

GLOBAL
EDITION



Statistics for Managers

Using Microsoft[®] Excel

SEVENTH EDITION

David M. Levine • David F. Stephan • Kathryn A. Szabat

ALWAYS LEARNING

PEARSON

A ROADMAP FOR SELECTING A STATISTICAL METHOD

Data Analysis Task	For Numerical Variables	For Categorical Variables
Describing a group or several groups	Ordered array, stem-and-leaf display, frequency distribution, relative frequency distribution, percentage distribution, cumulative percentage distribution, histogram, polygon, cumulative percentage polygon (Sections 2.2 2.4) Mean, median, mode, geometric mean, quartiles, range, interquartile range, standard deviation, variance, coefficient of variation, skewness, kurtosis, boxplot, normal probability plot (Sections 3.1, 3.2, 3.3, 6.3) Index numbers (bonus eBook Section 16.8)	Summary table, bar chart, pie chart, Pareto chart (Sections 2.1, 2.3)
Inference about one group	Confidence interval estimate of the mean (Sections 8.1 and 8.2) t test for the mean (Section 9.2) Chi-square test for a variance or standard deviation (bonus eBook Section 12.7)	Confidence interval estimate of the proportion (Section 8.3) Z test for the proportion (Section 9.4)
Comparing two groups	Tests for the difference in the means of two independent populations (Section 10.1) Wilcoxon rank sum test (Section 12.5) Paired t test (Section 10.2) F test for the difference between two variances (Section 10.4)	Z test for the difference between two proportions (Section 10.3) Chi-square test for the difference between two proportions (Section 12.1) McNemar test for two related samples (bonus eBook Section 12.6)
Comparing more than two groups	One-way analysis of variance for comparing several means (Section 11.1) Kruskal-Wallis test (Section 12.6) Two-way analysis of variance (Section 11.2) Randomized block design (bonus eBook Section 11.3)	Chi-square test for differences among more than two proportions (Section 12.2)
Analyzing the relationship between two variables	Scatter plot, time series plot (Section 2.5) Covariance, coefficient of correlation (Section 3.5) Simple linear regression (Chapter 13) t test of correlation (Section 13.7) Time series forecasting (Chapter 16)	Contingency table, side-by-side bar chart, PivotTables (Sections 2.1, 2.3, 2.8) Chi-square test of independence (Section 12.3)
Analyzing the relationship between two or more variables	Multiple regression (Chapters 14 and 15)	Multidimensional contingency tables (Section 2.7) PivotTables and business analytics (Section 2.8) Logistic regression (Section 14.7) Predictive analytics and data mining (Section 15.6)

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Pearson Education Limited

Edinburgh Gate
Harlow
Essex CM20 2JE

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www.pearson.com/uk

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Authorised adaptation from the United States edition, entitled Statistics for Managers: Using Microsoft Excel, 7th Edition, ISBN: 978-0-13-306181-9 by David M. Levine, David F. Stephan and Kathryn A. Szabat, published by Pearson Education, Inc., © 2014.

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ISBN 13: 978-0-273-78711-2
ISBN 10: 0-273-78711-X

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

10 9 8 7 6 5 4 3 2 1
17 16 15 14 13

Typeset in TimesNewRomanPS by PreMediaGlobal, Inc.
Printed and bound by Courier/Kendallville in The United States of America

The publisher's policy is to use paper manufactured from sustainable forests.

*To our spouses and children,
Marilyn, Mary, Sharyn, and Mark,*

*and to our parents,
in loving memory, Lee, Reuben, Ruth, Francis, and William,
in honor, Mary*

About the Authors



The authors of this book: Kathryn Szabat, David Levine, and David Stephan at a Decision Sciences Institute meeting.

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Preface

Over a generation ago, advances in “data processing” led to new business opportunities as first centralized and then desktop computing proliferated. The Information Age was born. Computer science became much more than just an adjunct to a mathematics curriculum, and whole new fields of studies, such as computer information systems, emerged.

More recently, further advances in information technologies have combined with data analysis techniques to create new opportunities in what is more data *science* than data *processing* or *computer science*. The world of business statistics has grown larger, bumping into other disciplines. And, in a reprise of something that occurred a generation ago, new fields of study, this time with names such as informatics, data analytics, and decision science, have emerged.

This time of change makes what is taught in business statistics and how it is taught all the more critical. These new fields of study all share statistics as a foundation for further learning. We are accustomed to thinking about change, as seeking ways to continuously improve the teaching of business statistics have always guided our efforts. We actively participate in Decision Sciences Institute (DSI), American Statistical Association (ASA), and Making Statistics More Effective in Schools and Business (MSMESB) conferences. We use the ASA’s Guidelines for Assessment and Instruction (GAISE) reports and combine them with our experiences teaching business statistics to a diverse student body at several large universities.

What to teach and how to teach it are particularly significant questions to ask during a time of change. As an author team, we bring a unique collection of experiences that we believe helps us find the proper perspective in balancing the old and the new. Our lead author, David M. Levine, was the first educator, along with Mark L. Berenson, to create a business statistics textbook that discussed using statistical software and incorporated “computer output” as illustrations—just the first of many teaching and curricular innovations in his many years of teaching business statistics. Our second author, David F. Stephan, developed courses and teaching methods in computer information systems and digital media during the information revolution, creating, and then teaching in, one of the first personal computer *classrooms* in a large school of business along the way. Early in his career, he introduced spreadsheet applications to a business statistics faculty audience that included David Levine, an introduction that eventually led to the first edition of this textbook. Our newest co-author, Kathryn A. Szabat, has provided statistical advice to various business and non-business communities. Her background in statistics and operations research and her experiences interacting with professionals in practice have guided her, as departmental chair, in developing a new, interdisciplinary academic department, Business Systems and Analytics, in response to the technology- and data-driven changes in business today.

All three of us benefit from our many years teaching undergraduate business subjects and the diversity of interests and efforts of our past co-authors, Mark Berenson and Timothy Krehbiel. We are pleased to offer the innovations and new content that are itemized starting on the next page. As in prior editions, we are guided by these key learning principles:

- Help students see the relevance of statistics to their own careers by providing examples drawn from the functional areas in which they may be specializing.
- Emphasize interpretation of statistical results over mathematical computation.
- Give students ample practice in understanding how to apply statistics to business.
- Familiarize students with how to use statistical software to assist business decision making.
- Provide clear instructions to students for using statistical applications.

Read more about these principles on page 27.

What’s New and Innovative in This Edition?

This seventh edition of *Statistics for Managers Using Microsoft Excel* contains both new and innovative features and content, while refining and extending the use of the DCOVA (**D**efine, **C**ollect, **O**rganize, **V**isualize, and **A**nalyze) framework, first introduced in the sixth edition as an integrated approach for applying statistics to help solve business problems.

Innovations

Let’s Get Started: Big Things to Learn First—In a time of change, you can never know exactly what knowledge and background students bring into an introductory business statistics classroom. Add that to the need to curb the fear factor about learning statistics that so many students begin with, and there’s a lot to cover even before you teach your first statistical concept.

We created “Let’s Get Started: Big Things to Learn First” to meet this challenge. This unit sets the context for explaining what statistics is (not what students may think!) while ensuring that all students share an understanding of the forces that make learning business statistics critically important today. Especially designed for instructors teaching with course management tools, including those teaching hybrid or online courses, “Let’s Get Started” has been developed to be posted online or otherwise distributed before the first class section begins and is available from the download page for this book that is discussed in Appendix Section C.1.

Complete Microsoft Windows and OS X Excel-Based Solutions for Learning Business Statistics—Expanding on the contents of previous editions, this book features revised Excel Guides that address differences in current versions and features a new version of PHStat, the Pearson Education statistics add-in, that is simpler to set up and is compatible with both Microsoft Windows and OS X versions of Microsoft Excel. Using PHStat or the expanded set of Excel Guide workbooks that serve as models and templates for solutions gives students two distinct ways of incorporating Excel in their study of statistics. (See Section EG.2 on page 40 in the Excel Guide for “Let’s Get Started: Big Things to Learn First” for complete details.)

Student Tips—In-margin notes reinforce hard-to-master concepts and provide quick study tips for mastering important details.

Discussion of Business Analytics—“Let’s Get Started: Big Things to Learn First” quickly defines *business analytics* and *big data* and explains how these things are changing the face of statistics. Section 2.38, “PivotTables and Business Analytics,” uses standard Microsoft Excel features to explain and illustrate descriptive analytics techniques. Section 44.37, “Logistic Regression,” and Section 15.36, “Predictive Analytics and Data Mining,” explain and illustrate predictive analytics concepts and techniques.

Digital Cases—In the Digital Cases, learners must examine interactive PDF documents to sift through various claims and information in order to discover the data most relevant to a business case scenario. Learners then determine whether the conclusions and claims are supported by the data. In doing so, learners discover and learn how to identify common misuses of statistical information. Many Digital Cases extend a chapter’s Using Statistics scenario by posing additional questions and raising issues about the scenario.

Digital Cases appear at the end of all chapters and are the successors to the Web Cases found in previous editions. (Instructional tips for using the Digital Cases and solutions to the Digital Cases are included in the Instructor’s Solutions Manual.)

Chapter—Short Takes Online electronic documents that are available for viewing or download supply additional insights or explanations to important statistical concepts or details about the worksheet-based solutions presented in this book.

Revised and Enhanced Content

New Continuing End-of-Chapter Cases—This seventh edition features several new end-of-chapter cases. Managing Ashland MultiComm Services is a new integrated case about a consumer-oriented telecommunications provider that appears throughout the book, replacing the *Springville Herald* case in the previous edition. New and recurring throughout the book is a case that concerns analysis of sales and marketing data for home fitness equipment (CardioGood Fitness), a case that concerns pricing decisions made by a retailer (Sure Value Convenience Stores), and the More Descriptive Choices Follow-Up case, which extends the use of the retirement funds sample first introduced in Chapter 2. Also recurring is the Clear Mountain State Student Surveys case, which uses data collected from surveys of undergraduate and graduate students to practice and reinforce statistical methods learned in various chapters. This case replaces end-of-chapter

questions related to the student survey database in the previous edition. Joining the Mountain States Potato Company regression case of the previous edition are new cases in simple linear regression (Brynne Packaging) and multiple regression (The Craybill Instrumentation Company).

Many New Applied Examples and Problems—Many of the applied examples throughout this book use new problems or revised data. The ends-of-section and ends-of-chapter problem sets contain many new problems that use data from *The Wall Street Journal*, *USA Today*, and other sources.

Checklist for Getting Started to use Microsoft Excel with This Book—Part of the Excel Guide in “Let’s Get Started: Big Things to Learn First,” the checklist and related material explain for students which Excel skills they will need and where they will find information about those skills in the book.

Revised Appendices Keyed to the Getting-Started Microsoft Excel Checklist—The revised Appendix B discusses the Excel skills that readers need to make best use of the *In-Depth Excel* instructions in this book. The all-new Appendix F presents useful Excel knowledge, including a discussion of the new worksheet function names that were introduced in Excel 2010.

Enhanced Online Resources Appendix—Appendix C presents a complete summary of all the online resources for this book that are available for download. This appendix expands and replaces the sixth edition’s Appendix F.

Enhanced Configuring Software Appendix—Primarily designed for readers who maintain their own computer systems, Appendix D helps readers to eliminate the common types of technical problems that could complicate their use of Microsoft Excel as they learn business statistics with this book.

Distinctive Features

We have continued many of the traditions of past editions and have highlighted some of these features below.

Using Statistics Business Scenarios—Each chapter begins with a Using Statistics example that shows how statistics is used in the functional areas of business—accounting, finance, information systems, management, and marketing. Each scenario is used throughout the chapter to provide an applied context for the concepts. The chapter concludes with a Using Statistics, Revisited section that reinforces the statistical methods and applications discussed in each chapter.

Emphasis on Data Analysis and Interpretation of Excel Worksheet Results—We believe that the use of computer software is an integral part of learning statistics. Our focus emphasizes analyzing data by interpreting results while reducing emphasis on doing computations. For example, in the coverage of tables and charts in Chapter 2, the focus is on the interpretation of various charts and on when to use each chart. In our coverage of hypothesis testing in Chapters 9 through 11, and regression and multiple regression in Chapters 12 and 13, extensive computer results have been included so that the p -value approach can be emphasized.

Pedagogical Aids—An active writing style is used, with boxed numbered equations, set-off examples to provide reinforcement for learning concepts, student tips, problems divided into “Learning the Basics” and “Applying the Concepts,” key equations, and key terms.

Answers—Most answers to the even-numbered exercises are included at the end of the book.

Flexibility Using Excel—For almost every statistical method discussed, this book presents more than one way of using Excel. Students can use *In-Depth Excel* instructions to directly work with worksheet solution details *or* they can use either the *PHStat* instructions *or* the *Analysis ToolPak* instructions to automate the creation of those worksheet solutions.

Visual Explorations—The Excel add-in workbook allows students to interactively explore important statistical concepts in descriptive statistics, the normal distribution, sampling distributions, and regression analysis. For example, in descriptive statistics, students observe the effect of changes in the data on the mean, median, quartiles, and standard deviation. With the normal distribution, students see the effect of changes in the mean and standard deviation on the areas under the normal curve. In sampling distributions, students use simulation to explore the effect of sample size on a sampling distribution. In regression analysis, students have the opportunity to fit a line and observe how changes in the slope and intercept affect the goodness of fit.

Chapter-by-Chapter Changes Made for This Edition

Besides the new and innovative content described in “What’s New and Innovative in This Edition?” the seventh edition of *Statistics for Managers Using Microsoft Excel* contains the following specific changes to each chapter. Highlights of the changes to the individual chapters are as follows.

Let’s Get Started: Big Things to Learn First—This all-new chapter includes new material on business analytics and introduces the DCOVA framework and a basic vocabulary of statistics, both of which were introduced in Chapter 1 of the sixth edition.

Chapter 1—Measurement scales have been relocated to this chapter from Section 2.1. Collecting data, sampling methods, and types of survey errors have been relocated from Sections 7.1 and 7.2. There is a new subsection on data cleaning. The CardioGood Fitness and Clear Mountain State Surveys cases are included.

Chapter 2—Section 2.1, “Data Collection,” has been moved to Chapter 1. The chapter uses a new data set that contains a sample of 318 mutual funds. There is a new section on PivotTables and business analytics that presents Excel slicers. The CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included.

Chapter 3—For many examples, this chapter uses the new mutual funds data set that is introduced in Chapter 2. There is increased coverage of skewness and kurtosis. There is a new example on computing descriptive measures from a population using “Dogs of the Dow.” The CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included.

Chapter 4—The chapter example has been updated. There are new problems throughout the chapter. The CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included.

Chapter 5—There is an additional example on applying probability distributions in finance, and there are many new problems throughout the chapter.

Chapter 6—This chapter has an updated Using Statistics scenario and some new problems. The CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included.

Chapter 7—Sections 7.1 and 7.2 have been moved to Chapter 1.

Chapter 8—This chapter includes an updated Using Statistics scenario, additional problems on sigma known in Sections 8.1, and new examples and exercises throughout the chapter. The Sure Value Convenience Stores, CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included. The section “Applications of Confidence Interval Estimation in Auditing” has been moved online.

Chapter 9—This chapter includes additional coverage of the pitfalls of hypothesis testing. The Sure Value Convenience Stores case is included.

Chapter 10—This chapter has an updated Using Statistics scenario, increased coverage of the test for the difference between two means assuming unequal variances, and a new example on the paired t -test on textbook prices. The Sure Value Convenience Stores, CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases are included.

Chapter 11—This chapter includes the Sure Value Convenience Stores, CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases. It now includes an online section on fixed effects, random effects, and mixed effects models.

Chapter 12—The chapter includes many new problems. This chapter includes the Sure Value Convenience Stores, CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases. The McNemar test is now an online section.

Chapter 13—The Using Statistics scenario has been updated and changed, with new data used throughout the chapter. This chapter includes the Sure Value Convenience Stores, CardioGood Fitness, More Descriptive Choices Follow-up, and Clear Mountain State Surveys cases.

Chapter 14—This chapter now includes a section on logistic regression.

Chapter 15—This chapter now includes a section on predictive analytics and data mining. This chapter includes the Sure Value Convenience Stores, Craybill Instrumentation, and More Descriptive Choices Follow-up cases.

Chapter 16—This chapter includes new data involving movie attendance in Section 16.3 and updated data for The Coca-Cola Company in Sections 16.4 through 16.6 and Wal-Mart Stores, Inc., in Section 16.7. In addition, most of the problems are new or updated.

Chapter 17—This chapter now includes some new problems.

About Our Educational Philosophy

In *Our Starting Point* at the beginning of this preface, we stated that we are guided by these key learning principles:

- Help students see the relevance of statistics to their own careers by providing examples drawn from the functional areas in which they may be specializing.
- Emphasize interpretation of statistical results over mathematical computation.
- Give students ample practice in understanding how to apply statistics to business.
- Familiarize students with how to use statistical software to assist business decision making.
- Provide clear instructions to students for using statistical applications.

The following further explains these principles:

1. **Help students see the relevance of statistics to their own careers by providing examples drawn from the functional areas in which they may be specializing.** Students need a frame of reference when learning statistics, especially when statistics is not their major. That frame of reference for business students should be the functional areas of business, such as accounting, finance, information systems, management, and marketing. Each statistics topic needs to be presented in an applied context related to at least one of these functional areas. The focus in teaching each topic should be on its application in business, the interpretation of results, the evaluation of the assumptions, and the discussion of what should be done if the assumptions are violated.
2. **Emphasize interpretation of statistical results over mathematical computation.** Introductory business statistics courses should recognize the growing need to *interpret* statistical results that computerized processes create. This makes the interpretation of results more important than knowing how to execute the tedious hand calculations required to produce them.
3. **Give students ample practice in understanding how to apply statistics to business.** Both classroom examples and homework exercises should involve actual or realistic data as much as possible. Students should work with data sets, both small and large, and be encouraged to look beyond the statistical analysis of data to the interpretation of results in a managerial context.
4. **Familiarize students with how to use statistical software to assist business decision making.** Introductory business statistics courses should recognize that programs with statistical functions are commonly found on a business decision maker's desktop computer. Integrating statistical software into all aspects of an introductory statistics course allows the course to focus on interpretation of results instead of computations (see point 2).
5. **Provide clear instructions to students for using statistical applications.** Books should explain clearly how to use programs such as Microsoft Excel with the study of statistics, without having those instructions dominate the book or distract from the learning of statistical concepts.

Student Resources

Student Solutions Manual—Written by Professor Pin Tian Ng of Northern Arizona University, this manual provides detailed solutions to virtually all the even-numbered exercises and worked-out solutions to the self-test problems.

Online resources—This book comes with a complete set of online resources that are discussed in detail in Appendix C. These resources include the **Excel Data Workbooks** that contain the data used in chapter examples or named in problems and end-of-chapter cases; the **Excel Guide Workbooks** that contain templates or model solutions for applying Excel to a particular statistical method; the **Digital Cases** PDF files that support the end-of-chapter Digital Cases; the **Visual Explorations Workbooks** that interactively demonstrate various key statistical concepts; and the **PHStat Files** that include the Microsoft Windows and (Mac) OS X Excel add-in workbook that simplifies the use of Microsoft Excel with this book, as explained in Section EG.2.

The online resources also include the **Chapter Short Takes** and **Bonus eBook Sections** that expand and extend the discussion of statistical concepts worksheet-based solutions as well as the full text of two bonus chapters, “Statistical Applications in Quality Management” and “Decision Making.”

MyMathLab Global

MyMathLab Global provides students with direct access to the online resources as well as the following exclusive online features and tools:

- **Interactive tutorial exercises.** A comprehensive set of exercises have been written especially for use with this book that are algorithmically generated for unlimited practice and mastery. Most exercises are free-response exercises and provide guided solutions, sample problems, and learning aids for extra help at point of use.
- **Personalized study plan.** A plan indicates which topics have been mastered and creates direct links to tutorial exercises for topics that have not been mastered. MyMathLab Global manages the study plan, updating its content based on the results of online assessments.
- **Integration with Pearson eTexts.** iPad or Android tablet users can download a free app at www.pearsonhighered.com/etextmobile/ and then sign in using their MyMathLab Global account to access a bookshelf of all their Pearson eTexts.

@RISK trial Palisade Corporation, the maker of the market-leading risk and decision analysis Excel add-ins @RISK and the DecisionTools® Suite, provides special academic versions of its software to students (and faculty). Its flagship product, @RISK, debuted in 1987 and performs risk analysis using Monte Carlo simulation. To download a trial version of @RISK software, visit www.palisade.com/academic/.

Instructor Resources

Instructor’s Resource Center—The Instructor’s Resource Center contains the electronic files for the complete Instructor’s Solutions Manual, the Test Item File, and PowerPoint lecture presentations (www.pearsonglobaleditions.com/levine).

- **Register, Redeem, Login:** At www.pearsonglobaleditions.com/levine, instructors can register to 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.

The following supplements are among the resources available to adopting instructors at the Instructor’s Resource Center.

- **Instructor’s Solutions Manual.** Written by Professor Pin Tian Ng of Northern Arizona University and checked for accuracy by Annie Puciloski, this manual includes solutions for end-of-section and end-of-chapter problems, answers to case questions, where applicable, and teaching tips for each chapter. An electronic version of the *Instructor’s Solutions Manual* is available at the Instructor’s Resource Center.

- **Lecture PowerPoint Presentations.** PowerPoint presentations, created by Professor Patrick Schur of Miami University and accuracy checked by Annie Puciloski, are available for each chapter. The PowerPoint slides provide an instructor 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.** Created by Professor Pin Tian Ng of Northern Arizona University and checked for accuracy by Annie Puciloski, the downloadable Test Item File contains true/false, multiple-choice, fill-in, and problem-solving questions based on the definitions, concepts, and ideas developed in each chapter of the text.
- **TestGen.** Instructors can download TestGen, Pearson Education’s test-generating software. The software is Microsoft Windows compatible and preloaded with all of the Test Item File questions. You can manually or randomly view test questions and drag and drop to create a test. You can add or modify test-bank questions as needed.

MyMathLab Global

MyMathLab Global is a text-specific, easily customizable online course that integrates interactive multimedia instruction with textbook content. MyMathLab Global gives you the tools you need to deliver all or a portion of your course online, whether your students are in a lab setting or working from home. Key features include:

- **Assessment manager.** An easy-to-use assessment manager lets instructors create online homework, quizzes, and tests that are automatically graded and correlated directly to your textbook. Assignments can be created using a mix of questions from the MyMathLab Global exercise bank, instructor-created custom exercises, and/or TestGen test items.
- **Grade book.** Designed specifically for mathematics and statistics, the MyMathLab Global grade book automatically tracks students’ results and gives you control over how to calculate final grades. You can also add offline (paper-and-pencil) grades to the grade book.
- **MyMathLab Global Exercise Builder.** You can use the MyMathLab Global Exercise Builder to create static and algorithmic exercises for your online assignments. A library of sample exercises provides an easy starting point for creating questions, and you can also create questions from scratch.
- **eText-MyMathLab Global for Statistics Full Integration.** Students using appropriate mobile devices can use your eText annotations and highlights for each course, and iPad users can download a free app that allows them access to the Do Homework, Take a Test, and Study Plan pages of their course.
- **“Ask the Publisher” Link in “Ask My Instructor” Email.** You can easily notify the content team of any irregularities with specific questions by using the “Ask the Publisher” functionality in the “Ask My Instructor” emails you receive from students.
- **Tracking Time Spent on Media.** Because the latest version of MyMathLab Global requires students to explicitly click a “Submit” button after viewing the media for their assignments, you will be able to track how long students are spending on each media file.

Acknowledgments

We are extremely grateful to the RAND Corporation and the American Society for Testing and Materials for their kind permission to publish various tables in Appendix E, and to the American Statistical Association for its permission to publish diagrams from the *American Statistician*.

A Note of Thanks

We would like to thank William Borders, Troy University; Ozgun C. Demirag, Pennsylvania State University; Annette Gourgey, Baruch College; Hyokyoung Hong, Baruch College; Min Li, California State University; Robert Loomis, Florida Institute of Technology; Mahmood Shandiz, Oklahoma City University; Joe Sullivan, Mississippi State University; Rene Villano, University of New England; and Rongning Wu, Baruch College, for their comments, which have made this a better book.

We would especially like to thank Chuck Synovec, Mary Kate Murray, Ashlee Bradbury, Donna Battista, Judy Leale, Anne Fahlgren, and Jane Bonnell of the editorial, marketing, and production teams at Pearson Education. We would like to thank our statistical reader and accuracy checker Annie Puciloski for her diligence in checking our work; Kitty Wilson for her copy editing; Martha Ghent for her proofreading; and Tammy Haskins of PreMediaGlobal for her outstanding work in the production of this book.

Finally, we would like to thank our families for their patience, understanding, love, and assistance in making this book a reality. It is to them that we dedicate this book.

Concluding Remarks

Please email us at authors@davidlevinstatistics.com if you have a question or require clarification about something discussed in this book. We also invite you to communicate any suggestions you may have for a future edition of this book. And while we have strived to make this book both pedagogically sound and error-free, we encourage you to contact us if you discover an error. When contacting us electronically, please include “SMUME edition 7” in the subject line of your message.

You can also visit davidlevinstatistics.com, where you will find an email contact form and links to additional information about this book. For technical assistance using Microsoft Excel or any of the add-ins that you can use with this book including PHStat, review Appendices D and G and follow the technical support links discussed in Appendix Section G.1, if necessary.

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Global Edition

Pearson would like to acknowledge and thank the following people for their work on the Global Edition:

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