

STATISTICS

INFORMED DECISIONS USING DATA 5e

Michael Sullivan III



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Michael Sullivan, III

Joliet Junior College

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To My Wife Yolanda
and My Children
Michael, Kevin, and Marissa

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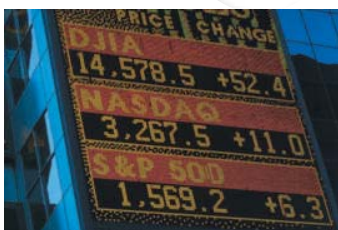
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Preface to the Instructor

Capturing a Powerful and Exciting Discipline in a Textbook

Statistics is a powerful subject, and it is one of my passions. Bringing my passion for the subject together with my desire to create a text that would work for me, my students, and my school led me to write the first edition of this textbook. It continues to motivate me as I reflect on changes in students, in the statistics community, and in the world around us.

When I started writing, I used the manuscript of this text in class. My students provided valuable, insightful feedback, and I made adjustments based on their comments. In many respects, this text was written by students and for students. I also received constructive feedback from a wide range of statistics faculty, which has refined ideas in the book and in my teaching. I continue to receive valuable feedback from both faculty and students, and this text continues to evolve with the goal of providing clear, concise, and readable explanations, while challenging students to think statistically.

In writing this edition, I continue to make a special effort to abide by the Guidelines for Assessment and Instruction in Statistics Education (GAISE) for the college introductory course endorsed by the American Statistical Association (ASA). The GAISE Report gives six recommendations for the course:

1. Emphasize statistical literacy and develop statistical thinking
2. Use real data in teaching statistics
3. Stress conceptual understanding
4. Foster active learning
5. Use technology for developing conceptual understanding
6. Use assessments to improve and evaluate student learning

Changes to this edition and the hallmark features of the text reflect a strong adherence to these important GAISE guidelines.

Putting It Together

When students are learning statistics, often they struggle with seeing the big picture of how it all fits together. One of my goals is to help students learn not just the important concepts and methods of statistics but also how to put them together.

On the inside front cover, you'll see a pathway that provides a guide for students as they navigate through the process of learning statistics. The features and chapter organization in the fifth edition reinforce this important process.

New to This Edition

- **Over 350 New and Updated Exercises** The fifth edition makes a concerted effort to require students to write a few sentences that explain the results of their statistical

analysis. To reflect this effort, the answers in the back of the text provide recommended explanations of the statistical results. In addition, exercises have been written to require students to understand pitfalls in faulty statistical analysis.

- **Over 100 New and Updated Examples** The examples continue to engage and provide clear, concise explanations for the students while following the Problem, Approach, Solution presentation. Problem lays out the scenario of the example, Approach provides insight into the thought process behind the methodology used to solve the problem, and Solution goes through the solution utilizing the methodology suggested in the approach.
- **Videos** The suite of videos available with this edition has been extensively updated. Featuring the author and George Woodbury, there are both instructional videos that develop statistical concepts and example videos. Most example videos have both by-hand solutions and technology solutions (where applicable). In addition, each Chapter Test problem has video solutions available.
- **Retain Your Knowledge** A new problem type. The Retain Your Knowledge problems occur periodically at the end of section exercises. These problems are meant to assist students in retaining skills learned earlier in the course so that the material is fresh for the final exam.
- **Big Data Problems** Data is ubiquitous today. The ability to collect data from a variety of sources has resulted in very large data sets. While analysis of data sets with tens of thousands of observations with thousands of variables is not practical at the introductory level, it is important for students to analyze data sets with more than fifty observations. These problems are marked with a 📊 icon and the data is available at www.pearsonhighered.com/sullivanstats.
- **Technology Help in MyStatLab** Problems in MyStatLab that may be analyzed using statistical packages now have an updated technology help feature. Marked with a ? icon, this feature provides step-by-step instructions on how to obtain results using StatCrunch, TI-84 Plus/TI-84 Plus C, and Excel.
- **Instructor Resource Guide** The Instructor Resource Guide provides an overview of the chapter. It also details points to emphasize within each section and suggestions for presenting the material. In addition, the guide provides examples that may be used in the classroom.

Hallmark Features

- **Student Activity Workbook** The updated activity workbook contains many in-class activities that may be used to enhance your students' conceptual understanding of statistical concepts. The activities involve many tactile and applet-based simulations. Applets for the activities may be found at www.pearsonhighered.com/sullivanstats. In addition, the activity workbook

includes many exercises that introduce **simulation** and **randomization methods** for statistical inference.

- Chapter 10 has simulation techniques that are powerful introductions to the logic of hypothesis testing. There are two activities that utilize simulation techniques. It also contains an activity on using Bootstrapping to test hypotheses for a single mean.
- Chapter 11 has randomization techniques for analyzing the difference of two proportions and the difference of two means. There are four activities for analyzing the difference of two proportions and two activities for analyzing the difference of two means.
- Chapter 14 has randomization techniques for analyzing the strength of association between two quantitative variables. There are two activities for a randomization test for correlation.

The workbook is accompanied by an instructor resource guide with suggestions for incorporating the activities into class.

- Because the use of **Real Data** piques student interest and helps show the relevance of statistics, great efforts have been made to extensively incorporate real data in the exercises and examples.
- **Putting It Together** sections appear in Chapters 5, 9, 10, and 11. The problems in these sections are meant to help students identify the correct approach to solving a problem. Many new exercises have been added to these sections that mix in inferential techniques from previous sections. Plus, there are new problems that require students to identify the inferential technique that may be used to answer the research objective (but no analysis is required). For example, see Problems 23 to 29 in Section 10.5.
- **Step-by-Step Annotated Examples** guide a student from problem to solution in three easy-to-follow steps.
- “**Now Work**” problems follow most examples so students can practice the concepts shown.
- Multiple types of **Exercises** are used at the end of sections and chapters to test varying skills with progressive levels of difficulty. These exercises include **Vocabulary and Skill Building**, **Applying the Concepts**, and **Explaining the Concepts**.
- **Chapter Review** sections include:
 - **Chapter Summary**.
 - A list of key chapter **Vocabulary**.
 - A list of **Formulas** used in the chapter.
 - **Chapter Objectives** listed with corresponding review exercises.
 - **Review Exercises** with all answers available in the back of the book.
 - **Chapter Test** with all answers available in the back of the book. In addition, the Chapter Test problems have **video solutions** available.
- Each chapter concludes with **Case Studies** that help students apply their knowledge and promote active learning.

Integration of Technology

This book can be used with or without technology. Should you choose to integrate technology in the course, the following resources are available for your students:

- Technology Step-by-Step guides are included in applicable sections that show how to use Minitab®, Excel®, the TI-83/84, and StatCrunch to complete statistics processes.
- Any problem that has 12 or more observations in the data set has a 📊 icon indicating that data set is included on the companion website (<http://www.pearsonhighered.com/sullivanstats>) in various formats. Any problem that has a very large data set that is not printed in the text has a 📄 icon, which also indicates that the data set is included on the companion website. These data sets have many observations and often many variables.
- Where applicable, exercises and examples incorporate output screens from various software including Minitab, the TI-83/84 Plus C, Excel, and StatCrunch.
- Twenty new Applets are included on the companion website and connected with certain activities from the Student Activity Workbook, allowing students to manipulate data and interact with animations. See the front inside cover for a list of applets.
- Accompanying Technology Manuals are available that contain detailed tutorial instructions and worked out examples and exercises for the TI-83/84 and 89 and Excel.

Companion Website Contents

- Data Sets
- Twenty new Applets (See description on the insert in front of the text.)
- Formula Cards and Tables in PDF format
- Additional Topics Folder including:
 - Sections 4.5, 5.7, and 6.4
 - Appendix A and Appendix B
- A copy of the questions asked on the Sullivan Statistics Survey I and Survey II
- Consumer Reports projects that were formerly in the text

Key Chapter Content Changes

Chapter 1 Data Collection

The chapter now includes an expanded discussion of confounding, including a distinction between lurking variables and confounding variables.

Chapter 4 Describing the Relation between Two Variables

Section 4.3 now includes a brief discussion of the concept of leverage in the material on identifying influential observations. The conditional bar graphs in Section 4.4 have been drawn so that each category of the explanatory

variable is grouped. This allows the student to see the complete distribution of each category of the explanatory variable. In addition, the material now includes stacked (or segmented) conditional bar graphs.

Chapter 6 Discrete Probability Distributions

The graphical representation of discrete probability distributions no longer is presented as a probability histogram. Instead, the graph of a discrete probability distribution is presented to emphasize that the data is discrete. Therefore, the graph of discrete probability distributions is drawn using vertical lines above each value of the random variable to a height that is the probability of the random variable.

Chapter 7 The Normal Probability Distribution

The assessment of normality of a random variable using normal probability plots has changed. We no longer rely on normal probability plots drawn using Minitab. Instead, we utilize the correlation between the observed data and normal scores. This approach is based upon the research of S.W. Looney and T. R. Gullledge in their paper, “Use of the Correlation Coefficient with Normal Probability Plots,” published in the *American Statistician*. This material may be skipped without loss of continuity (especially for those who postponed the material in Chapter 4). Some problems from Chapter 9 through 13 may need to be skipped or edited, however.

Chapter 9 Estimating the Value of a Parameter

The Putting It Together section went through an extensive renovation of the exercises. Emphasis is placed on identifying the variable of interest in the study (in particular, whether the variable is qualitative or quantitative). In addition, there are problems that simply require the student to identify the type of interval that could be constructed to address the research concerns.

Chapter 10 Hypothesis Testing Regarding a Parameter

The Putting It Together section went through an extensive revision. Again, emphasis is placed on identifying the variable of interest in the study. The exercises include a mix of hypothesis tests and confidence intervals. Plus, there are problems that require the student to identify the type of inference that could be constructed to address the research.

Chapter 11 Inference on Two Samples

The material on inference for two dependent population proportions is now covered in Section 12.3 utilizing the chi-square distribution. As in Chapter 9 and Chapter 10, the Putting It Together section’s exercises were revised extensively. There is a healthy mix of two-sample and single-sample analysis (both hypothesis tests and confidence intervals). This will help students to develop the ability to determine the type of analysis required for a given research objective.

Chapter 12 Inference on Categorical Data

In Section 12.2, we now emphasize how to distinguish between the chi-square test for independence and the chi-square test for homogeneity of proportions. The material on inference for two dependent proportions formerly in Section 11.1 is now a stand-alone Section 12.3 so that we might use chi-square methods to analyze the data.

Chapter 13 Comparing Three or More Means

The Analysis of Variance procedures now include construction of normal probability plots of the residuals to verify the normality requirement.

Chapter 14 Inference on the Least-Squares Regression Model and Multiple Regression

Section 14.3 Multiple Regression from the fourth edition has been expanded to four sections. The discussion now includes increased emphasis on interaction, dummy variables, and polynomial regression. Building regression models is now its own section and includes stepwise, forward, and backward regression model building.

Flexible to Work with Your Syllabus

To meet the varied needs of diverse syllabi, this book has been organized to be flexible.

You will notice the “Preparing for This Section” material at the beginning of each section, which will tip you off to dependencies within the course. The two most common variations within an introductory statistics course are the treatment of regression analysis and the treatment of probability.

- **Coverage of Correlation and Regression** The text was written with the descriptive portion of bivariate data (Chapter 4) presented after the descriptive portion of univariate data (Chapter 3). Instructors who prefer to postpone the discussion of bivariate data can skip Chapter 4 and return to it before covering Chapter 14. (Because Section 4.5 on nonlinear regression is covered by a select few instructors, it is located on the website that accompanies the text in Adobe PDF form, so that it can be easily printed.)
- **Coverage of Probability** The text allows for light to extensive coverage of probability. Instructors wishing to minimize probability may cover Section 5.1 and skip the remaining sections. A mid-level treatment of probability can be accomplished by covering Sections 5.1 through 5.3. Instructors who will cover the chi-square test for independence will want to cover Sections 5.1 through 5.3. In addition, an instructor who will cover binomial probabilities will want to cover independence in Section 5.3 and combinations in Section 5.5.

Acknowledgments

Textbooks evolve into their final form through the efforts and contributions of many people. First and foremost, I would like to thank my family, whose dedication to this project was just as much theirs as mine: my wife, Yolanda, whose words of encouragement and support were unabashed, and my children, Michael, Kevin, and Marissa, who have been supportive throughout their childhood and now into adulthood (my how time flies). I owe each of them my sincerest gratitude. I would also like to thank the entire Mathematics Department at Joliet Junior College and my colleagues who provided support, ideas, and encouragement to help me complete this project. From Pearson Education: I thank Patrick Barbera, whose editorial expertise has been an invaluable asset; Deirdre Lynch, who has provided many suggestions



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Michael Sullivan, III
Joliet Junior College

Resources for Success

MyStatLab™ Online Course for Statistics: Informed Decisions Using Data 5e by Michael Sullivan, III

(access code required)

MyStatLab is available to accompany Pearson's market leading text offerings. To give students a consistent tone, voice, and teaching method each text's flavor and approach is tightly integrated throughout the accompanying MyStatLab course, making learning the material as seamless as possible.

New! Technology Support Videos

In these videos, the author demonstrates the easy-to-follow steps needed to solve a problem in several different formats—by-hand, TI-84 Plus C, and StatCrunch.



Technology Step-by-Step - StatCrunch

Approximating the Mean and Standard Deviation from Grouped Data

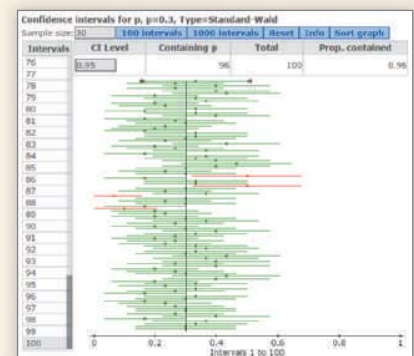
1. If necessary, enter the summarized data into the spreadsheet. Name the columns.
2. Select **Stat**, highlight **Summary Stats**, and select **Grouped/Binned data**.
3. Choose the column that contains the class under the "Bins in:" drop-down menu. Choose the column that contains the frequencies in the "Counts in:" drop-down menu. Select the "Consecutive lower limits" radio button for defining the midpoints. Click **Compute!**.

Technology Step-by-Step

Technology Step-by-Step guides show how to use StatCrunch®, Excel®, and the TI-84 graphing calculators to complete statistics processes.

Interactive Applets

Applets are a powerful tool for developing statistical concepts and enhancing understanding. There are twenty new applets that accompany the text and many activities in the Student Activity Workbook that utilize these applets.



Resources for Success

BREAK THROUGH
To improving results

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.

- The author analyzed aggregated student usage and performance data from MyStatLab for the previous edition of this text. The results of this analysis helped improve the quality and quantity of exercises that matter the most to instructors and students.
- 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:** MyStatLab's personalized homework, and adaptive and companion study plan features 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.

- **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.
 - **1000 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 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 that 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.

www.mystatlab.com

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.
- Students can also access supplemental animations and video clips directly from selected exercises.
- Knowing that students often use external statistical software, we make it easy to 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.

StatCrunch™

StatCrunch is powerful web-based statistical software that allows users to perform complex analyses, share data sets, and generate compelling reports of their data. The vibrant online community offers tens of thousand shared data sets for students to analyze.

- **Collect.** Users can upload their own data to StatCrunch or search a large library of publicly shared data sets, spanning almost any topic of interest. Also, an online survey tool allows users to quickly collect data via web-based surveys.
- **Crunch.** A full range of numerical and graphical methods allow users to analyze and gain insights from any data

set. Interactive graphics help users understand statistical concepts, and are available for export to enrich reports with visual representations of data.

- **Communicate.** Reporting options help users create a wide variety of visually-appealing representations of their data.

Full access to StatCrunch is available with a MyStatLab kit, and StatCrunch is available by itself to qualified adopters. StatCrunch Mobile is also now available; just visit www.statcrunch.com from the browser on your smart phone or tablet. For more information, visit our website at www.statcrunch.com, or contact your Pearson representative.

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 testbank are available for download from Pearson's Instructor Resource Center.

Learning Catalytics™ Foster student engagement and peer-to-peer learning

Generate class discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics. MyMathLab and MyStatLab now provide Learning Catalytics—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.

Instructors, you can:

- Pose a variety of open-ended questions that help your students develop critical thinking skills
- Monitor responses to find out where students are struggling
- Use real-time data to adjust your instructional strategy and try other ways of engaging your students during class
- Manage student interactions by automatically grouping students for discussion, teamwork, and peer-to-peer learning

Resources for Success

BREAK THROUGH
To improving results

Instructor Resources

Annotated Instructor's Edition

(ISBN 978-0-13-413542-7; ISBN 10: 0-13-413542-3)

Margin notes include helpful teaching tips, suggest alternative presentations, and point out common student errors. Exercise answers are included in the exercise sets when space allows. The complete answer section is located in the back of the text.

Instructor's Resource Center

All instructor resources can be downloaded from www.pearsonhighered.com/irc. This is a password-protected site that requires instructors to set up an account or, alternatively, instructor resources can be ordered from your Pearson Higher Education sales representative.

Instructor's Solutions Manual (Download only)

by GEX Publishing Services.

Fully worked solutions to every textbook exercise, including the chapter review and chapter tests. Case Study Answers are also provided. Available from the Instructor's Resource Center and MyStatLab.

Online Test Bank

A test bank derived from TestGen is available on the Instructor's Resource Center. There is also a link to the TestGen website within the Instructor Resource area of MyStatLab.

PowerPoint® Lecture Slides

Free to qualified adopters, this classroom lecture presentation software is geared specifically to the sequence and philosophy of *Statistics: Informed Decisions Using Data*. Key graphics from the book are included to help bring the statistical concepts alive in the classroom. Slides are available for download from the Instructor's Resource Center and MyStatLab.

New! Instructor's Guide for Student Activity Workbook (Download only)

by Heather Foes and Kathleen Almy, *Rock Valley College* and Michael Sullivan, III, *Joliet Junior College*. Accompanies the activity workbook with suggestions for incorporating the activities into class. The Guide is available from the Instructor's Resource Center and MyStatLab.

New! Instructor's Resource Guide (Download only)

by Michael Sullivan, III, *Joliet Junior College*. This guide presents an overview of each chapter along with details about concepts that should be emphasized for each section. The resource guide also provides additional examples (complete with solutions) for each section that may be used for classroom presentations. This Guide is available from the Instructor's Resource Center and MyStatLab.

Student Resources

New! Author in the Classroom Videos

by Michael Sullivan, III, *Joliet Junior College* and George Woodbury, *College of the Sequoias*

The suite of videos available with this edition has been extensively updated. Featuring the author and George Woodbury, there are both instructional videos that develop statistical concepts and example videos. Most example videos have both by-hand solutions and technology solutions (where applicable). In addition, each Chapter Test problem has video solutions available.

Student's Solutions Manual

by GEX Publishing Services

(ISBN 13: 978-0-13-413540-3; ISBN 10: 0-13-413540-7)

Fully worked solutions to odd-numbered exercises with all solutions to the chapter reviews and chapter tests.

Technology Manuals

The following technology manuals contain detailed tutorial instructions and worked-out examples and exercises.

Available on the Pearson site: www.pearsonhighered.com/mathstatsresources

- **Excel Manual (including XLSTAT)** by Alana Tuckey, *Jackson Community College*
- **Graphing Calculator Manual for the TI-83/84 Plus and TI-89** by Kathleen McLaughlin and Dorothy Wakefield

New! Student Activity Workbook

by Heather Foes and Kathleen Almy, *Rock Valley College*, and Michael Sullivan, III, *Joliet Junior College*

(ISBN 13: 978-0-13-411610-5; ISBN 10: 0-13-411610-0)

Includes classroom and applet activities that allow students to experience statistics firsthand in an active learning environment. Also introduces resampling methods that help develop conceptual understanding of hypothesis testing.

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PART

1

Getting the Information You Need

CHAPTER 1

Data Collection

Statistics is a process—a series of steps that leads to a goal. This text is divided into four parts to help the reader see the process of statistics.

Part 1 focuses on the first step in the process, which is to determine the research objective or question to be answered. Then information is obtained to answer the questions stated in the research objective.

1

Data Collection

Outline

- 1.1 Introduction to the Practice of Statistics
- 1.2 Observational Studies versus Designed Experiments
- 1.3 Simple Random Sampling
- 1.4 Other Effective Sampling Methods
- 1.5 Bias in Sampling
- 1.6 The Design of Experiments

Making an Informed Decision



It is your senior year of high school. You will have a lot of exciting experiences in the upcoming year, plus a major decision to make—which college should I attend? The choice you make may affect many aspects of your life—your career, where you live, your significant other, and so on, so you don't want to simply choose the college that everyone else picks. You need to design a questionnaire to help you make an informed decision about college. In addition, you want to know how well the college you are considering educates its students. See Making an Informed Decision on page 59.

PUTTING IT TOGETHER

Statistics plays a major role in many aspects of our lives. It is used in sports, for example, to help a general manager decide which player might be the best fit for a team. It is used in politics to help candidates understand how the public feels about various policies. And statistics is used in medicine to help determine the effectiveness of new drugs.

Used appropriately, statistics can enhance our understanding of the world around us. Used inappropriately, it can lend support to inaccurate beliefs. Understanding statistical methods will provide you with the ability to analyze and critique studies and the opportunity to become an informed consumer of information. Understanding statistical methods will also enable you to distinguish solid analysis from bogus “facts.”

To help you understand the features of this text and for hints to help you study, read the *Pathway to Success* on the front inside cover of the text.

1.1 Introduction to the Practice of Statistics

- Objectives**
- 1 Define statistics and statistical thinking
 - 2 Explain the process of statistics
 - 3 Distinguish between qualitative and quantitative variables
 - 4 Distinguish between discrete and continuous variables
 - 5 Determine the level of measurement of a variable

1 Define Statistics and Statistical Thinking

What is statistics? Many people say that statistics is numbers. After all, we are bombarded by numbers that supposedly represent how we feel and who we are. For example, we hear on the radio that 50% of first marriages, 67% of second marriages, and 74% of third marriages end in divorce (Forest Institute of Professional Psychology, Springfield, MO).

Another interesting consideration about the “facts” we hear or read is that two different sources can report two different results. For example, an October 23, 2014 poll by ABC News and the *Washington Post* indicated that 70% of Americans believed the country was on the wrong track. However, an October 30, 2014 poll by NBC News and the *Wall Street Journal* indicated that 63% of Americans believed the country was on the wrong track. Is it possible that the percent of Americans who believe the country is on the wrong track could decrease by 7% in one week, or is something else going on? Statistics helps to provide the answer.

Certainly, statistics has a lot to do with numbers, but this definition is only partially correct. Statistics is also about where the numbers come from (that is, how they were obtained) and how closely the numbers reflect reality.

Definition **Statistics** is the science of collecting, organizing, summarizing, and analyzing information to draw conclusions or answer questions. In addition, statistics is about providing a measure of confidence in any conclusions.

Let’s break this definition into four parts. The first part states that statistics involves the collection of information. The second refers to the organization and summarization of information. The third states that the information is analyzed to draw conclusions or answer specific questions. The fourth part states that results should be reported using some measure that represents how convinced we are that our conclusions reflect reality.

What is the information referred to in the definition? The information is **data**, which the *American Heritage Dictionary* defines as “a fact or proposition used to draw a conclusion or make a decision.” Data can be numerical, as in height, or nonnumerical, as in gender. In either case, data describe characteristics of an individual.

Analysis of data can lead to powerful results. Data can be used to offset anecdotal claims, such as the suggestion that cellular telephones cause brain cancer. After carefully collecting, summarizing, and analyzing data regarding this phenomenon, it was determined that there is no link between cell phone usage and brain cancer. See Examples 1 and 2 in Section 1.2.

Because data are powerful, they can be dangerous when misused. The misuse of data usually occurs when data are incorrectly obtained or analyzed. For example, radio or television talk shows regularly ask poll questions for which respondents must call in or use the Internet to supply their vote. Most likely, the individuals who are going to call in are those who have a strong opinion about the topic. This group is not likely to be representative of people in general, so the results of the poll are not meaningful. Whenever we look at data, we should be mindful of where the data come from.

In Other Words

Anecdotal means that the information being conveyed is based on casual observation, not scientific research.