence Level
- Confidence Intervals for Population Proportions
- Checking Assumptions and Conditions
- Using the TI84+
- Activity: Flipping Coin Simulation to Investigate affects of Sample Size and Confidence Level

Chapter 20: Testing Hypotheses About Proportions

- Forming Hypotheses
- Logic of Hypothesis Testing
- Type I and Type II Errors
- One and Two-Sided Hypothesis Tests for Population Proportions
- Test Statistics and p-values
- Checking Conditions
- Using the TI84+
- Activity: Water Area Activity

Chapter 21: More About Tests

- Interpreting p-values
- Significance Level
- Relationship between Confidence Intervals and Hypothesis Tests
- Power
- Effect Size
- Video: Against All Odds “Significance Tests”

Chapter 22: Comparing Two Proportions

- Two-sided Hypothesis Test for Population Proportions
- Pooling
- Checking Conditions
- Using the TI84+

Unit V Test

Unit VI – Learning About the World

Chapter 23: Inferences About Means

- The t-Distribution
- Degrees of Freedom
- Assumptions and Conditions
- Finding t-values and probabilities
- Hypothesis Testing for the Population Mean
- Confidence Intervals for the Population Mean
- Using the TI84+
- Activity: ESP Lab

Chapter 24: Comparing Means

- Hypothesis Test for the difference of two means (unpaired)
- Two-sided Tests
- Confidence Interval for the difference of two means (unpaired)
- Activity: Comparing SAT Verbal and Math Scores

Chapter 25: Paired Samples and Blocks

- Matched Pairs Hypothesis Test
- Matched Pairs Confidence Interval
- Using the TI-84+
- Choosing the correct test
- Activity: Comparing SAT Verbal and Math Scores (Part 2)
- Activity: Group Project from BVD Teacher Resource Guide

Unit VI Test

Unit VI – Learning About the World

Chapter 26: Comparing Counts

- The Chi-Square Distribution
- Goodness of Fit test
- Checking conditions
- Assessing normality
- Homogeneity of Proportions Test
- Test of independence
- Choosing the correct test
- Using the TI-84+
- Activity: M&M's

Chapter 27: Inferences for Regression

- Hypothesis Test for the slope of a least squares regression line
- Confidence interval for the slope of a least squares regression line
- Using computer output
- Using the TI-84+
- Activity: Models, Models, Models

Unit VII Test

Review for the AP Exam

- 2002 Complete Exam (under actual testing conditions)
- All free-response questions that were not completed during the year
- Multiple choice questions from various review books

Post AP Exam

- Cumulative Review Project (complete process from design to data collection to analysis to presentation)
- Student created lessons for Multiple Regression and ANOVA
- Movie Projects: “A Civil Action” and/or “And the Band Played On”