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About This Guide

Whether you are teaching Statistics for the first time, or just adapting to the new approach we take in this book, we hope this Teacher's Guide will help you optimize your students' experience. Here we explain the reasoning behind our approach to teaching Statistics. We summarize each chapter, highlighting the important concepts and pointing out where they'll show up later in the course. We offer some pedagogical suggestions—do's and don'ts—and include examples and activities you might use in teaching your class. We offer suggested quizzes, tests, and investigative tasks. And we provide references to other resources that you may find helpful.

Each chapter of this Teacher's Guide contains some or all of the following features.

What's It About?

This section summarizes the major topics included in the chapter. More important, we tell the *story* of the chapter. Each chapter introduces new concepts and methods, and each one fits with what students have learned in previous chapters and will learn in subsequent ones. We give you the overview to help you show your students how it all fits together.

Comments

The Comments section explains the statistical and pedagogical reasons for the choices we've made in what to teach, in how to present it, and in what order to discuss it. Some of these choices may differ from those made by other textbooks. We try to point out these differences and explain our approach.

Looking Ahead

The Looking Ahead sections point out ways that many of the ideas we introduce in early chapters foreshadow or pave the way for important features of later chapters. These are often good points to make in class to motivate students and to help them fit all these new concepts together into a coherent whole.

Class Do's

We offer pedagogical advice about approaches that have worked for us, ideas to stress, and other ways to highlight important concepts or take advantage of important features of this text.

The Importance of What You Don't Say

One of the challenges of teaching AP* Stats is that there's so much to say. But too much information at the wrong time can be confusing to the beginning student. Because deciding how much to say and when to say it can be tricky, we offer some suggestions about what *not* to say and what not to say quite *yet*.

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What If…?

You will probably want to expand on the "What If…?" section in the text. Starting in Chapter 2, we provide several questions that will stimulate class discussions, and get students thinking about the important concepts that will lead to deeper understanding of the major topics of the course, such as independence, sampling variability, the Central Limit Theorem, or statistical significance.

Class Examples

It's always good to have another example for class. Students seem to always want one more example. So we provide new examples different from those in the book. These can include actual classroom materials in the form of worksheets or guided explorations.

Resources

We offer a list of resources for background information, data sets, and classroom activities. These may include other books, videos, software, or Web sites.

Assignments

We make general suggestions about pace and timing of your work in the chapter, including the amount of reading and the number of exercises you might assign each night.

Chapter Quiz

We offer four versions of a quiz you might choose to give after completing the chapter.

Investigative Task

Instead of a quiz, you may choose to have students complete a written assignment that asks them to apply the major concepts of the chapter. Along with each classroom-tested task we include a scoring rubric you can use as you grade each student's work and return to the student to provide them with guidance about writing clear, complete, concise statistical analyses. (We prefer these to quizzes, but that's us.)

Unit Test

We offer four versions of a sample exam at the end of each of the text's seven Parts (and occasionally more often). These exams, also classroom-tested, include multiple choice questions, short questions requiring some calculations or written explanations, and longer questions requiring more in-depth analysis. They are not easy. When students take the AP* Exam they will be asked to work on difficult problems asking for clear understanding of important concepts, accurate application of statistical techniques, and proper interpretation of the results – all under pressure of time. Many will not finish, but no one is expected to come close to getting everything right. Do not imagine that we think students should succeed on 90% of these questions to earn an A! After all, that's not the expectation on the AP* Exam either.

Also In This Guide

Suggested time lines appear right after this introduction. The full year timeline is based on Dave Bock's experiences at Ithaca High School, where the school year begins right after Labor Day and classes meet 5 days a week for 44 minutes. The alternating block timeline comes from Greg Timm of Roland Park Country School in Baltimore. That school opens right after Labor Day, and classes meet on alternating days for 70 minutes with an additional 40-minute class each week.

A ***Correlation to the AP* Exam*** is included at the end of this guide.

And a word about the Texas Instruments calculators

You'll find the textbook's TI Tips allow students to learn to use the statistics functions for their TI-83+/84+ family of calculators, freeing you from spending valuable classroom time on button-pushing. We prepared those instructions based on the latest TI operating system at the time the text was published, which we urge you to download and install. Occasionally in this Guide we'll provide additional TI Tips supporting calculators with older operating systems. And if your students use TI-89s or TI-Nspire™ handhelds, they'll find calculator instructions in Appendix B's guide to statistical software. Additionally, this Guide directs you to TI-Nspire activities available on the book's website, www.pearsonhighered.com/bock.

A Few More Words about the Text

The Preface

We know students won't read the preface, but you should. We think this text is different. We hope to entice students to read the book with our easy-to-understand conversational style—and to entertain them with occasional humor. We have created several features that provide consistent themes and helpful resources for doing Statistics. Take advantage of them!

New to the Fifth Edition

- **More extensive, and more integrated, use of simulations.** Previous editions all included simulations, but in the fifth edition we've incorporated even more of them, and they're now integrated more fluidly with the text. There's hardly a chapter that doesn't use simulations to motivate a new topic, or to illustrate a concept, or to assist in analyzing data when traditional methods requiring strong assumptions or cumbersome computations are insufficient.
- **Applets.** Margin pointers alert students to an innovative set of applets allowing them to explore important concepts and develop deeper understanding of key ideas. Among these: What does standard deviation mean? How might outliers affect our analyses? What does a correlation reveal about a relationship? How does linear regression work? How large should a sample be? What does the all-important Central Limit Theorem say? What does "95% confident" mean? How does hypothesis testing work, and what is a P-value? What are power and Type I and II errors, and how are they interrelated? The applets are found on the book's resource site (www.pearsonhighered.com/bock).

- **Updated examples, exercises, and data.** We've updated our innovative *Think/Show/Tell Step-by-Step* examples with new contexts and data. We've added hundreds of new exercises and updated continuing exercises with the most recent data. Whenever possible, we've provided those data on the book's resource site (www.pearsonhighered.com/bock). Most of the examples and exercises are based on recent news stories, research articles, and other real-world sources. We've listed many of those sources so students can explore them further.

Continued Features

- **Chapter 1 (and beyond).** Chapter 1 gets down to business immediately, looking at data. And throughout the book chapters lead with new up-to-the-minute motivating examples and follow through with analyses of the data, and real-world examples provide a basis for sample problems and exercises.
- **Think, Show, Tell.** The worked examples repeat the mantra of Think, Show, and Tell in every chapter. They emphasize the importance of thinking about a Statistics question (What do we know? What do we hope to learn? Are the assumptions and conditions satisfied?) and reporting our findings (the Tell step). The Show step contains the mechanics of calculating results and conveys our belief that it is only one part of the process.
- **Step-by-Step** examples guide students through the process of analyzing a problem by showing the general explanation on the left and the worked-out solution on the right. The result: better understanding of the concept, not just number crunching.
- **For Example**. In every chapter, an interconnected series of For Example elements present a continuing discussion, recapping a story and moving it forward to illustrate how to apply each new concept or skill.
- **Just Checking**. At key points in each chapter, we ask students to pause and think with questions designed to be a quick check that they understand the material they've just read. Answers are at the end of the exercise sets in each chapter so students can easily check themselves.
- **Updated TI Tips.** Each chapter's easy-to-read "TI Tips" now show students how to use TI-84 Plus CE Statistics functions with the StatWizard operating system. (Help using a TI-Nspire appears in Appendix B, and help with a TI-89 is on the book's resource site (www.pearsonhighered.com/bock.) As we strive for a sound understanding of formulas and methods, we want students to use technology for actual calculations. We do emphasize that calculators are just for "Show"—they cannot Think about what to do or Tell what it all means.
- **Math Boxes**. In many chapters we present the mathematical underpinnings of the statistical methods and concepts. By setting these proofs, derivations, and justifications apart from the narrative, we allow students to continue to follow the logical development of the topic at hand, yet also explore the underlying mathematics for greater depth.
- **TI-Nspire Activities**. Margin pointers identify demonstrations and investigations for TI-Nspire handhelds to enhance each chapter. They're found at the book's resource site (www.pearsonhighered.com/bock).

- **What Can Go Wrong?** Each chapter still contains our innovative What Can Go Wrong? sections that highlight the most common errors people make and the misconceptions they have about Statistics. Our goals are to help students avoid these pitfalls and to arm them with the tools to detect statistical errors and to debunk misuses of statistics, whether intentional or not.
- **What Have We Learned?** Chapter-ending study guides help students review key concepts and terms.
- **Exercises**. We've maintained the pairing of examples so that each odd-numbered exercise (with an answer in the back of the book) is followed by an even-numbered exercise illustrating the same concept. Exercises are ordered by approximate level of complexity.
- **Practice Exams.** At the end of each of the book's seven parts you'll find a practice exam, consisting of both multiple choice and free response questions. These cumulative exams encourage students to keep important concepts and skills in mind throughout the course while helping them synthesize their understanding as they build connections among the various topics.
- **Reality Check**. We regularly remind students that Statistics is about understanding the world with data. Results that make no sense are probably wrong, no matter how carefully we think we did the calculations. Mistakes are often easy to spot with a little thought, so we ask students to stop for a reality check before interpreting their result.
- **Notation Alerts.** Clear communication is essential in Statistics, and proper notation is part of the vocabulary students need to learn. We've found that it helps to call attention to the letters and symbols statisticians use to mean very specific things.
- **On the Computer**. Because real-world data analysis is done on computers, at the end of each chapter we summarize what students can find in most Statistics software, usually with an annotated example.

Review of Part …

The 26 chapters of this book are divided into seven units. The end of each Part includes a one page **Quick Review** of the major concepts followed by a large set of **Exercises**. These exercises are comprehensive, often integrate several concepts, and appear in random order. You should find everything you need to prepare your students for tests. We have also provided an opportunity for your students to prepare *themselves* for tests, with an AP*-style Practice Test following the Review Exercises in each Part. Each Practice Test contains both multiple choice and free response questions, just like the AP* Exam.

Some Important Resources

We offer advice on resources we think you'll find helpful.

TI-Nspire Demonstrations and Activities

Looking for a great way to illustrate an important statistical concept? We've created 29 classroom demonstrations that run on your computer's TI-Nspire software, and included them on the resource on the book's website. These demonstrations were written using Version 1.4 of the TI-Nspire Computer Software – Teacher Edition and will run on the CAS Computer Software. Any updates for these activities will be posted, www.pearsonhighered.com/bock.

Note that the TI-Nspire demos are best shown using the software's Normal, Presentation View. (They are not formatted for the handheld units.) Many use the command Control-R on a PC to re-randomize data. The equivalent command on a Mac is Command-R. To rerun the simulations, you can either delete the contents of some of the columns in the spreadsheet or reload the file.

AP* Review Book

There are several review books on the market, from the usual sources. Our favorite is *Pearson Education AP* Test Prep: Statistics for Stats: Modeling the World, Fifth Edition.*, 2019. On one level, that's no surprise, as it was written to accompany this text. However, before this review book came out we used three of the others in our own classrooms. Speaking now as teachers rather than authors, we found our students were best prepared after using this *AP* Test Prep* workbook. It was written by four veteran AP* teachers who have long served as AP* exam Readers. For many years they have seen the mistakes students make on the test, they know the AP* grading criteria well, and all have personal experience structuring review with their own students. It works. The review book can be bundled with the textbooks or purchased separately. For more information, contact your Pearson sales representative.

StatCrunch®

StatCrunch is a powerful online tool that allows you to:

- Upload data files from your computer or the Web to you own datasets library.
- Analyze data using the extensive list of numerical and graphical procedures StatCrunch offers.
- Report your insights along with attached data sets and analysis results.
- Share your data, results and reports with the rest of the world or keep them private.
- Comment on your items or those being shared by other subscribers.

Explore and learn more at www.statcrunch.com

Classroom Activities

- *Activity-Based Statistics*, 2nd Ed., Schaeffer, Gnanadesekan, Watkins, and Witmer; Key College Press, 2004. Here's a great source of excellent classroom activities. We'll cite many in the chapters ahead, and you'll find others that you will want to use.

- *Workshop Statistics: Discovery with Data and the Graphing Calculator*, 3rd Ed., Rossman, Chance, and Von Oehsen; Key Curriculum Press, 2008. Some adopt this workbook style approach as a primary text. We think it's a valuable source of classroom explorations, and will recommend some in particular. Again you are likely to find others you will want to use or adapt.

- *Fifty Fathoms: Statistics Demonstrations for Deeper Understanding,* Erickson; eepsmedia, 2002. This is a book of computer-based demonstrations of concepts. Teachers can perform these demos for the class – using a projection system – either as an introduction to a topic, as review to clarify some idea that the students found challenging, or simply embedded in a lesson as another way to illustrate a concept. We'll indicate appropriate Demos in many chapters.

Videos

- *Decisions Through Data*; COMAP, 1992. This set of 5 DVDs contains 21 lessons to show in class. Each looks at real-life situations and demonstrates the use of statistics to answer important questions. The units are typically 10-15 minutes in length, allowing you to show the video segment and have time to discuss the statistical concepts and techniques introduced. We'll indicate appropriate units in many chapters. Video Guides, Exercises and Quizzes are available or each unit.

- *The Joy of Stats* – This hour-long video originally aired on BBC in 2010. Host Hans Rosling gives an overview of how statistics can be used to make sense of the world and "is now the sexiest subject around." Available for free on the internet through gap minder, vimeo or youtube. Free worksheets are available on the internet.

- *Why You Need to Study Statistics* – available from the 'This is Statistics' page on the American Statistical Association website or https://www.youtube.com/watch?time_continue=106&v=wV0Ks7aS7YI

- *Teach Statistics Before Calculus* – TED Talk with Arthur Benjamin. https://www.youtube.com/watch?v=BhMKmovNjvc

- *Meaning from Data: Statistics Made Clear*, M. Starbird, The Great Courses, The Teaching Company, 2006. This set of 4 DVDs contains 24 30-minute lectures. Part I contains 12 lectures which explore topics in all 4 AP Statistics topic threads [Exploring Data; Sampling and Experimentation; Anticipating Patterns; Statistical Inference] while Part II contains 12 lectures which apply the concepts to real life scenarios including real estate, sports, insurance and war, economics, social science, biology and elections and juries.

Other Books and Magazines

- *Statistics*, 3rd Ed., Freedman, Pisani, and Purvis; Norton, 2001. This book contains interesting stories and great explanations of statistical concepts; it's a valuable resource to have on your shelf.
- *Statistics: Concepts and Controversies,* 6th Ed., Moore; Freeman, 2006. This collection of great stories about the uses and misuses of statistics is a valuable resource when you are looking for examples to talk about in class.
- *Chance*, American Statistical Association. This magazine, published quarterly, provides articles about statistics as well as excellent examples and data sets to use in class.
- *Significance*, Royal Statistical Society and American Statistical Association. This bimonthly magazine challenges myths, provide a unique perspective on the stories of the day, and use statistics to answer society's most difficult questions. Excellent class examples.
- *Innumeracy,* Paulos; Holt McDougal, 2001. This book introduces most of the concepts covered in this course in an interesting manner with plenty of real life context to intrigue the high school student. This book can be used as a summer assignment to introduce the course; it reads like a marketing brochure for the need for this course.
- *The Lady Tasting Tea: How Statistics Revolutionized Science in the Twentieth Century,* Salsburg, Holt, 2001. This book examines the development of ever-more-powerful statistical methods for determining scientific truth. A series of historical and biographical sketches illuminate the reader and "are unified in a single theme: the conversion of science from observational natural history into rigorously defined statistical models of data collection and analysis." Excellent for class discussions, particularly for Part III on this textbook.
- *The Cartoon Guide to Statistics*, Gonick, HarperCollins, 1993. This book dovetails nicely with the AP* Statistics curriculum and can be used as a fun way to review topics in a comic strip format.
- BARRON'S AP STATISTICS FLASH CARDS, M. Sternstein, ISBN-13: 9780764194108. Excellent review resource (multiple choice and free response) for AP* Statistics students on the go. Each card is the size of a credit card and includes a punched hole; a key ring is included for easy transport of selected cards

AP Central – AP* Teacher Community*

The AP* Statistics website maintained by the College Board at AP* Central (https://apcentral.collegeboard.org and https://apcommunity.collegeboard.org) is a treasure trove of valuable material. Among other things, after registering you'll be able to:

- *get the latest AP* Statistics course description and outline;*
- *download free response questions, solutions, and scoring rubrics for all prior AP* Exams dating back to 1997;*
- *download teaching materials and insightful articles written by other AP* Statistics teachers from the Resource Library;*
- *read reviews of texts, review books, and other teaching materials;*
- *download the full released 2012 AP* Statistics exam;*
- *download several unreleased Practice Exams, after passing your course audit;*
- *search for professional development workshops.*

The AP Statistics Teacher Community Discussion Board*

The Teacher Community Discussion Board is a gathering place for people teaching AP* Statistics, and perhaps the gentlest discussion group on the web. Whether you are looking for teaching ideas or have questions about statistical concepts or theory, the response will be quick, varied, and supportive. You'll hear from teachers all over the country with fantastic ideas to share and gain statistical knowledge generously offered by some of the biggest names in the field. This is a must.

Sign up at: https://apcommunity.collegeboard.org/getting-started

*Launching in 2019: Additional supports for AP**

According to The College Board, "starting in the 2019-20 school year, the following resources will be available to support AP teachers and students:

- AP Question Bank: A library of real AP Exam questions teachers can use to easily create practice tests and assignments for students to take online or on paper.
- Official Student Practice with Khan Academy(r): Instructional videos and practice resources for students that teachers will also be able to assign and use in lesson plans.
- Unit Guides: Planning guides that outline critical content and skills for major topic areas within a course, so teachers can focus and deepen instruction.
- Unit Tests: Formative questions that provide feedback to students on which areas they need to focus.

- Performance Dashboard: Interactive reports that track and measure students' performance on critical concepts and skills.

These flexible resources are being developed in collaboration with educators like you. They are designed to provide meaningful feedback throughout the year to help empower AP teachers and students to succeed together.

What's more, the technology and processes that provide teachers and students with these supports enable us to make important operational changes requested by AP coordinators. These include an online student registration process and personalized student labels, which will eliminate most of the registration "bubbling" students currently do on exam day. Additionally, the exam ordering deadline will be moved up to identify exam takers earlier in the school year, a best practice many schools already do today."

AP Statistics Course Audit Syllabus*

The College Board requires each teacher submit a syllabus for approval before using the AP* designation in course descriptions and transcripts. Since such a document is quite lengthy, we have provided a sample audit syllabus on the text website, www.pearsonhighered.com/bock. Please be sure that your audit syllabus outlines what will happen in your classroom. The College Board Course Audit page for AP Statistics can be found here: https://apcentral.collegeboard.org/courses/ap-statistics/course-audit?course=ap-statistics

Net Links

The Internet is a valuable source of data sets, examples, tables, random numbers, and current events. The good news is that you can probably find almost everything you need or want to know there. The bad news is that the materials will not be consistent or integrated. Be especially wary of introducing students to a variety of online applets, each with its own interface, notation, terminology, and assumptions.

Many of the data sets and examples of the book are sourced from Internet sites. Where appropriate, we provide URL references to the top level, and key search terms to help locate the particular data or discussion. These references may lead to even more up-to-date data than were available when we found them for the book. The data used in the book are available on our website www.pearsonhighered.com/bock.

We provide below some useful jumping off points, with the obvious caveat that many of them may move, change, or disappear altogether between the time we compile this list and you try to use it. With our apologies in advance when a link fails, we hope you find this effort of value. You'll find information on many other useful links on our website www.pearsonhighered.com/bock.

- Materials posted by other teachers

  courses.ncssm.edu/math/Stat_Inst/Notes.htm

  www.bbn-school.org/us/math/ap_stats/

exploringdata.net/intro.htm

- Sources of Data

  dartmouth.edu/~chance/teaching_aids/data.html

  exploringdata.net/intro.htm

  www.census.gov

  www.fedstats.sites.usa.gov

  lib.stat.cmu.edu/DASL/ (data sets indexed by topic)

  ucr.fbi.gov/ucr (crime statistics)

  www.amstat.org/publications/jse

  www.wri.org/resources

- Applets you may find useful for classroom demonstration:

  media.pearsoncmg.com/cmg/pmmg_mml_shared/animations/statistics/west_applets_HTML5/index.html (StatCrunch Applets—no log-in required)

  students.brown.edu/seeing-theory/index.html

  www.amstat.org/asa/education/Useful-Websites-for-Teachers.aspx

  www2.stat.duke.edu/sites/java.html

  davidmlane.com/hyperstat/index.html

  wise.cgu.edu/portfolio/

  www.rossmanchance.com/applets/

  onlinestatbook.com/stat_sim/

  sites.berry.edu/vbissonnette/index/stats-homework/documentation/generating-sampling-distributions/

- Software – calculators, commercial software

  education.ti.com

  www.casioeducation.com/home

  edu.casio.com/software_app/app/index.php

  datadesk.com/products/activstats

  www.minitab.com

  www.jmp.com

  www.spss.com

- Statistics Background

  dartmouth.edu/~chance/teaching_aids/data.html

  courses.ncssm.edu/math/Stat_Inst/Notes.htm

AP* Statistics Full Year TimeLine for *Stats: Modeling the World*

Chapter		Class days
1	Stats Starts Here	2
2	Displaying & Describing Categorical Data	3
3	Displaying and Summarizing Quantitative Data	6
4	Understanding and Comparing Distributions	3
5	The Standard Deviation as Ruler and the Normal Model	5
	Part I – Review and Testing	2
6	Scatterplots, Association, and Correlation	3
7	Linear Regression (including a test)	8
8	Regression Wisdom	4
9	Re-Expressing Data: Get It Straight!	6
	Part II – Review and Testing	2
10	Understanding Randomness	4
11	Sample Surveys	5
12	Experiments and Observational Studies	4
	Part III – Review and Testing	2
	Project (Data Collection and Analysis)	4
13	From Randomness to Probability	3
14	Probability Rules!	4
15	Random Variables	4
16	Probability Models	4
	Part IV – Review and Testing	2
17	Sampling Distribution Models	4
18	Confidence Intervals for Proportions	4
19	Testing Hypotheses about Proportions	2
20	More About Tests	3
21	Comparing Two Proportions	2
	Part V – Review and Testing	2
22	Inferences about Means	3
23	Comparing Means	2
24	Paired Samples and Blocks	2
	Part VI – Group Project, Review, and Testing	4
25	Comparing Counts	6
26	Inferences for Regression	4
	Part VII – Review and Testing	2
	Review for the AP* Exam, with a practice exam	20

AP* Statistics Block TimeLine for *Stats: Modeling the World*

Chapter		Class days
1	Stats Starts Here	1
2	Displaying & Describing Categorical Data	1.5
3	Displaying and Summarizing Quantitative Data	2.5
4	Understanding and Comparing Distributions	2.5
5	The Standard Deviation as Ruler and the Normal Model	2.5
	Part I – Review and Testing	2
6	Scatterplots, Association, and Correlation	1.5
7	Linear Regression (including a test)	5
8	Regression Wisdom	2.5
9	Re-Expressing Data: Get It Straight!	3.5
	Part II – Review and Testing	2
10	Understanding Randomness	2.5
11	Sample Surveys	2.5
12	Experiments and Observational Studies	2.5
	Part III – Review and Testing	2
	Project (Data Collection and Analysis)	2.5
13	From Randomness to Probability	2
14	Probability Rules!	2.5
15	Random Variables	3
16	Probability Models	2
	Part IV – Review and Testing	2
17	Sampling Distribution Models	2
18	Confidence Intervals for Proportions	2.5
19	Testing Hypotheses about Proportions	2
20	More About Tests	2
21	Comparing Two Proportions	1.5
	Part V – Review and Testing	2
22	Inferences about Means	2
23	Comparing Means	1.5
24	Paired Samples and Blocks	2
	Part VI – Group Project, Review, and Testing	3
25	Comparing Counts	2.5
26	Inferences for Regression	2
	Part VII – Review and Testing	2
	Review for the AP* Exam, with a practice exam	6

Part I: Exploring and Understanding Data: Chapters 1 – 6

This Part of the book covers data displays and summaries. Many students will recognize some of the material from middle and high school, so our emphasis is on statistical thinking. Of course, we define terms and provide examples. But we also discuss *why* methods presented are used, and what we hope to learn from them. These are concepts that appear throughout the course. Even more important than what to look for in a histogram or how to summarize the spread of a distribution is the underlying lesson that there *are* reasons for displaying and summarizing data. These reasons inform and motivate the entire course.

Chapter 1
Stats Starts Here

What's it about?

This chapter is about Statistics – what it is and why we care. It also describes the important features of the text. We've given the chapter an unusual title and tried to grab students' attention with a humorous footnote. (Some have e-mailed us to assure us that they *do* read the footnotes.) If we can get them to read three words and the footnote, maybe we can get them to read on.

We then introduce students to *data*. We talk about the importance of context (the W's), about variables, and make the distinction between categorical and quantitative data. We begin to introduce the vocabulary of Statistics. And the TI Tips section shows students how to enter data into the calculator's lists.

Comments

Do expect your students to read the book. Give them specific reading assignments, starting with this first chapter. We've tried to make the book engaging. You can assign a few pages of reading along with some problems each night.

This is the students' first look at the style of the book, and we do lay it on more heavily here than we will when discussing, say, confidence intervals. We want to shake things up. We want them to notice that this is not the same old math or science textbook they've seen before. And we'd like to get them on our side. That's the reason for the humor and self-deprecating remarks.

Every Statistics text starts with a definition of *Statistics.* We do too, but ours is different. And the difference matters. We say that Statistics is *a way of reasoning* and that the goal is *to help us understand the world.* We've found it helpful to reinforce this idea throughout the semester, especially when we get into the methods sections of the course. This book is first and primarily about statistical thinking. Methods, definitions, and skills are all here, but each is presented with the purpose of understanding the world. That's why every example follows the *Think, Show, Tell* pattern, starting with careful reasoning and concluding with a sentence or two telling what we've learned about the world.

It is easy to be drawn into a focus on definitions, on algorithms, and on getting the "right answer." Those are easier to teach and certainly easier to grade. Please resist the temptation. If you can help your students to stay focused on statistical thinking and understanding, this course can change the way they view the world.

Get students involved with data from the start. We don't take a "big picture" approach at this time. There will be plenty of time to build models and draw inferences later. For now, let's just get our hands dirty playing with the data. When students have a good sense of what kinds of things data can say to us, they learn to expect to listen to the data. Throughout the course, we insist that no analysis of data is complete without telling what it means. This is where that understanding starts.

Rather than head directly for the "real purpose" of the course in the inference chapters, we prefer to emphasize the connection between our work with data and what they tell us about the world. No analysis (and no AP* Part II answer) is complete without a connection back to the real-world circumstances. Setting that stage is the underlying motivation for this chapter. We'll spend the next 10 chapters or so looking at and exploring data without making formal inferences.

Looking Ahead

Most of our own students actually do the reading. (Yes, we were surprised at first.) If you can hook students on reading the text, there are big benefits later on. As they read they learn that the book is a valuable resource to help them understand sticky concepts, to help lead them through writing complete and clear solutions, and to help them avoid common mistakes. Many find that they can easily catch up after absences by reading the relevant chapters on their own.

Technology plays an important role in this book. We expect students to use a calculator or computer statistics package for finding the numerical "answers." So we won't spend much time worrying about the calculation details, although we do expect them to understand what's happening. Instead, we focus on understanding and meaning. But the book is "technology neutral." The "computer output" in the book is designed to look like the results of many statistical packages, but exactly match none of them. Students should feel comfortable using output from almost any statistics program or graphing calculator.

You might have the students thumb through the book and read the opening of some chapters. Each one starts with a story and data, and most have additional stories and more data inside. Statistics is about the real world. Among other topics, we'll be discussing how well we can predict hurricane tracks, whether generic batteries perform as well as their brand name competitors, the debate about the safety of a widely used drug, and whether or not people over 30 snore more. We need to get students thinking about the context of data and able to make the distinction between categorical and quantitative data. These are fundamental skills for everything that follows, and they'll be used throughout the course.

We also want students to discover how helpful the TI Tips are. If you can get them to follow these instructions in each chapter you won't need to spend much class time helping with button-pushing, and students will be up to speed for the tests. If you use computer software in addition to calculators, you may want to give students a customized handout to get them started in your school's particular computing environment.

Class Do's

One of our favorite definitions says "Statistics is the art of distilling meaning from data." Data have a story to tell. Our objective is to uncover that story. Collect some data in class, and ask students to look for interesting facts hiding there.

Encourage students to think about the concepts and definitions in this chapter. For example, why do we talk about "a statistic" when we don't discuss "a mathematic" or "a physic"? Statistics is a whole that is made up of many parts, and each of those parts has its own meaning and its own story to tell.

Get the class thinking about what the term "data" means. Students need to understand that data are not just numbers and that they must have a context (the W's). When data are quantitative, they should also have units. There are two ways we treat data: *categorical* and *quantitative*. Don't get distracted by worrying about ratio, interval, and other distinctions. These are problematic and don't matter for the concepts and methods discussed in this book. Emphasize that the distinction between treating data as categorical or quantitative may be more about how *we* display and analyze data than it is about the variable itself. The variable "sex" is data, but just because we might label the males as 1 and the females as 0 doesn't mean that it's quantitative. On the other hand, taking the average of those 0's and 1's does give us the percentage of males. How about *age*? It is often quantitative, but could be categorical if broken down only into *child*, *adult*, and *senior*. Zip code is usually categorical, but if one business had an "average" zip code for their customers of 10000 while another had 90000, we'd know the latter had more customers in the western United States. Emphasize the importance of the context and the W's in summarizing these data.

Students should recognize that every discipline has its own vocabulary, and Statistics is no exception. They'll need to understand and use that vocabulary properly. Unfortunately, many Statistics words have a common everyday usage that's not quite the same. We'll be pointing those out as we go along.

Write vocabulary words on the board as they come up. One of the first should be *variable*. Make the point that it does not mean exactly the same thing as it did in Algebra. There, we call "x" a variable, but often that means that we just don't currently know its value. In Statistics a variable is an attribute or characteristic of an individual or object whose value varies from case to case.

A *statistic* is a numerical summary of data; one of the first you'll likely hear is that the class is x% male. Point out the difference between statistics and data. The book wisecracks that, contrary to an advertised saying, you can't be a statistic, only a datum.

Some students will suggest pie charts or histograms. It's sufficient for now to point out that graphical displays are useful visual summaries of data.

Point out that summaries of data can be verbal, visual, and numerical. All are important. In fact, any complete analysis of data almost always includes all three of these.

After looking at the data from your class survey, some students may say things like, "The males are more conservative." Point out the difference between *univariate* and *bivariate* analysis. Note that bivariate is a lot more interesting.

Hope that someone objects to finding an overall average shoe size or to comparing men's and women's sizes—shoe sizes are inconsistent in terms of units. This adds emphasis to the importance of units and the W's.

The Importance of What You Don't Say

One of the reasons Statistics can be difficult to teach is that we often deal with vague concepts. Students and teachers both like clear definitions; they're easier to teach, learn, and grade. But reasonable people can disagree about whether a histogram is symmetric or skewed, whether a straggling point is really an outlier or just the largest value, or whether the spread really is the same in two groups we want to compare. It is important to allow students their own opinions and insights into data.

This raises the issue of ethical practice in Statistics. We are engaged in an honest search for truth and understanding, and that's what should guide our (and our students') judgments. Emphasize this point now to alert students that this isn't a course about calculating the right answer, but about understanding the world.

Avoid the temptation to lead students in any particular direction or give them hints about how to examine the data you collected. They know some things to do—they'll find percents and averages, maybe draw some simple graphs, and write a few sentences about what they see. Just let it happen. You'll have plenty of chances to suggest, lead, and modify later on.

The motivation of hoping to understand the world is quite sufficient to justify thinking beyond the numbers at hand. This is not the time to introduce technical concepts such as *population* and *sample*. We'd rather not even see these terms yet (and you won't find them this early in the text). We all know that we'll be heading that way eventually, but if we make reasoning about patterns in the data too formal too soon, we'll stifle students' interest and enthusiasm and burden them with a lot of terms they don't have a context for just yet.

There was a time, not long ago, when our students' first question, "Why am I taking this course?" was typically answered by "It's required. Sit down and be quiet." We propose that a better answer is "So you can learn how data can tell us about the world. Stand up and tell us what you see."

We are laying a foundation here. Stretching up to the attic at this point just makes everyone feel unsafe. Many fundamental Statistics terms are left unmentioned in this chapter. You'll find it best to leave it that way. We'll get to them when the students have a safe place to file them along with their other knowledge. So we have an unusually long list of terms we recommend leaving for later in the course. In particular, avoid saying the following:

Hypothesis, Inference. These are certainly important in this course, but we have no background for discussing them honestly now, so they would just be confusing and intimidating.

Nominal, Ordinal, Interval, Ratio. "Nominal" is used by some software packages as a synonym for "categorical" as "continuous" is used for "quantitative." These distinctions arise from studies of measurement scales. But it isn't correct to claim that each variable falls into one of these categories. It is the use to which the data are put that determines what properties the variable must have. Ordinal categorical data may come up, but there are no special techniques for dealing with ordered categories in this course. And any differences between interval- and ratio-scaled data are commonly ignored in statistical analyses. If any of these terms were mentioned now, they'd never come up again anyway.

Random, Probability, Correlation. Everyone has some intuitive sense of these terms, and we'll deal with them formally—but not for a while. Students may want to use these terms, but at this early stage in the course, we don't need them. Without background and careful definition, they are likely to be misused and can simply be frightening.

Class Examples

Take a quick class survey. We suggest asking for things like gender, political leaning (Liberal, Moderate, Conservative), number of siblings, number of states visited, number of countries visited, whether they play varsity sports, GPA, height, handedness (left or right), and shoe size. Be sure to include both categorical and quantitative values. Recall what you were interested in at that age and try some carefully worded questions on those subjects. Try this question after getting everyone's attention: Ask your students to pick a number between 1 and 10 and write it down quickly. (Later you can look to see how "random" these numbers really are.) Start passing the survey sheet (a sample is provided in the resources section of Chapter 1) around at the very beginning of class; it can circulate quickly while you are introducing yourself and talking about the course, expectations, and so on. If you choose to use the number of states visited, passing out slips of paper with a list of states for each student to check off will speed things up, so we provide that, too. You should be able to have the data collected and duplicated by the end of the class, or put up on a course Web site soon. For their first assignment, ask students what story the data tell about their class. You'll find that a lot of important issues will surface during discussions over the next few days.

Hints: Data are rarely as simple as they seem. Suggest the variable above, then pause for some discussion. Does touching down at an airport qualify as "visiting" a state? Does an only child count herself when counting siblings? Should shoe sizes be adjusted because men's and women's size 7 are different sizes? If you write with your left hand , but throw with your right, are you left handed? Give them a chance and they'll find other issues—and they'll be developing a healthy skepticism for data. That's just what we want, so they'll value the tools that help them look at data more carefully.

If you don't specify units for height, you may get some values in centimeters. Alternatively, if you specify inches, you may get a "55" from someone who meant 5'5". Those outliers make for good class discussion.

If you teach several sections, consider collecting data online. There are a number of services that will let you design an online survey and will host it for a modest price, letting students respond online at their convenience and providing you with anonymous and machine-readable responses. One we have used successfully is at www.surveymonkey.com. If you use Fathom software, Fathom Surveys is another nice option.

Some follow-up ideas:

1. Ask students to tell some things they learned about the class from inspecting the data collected in the survey. You can use that discussion to develop several of the important points later in the chapter.
2. Consider 17, 21, 44, and 76. Are those data? Context is critical—they could be test scores, ages in a golf foursome, or uniform numbers of the starting backfield on the football team. In each case, our reaction changes.
3. Run through some other examples of data, asking about the W's, the variables (what are they, what type is each used as, and what are the units), and so on.

   •A Consumer Reports article on energy bars gave the brand name, flavor, price, number of calories, and grams of protein and fat.

   •A report on the Boston Marathon listed each runner's gender, country, age, and time.

Solution:

Consumer Reports
Who: energy bars
What: brand name, flavor, price, calories, protein, fat
When: not specified
Where: not specified
How: not specified. Are data collected from the label? Are independent tests performed?
Why: information for potential consumers
Categorical variables: brand name, flavor
Quantitative variables: price (US$), number of calories (calories), protein (grams), fat(grams)

Boston Marathon
Who: Boston Marathon runners
What: gender, country, age, time
When: not specified
Where: Boston
How: not specified. Presumably, the data were collected from registration information.
Why: race result reporting
Categorical variables: gender, country
Quantitative variables: age (years), time (hours, minutes, seconds)

Resources

Decisions Through Data

- Video Unit 1: What Is Statistics?
- *Why You Need to Study Statistics* – available from the 'This is Statistics' page on the American Statistical Association website or https://www.youtube.com/watch?time_continue=106&v=wV0Ks7aS7YI
- *Teach Statistics Before Calculus* – TED Talk with Arthur Benjamin. https://www.youtube.com/watch?v=BhMKmovNjvc

Web Links

- The Data and Story Library (DASL) is a source of data for student projects and classroom examples. dasl.datadesk.com
- The U.S. Census Bureau, www.census.gov
- See many sources of data in the "About this Guide" section (pages 0-11 and 0-12)

Other

- Read polls, studies, or other reports in newspaper and magazine articles. It's always interesting to see how well (or poorly) they provide information about the W's.

  If you have a computer and projection capabilities in class, you can find daily surveys at Gallup and other polling organizations. Current data are often particularly interesting

to students. But don't use results of voluntary-response online surveys. We'll be making the point that these are fatally flawed—but we can't say that clearly without concepts and terms that we haven't developed yet.

Assignment:

Have students read Chapter 1. Explore the data collected, and make some observations about the class. What could you report to someone who asked you to describe your class? What did you find interesting (or perhaps surprising) about the class?

Be sure that they work through the TI Tips. We want them to learn that the book will show them how to use their calculators. Students should become able to enter and edit data in the lists without help from you.

Assign 5 or 6 of the exercises. After discussion tomorrow, assign another one or two of these exercises each day for a few days (as you are working along into Chapter 2) until everyone seems to have all the issues figured out.

Four chapter quizzes are provided.

States – Count the number you have visited

Alabama	Indiana	Nebraska	Rhode Island
Alaska	Iowa	Nevada	South Carolina
Arizona	Kansas	New Hampshire	South Dakota
Arkansas	Kentucky	New Jersey	Tennessee
California	Louisiana	New Mexico	Texas
Colorado	Maine	New York	Utah
Connecticut	Maryland	North Carolina	Vermont
Delaware	Massachusetts	North Dakota	Virginia
Florida	Michigan	Ohio	Washington
Georgia	Minnesota	Oklahoma	West Virginia
Hawaii	Mississippi	Oregon	Wisconsin
Idaho	Missouri	Pennsylvania	Wyoming
Illinois	Montana		

States – Count the number you have visited

Alabama	Indiana	Nebraska	Rhode Island
Alaska	Iowa	Nevada	South Carolina
Arizona	Kansas	New Hampshire	South Dakota
Arkansas	Kentucky	New Jersey	Tennessee
California	Louisiana	New Mexico	Texas
Colorado	Maine	New York	Utah
Connecticut	Maryland	North Carolina	Vermont
Delaware	Massachusetts	North Dakota	Virginia
Florida	Michigan	Ohio	Washington
Georgia	Minnesota	Oklahoma	West Virginia
Hawaii	Mississippi	Oregon	Wisconsin
Idaho	Missouri	Pennsylvania	Wyoming
Illinois	Montana		

States – Count the number you have visited

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Alaska	Iowa	Nevada	South Carolina
Arizona	Kansas	New Hampshire	South Dakota
Arkansas	Kentucky	New Jersey	Tennessee
California	Louisiana	New Mexico	Texas
Colorado	Maine	New York	Utah
Connecticut	Maryland	North Carolina	Vermont
Delaware	Massachusetts	North Dakota	Virginia
Florida	Michigan	Ohio	Washington
Georgia	Minnesota	Oklahoma	West Virginia
Hawaii	Mississippi	Oregon	Wisconsin
Idaho	Missouri	Pennsylvania	Wyoming
Illinois	Montana		

AP Stats – Class Survey

Gender (M/F)	Politics (L, M, C)	Number of Siblings	States Visited	Shoe Size

AP Statistics Quiz A – Chapter 1* *Name* _____

1. One of the reasons that the Monitoring the Future (MTF) project was started was "to study changes in the beliefs, attitudes, and behavior of young people in the United States." Data are collected from 8th, 10th, and 12th graders each year. To get a representative nationwide sample, surveys are given to a randomly selected group of students. In Spring 2004, students were asked about alcohol, illegal drug, and cigarette use. Describe the W's, if the information is given. If the information is not given, state that it is not specified.

   - Who:
   - What:
   - When:
   - Where:
   - How:
   - Why:

2. Consider the following part of a data set:

Age (years)	Sex	Only child?	Height (inches)	Weight (pounds)	Credit Hours	GPA	Major
21	Female	Yes	67.00	140.0	16	3.60	animal science
20	Female	No	62.00	130.0	18	3.86	biology
28	Female	No	64.00	188.0	21	3.25	psychology
21	Male	No	65.00	140.0	15	2.95	psychology
24	Female	No	67.00	130.0	20	3.00	anthropology
22	Male	Yes	68.00	135.0	15	2.94	journalism

   List the variables in the data set. Indicate whether each variable is treated as categorical or quantitative in this data set. If the variable is quantitative, state the units.

AP Statistics Quiz A – Chapter 1 – Key*

1. One of the reasons that the Monitoring the Future (MTF) project was started was "to study changes in the beliefs, attitudes, and behavior of young people in the United States." Data are collected from 8th, 10th, and 12th graders each year. To get a representative nationwide sample, surveys are given to a randomly selected group of students. In Spring 2004, students were asked about alcohol, illegal drug, and cigarette use. Describe the W's, if the information is given. If the information is not given, state that it is not specified.
   - Who: 8th, 10th, and 12th graders
   - What: alcohol, illegal drug, and cigarette use
   - When: Spring 2004
   - Where: United States
   - How: survey
   - Why: "to study changes in the beliefs, attitudes, and behavior of young people in the United States"

2. Consider the following part of a data set:

Age (years)	Sex	Only child?	Height (inches)	Weight (pounds)	Credit Hours	GPA	Major
21	Female	Yes	67.00	140.0	16	3.60	animal science
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24	Female	No	67.00	130.0	20	3.00	anthropology
22	Male	Yes	68.00	135.0	15	2.94	journalism

   List the variables in the data set. Indicate whether each variable is treated as categorical or quantitative in this data set. If the variable is quantitative, state the units.

   Categorical: sex, only child?, major
   Quantitative: age (years), height (inches), weight (pounds), credit hours, GPA

AP* Statistics Quiz B – Chapter 1 ***Name*** _____

In November 2003 *Discover* published an article on the colonies of ants. They reported some basic information about many species of ants and the results of some discoveries found by myrmecologist Walter Tschinkel of the University of Florida. Information included the scientific name of the ant species, the geographic location, the depth of the nest (in feet), the number of chambers in the nest, and the number of ants in the colony. The article documented how new ant colonies begin, the ant-nest design, and how nests differ in shape, number, size of chambers, and how they are connected, depending on the species. It reported that nest designs include vertical, horizontal, or inclined tunnels for movement and transport of food and ants.

1. Describe the W's, if the information is given:
    - Who:
    - What:
    - When:
    - Where:
    - How:
    - Why:

2. List the variables. Indicate whether each variable is categorical or quantitative. If the variable is quantitative, tell the units.

AP* Statistics Quiz B – Chapter 1 – Key

In November 2003 *Discover* published an article on the colonies of ants. They reported some basic information about many species of ants and the results of some discoveries found by myrmecologist Walter Tschinkel of the University of Florida. Information included the scientific name of the ant species, the geographic location, the depth of the nest (in feet), the number of chambers in the nest, and the number of ants in the colony. The article documented how new ant colonies begin, the ant-nest design, and how nests differ in shape, number, size of chambers, and how they are connected, depending on the species. It reported that nest designs include vertical, horizontal, or inclined tunnels for movement and transport of food and ants.

1. Describe the W's, if the information is given:
    - Who: Colonies of ants. "Many species of ants," but no indication of exactly how many.
    - What: scientific name, geographic location, average nest depth, average number of chambers, average colony size, how new ant colonies begin, the ant-nest design, and how nests differ in architecture.
    - When: November 2003
    - Where: not specified
    - How: The results of some discoveries found by myrmecologist Walter Tschinkel of the University of Florida
    - Why: Information of interest to readers of the magazine

2. List the variables. Indicate whether each variable is categorical or quantitative. If the variable is quantitative, tell the units.

    Categorical: species, geographic location, how new ant colonies begin, and nest design.
    Quantitative: nest depth (feet), number of chambers (units), and colony size (units).