MATHEMATICS COURSE SYLLABUS

Course Title: Statistics-AP (Summer 2012)
Department: Mathematics

Primary Course Materials:
Textbook: Stats Modeling the World Third Edition
Publisher: Pearson Addison Wesley
Authors: Bock, Velleman, De Veaux

Review Books:
   Publisher: Pearson Addison Wesley
   Authors: Carroll, Carver, Peters, Ricks
   Publisher: Random House
   Author: Mulekar
3. Barron’s How to Prepare for the AP Statistics Third Edition
   Publisher: Barron’s Educational Series, Inc.
   Author: Sternstein

College Board on-line exams and scoring guidelines from recent years

TI-84+ Graphing Calculator Applications

Course Description:
This course is designed for students who have sucessfully completed Advanced Algebra H2. The course will provide an in-depth treatment of statistical concepts and applications and prepare students to take the AP Statistics exam. Major topics will include

- Exploring Data – observing patterns and departures from patterns
- Sampling and Experimentation – planning and conducting a study
- Anticipating Patterns – producing models using probability theory and simulation
- Statistical Inference – estimating population parameters and testing hypotheses

Students will be required to keep an organized notebook, read and interpret the textbook, and do independent work. Emphasis will be placed on investigating and solving real world problems that will include open response questions for a variety of applications.

Since this course will encourage the proper use of technology, the purchase of a TI-84+ graphics calculator is strongly recommended.

Essential Questions:
1. How are various graphical displays and distributions of categorical and quantitative data used to analyze and model real world applications in such disciplines as medicine, business, education, political science, psychology, sports, and entertainment?

2. What methods are appropriate for designing and implementing an observational study, survey, or experiment that can be used to make conclusions about the larger population?

3. How are probability, discrete probability distributions, normal distributions, and sampling distributions used to model and understand real world applications?

4. How are confidence intervals and hypothesis tests used to inform real-life decisions?
5. How can technology be used to facilitate and deepen understanding of descriptive and inferential statistics in the context of real world situations?

Course Objectives:

Common Goals:

Thinking and Communicating
1) ☑ Read information critically to develop understanding of concepts, topics and issues.
2) ☑ Write clearly, factually, persuasively and creatively in Standard English.
3) ☑ Speak clearly, factually, persuasively and creatively in Standard English.
4) ☑ Use computers and other technologies to obtain, organize and communicate information and to solve problems.
5) ☑ Conduct research to interpret issues or solve complex problems using a variety of data and information sources.

Gain and Apply Knowledge in and across the Disciplines
6) ☑ Gain and Apply Knowledge in:
   a) ☑ Literature and Language
   b) ☑ Mathematics
   c) ☑ Science and Technology
   d) ☑ Social Studies, History and Geography
   e) ☑ Visual and Performing Arts
   f) ☑ Health and Physical Education

Work and Contribute
7) ☑ Demonstrate personal responsibility for planning one’s future academic and career options.
8) ☑ Participate in a school or community service activity.
9) ☑ Develop informed opinions about current economic, environmental, political and social issues affecting Massachusetts, the United States and the world and understand how citizens can participate in the political and legal system to affect improvements in these areas.

Learning Standards from the Massachusetts Curriculum Framework:

A chart is attached identifying which of the standards from the Massachusetts Curriculum Framework will be assessed in this course.

Additional Learning Objectives Beyond the Curriculum Framework:

21st Century Skills:

<table>
<thead>
<tr>
<th>Instructional practices support the achievement of 21st C. Learning Expectations by: (check those that apply to the Unit)</th>
<th>☑ personalizing instruction</th>
<th>☑ engaging students in cross disciplinary learning</th>
<th>☑ engaging students as active and self directed learners</th>
<th>☑ emphasizing inquiry, problem solving and higher order thinking</th>
<th>☑ applying knowledge and skills in authentic tasks</th>
<th>☑ engaging students in self assessment and reflection</th>
<th>☑ integrating technology</th>
</tr>
</thead>
</table>

10/4/2012 - 2 -
Content Outline:

1. Exploring and Understanding Data  
   - Introduction  
   - Data – the six W’s, categorical and quantitative variables  
   - Displaying and Describing Categorical Data – frequency and relative frequency tables, bar and pie charts, contingency tables, conditional distributions, Simpson’s Paradox  
   - Displaying and Summarizing Quantitative Data – histograms, stem-and-leaf displays, dot plots, measures of center (mean, median, mode), distribution shapes (uniform, symmetric, skewed), measures of spread (range, IQR, standard deviation), outliers  
   - Understanding and Comparing Distributions – boxplots, timeplots, introduction to data re-expression  
   - The Normal and Standard Normal Models – z scores, effects of adding/subtracting/multiplying/dividing all data values by a constant, The Empirical Rule, finding normal percentiles, converting percentiles to z-scores, converting z-scores to raw scores, Normal probability plots  

Activites to Support Instruction: Class survey, Smoking and Education, Race and the Death Penalty, Dollars for Students, Mooseburgers vs. McTofu, Data Desk Lab, Auto Safety, SUV Insurance, Normal Models

2. Exploring Relationships Between Variables  
   - Scatterplots, Association, and Correlation – response and predictor variables, outliers, correlation coefficient, correlation tables  
   - Linear Regression – least squares line, predicted values, residuals, the slope and the y-intercept, residual standard deviation, the squared correlation, regression assumptions and conditions  
   - Regression Wisdom – sifting residuals for groups, extrapolation, leverage, influential points, lurking variables  
   - Re-Expressing Data – goals of re-expression, the Ladder of Powers, logarithmic re-expressions  

Activites to Support Instruction: Correlation, Regression, Prediction Worksheet; Distance and Ticket Price; Fuel Economy; Smoking; Classes; The Wandering Point; Olympic Long Jumps; Models Classwork; Alligators

3. Gathering Data  
   - Understanding Randomness – generating random numbers, simulations  
   - Sample Surveys – population versus sample; simple random sample; stratified, cluster, systematic, and convenience sampling; bias  
   - Experiments and Observational Studies – control groups, blinding, the placebo effect, blocking, confounding variables  

Activites to Support Instruction: ESP, Backhoes & Forklifts, Project: Data Collection & Analysis

4. Randomness and Probability  
   - Introduction – sample space, events; empirical, theoretical, and subjective probability; equally likely outcomes; mutually exclusive events and the addition rule; independent events and the multiplication rule  
   - Probability Rules – the general addition and multiplication rules, conditional probability and checking for independence, tree diagrams

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Random Variables – discrete versus continuous random variables, expected value and standard deviation for a discrete probability distribution, effect of changing a random variable by a constant or adding/subtracting random variables
Probability Models – the geometric and binomial models, the normal approximation to the binomial model

Activites to Support Instruction: The Monty Hall Problem, The Law of Large Numbers Coin Demonstration

5. From the Data at Hand to the World at Large 13 days
   • Sampling Distribution Models – the sampling distribution of a proportion or a mean, sampling variability, The Central Limit Theorem
   • Confidence Intervals for Proportions – standard error, margin of error, critical values, minimum sample size
   • Testing Hypotheses about Proportions – the null and alternative hypotheses, P-values, one-proportion z-test, one-sided and two-sided alternatives
   • More About Tests and Intervals - writing hypotheses, significance level, Type I and Type II errors
   • Comparing Two Proportions – the standard deviation of the difference between two proportions, the sampling distribution model for a difference between two independent proportions, two-proportion z-test

Activites to Support Instruction: Simulated Coins, Life After High School?

6. Learning About the World 9 days
   • Inferences about Means – the t-distribution, confidence interval for means, one-sample t-interval for the mean
   • Comparing Means – two-sample t-interval for the difference between means, two-sample t-test for the difference between means, pooled-t methods
   • Paired Samples and Blocks – paired t-test, paired-t confidence interval

Activites to Support Instruction: SAT Performance, SAT Performance (Part II)

7. Inference When Variables Are Related 10 days
   • Comparing Counts – chi-square test for goodness-of-fit, chi-square test for homogeneity, chi-square test for independence
   • Inferences for Regression – residual standard deviation, t-test for the regression slope, confidence interval for the regression slope

Activites to Support Instruction: ’97 AP Stat Scores

8. AP Exam Review 14 days

Activites to Support Instruction: Practice Tests from College Board and Review Books

9. Supplemental Chapters 21 days
   • Analysis of Variance
   • Multiple Regression
   • Combinatorics – Permutations, Combinations, the Binomial Theorem
# Activites to Support Instruction: Final Project

## Major Evaluation Strategies:

<table>
<thead>
<tr>
<th>Name of Assessment</th>
<th>Type of Assessment</th>
<th>Common Goals Assessed</th>
<th>Standards Assessed</th>
<th>Other Objectives Assessed</th>
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<td>Chapter Tests and Quizzes</td>
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## High School Content Standards

### Conceptual Category: Number and Quantity

<table>
<thead>
<tr>
<th>N-Q</th>
<th>Quantities</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Reason quantitatively and use units to solve problems.</td>
</tr>
<tr>
<td></td>
<td>1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *</td>
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<tr>
<td></td>
<td>2. Define appropriate quantities for the purpose of descriptive modeling. ★</td>
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<td></td>
<td>3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. ★</td>
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</tbody>
</table>

MA.3.a. Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the tools used to measure. ★

### Conceptual Category: Algebra

<table>
<thead>
<tr>
<th>A-SSE</th>
<th>Seeing Structure in Expressions</th>
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<tbody>
<tr>
<td></td>
<td>Interpret the structure of expressions.</td>
</tr>
<tr>
<td></td>
<td>1. Interpret expressions that represent a quantity in terms of its context. *</td>
</tr>
<tr>
<td></td>
<td>a. Interpret parts of an expression, such as terms, factors, and coefficients.</td>
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<tr>
<td></td>
<td>b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret ( P(1 + r)^n ) as the product of ( P ) and a factor not depending on ( P ).</td>
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### Conceptual Category: Statistics & Probability

<table>
<thead>
<tr>
<th>S-ID</th>
<th>Interpreting Categorical and Quantitative Data</th>
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<tbody>
<tr>
<td></td>
<td>Summarize, represent, and interpret data on a single count or measurement variable.</td>
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<tr>
<td></td>
<td>1. Represent data with plots on the real number line (dot plots, histograms, and box plots). *</td>
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<td></td>
<td>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. *</td>
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<td>3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). *</td>
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<td>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</td>
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* indicates Modeling standard.
(+) indicates standard beyond College and Career Ready.
* indicates Modeling standard.
(+) indicates standard beyond College and Career Ready.
* indicates Modeling standard.
procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Summarize, represent, and interpret data on two categorical and quantitative variables.

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.

6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
   a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
   b. Informally assess the fit of a function by plotting and analyzing residuals.
   c. Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models.

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

9. Distinguish between correlation and causation.

S-IC Making Inferences and Justifying Conclusions

Understand and evaluate random processes underlying statistical experiments.

1. Understand statistics as a process for making inferences to be made about population parameters based on a random sample from that population.

2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. 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?

Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

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.

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

6. Evaluate reports based on data.
Conditional Probability and the Rules of Probability

Understand independence and conditional probability and use them to interpret data.¹

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”). ★

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. ★

3. Understand the conditional probability of A given B as \( P(A \text{ and } B)/P(B) \), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. ★

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. 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. ★

5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. 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. ★

Use the rules of probability to compute probabilities of compound events in a uniform probability model.²

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. ★

7. Apply the Addition Rule, \( P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) \), and interpret the answer in terms of the model. ★

8. (+) Apply the general Multiplication Rule in a uniform probability model, \( P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B) \), and interpret the answer in terms of the model. ★

9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems. ★

Using Probability to Make Decisions

Calculate expected values and use them to solve problems.

1. (+) Define a random variable for a quantity of interest by

¹ Link to data from simulations or experiments.
★ indicates Modeling standard.
(+) indicates standard beyond College and Career Ready.
² Introductory only.
<table>
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<th>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.</th>
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<tbody>
<tr>
<td>2.</td>
<td>(+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.</td>
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<tr>
<td>3.</td>
<td>(+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. <em>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.</em></td>
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<tr>
<td>4.</td>
<td>(+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. <em>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?</em></td>
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**Use probability to evaluate outcomes of decisions.**

| 5. | (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.*  
|    | a. (+) Find the expected payoff for a game of chance. *For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.*  
|    | b. (+) Evaluate and compare strategies on the basis of expected values. *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.*  
| 6. | (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). |
| 7. | (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*  

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*Replacing the hockey goalie with an extra skater.*  
* indicates Modeling standard.  
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