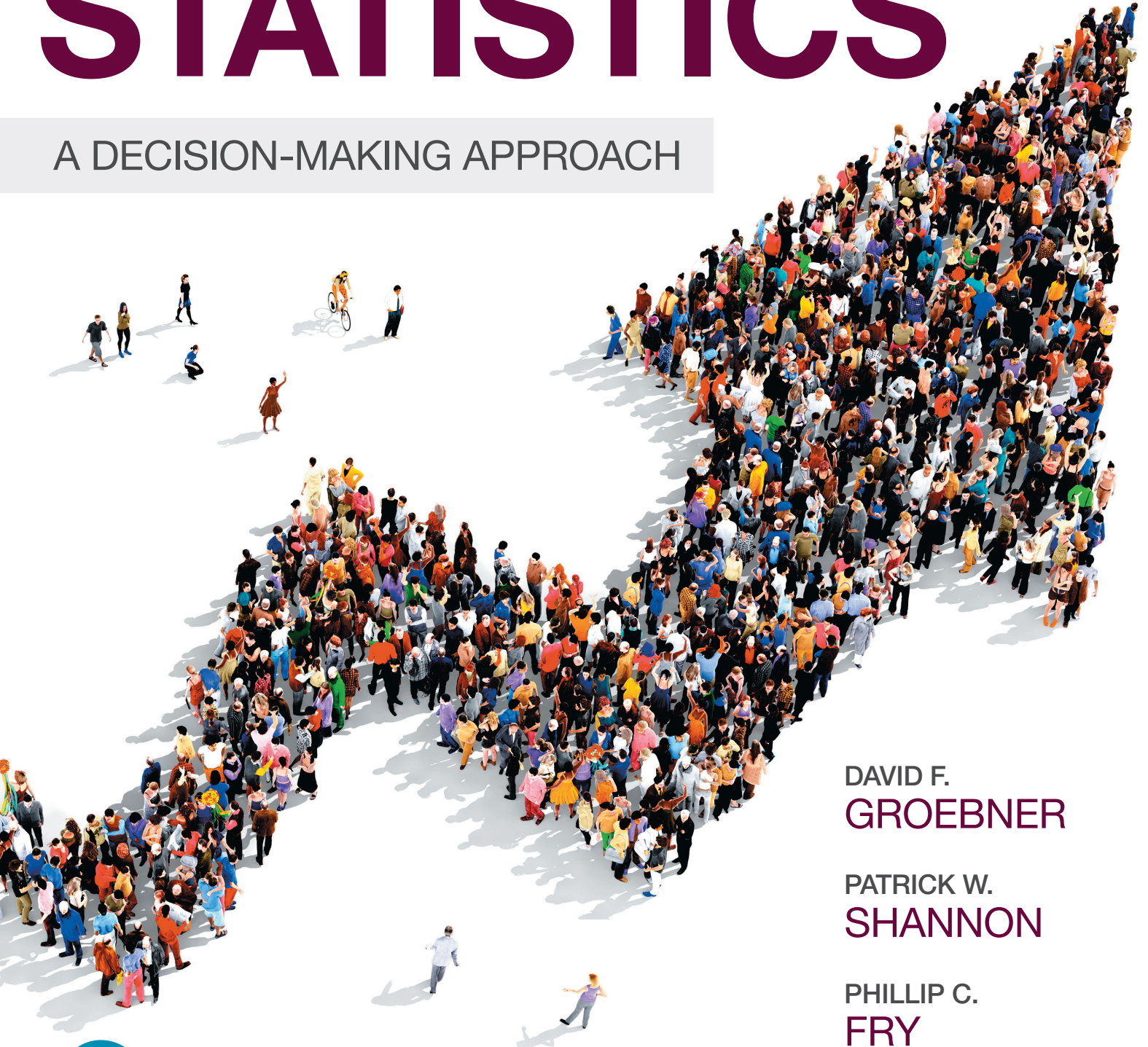


TENTH EDITION

BUSINESS STATISTICS

A DECISION-MAKING APPROACH



DAVID F.
GROEBNER

PATRICK W.
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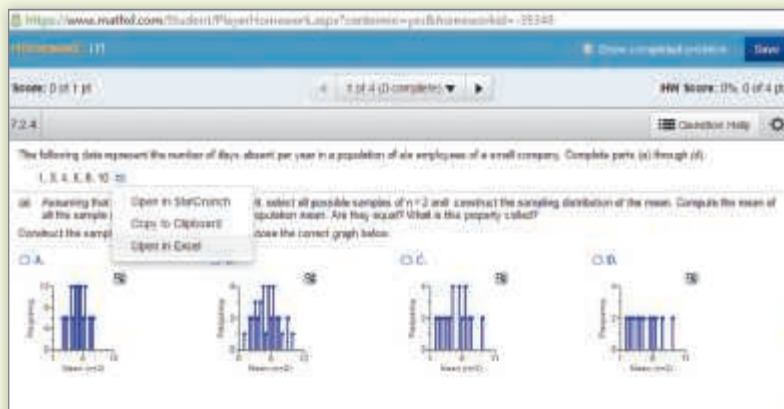
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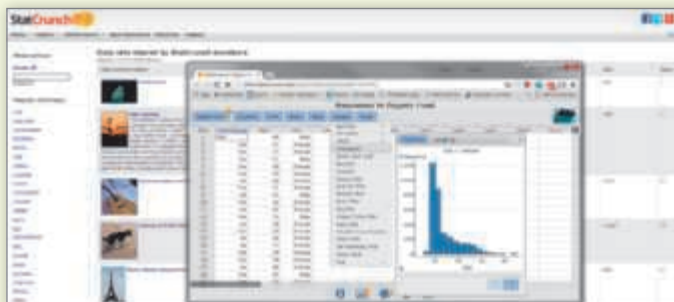


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BUSINESS Statistics

A Decision-Making Approach

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TENTH EDITION

BUSINESS Statistics

A Decision-Making Approach

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To Jane and my family, who survived the process one more time.

DAVID F. GROEBNER

To Kathy, my wife and best friend; to our children, Jackie and Jason.

PATRICK W. SHANNON

To my wonderful family: Susan, Alex, Allie, Candace, and Courtney.

PHILLIP C. FRY

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Preface

In today's workplace, students can have an immediate competitive edge over both new graduates and experienced employees if they know how to apply statistical analysis skills to real-world decision-making problems.

Our intent in writing *Business Statistics: A Decision-Making Approach* is to provide an introductory business statistics text for students who do not necessarily have an extensive mathematics background but who need to understand how statistical tools and techniques are applied in business decision making.

This text differs from its competitors in three key ways:

1. Use of a direct approach with concepts and techniques consistently presented in a systematic and ordered way.
2. Presentation of the content at a level that makes it accessible to students of all levels of mathematical maturity. The text features clear, step-by-step explanations that make learning business statistics straightforward.
3. Engaging examples, drawn from our years of experience as authors, educators, and consultants, to show the relevance of the statistical techniques in realistic business decision situations.

Regardless of how accessible or engaging a textbook is, we recognize that many students do not read the chapters from front to back. Instead, they use the text “backward.” That is, they go to the assigned exercises and try them, and if they get stuck, they turn to the text to look for examples to help them. Thus, this text features clearly marked, step-by-step examples that students can follow. Each detailed example is linked to a section exercise, which students can use to build specific skills needed to work exercises in the section.

Each chapter begins with a clear set of specific chapter outcomes. The examples and practice exercises are designed to reinforce the objectives and lead students toward the desired outcomes. The exercises are ordered from easy to more difficult and are divided into categories: Conceptual, Skill Development, Business Applications, and Computer Software Exercises.

This text places on data and how data are obtained. Many business statistics texts assume that data have already been collected. We have decided to underscore a more modern theme: Data are the starting point. We believe that effective decision making relies on a good understanding of the different types of data and the different data collection options that exist. To highlight our theme, we begin a discussion of data and data collection methods in Chapter 1 before any discussion of data analysis is presented. In Chapters 2 and 3, where the important descriptive statistical techniques are introduced, we tie these statistical techniques to the type and level of data for which they are best suited.

We are keenly aware of how computer software is revolutionizing the field of business statistics. Therefore, this textbook purposefully integrates Microsoft Excel throughout as a data-analysis tool to reinforce taught statistical concepts and to

give students a resource that they can use in both their academic and professional careers.

New to This Edition

- **Textual Examples:** Many new business examples throughout the text provide step-by-step details, enabling students to follow solution techniques easily. These examples are provided in addition to the vast array of business applications to give students a real-world, competitive edge. Featured companies in these new examples include Dove Shampoo and Soap, the Frito-Lay Company, Goodyear Tire Company, Lockheed Martin Corporation, the National Federation of Independent Business, Oakland Raiders NFL Football, Southwest Airlines, and Whole Foods Grocery.
- **More Excel Focus:** This edition features Excel 2016 with Excel 2016 screen captures used extensively throughout the text to illustrate how this highly regarded software is used as an aid to statistical analysis.
- **New Excel Features:** This edition introduces students to new features in Excel 2016, including Statistic Chart, which provides for the quick construction of histograms and box and whisker plots. Also, Excel has a new Data feature—Forecasting Sheet—for time-series forecasting, which is applied throughout this edition's forecasting chapter. Also new to this edition is the inclusion of the XLSTAT Excel add-in that offers many additional statistical tools.
- **New Business Applications:** Numerous new business applications have been included in this edition to provide students current examples showing how the statistical techniques introduced in this text are actually used by real companies. The new applications covering all business areas from accounting to finance to supply chain management, involve companies, products, and decision-making scenarios that are familiar to students. These applications help students understand the relevance of statistics and are motivational.
- **New Topic Coverage:** A new chapter, Introducing Business Analytics, is now a part of the textbook. This chapter introduces students to basic business intelligence and business analytics concepts and tools. Students are shown how they can use Microsoft's Power BI tool to analyze large data sets. The topics covered include loading data files into Power BI, establishing links between large data files, creating new variables and measures, and creating dashboards and reports using the Power BI tool.
- **New Exercises and Data Files:** New exercises have been included throughout the text, and other exercises have been revised and updated. Many new data files have been added to correspond to the new Computer Software Exercises, and other data files have been updated with current data.

- **Excel 2016 Tutorials:** Brand new Excel 2016 tutorials guide students in a step-by-step fashion on how to use Excel to perform the statistical analyses introduced throughout the text.
- **Improved Notation:** The notation associated with population and sample proportions has been revised and improved to be consistent with the general approach taken by most faculty who teach the course.
- **New Test Manual:** A new test manual has been prepared with well-thought-out test questions that correspond directly to this new edition.
- **MyStatLab:** The latest version of this proven student learning tool provides text-specific online homework and assessment opportunities and offers a wide set of course materials, featuring free-response exercises that are algorithmically generated for unlimited practice and mastery. Students can also use a variety of online tools to independently improve their understanding and performance in the course. Instructors can use MyStatLab's homework and test manager to select and assign their own online exercises and can import TestGen tests for added flexibility.

Key Pedagogical Features

- **Business Applications:** One of the strengths of the previous editions of this textbook has been the emphasis on business applications and decision making. This feature is expanded even more in the tenth edition. Many new applications are included, and all applications are highlighted in the text with special icons, making them easier for students to locate as they use the text.
- **Quick Prep Links:** Each chapter begins with a list that provides several ways to get ready for the topics discussed in the chapter.
- **Chapter Outcomes:** At the beginning of each chapter, outcomes, which identify what is to be gained from completing the chapter, are linked to the corresponding main headings. Throughout the text, the chapter outcomes are recalled at the appropriate main headings to remind students of the objectives.
- **Clearly Identified Excel Functions:** Text boxes located in the left-hand margin next to chapter examples provide the Excel function that students can use to complete a specific test or calculation.
- **Step-by-Step Approach:** This edition provides continued and improved emphasis on providing concise, step-by-step details to reinforce chapter material.
 - **How to Do It** lists are provided throughout each chapter to summarize major techniques and reinforce fundamental concepts.
 - **Textual Examples** throughout the text provide step-by-step details, enabling students to follow solution techniques easily. Students can then apply the methodology from each example to solve other problems. These examples are provided in addition to the vast array of business applications to give students a real-world, competitive edge.
- **Real-World Application:** The chapters and cases feature real companies, actual applications, and rich data sets, allowing the authors to concentrate their efforts on addressing how students apply this statistical knowledge to the decision-making process.
 - **Chapter Cases**—Cases provided in nearly every chapter are designed to give students the opportunity to apply statistical tools. Each case challenges students to define a problem, determine the appropriate tool to use, apply it, and then write a summary report.
- **Special Review Sections:** For Chapters 1 to 3 and Chapters 8 to 12, special review sections provide a summary and review of the key issues and statistical techniques. Highly effective flow diagrams help students sort out which statistical technique is appropriate to use in a given problem or exercise. These flow diagrams serve as a mini-decision support system that takes the emphasis off memorization and encourages students to seek a higher level of understanding and learning. Integrative questions and exercises ask students to demonstrate their comprehension of the topics covered in these sections.
- **Problems and Exercises:** This edition includes an extensive revision of exercise sections, featuring more than 250 new problems. The exercise sets are broken down into three categories for ease of use and assignment purposes:
 1. **Skill Development**—These problems help students build and expand upon statistical methods learned in the chapter.
 2. **Business Applications**—These problems involve realistic situations in which students apply decision-making techniques.
 3. **Computer Software Exercises**—In addition to the problems that may be worked out manually, many problems have associated data files and can be solved using Excel or other statistical software.
- **Computer Integration:** The text seamlessly integrates computer applications with textual examples and figures, always focusing on interpreting the output. The goal is for students to be able to know which tools to use, how to apply the tools, and how to analyze their results for making decisions.
 - **Microsoft Excel 2016** integration instructs students in how to use the Excel 2016 user interface for statistical applications.
 - **XLSTAT** is the Pearson Education add-in for Microsoft Excel that facilitates using Excel as a statistical analysis tool. XLSTAT is used to perform analyses that would otherwise be impossible, or too cumbersome, to perform using Excel alone.

Resources for Success

Student Resources

Student Solutions Manual

The Student Solutions Manual contains worked-out solutions to odd-numbered problems in the text. It displays the detailed process that students should use to work through the problems. The manual also provides interpretation of the answers and serves as a valuable learning tool for students. Students can purchase this solutions manual by visiting www.mypearsonstore.com and searching for ISBN: 0-13-450646-4.

MyStatLab™ Online Course (access code required)

MyStatLab from Pearson is the world's leading online resource for teaching and learning statistics, integrating interactive homework, assessment, and media in a flexible, easy-to-use format. MyStatLab is a course management system that helps individual students succeed.

- MyStatLab can be implemented successfully in any environment—lab-based, traditional, fully online, or hybrid—and demonstrates the quantifiable difference that integrated usage has on student retention, subsequent success, and overall achievement.
- MyStatLab's comprehensive gradebook automatically tracks students' results on tests, quizzes, homework, and in the study plan. Instructors can use the gradebook to provide positive feedback or intervene if students have trouble. Gradebook data can be easily exported to a variety of spreadsheet programs, such as Microsoft® Excel®.

MyStatLab provides **engaging experiences** that personalize, stimulate, and measure learning for each student. In addition to the resources below, each course includes a full interactive online version of the accompanying textbook.

- **Personalized Learning:** Not every student learns the same way or at the same rate. Personalized homework and the companion study plan allow your students to work more efficiently, spending time where they really need to.

- **Tutorial Exercises with Multimedia Learning Aids:** The homework and practice exercises in MyStatLab align with the exercises in the textbook, and most regenerate algorithmically to give students unlimited opportunity for practice and mastery. Exercises offer immediate helpful feedback, guided solutions, sample problems, animations, videos, statistical software tutorial videos, and eText clips for extra help at point of use.
- **Learning Catalytics™:** MyStatLab now provides Learning Catalytics—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.
- **Videos** tie statistics to the real world.
 - **StatTalk Videos:** Fun-loving statistician Andrew Vickers takes to the streets of Brooklyn, NY, to demonstrate important statistical concepts through interesting stories and real-life events. This series of 24 fun and engaging videos will help students actually understand statistical concepts. Available with an instructor's user guide and assessment questions.
 - **Business Insight Videos** Ten engaging videos show managers at top companies using statistics in their everyday work. Assignable questions encourage discussion.
- **Additional Question Libraries:** In addition to algorithmically regenerated questions that are aligned with your textbook, MyStatLab courses come with two additional question libraries:
 - **450 exercises** in **Getting Ready for Statistics** cover the developmental math topics students need for the course. These can be assigned as a prerequisite to other assignments, if desired.
 - **Nearly 1,000 exercises** in the **Conceptual Question Library** require students to apply their statistical understanding.
- **StatCrunch™:** MyStatLab integrates the web-based statistical software StatCrunch within the online assessment platform so that students can

Resources for Success

easily analyze data sets from exercises and the text. In addition, MyStatLab includes access to www.statcrunch.com, a vibrant online community where users can access tens of thousands of shared data sets, create and conduct online surveys, perform complex analyses using the powerful statistical software, and generate compelling reports.

- **Statistical Software, Support, and Integration:** We make it easy to copy our data sets, from both the eText and the MyStatLab questions, into software such as StatCrunch, Minitab®, Excel®, and more. Students have access to a variety of support tools—Technology Tutorial Videos, Technology Study Cards, and Technology Manuals for select titles—to learn how to effectively use statistical software.

MyStatLab Accessibility

- MyStatLab is compatible with the JAWS screen reader, and enables multiple choice, fill-in-the-blank, and free-response problem types to be read and interacted with via keyboard controls and math notation input. MyStatLab also works with screen enlargers, including ZoomText, MAGic®, and SuperNova. And all MyStatLab videos accompanying texts with copyright 2009 and later have closed captioning.
- More information on this functionality is available at <http://mystatlab.com/accessibility>.

And, MyStatLab comes from an **experienced partner** with educational expertise and an eye on the future.

- Knowing that you are using a Pearson product means knowing that you are using quality content. That means our eTexts are accurate and our assessment tools work. It means we are committed to making MyStatLab as accessible as possible.
- Whether you are just getting started with MyStatLab or have a question along the way, we're here to help you learn about our technologies and how to incorporate them into your course.

To learn more about how MyStatLab combines proven learning applications with powerful assessment, visit www.mystatlab.com or contact your Pearson representative.

Student Online Resources

Valuable online resources for both students and professors can be downloaded from www.pearsonhighered.com/groebner; these include the following:

- **Online Chapter—Introduction to Decision Analysis:** This chapter discusses the analytic methods used to deal with the wide variety of decision situations a student might encounter.
- **Online Chapter—Introduction to Quality and Statistical Process Control:** This chapter discusses the tools and techniques today's managers use to monitor and assess process quality.
- **Data Files:** The text provides an extensive number of data files for examples, cases, and exercises. These files are also located at MyStatLab.
- **Excel Simulations:** Several interactive simulations illustrate key statistical topics and allow students to do “what if” scenarios. These simulations are also located at MyStatLab.

Instructor Resources

Instructor Resource Center: The Instructor Resource Center contains the electronic files for the complete Instructor's Solutions Manual, the Test Item File, and Lecture PowerPoint presentations (www.pearsonhighered.com/groebner).

- **Register, Redeem, Login:** At www.pearsonhighered.com/irc, instructors can access a variety of print, media, and presentation resources that are available with this text in downloadable, digital format.
- **Need help?** Our dedicated technical support team is ready to assist instructors with questions about the media supplements that accompany this text. Visit <http://247pearsoned.com/> for answers to frequently asked questions and toll-free user-support phone numbers.



Resources for Success

Instructor's Solutions Manual

The Instructor's Solutions Manual, created by the authors and accuracy checked by Paul Lorczak, contains worked-out solutions to all the problems and cases in the text.

Lecture PowerPoint Presentations

A PowerPoint presentation is available for each chapter. The PowerPoint slides provide instructors with individual lecture outlines to accompany the text. The slides include many of the figures and tables from the text. Instructors can use these lecture notes as is or can easily modify the notes to reflect specific presentation needs.

Test Item File

The Test Item File contains a variety of true/false, multiple choice, and short-answer questions for each chapter.

TestGen®

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions.

The software and test bank are available for download from Pearson's Instructor Resource Center.

MathXL® for Statistics

Online Course (access code required)

MathXL® is the homework and assessment engine that runs MyStatLab. (MyStatLab is MathXL plus a learning management system.)

With MathXL for Statistics, instructors can

- Create, edit, and assign online homework and tests using algorithmically generated exercises correlated at the objective level to the textbook.
- Create and assign their own online exercises and import TestGen® tests for added flexibility.
- Maintain records of all student work, tracked in MathXL's online gradebook.

With MathXL for Statistics, students can

- Take chapter tests in MathXL and receive personalized study plans and/or personalized homework assignments based on their test results.
- Use the study plan and/or the homework to link directly to tutorial exercises for the objectives they need to study.
- Access supplemental animations and video clips directly from selected exercises.
- Copy our data sets, both from the eText and the MyStatLab questions, into software like StatCrunch™, Minitab, Excel, and more.

MathXL for Statistics is available to qualified adopters. For more information, visit our website at www.mathxl.com, or contact your Pearson representative.

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—Phillip C. Fry

1 The Where, Why, and How of Data Collection



1.1 What Is Business Statistics? (pg. 2–5)

1.2 Procedures for Collecting Data (pg. 5–13)

OUTCOME 1 Know the key data collection methods.

1.3 Populations, Samples, and Sampling Techniques (pg. 13–19)

OUTCOME 2 Know the difference between a population and a sample.

OUTCOME 3 Understand the similarities and differences between different sampling methods.

1.4 Data Types and Data Measurement Levels (pg. 19–23)

OUTCOME 4 Understand how to categorize data by type and level of measurement.

1.5 A Brief Introduction to Data Mining (pg. 23–24)

OUTCOME 5 Become familiar with the concept of data mining and some of its applications.

Data Mining

The application of statistical techniques and algorithms to the analysis of large data sets.

Business Analytics/Business Intelligence

The application of tools and technologies for gathering, storing, retrieving, and analyzing data that businesses collect and use.

WHY YOU NEED TO KNOW

A transformation is taking place in many organizations involving how managers are using data to help improve their decision making. Because of the recent advances in software and database systems, managers are able to analyze data in more depth than ever before. Disciplines called **business analytics/business intelligence** and **data mining** are among the fastest-growing career areas. Data mining or knowledge discovery is an interdisciplinary field involving primarily computer science and statistics. While many data mining statistical techniques are beyond the scope of this text, most are based on topics covered in this course.

Quick Prep

Locate a recent copy of a business periodical, such as *The Economist*, *Fortune*, or *Bloomberg Businessweek*, and take note of the graphs, charts, and tables that are used in the articles and advertisements.

Recall any recent experiences you have had in which you were asked to complete a written survey or respond to a telephone survey.

Make sure that you have access to Excel software. Open Excel and familiarize yourself with the software.

Chapter 18 provides an overview of business analytics and introduces you to Microsoft analytics software called Microsoft Power BI. People working in this field are referred to as “data scientists.” Doing an Internet search on data mining will yield a large number of sites that describe the field.

In today’s workplace, you can have an immediate competitive edge over other new employees, and even those with more experience, by applying statistical analysis skills to real-world decision making. The purpose of this text is to assist in your learning and to complement your instructor’s efforts in conveying how to apply a variety of important statistical procedures.

Cell phone companies such as Apple, Samsung, and LG maintain databases with information on production, quality, customer satisfaction, and much more. Amazon collects data on customers’ online purchases and uses the data to suggest additional items the customer may be interested in purchasing. Walmart collects and manages massive amounts of data related to the operation of its stores throughout the world. Its highly sophisticated database systems contain sales data, detailed customer data, employee satisfaction data, and much more. Governmental agencies amass extensive data on such things as unemployment, interest rates, incomes, and education. However, access to data is not limited to large companies. The relatively low cost of computer hard drives with massive data storage capacities makes it possible for small firms and even individuals to store vast amounts of data on desktop computers. But without some way to transform the data into useful information, the data these companies have gathered are of little value.

Transforming data into information is where business statistics comes in—the statistical procedures introduced in this text are those that are used to help transform data into information. This text focuses on the practical application of statistics; we do not develop the theory you would find in a mathematical statistics course. Will you need to use math in this course? Yes, but mainly the concepts covered in your college algebra course.

Statistics does have its own terminology. You will need to learn various terms that have special statistical meaning. You will also learn certain dos and don’ts related to statistics. But most importantly, you will learn specific methods to effectively convert data into information. Don’t try to memorize the concepts; rather, go to the next level of learning called *understanding*. Once you understand the underlying concepts, you will be able to *think statistically*.

Because data are the starting point for any statistical analysis, Chapter 1 is devoted to discussing various aspects of data, from how to collect data to the different types of data that you will be analyzing. You need to gain an understanding of the where, why, and how of data and data collection, because the remaining chapters deal with the techniques for transforming data into useful information.

1.1

What Is Business Statistics?

Articles in your local newspaper and on the Internet, news stories on television, and national publications such as *The Wall Street Journal* and *Fortune* discuss stock prices, crime rates, government-agency budgets, and company sales and profit figures. These values are statistics, but they are just a small part of the discipline called **business statistics**, which provides a wide variety of methods to assist in data analysis and decision making.

Business statistics can be segmented into two general categories. The first category involves the procedures and techniques designed to *describe data*, such as charts, graphs, and numerical measures. The second category includes tools and techniques that help decision makers *draw inferences* from a set of data. Inferential procedures include estimation and hypothesis testing. A brief discussion of these techniques follows.

Business Statistics

A collection of procedures and techniques that are used to convert data into meaningful information in a business environment.

Descriptive Statistics

BUSINESS APPLICATION

Describing Data

Independent Textbook Publishing, Inc. Independent Textbook Publishing, Inc. publishes 15 college-level texts in the business and social sciences areas. Figure 1.1 shows an Excel spreadsheet containing data for each of these 15 textbooks. Each column in the spreadsheet corresponds to a different factor for which data were collected. Each row corresponds to a different textbook. Many statistical procedures might help the owners describe these textbook data, including descriptive techniques such as *charts*, *graphs*, and *numerical measures*.

FIGURE 1.1 Excel 2016 Spreadsheet of Independent Textbook Publishing, Inc.

Excel 2016 Instructions:

1. Open File: **Independent Textbook.xlsx**.

	A	B	C	D	E	F	G
1	Book	Units Sold	Pages	Competing Books	Advertising Budget	Age of Author	Market Classification
2	1	15000	176	5	25000	49	Social Sciences
3	2	140000	296	10	83000	57	Business
4	3	75000	483	7	40000	29	Business
5	4	100000	811	14	29000	37	Social Sciences
6	5	26000	302	9	52000	35	Business
7	6	33000	411	15	33000	43	Business
8	7	59000	333	7	19000	51	Social Sciences
9	8	103000	602	4	37000	62	Business
10	9	88000	504	12	51000	33	Social Sciences
11	10	10000	204	3	30000	50	Business
12	11	9000	376	4	19000	26	Business
13	12	77000	600	7	41000	40	Business
14	13	59000	400	3	26000	44	Social Sciences
15	14	183000	597	8	51000	59	Business
16	15	16000	126	1	27000	38	Social Sciences

Charts and Graphs Chapter 2 will discuss many different charts and graphs—such as the one shown in Figure 1.2, called a *histogram*. This graph displays the shape and spread of the distribution of number of copies sold. The *bar chart* shown in Figure 1.3 shows the total number of textbooks sold broken down by the two markets, business and social sciences.

Bar charts and histograms are only two of the techniques that can be used to graphically analyze the data for the textbook publisher. In Chapter 2, you will learn more about these and other techniques.

FIGURE 1.2 Histogram Showing the Copies Sold Distribution

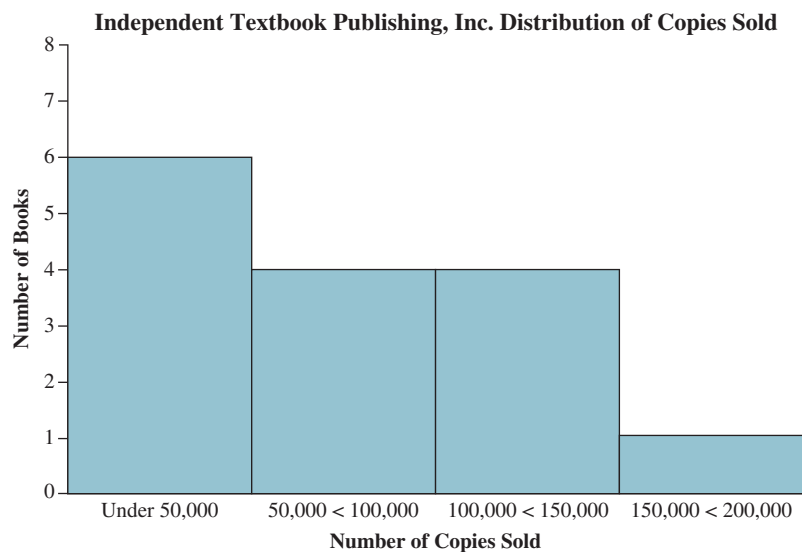
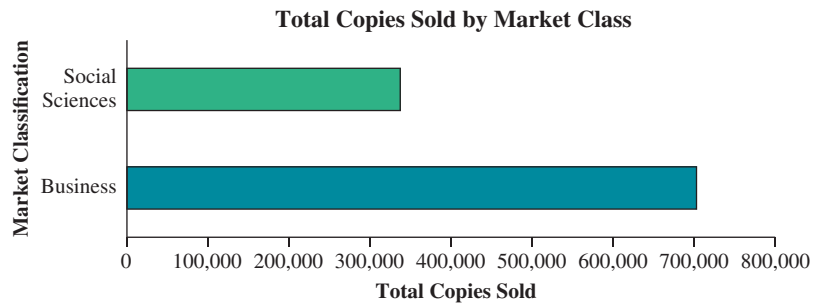


FIGURE 1.3 Bar Chart Showing Copies Sold by Sales Category



In addition to preparing appropriate graphs, you will compute a variety of numerical measures. Chapter 3 introduces the most important measures that are used along with graphs, charts, and tables to describe data.

Inferential Procedures

Advertisers pay for television ads based on the audience level, so knowing how many viewers watch a particular program is important; millions of dollars are at stake. Clearly, the networks don't check with everyone in the country to see if they watch a particular program. Instead, they pay a fee to the Nielsen company (www.nielsen.com/), which uses **statistical inference procedures** to *estimate* the number of viewers who watch a particular television program.

There are two primary categories of statistical inference procedures: *estimation* and *hypothesis testing*. These procedures are closely related but serve very different purposes.

Estimation In situations in which we would like to know about all the data in a large data set but it is impractical to work with all the data, decision makers can use techniques to estimate what the larger data set looks like. These techniques arrive at estimates by looking closely at a subset of the larger data set.

For example, energy-boosting drinks such as Red Bull, Rockstar, Monster, and Full Throttle have become very popular among college students and young professionals. But how do the companies that make these products determine whether they will sell enough to warrant the product introduction? A typical approach is to do market research by introducing the product into one or more test markets. People in the targeted age, income, and educational categories (*target market*) are asked to sample the product and indicate the likelihood that they would purchase the product. The percentage of people who say that they will buy forms the basis for an *estimate* of the true percentage of *all* people in the target market who will buy. If that estimate is high enough, the company will introduce the product.

In Chapter 8, we will discuss the estimating techniques that companies use in new product development and many other applications.

Hypothesis Testing Media advertising is full of product claims. For example, we might hear that “Goodyear tires will last at least 60,000 miles” or that “more doctors recommend Bayer Aspirin than any other brand.” Other claims might include statements like “General Electric light bulbs last longer than any other brand” or “customers prefer McDonald's over Burger King.” Are these just idle boasts, or are they based on actual data? Probably some of both! However, consumer research organizations such as Consumers Union, publisher of *Consumer Reports*, regularly test these types of claims. For example, in the hamburger case, *Consumer Reports* might select a sample of customers who would be asked to blind taste test Burger King's and McDonald's hamburgers, under the hypothesis that there is no difference in customer preferences between the two restaurants. If the sample data show a substantial difference in preferences, then the hypothesis of no difference would be rejected. If only a slight difference in preferences was detected, then *Consumer Reports* could not reject the hypothesis. Chapters 9 and 10 introduce basic hypothesis-testing techniques that are used to test claims about products and services using information taken from samples.

Statistical Inference Procedures
Procedures that allow a decision maker to reach a conclusion about a set of data based on a subset of that data.

1.1 EXERCISES

Skill Development

- 1-1.** For the following situation, indicate whether the statistical application is primarily descriptive or inferential.

“The manager of Anna’s Fabric Shop has collected data for 10 years on the quantity of each type of dress fabric that has been sold at the store. She is interested in making a presentation that will illustrate these data effectively.”

- 1-2.** Consider the following graph that appeared in a company annual report. What type of graph is this? Explain.



- 1-3.** Review Figures 1.2 and 1.3 and discuss any differences you see between the histogram and the bar chart.
- 1-4.** Think of yourself as working for an advertising firm. Provide an example of how hypothesis testing can be used to evaluate a product claim.

Business Applications

- 1-5.** Describe how statistics could be used by a business to determine if the dishwasher parts it produces last longer than a competitor’s brand.

- 1-6.** Locate a business periodical such as *Fortune* or *Forbes* or a business newspaper such as *The Wall Street Journal*. Find three examples of the use of a graph to display data. For each graph,
- Give the name, date, and page number of the periodical in which the graph appeared.
 - Describe the main point made by the graph.
 - Analyze the effectiveness of the graphs.
- 1-7.** The human resources manager of an automotive supply store has collected the following data showing the number of employees in each of five categories by the number of days missed due to illness or injury during the past year.

Missed Days	0–2 days	3–5 days	6–8 days	8–10 days
Employees	159	67	32	10

Construct the appropriate chart for these data. Be sure to use labels and to add a title to your chart.

- 1-8.** Suppose *Fortune* would like to determine the average age and income of its subscribers. How could statistics be of use in determining these values?
- 1-9.** Locate an example from a business periodical or newspaper in which estimation has been used.
- What specifically was estimated?
 - What conclusion was reached using the estimation?
 - Describe how the data were extracted and how they were used to produce the estimation.
 - Keeping in mind the goal of the estimation, discuss whether you believe that the estimation was successful and why.
 - Describe what inferences were drawn as a result of the estimation.
- 1-10.** Locate one of the online job websites and pick several job listings. For each job type, discuss one or more situations in which statistical analyses would be used. Base your answer on research (Internet, business periodicals, personal interviews, etc.). Indicate whether the situations you are describing involve descriptive statistics or inferential statistics or a combination of both.

1.2

Procedures for Collecting Data

We have defined business statistics as a set of procedures that analysts use to transform data into information. Before you learn how to use statistical procedures, it is important that you become familiar with different types of data collection methods.

OUTCOME 1

Primary Data Collection Methods

Many methods and procedures are available for collecting data. The following are considered some of the most useful and frequently used data collection methods:

- Experiments
- Telephone surveys
- Written questionnaires and online surveys
- Direct observation and personal interviews

BUSINESS APPLICATION Experiments

Food Processing A company often must conduct a specific experiment or set of experiments to get the data managers need to make informed decisions. For example, Con-Agra Foods, Inc., McCain Foods from Canada, and the J. R. Simplot Company are the primary suppliers of french fries to McDonald’s in North America. These companies have testing facilities where they conduct experiments on their potato manufacturing processes. McDonald’s has strict standards on the quality of the french fries it buys. One important attribute is the color of the fries after cooking. They should be uniformly “golden brown”—not too light or too dark.

French fries are made from potatoes that are peeled, sliced into strips, blanched, partially cooked, and then freeze-dried—not a simple process. Because potatoes differ in many ways (such as sugar content and moisture), blanching time, cooking temperature, and other factors vary from batch to batch.

Company employees start their **experiments** by grouping the raw potatoes into batches with similar characteristics. They run some of the potatoes through the line with blanch time and temperature settings at specific levels defined by an **experimental design**. After measuring one or more output variables for that run, employees change the settings and run another batch, again measuring the output variables.

Figure 1.4 shows a typical data collection form. The output variable (for example, percentage of fries without dark spots) for each combination of potato category, blanch time, and temperature is recorded in the appropriate cell in the table. Chapter 12 introduces the fundamental concepts related to experimental design and analysis.

Experiment
A process that produces a single outcome whose result cannot be predicted with certainty.

Experimental Design
A plan for performing an experiment in which the variable of interest is defined. One or more factors are identified to be manipulated, changed, or observed so that the impact (or influence) on the variable of interest can be measured or observed.

FIGURE 1.4 Data Layout for the French Fry Experiment

Blanch Time	Blanch Temperature	Potato Category			
		1	2	3	4
10 minutes	100				
	110				
	120				
15 minutes	100				
	110				
	120				
20 minutes	100				
	110				
	120				
25 minutes	100				
	110				
	120				

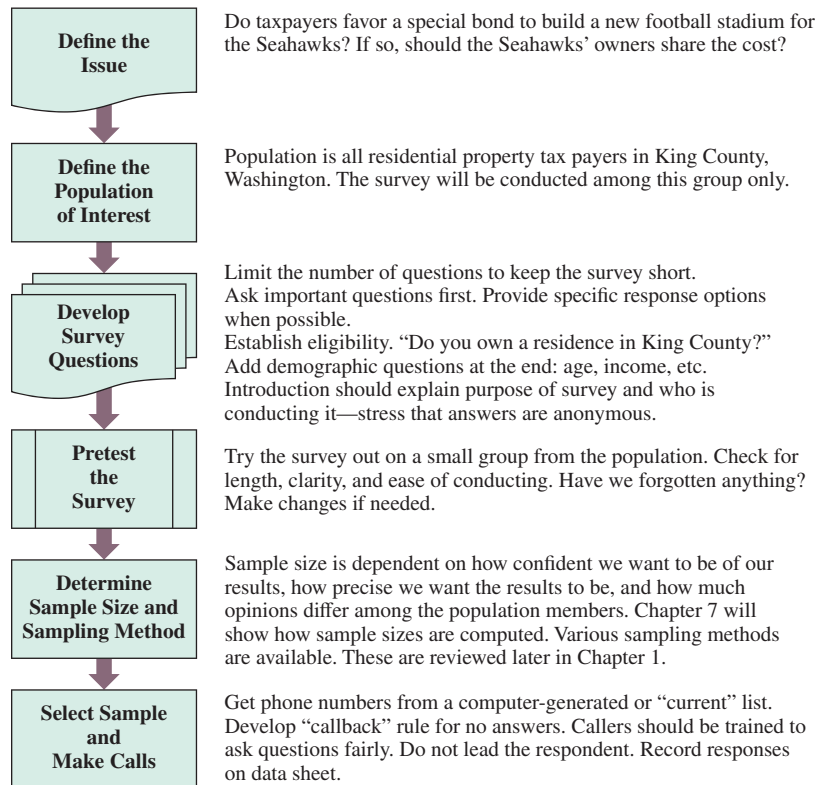
BUSINESS APPLICATION Telephone Surveys

Public Issues Chances are that you have been on the receiving end of a telephone call that begins something like: “Hello. My name is Mary Jane and I represent the XYZ organization. I am conducting a survey on . . .” Political groups use telephone surveys to poll people about candidates and issues. Marketing research companies use phone surveys to learn likes and dislikes of potential customers.

Telephone surveys are a relatively inexpensive and efficient data collection procedure. Of course, some people will refuse to respond to a survey, others are not home when the calls come, and some people do not have home phones—they only have a cell phone—or cannot be reached by phone for one reason or another. Figure 1.5 shows the major steps in conducting a telephone survey. This example survey was run a number of years ago by a Seattle television station to determine public support for using tax dollars to build a new football stadium for the National Football League’s Seattle Seahawks. The survey was aimed at property tax payers only.

Because most people will not stay on the line very long, the phone survey must be short—usually one to three minutes. The questions are generally what are called

FIGURE 1.5 Major Steps for a Telephone Survey



Closed-End Questions

Questions that require the respondent to select from a short list of defined choices.

Demographic Questions

Questions relating to the respondents' characteristics, backgrounds, and attributes.

closed-end questions. For example, a closed-end question might be, "To which political party do you belong? Republican? Democrat? Or other?"

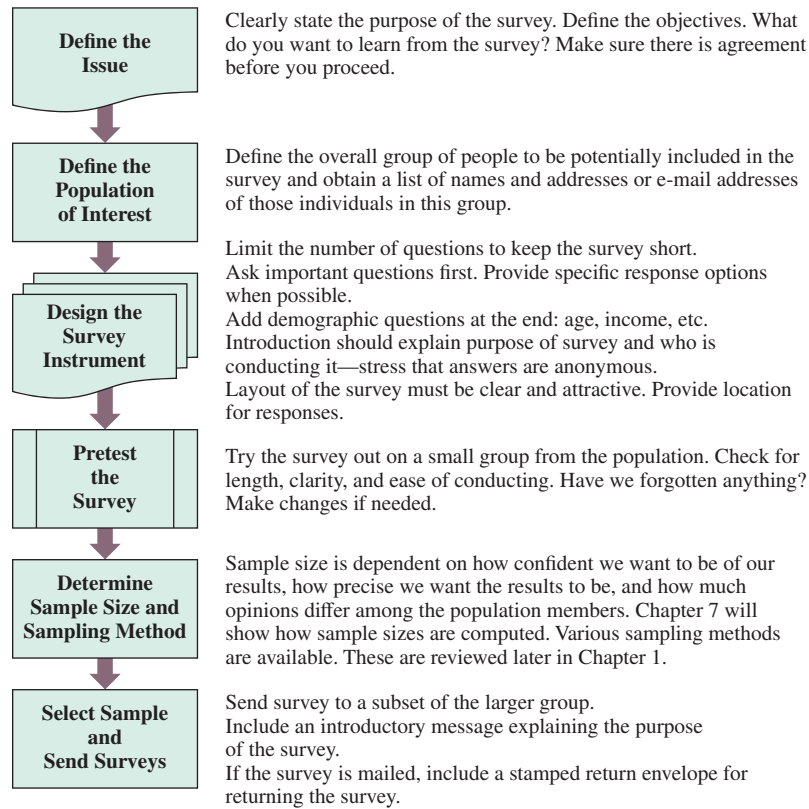
The survey instrument should have a short statement at the beginning explaining the purpose of the survey and reassuring the respondent that his or her responses will remain confidential. The initial section of the survey should contain questions relating to the central issue of the survey. The last part of the survey should contain **demographic questions** (such as gender, income level, education level) that will allow researchers to break down the responses and look deeper into the survey results.

A researcher must also consider the survey budget. For example, if you have \$3,000 to spend on calls and each call costs \$10 to make, you obviously are limited to making 300 calls. However, keep in mind that 300 calls may not result in 300 usable responses.

The phone survey should be conducted in a short time period. Typically, the prime calling time for a voter survey is between 7:00 P.M. and 9:00 P.M. However, some people are not home in the evening and will be excluded from the survey unless there is a plan for conducting callbacks.

Telephone surveys are becoming more problematic as more and more households drop their landlines in favor of cell phones, which makes it difficult to reach prospective survey responders. Additionally, many people refuse to answer if the caller ID is not a number they recognize.

Written Questionnaires and Surveys The most frequently used method to collect opinions and factual data from people is a written questionnaire. In some instances, the questionnaires are mailed to the respondents. In others, they are administered directly to the potential respondents. Written questionnaires are generally the least expensive means of collecting survey data. If they are mailed, the major costs include postage to and from the respondents, questionnaire development and printing costs, and data analysis. Online surveys are being used more frequently for written surveys now that software packages such as Survey Monkey are readily available. This technology eliminates postage costs and makes it

FIGURE 1.6 Written Survey Steps

easier to format the data for statistical analysis. Figure 1.6 shows the major steps in conducting a written survey. Note how written surveys are similar to telephone surveys; however, written surveys can be slightly more involved and, therefore, take more time to complete than those used for a telephone survey. You still must be careful to construct a questionnaire that can be easily completed without requiring too much time.

Open-End Questions

Questions that allow respondents the freedom to respond with any value, words, or statements of their own choosing.

A written survey can contain both closed-end and **open-end questions**. Open-end questions provide the respondent with greater flexibility in answering a question; however, the responses can be difficult to analyze. Note that telephone surveys can use open-end questions, too. However, the caller may have to transcribe a potentially long response, and there is risk that the interviewees' comments may be misinterpreted.

Written surveys also should be formatted to make it easy for the respondent to provide accurate and reliable data. This means that proper space must be provided for the responses, and the directions must be clear about how the survey is to be completed. A written survey needs to be pleasing to the eye. How it looks will affect the response rate, so it must look professional.

You also must decide whether to manually enter or scan the data gathered from your written survey. The approach you take will affect the survey design. If you are administering a large number of surveys, scanning is preferred. It cuts down on data entry errors and speeds up the data gathering process. However, you may be limited in the form of responses that are possible if you use scanning.

If the survey is administered directly to the desired respondents, you can expect a high response rate. For example, you probably have been on the receiving end of a written survey many times in your college career, when you were asked to fill out a course evaluation form right in the classroom. In this case, most students will complete the form. On the other hand, if a survey is administered through the mail or online, you can expect a low response rate—typically 5% to 10% for mailed surveys. Although there are mixed findings about online survey response rates, some authors suggest that online response rates tend to be lower than rates for mailed surveys. (See A. Bryman, *Social Research Methods*, Fifth Edition, Oxford University Press, 2015.) Therefore, if you want 200 responses, you might need to distribute as many as 4,000 questionnaires.

Overall, written surveys can be a low-cost, effective means of collecting data if you can overcome the problems of low response. Be careful to pretest the survey and spend extra time on the format and look of the survey instrument.

Developing a good written questionnaire or telephone survey instrument is a major challenge. Among the potential problems are the following:

- Leading questions

Example: “Do you agree with most other reasonably minded people that the city should spend more money on neighborhood parks?”

Issue: In this case, the phrase “Do you agree” may suggest that you should agree.

Also, since the question suggests that “most reasonably minded people” already agree, the respondent might be compelled to agree so that he or she can also be considered “reasonably minded.”

Improvement: “In your opinion, should the city increase spending on neighborhood parks?”

Example: “To what extent would you support paying a small increase in your property taxes if it would allow poor and disadvantaged children to have food and shelter?”

Issue: The question is ripe with emotional feeling and may imply that if you don’t support additional taxes, you don’t care about poor children.

Improvement: “Should property taxes be increased to provide additional funding for social services?”

- Poorly worded questions

Example: “How much money do you make at your current job?”

Issue: The responses are likely to be inconsistent. When answering, does the respondent state the answer as an hourly figure or as a weekly or monthly total? Also, many people refuse to answer questions regarding their income.

Improvement: “Which of the following categories best reflects your weekly income from your current job?

_____ Under \$500 _____ \$500–\$1,000
 _____ Over \$1,000”

Example: “After trying the new product, please provide a rating from 1 to 10 to indicate how you like its taste and freshness.”

Issue: First, is a low number or a high number on the rating scale considered a positive response? Second, the respondent is being asked to rate two factors, taste and freshness, in a single rating. What if the product is fresh but does not taste good?

Improvement: “After trying the new product, please rate its taste on a 1 to 10 scale with 1 being best. Also rate the product’s freshness using the same 1 to 10 scale.

_____ Taste _____ Freshness”

The way a question is worded can influence the responses. Consider an example that occurred in 2008 that resulted from the sub-prime mortgage crisis and bursting of the real estate bubble. The bubble occurred because home prices were driven up due to increased demand by individuals who were lured into buying homes they could not afford. Many financial organizations used low initial interest rates and little or no credit screening to attract customers who later found they could not make the monthly payments. As a result, many buyers defaulted on their loans and the banks were left with abandoned homes and no way of collecting the money they had loaned out. Three surveys were conducted on the same basic issue. The following questions were asked:

“Do you approve or disapprove of the steps the Federal Reserve and Treasury Department have taken to try to deal with the current situation involving the stock market and major financial institutions?” (Dan Balz and Jon Cohen, “Economic fears give Obama clear lead over McCain in poll,” www.washingtonpost.com, Sep. 24, 2008) 44% Approve—42% Disapprove—14% Unsure