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5 STEPS TO A

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AP Statistics

Duane C. Hinders

2010–2011



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PREFACE

Congratulations, you are now an AP Statistics student. AP Statistics is one of the most interesting and useful subjects you will study in school. Sometimes it has the reputation of being easy compared to calculus. However, it can be deceptively difficult, especially in the second half. It is different and challenging in its own way. Unlike calculus, where you are expected to get precise answers, in statistics you are expected to learn to become comfortable with uncertainty. Instead of saying things like, “The answer is . . .” you will more often find yourself saying things like, “We are confident that . . .” or “We have evidence that . . .” It’s a new and exciting way of thinking.

How do you do well on the AP exam (by well, I mean a 4 or a 5 although most students consider 3 or better to be passing)? By reading this book; by staying on top of the material during your AP Statistics class; by studying when it is time to study. Note that the questions on the AP exam are only partially computational—they also involve thinking about the process you are involved in and communicating your thoughts clearly to the person reading your exam. You can always use a calculator so the test designers make sure the questions involve more than just button pushing.

This book is self-contained in that it covers all of the material required by the course content description published by the College Board. However, it is not designed to substitute for an in-class experience or for your textbook. Use this book as a supplement to your in-class studies, as a reference for a quick refresher on a topic, and as one of your major resource as you prepare for the AP exam.

This edition extends and updates previous editions. It takes into account changes in thinking about AP Statistics since the publication of the first edition in 2004 and includes some topics that, while not actually included in the official AP Statistics syllabus, sometimes appear on the actual exam. New multiple-choice questions have been added to each chapter, and the first part of the Diagnostic Exam has been updated so that it now contains only multiple-choice questions. In addition, about half of the multiple-choice questions on the two practice exams have been replaced to better reflect the types of questions seen on the most recently released exam.

You should begin your preparations by reading through the Introduction and STEP I. However, you shouldn’t attempt the Diagnostic Exam in Chapter 3 until you have been through all of the material in the course. Then you can take the exam to help you determine which topics need more of your attention during the course of your review. Note that the Diagnostic Test simulates the AP exam to a reasonable extent (although the questions are more basic) and the Practice Tests are similar in style and length to the AP exam.

So, how do you get the best possible score on the AP Statistics exam?

- Pick one of the study plans from this book.
- Study the chapters and do the practice problems.
- Take the Diagnostic Test and the Practice Tests.
- Review as necessary based on your performance on the Diagnostic Test and the Practice Tests.
- Get a good night’s sleep before the exam.

Selected Epigrams about Statistics

Statistics are like a bikini. What they reveal is suggestive, but what they conceal is vital.
—Aaron Levenstein

Torture numbers, and they'll confess to anything.
—Gregg Easterbrook

Satan delights equally in statistics and in quoting scripture . . .
—H.G. Wells, *The Undying Fire*

One survey found that ten percent of Americans thought Joan of Arc was Noah's wife . . .
—Rita May Brown

In God we trust. All others must bring data.
—Robert W. Hayden

The lottery is a tax on people who flunked math.
—Monique Lloyd

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The *Woodrow Wilson National Fellowship Foundation*, for getting me started thinking seriously about statistics.

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The participants who attended the College Board workshops—I learned as much from them as they did from me.

My AP Statistics classes at Gunn High School in Palo Alto, California, for being willing subjects as I learned to teach AP Statistics.

Grace Feedson, for giving me the opportunity to write this book.

My family, for their encouragement and patience at my unavailability as I worked through the writing process (especially Petra, Sophia, and Sammy—the world’s three cutest grandchildren).

ABOUT THE AUTHOR

DUANE HINDERS taught mathematics at the high school level for 37 years, including 12 years as chair of the Mathematics Department at Gunn High School in Palo Alto, California. He taught AP Calculus for more than 25 years and AP Statistics for 5 years before retiring from the public school system. He holds a BA (mathematics) from Pomona College, an MA and an EdD (mathematics education) from Stanford University. He was a reader for the AP Calculus exam for six years and was a table leader for the AP Statistics reading for the first seven years of the exam. He has conducted over 50 one-day workshops and over 15 one-week workshops for teachers of AP Statistics. He was a co-author of an online AP Statistics course and is also the author of the *Annotated Teacher's Edition* for the 3rd edition of *The Practice of Statistics* by Yates, Moore, and Starnes (W.H. Freeman & Co., New York, 2008). He was a *Woodrow Wilson Fellow* in 1984, a *Tandy Technology Scholar* in 1994, and served on the Editorial Panel of *the Mathematics Teacher* for 3 years. He currently lives in Mountain View, California and teaches Statistics at Foothill College in Los Altos Hills, California.

INTRODUCTION: THE FIVE-STEP PROGRAM

The Basics

Sometime, probably last Spring, you signed up for AP Statistics. Now you are looking through a book that promises to help you achieve the highest grade in AP Statistics: a 5. Your in-class experiences are all-important in helping you toward this goal but are often not sufficient by themselves. In statistical terms, we would say that there is strong evidence that specific preparation for the AP exam beyond the classroom results in significantly improved performance on the exam. If that last sentence makes sense to you, you should probably buy this book. If it didn't make sense, you should definitely buy this book.

Introducing the Five-Step Preparation Program

This book is organized as a five-step program to prepare you for success on the exam. These steps are designed to provide you with the skills and strategies vital to the exam and the practice that can lead you to that perfect 5. Each of the five steps will provide you with the opportunity to get closer and closer to that level of success. Here are the five steps.

Step 1: Set Up Your Study Program

In this step you will read an overview of the AP Statistics exam (Chapter 1). Included in this overview are: an outline of the topics included in the course; the percentage of the exam that you can expect to cover each topic; the format of the exam; how grades on the exam are determined; the calculator policy for Statistics; and what you need to bring to the exam. You will also learn about a process to help determine which type of exam preparation you want to commit yourself to (Chapter 2):

1. Month-by-month: September through mid-May
2. The calendar year: January through mid-May
3. Basic training: Six weeks prior to the exam

Step 2: Determine Your Test Readiness

In this step you will take a diagnostic exam in statistics (Chapter 3). This pretest should give you an idea of how prepared you are to take both of the practice tests in Step 5 as you prepare for the real exam. The diagnostic exam covers the material on the AP exam, but the questions are more basic. Solutions to the exams are given as well as suggestions for how to use your results to determine your level of readiness. You should go through the diagnostic exam and the given solutions step-by-step and question-by-question to build your confidence level.

Step 3: Develop Strategies for Success

In this step, you'll learn strategies that will help you do your best on the exam (Chapter 4). These cover general strategies for success as well as more specific tips and strategies for both the multiple-choice and free-response sections of the exam. Many of these are drawn from

my 7 years of experience as a grader for the AP exam; others are the collected wisdom of people involved in the development and grading of the exam.

Step 4: Review the Knowledge You Need to Score High

This step represents the major part, at least in length, of this book. You will review the statistical content you need to know for the exam. Step 4 includes Chapters 5–14 and provides a comprehensive review of statistics as well as sample questions relative to the topics covered in each chapter. If you thoroughly review this material, you will have studied all that is tested on the exam and hence have increased your chances of earning a 5. A combination of good effort all year long in your class and the review provided in these chapters should prepare you to do well.

Step 5: Build Your Test-Taking Confidence

In this step you'll complete your preparation by testing yourself on practice exams. There are two complete sample exams in Step 5 as well as complete solutions to each exam. These exams mirror the AP exam (although they are not reproduced questions from the actual exam) in content and difficulty.

Finally, at the back of this book you'll find additional resources to aid your preparation:

- A summary of formulas related to the AP Statistics exam
- A set of tables needed on the exam
- A brief bibliography
- A short list of Web sites that might be helpful
- A glossary of terms related to the AP Statistics exam.

The Graphics Used in This Book

To emphasize particular skills and strategies, we use several icons throughout this book. An icon in the margin will alert you to pay particular attention to the accompanying text. We use four icons:



This icon indicates a very important concept that you should not pass over.



This icon highlights a strategy that you might want to try.



This icon alerts you to a tip that you might find useful.



This icon indicates a tip that will help you with your calculator.

Boldfaced words indicate terms included in the glossary at the end of this book.

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AP Statistics

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Set Up Your Study Program

CHAPTER 1 What You Need to Know About the AP Statistics Exam

CHAPTER 2 How to Plan Your Time

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What You Need to Know About the AP Statistics Exam

IN THIS CHAPTER

Summary: Learn what topics are tested, how the test is scored, and basic test-taking information.



Key Ideas

- ✦ Most colleges will award credit for a score of 4 or 5. Some will award credit for a 3.
- ✦ Multiple-choice questions account for one-half of your final score.
- ✦ One-quarter of a point is deducted for each wrong answer on multiple-choice questions.
- ✦ Free-response questions account for one-half of your final score.
- ✦ Your composite score out of a possible 100 on the two test sections is converted to a score on the 1-to-5 scale.

Background Information

The AP Statistics exam that you are taking was first offered by the College Board in 1997. In that year, 7,667 students took the Stat exam (the largest first year exam ever). Since then, the number of students taking the test has grown rapidly. By 2008, the number of students taking the Statistics exam had increased to 108,284. Statistics is now one of the 10 largest AP exams. The mean score in 2008 was 2.86.

Some Frequently Asked Questions About the AP Statistics Exam

Why Take the AP Statistics Exam?

Most of you take the AP Statistics exam because you are seeking college credit. The majority of colleges and universities will accept a 4 or 5 as acceptable credit for their noncalculus-based statistics courses. A small number of schools will sometimes accept a 3 on the exam. This means you are one or two courses closer to graduation before you even begin. Even if you do not score high enough to earn college credit, the fact that you elected to enroll in AP courses tells admission committees that you are a high achiever and serious about your education. In 2008, 59.3% of students scored 3 or higher on the AP Statistics exam.

What Is the Format of the Exam?

AP Statistics

SECTION	NUMBER OF QUESTIONS	TIME LIMIT
I.	40	90 Minutes
Multiple-Choice		
II.		
A. Free-Response	5	60–65 Minutes
B. Investigative Task	1	25–30 Minutes

Approved graphing calculators are allowed during all parts of the test. The two sections of the test are completely separate and are administered in separate 90-minute blocks. Please note that you are not expected to be able answer all the questions in order to receive a grade of 5. Specific instructions for each part of the test are given in the diagnostic test and the sample exams at the end of this book.

You will be provided with a set of common statistical formulas and necessary tables. Copies of these materials are in the appendices to this book.

Who Writes the AP Statistics Exam?

Development of each AP exam is a multiyear effort that involves many education and testing professionals and students. At the heart of the effort is the AP Statistics Test Development Committee, a group of college and high school statistics teachers who are typically asked to serve for three years. The committee and other college professors create a large pool of multiple-choice questions. With the help of the testing experts at Educational Testing Service (ETS), these questions are then pretested with college students enrolled in Statistics courses for accuracy, appropriateness, clarity, and assurance that there is only one possible answer. The results of this pretesting allow each question to be categorized by degree of difficulty.

The free-response essay questions that make up Section II go through a similar process of creation, modification, pre-testing, and final refinement so that the questions cover the necessary areas of material and are at an appropriate level of difficulty and clarity. The committee also makes a great effort to construct a free-response exam that will allow for clear and equitable grading by the AP readers.

At the conclusion of each AP reading and scoring of exams, the exam itself and the results are thoroughly evaluated by the committee and by ETS. In this way, the College Board can use the results to make suggestions for course development in high schools and to plan future exams.

What Topics Appear on the Exam?

The College Board, after consulting with teachers of statistics, develops a curriculum that covers material that college professors expect to cover in their first-year classes. Based upon this outline of topics, the exams are written such that those topics are covered in proportion to their importance to the expected statistics understanding of the student. There are four major content themes in AP Statistics: exploratory data analysis (20%–30% of the exam); planning and conducting a study (10%–15% of the exam); probability and random variables (20%–30% of the exam); and statistical inference (30%–40% of the exam). Below is an outline of the curriculum topic areas:

SECTION	TOPIC AREA/ PERCENT OF EXAM	TOPICS
I	Exploring Data (20%–30%)	<ul style="list-style-type: none"> A. Graphical displays of distributions of one-variable data (dotplot, stemplot, histogram, ogive). B. Summarizing distributions of one-variable data (center, spread, position, boxplots, changing units). C. Comparing distributions of one-variable data. D. Exploring two-variable data (scatterplots, linearity, regression, residuals, transformations). E. Exploring categorical data (tables, bar charts, marginal and joint frequencies, conditional relative frequencies).
II	Sampling and Experimentation (10%–15%)	<ul style="list-style-type: none"> A. Methods of data collection (census, survey, experiment, observational study). B. Planning and conducting surveys (populations and samples, randomness, sources of bias, sampling methods—esp. SRS). C. Experiments (treatments and control groups, random assignment, replication, sources of bias, confounding, placebo effect, blinding, randomized design, block design). D. Generalizability of results
III	Anticipating Patterns (Probability and Random Variables) (20%–30%)	<ul style="list-style-type: none"> A. Probability (relative frequency, law of large numbers, addition and multiplication rules, conditional probability, independence, random variables, simulation, mean and standard deviation of a random variable). B. Combining independent random variables (means and standard deviations).

Continued

SECTION	TOPIC AREA/ PERCENT OF EXAM	TOPICS
		C. The normal distribution. D. Sampling distributions (mean, proportion, differences between two means, difference between two proportions, central limit theorem, simulation, t -distribution, chi-square distribution).
IV	Statistical Inference (30%–40%)	A. Estimation (population parameters, margin of error, point estimators, confidence interval for a proportion, confidence interval for the difference between two proportions, confidence interval for a mean, confidence interval for the difference between two means, confidence interval for the slope of a least-squares regression line). B. Tests of significance (logic of hypothesis testing, Type I and Type II errors, power of a test, inference for means and proportions, chi-square test, test for the slope of a least-squares line).

Who Grades My AP Statistics Exam?

Every June a group of statistics teachers (roughly half college professors and half high school teachers of statistics) gather for a week to assign grades to your hard work. Each of these Faculty Consultants spends several hours getting trained on the scoring rubric for each question they grade (an individual reader may read two to three questions during the week). Because each reader becomes an expert on that question, and because each exam book is anonymous, this process provides a very consistent and unbiased scoring of that question. During a typical day of grading, a random sample of each reader's scores is selected and crosschecked by other experienced Table Leaders to ensure that the consistency is maintained throughout the day and the week. Each reader's scores on a given question are also statistically analyzed to make sure that he or she not giving scores that are significantly higher or lower than the mean scores given by other readers of that question. All measures are taken to maintain consistency and fairness for your benefit.

Will My Exam Remain Anonymous?

Absolutely. Even if your high school teacher happens to randomly read your booklet, there is virtually no way he or she will know it is you. To the reader, each student is a number, and to the computer, each student is a bar code.

What About That Permission Box on the Back?

The College Board uses some exams to help train high school teachers so that they can help the next generation of statistics students avoid common mistakes. If you check this box, you simply give permission to use your exam in this way. Even if you give permission, your anonymity is still maintained.

How Is My Multiple-Choice Exam Scored?

The multiple-choice section contains 40 questions and is worth one-half of your final score. Your answer sheet is run through the computer, which adds up your correct responses and subtracts a fraction for each incorrect response. For every incorrect answer that you give, one-quarter of a point is deducted and the total is a raw score. Then this score is multiplied by 1.25 so that the score is a fraction of 50.

How Is My Free-Response Exam Scored?

Your performance on the free-response section is worth one-half of your final score. There are six questions and each question is given a score from 0–4 (4 = complete response, 3 = substantial response, 2 = developing response, 1 = minimal response, and 0 = insufficient response). Unlike, say, calculus, your response does not have to be perfect to earn the top score. These questions are scored holistically—that is, your entire response is considered before a score is assigned.

The raw score on each of questions 1–5 is then multiplied by 1.875 (this forces questions 1–5 to be worth 75% of your free-response score, based on a total of 50) and the raw score on question 6 is multiplied by 3.125 (making question 6 worth 25% of your free-response score). The result is a score based on 50 for the free-response part of the exam.

How Is My Final Grade Determined and What Does It Mean?

The scores on the multiple-choice and free-response sections of the test are then combined to give a single composite score based on 100 points. As can be seen from the descriptions above, this is not really a percentage score, and it's best not to think of it as one.

In the end, when all of the numbers have been crunched, the Chief Faculty Consultant converts the range of composite scores to the 5-point scale of the AP grades.

The table below gives the conversion for 2007 and, as you complete the practice exams, you may use this to give yourself a hypothetical grade. Keep in mind that the conversion changes every year to adjust for the difficulty of the questions. You should receive your grade in early July.

COMPOSITE SCORING RANGE (OUT OF 100)	AP GRADE	INTERPRETATION OF GRADE
60–100	5	Extremely well qualified
45–59	4	Well qualified
32–44	3	Qualified
23–31	2	Possibly qualified
0–22	1	No recommendation

There is no official passing grade on the AP Exam. However, most people think in terms of 3 or better as passing.

How Do I Register and How Much Does It Cost?

If you are enrolled in AP Statistics in your high school, your teacher is going to provide all of these details, but a quick summary wouldn't hurt. After all, you do not have to enroll in the AP course to register for and complete the AP exam. When in doubt, the best source of information is the College Board's Web site: www.collegeboard.com.

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