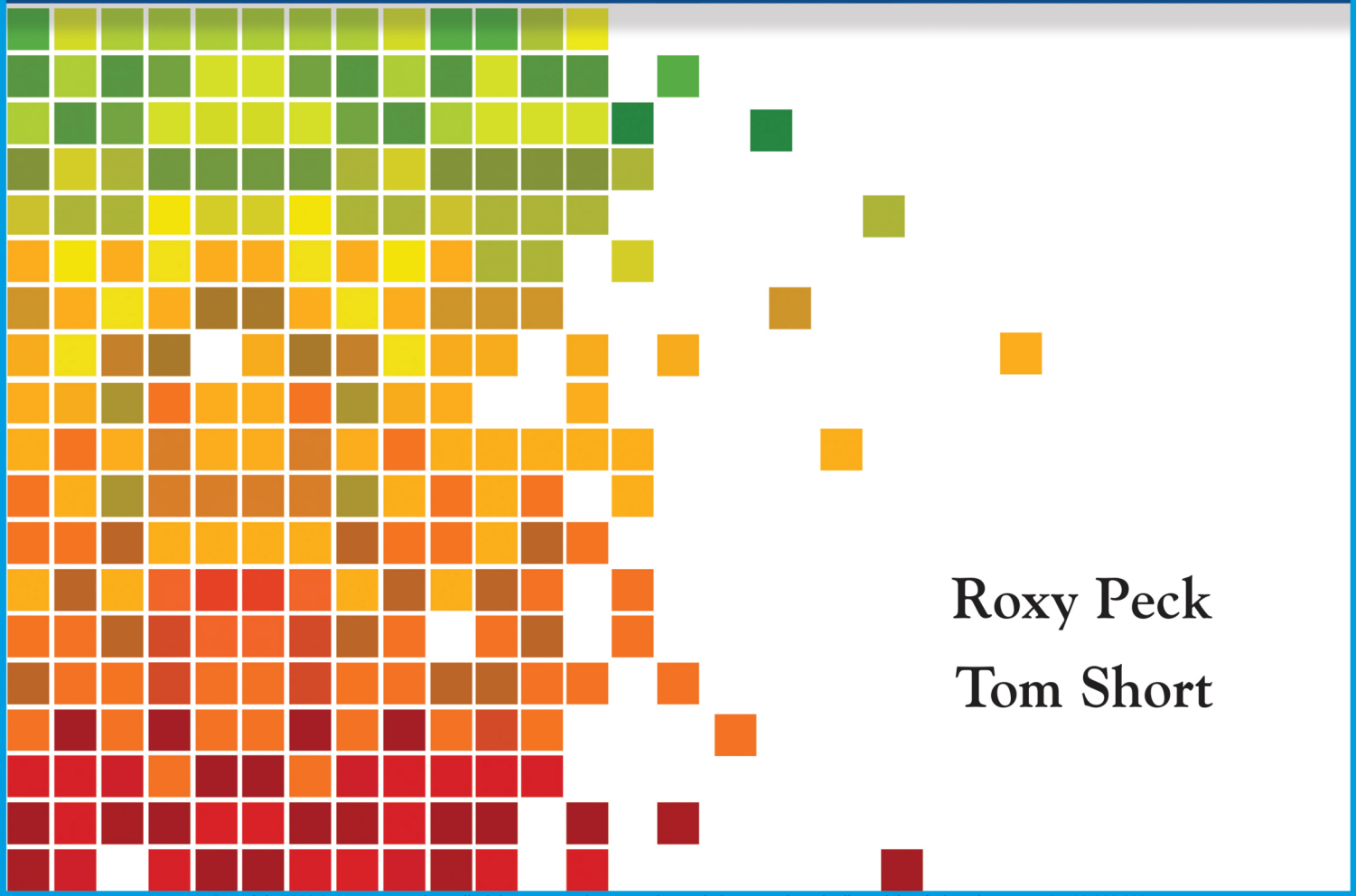
STATISTICS COMPANION

SUPPORT FOR INTRODUCTORY STATISTICS



Roxy Peck
Tom Short

How does the *Statistics Companion* help you in your Introductory Statistics course?

Chapters 1 through 7 contain review of math topics and problem-solving skills in contexts that will help you be successful in a Statistics course.

CHAPTER	SAMPLE TOPICS	STATISTICS COURSE CONNECTIONS
1	NUMBER LINES, ROUNDING AND ORDERING DECIMAL NUMBERS	Relative position, comparing values, calculating summary statistics
2	PROPORTIONS, DECIMALS AND PERCENTAGES, CHOOSING AN APPROPRIATE SCALE, INTERVALS	Graphical displays for univariate and bivariate data
3	SUMMATION NOTATION, VARIABLES, AND EVALUATING ALGEBRAIC EXPRESSIONS	Measures of center and variability
4	LINES AND LINEAR MODELS	Equation of the least-squares line, correlation, using a line to make predictions
5	FRACTIONS, DECIMAL NUMBERS AND PERCENTAGES, SETS AND SET NOTATION	Probability
6	EQUATIONS AND INEQUALITIES, AREAS UNDER A CURVE, SOLVING SIMPLE EQUATIONS	Random variables and probability distributions
7	HOW TO READ A STATISTICS PROBLEM	Word problems about confidence intervals and tests of hypotheses

Chapters 8 through 20 provide details of Evaluating Expressions, along with Guided Practice, as you prepare to encounter specific topics in Statistics.

THIS CHAPTER HELPS YOU TO...

CHAPTER 8 Calculate and interpret confidence intervals for one proportion

CHAPTER 9 Test hypotheses about one proportion

CHAPTER 10 Calculate and interpret confidence intervals for two proportions

CHAPTER 11 Test hypotheses about two proportions

CHAPTER 12 Calculate and interpret confidence intervals for one mean

CHAPTER 13 Test hypotheses about one mean

CHAPTER 14 Calculate and interpret confidence intervals for a difference in means (paired samples)

CHAPTER 15 Test hypotheses about a difference in means (paired samples)

CHAPTER 16 Calculate and interpret confidence intervals for a difference in means (independent samples)

CHAPTER 17 Test hypotheses about a difference in means (independent samples)

CHAPTER 18 Test hypotheses using categorical data (chi-square tests)

CHAPTER 19 Estimate and test hypotheses about the slope of a least-squares line

CHAPTER 20 Test hypotheses about means of more than two populations

STUDY SKILLS

Don't wait until you fall behind in class! Study smarter and faster with "Smart Study Strategies".

Chapter 0 of this text walks you through designing a study plan for the course. Learn the best ways to process and organize information and gain the confidence to keep going when the learning gets tough. This chapter lays the foundation for a successful learning experience in Statistics.

HOW TO READ A STATISTICS PROBLEM

Ever notice how Statistics seems to be a different language? Let us be your translator.

Chapter 7, How to Read a Statistics Problem, provides a systematic, three-step approach to tackling any statistics problem you will face. You'll be able to apply this new skill to your statistics class right away. Just like learning a language or any new habit, practice makes perfect!

WEBASSIGN From Cengage

What is WebAssign?

Learn, not just do, homework with an interactive eBook, assignments, videos, practice, study plans and more:

- My Class Insights tracks your progress on the homework and recommends areas you need to study for the test.
- Each question is tailored for diverse learning styles with interactive simulations, videos, tutorials and more.
- When you're stuck, easily contact your instructor within assignment questions.
- WebAssign grades more like a professor, accepting multiple variations of your answers.
- Find the information you need, when you need it with the ebook's flash card and note-taking ability.

STATISTICS COMPANION

SUPPORT FOR INTRODUCTORY STATISTICS

STATISTICS COMPANION

SUPPORT FOR INTRODUCTORY STATISTICS

Roxy Peck
California Polytechnic State University, San Luis Obispo

Tom Short
West Chester University of Pennsylvania

Contributors:

Paul D. Nolting
Hillsborough Community College

Kimberly Nolting
Academic Success Press, Inc.

Sue Ann Jones Dobbyn
Pellissippi State Community College

CENGAGE

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

CENGAGE

Statistics Companion: Support for Introductory Statistics
Roxy Peck, Tom Short

Product Director: Mark Santee

Product Manager: Catherine Van Der Laan

Senior Learning Designer: Elinor Gregory

Product Assistant: Amanda Rose

Marketing Manager: Mike Saver

Senior Content Manager: Michael Lepera

IP Analyst: Reba Frederics

IP Project Manager: Carly Belcher

Production Service: MPS Limited

Compositor: MPS Limited

Art Director: Vernon Boes

Text Designer: Diane Beasley

Cover Designer: Cheryl Carrington

Cover Image: simon2579/DigitalVision Vectors/Getty Images

Library of Congress Control Number: 2018950693

ISBN: 978-1-337-70559-2

Cengage
20 Channel Center Street
Boston, MA 02210
USA

Cengage is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage platforms and services, register or access your online learning solution, or purchase materials for your course, visit **www.cengage.com.**

Printed in the United States of America
Print Number: 01 Print Year: 2018

To Uri Treisman, for introducing
me to the joyful conspiracy.
Roxy Peck

To Allan Rossman and Roxy Peck, for their
friendship and mentorship.
Tom Short

Author Bios

ROXY PECK is a professor emerita of statistics at California Polytechnic State University, San Luis Obispo. She was a faculty member in the Statistics Department for thirty years, serving for six years as Chair of the Statistics Department and thirteen years as Associate Dean of the College of Science and Mathematics. Nationally known in the area of statistics education, Roxy was made a Fellow of the American Statistical Association in 1998, and in 2003 she received the American Statistical Association's Founders Award in recognition of her contributions to K-12 and undergraduate statistics education. In 2009, she received the USCOTS Lifetime Achievement Award in Statistics Education. In addition to coauthoring the textbooks *Statistics: Learning from Data, Introduction to Statistics and Data Analysis*, and *Statistics: The Exploration and Analysis of Data*, she is also editor of *Statistics: A Guide to the Unknown*, a collection of expository papers that showcases applications of statistical methods. Roxy served from 1999 to 2003 as the Chief Faculty Consultant for the Advanced Placement Statistics exam and she is a past chair of the joint ASA/NCTM Committee on Curriculum in Statistics and Probability for Grades K-12 and of the ASA Section on Statistics Education. Outside the classroom, Roxy enjoys travel and has visited all seven continents. She collects Navajo rugs and heads to Arizona and New Mexico whenever she can find the time.

TOM SHORT is an Associate Professor in the Statistics Program within the Department of Mathematics at West Chester University of Pennsylvania. He previously held faculty positions at Villanova University, Indiana University of Pennsylvania, and John Carroll University. He is a Fellow of the American Statistical Association and received the 2005 Mu Sigma Rho Statistics Education Award. Tom is part of the leadership team for readings of the Advanced Placement (AP) Statistics Exam, and was a member of the AP Statistics Development Committee. He has also served on the Board of Directors of the American Statistical Association. Tom treasures the time he shares with his four children and the many adventures experienced with his wife, Darlene.

Contributor Bios

Dr. Paul Nolting for over 30 years worked at State College of Florida in Bradenton, FL, as an undergraduate instructor, a learning specialist, an institutional test administrator, Title III director, and math lab coordinator. He also has been a graduate instructor for assessment and measurement courses. He is an expert on assessing math learning problems, developing effective student learning strategies, math study skills, assessing institutional variables that affect math success, math redesigns, and tutor training. He has consulted nationally and internationally with over a hundred college/university campuses on their QEPs and to improve math success and retention. He is now an adjunct professor at Hillsborough Community College in Tampa, FL.

Ms. Kim Nolting currently works as Research and Development Vice President for Academic Success Press, Inc. In addition, she consults with higher education institutions, focusing on faculty development and intervention workshops for improving classroom teaching and learning, as well as enriching academic support services. Her MAT focused on teaching English and communications, while her doctoral coursework specialized her in the area of measurement and research in higher education with a special focus on teaching and learning. Her multifaceted career includes college instruction, learning

assistance supervision, and manager of grant initiatives. In addition, she worked in mid-level administration, which allowed her to work closely with faculty in the academic disciplines of general education to improve student academic performance.

Sue Ann Jones Dobbyn graduated from the University of Tennessee in 1974 with a BS in Chemical Engineering. After working for Proctor and Gamble and Ford Motor Company, Sue Ann took a Masters' degree in Curriculum and Instruction with the primary goal of having a working schedule which better matched that of her three young daughters. Falling in love with the role of educator was a wonderful surprise. Sue Ann spent the next twenty years as a high school teacher in an alternative high school in Las Cruces, New Mexico. In this position, Sue Ann and her students participated in national and international educational programs, including *Project del Rio*, an ecological partnership with schools in New Mexico, Texas, and Mexico, and *Critical Issues Forum*, a nuclear nonproliferation program which involved students in the United States and the Russian Federation sponsored by the US Department of Energy. In addition, she received grants from GTE and Toyota to create curriculum in science and mathematics. An online version of one of these programs, *The Physics of Sports*, received an Eisenhower Clearinghouse award. Returning to Tennessee in 2007, Sue Ann accepted a position at Pellissippi State Community College in the Mathematics Department. When the state of Tennessee in 2014 decided to mandate that remediation in math be provided in a co-requisite model, Sue Ann volunteered to help construct the program for the entry level statistics course. The resulting curriculum was piloted in Fall 2015. The success of the co-requisite model in Introductory Statistics resulted in the implementing of this model for other entry level math courses.

Brief Contents

	Preface	xv
CHAPTER **0**	Smart Study Strategies	1
CHAPTER **1**	Getting Ready for Statistics	17
CHAPTER **2**	Creating Graphical Displays—The Math You Need to Know	33
CHAPTER **3**	Measures of Center and Variability—The Math You Need to Know	67
CHAPTER **4**	Describing Bivariate Numerical Data—The Math You Need to Know	81
CHAPTER **5**	Probability—The Math You Need to Know	133
CHAPTER **6**	Random Variables and Probability Distributions—The Math You Need to Know	141
CHAPTER **7**	How to Read a Statistics Problem	175
CHAPTER **8**	Estimating a Population Proportion—The Math You Need to Know	185
CHAPTER **9**	Testing Hypotheses About a Population Proportion—The Math You Need to Know	199
CHAPTER **10**	Estimating a Difference in Two Proportions—The Math You Need to Know	207
CHAPTER **11**	Testing Hypotheses About a Difference in Two Proportions—The Math You Need to Know	217
CHAPTER **12**	Estimating a Population Mean—The Math You Need to Know	227
CHAPTER **13**	Testing Hypotheses About a Population Mean—The Math You Need to Know	241
CHAPTER **14**	Estimating a Difference in Means Using Paired Samples—The Math You Need to Know	247
CHAPTER **15**	Testing Hypotheses About a Difference in Means Using Paired Samples—The Math You Need to Know	255
CHAPTER **16**	Estimating a Difference in Two Means Using Independent Samples—The Math You Need to Know	261
CHAPTER **17**	Testing Hypotheses About a Difference in Two Means Using Independent Samples—The Math You Need to Know	273
CHAPTER **18**	Chi-Square Tests—The Math You Need to Know	283
CHAPTER **19**	Estimating and Testing Hypotheses About the Slope of a Population Regression Line—The Math You Need to Know	299
CHAPTER **20**	Testing Hypotheses About More than Two Means—The Math You Need to Know	313
ANSWERS	Answers to the Odd Exercises	323

Contents

Preface xv

CHAPTER 0 **Smart Study Strategies** 1

0.1 The Learning and Memory Process 1
0.2 The Study Plan for Statistics 3
0.3 Productive Self-Concept Through Mindfulness 10
0.4 Putting It All Together 14

CHAPTER 1 **Getting Ready for Statistics** 17

1.1 Numbers and the Number Line—A Quick Review 17
1.2 Rounding Decimal Numbers 22
1.3 Ordering Decimal Numbers 23
1.4 Getting to Know Your Calculator—Order of Operations, Powers of Numbers, Square Roots, and Scientific Notation 25

CHAPTER 2 **Creating Graphical Displays—The Math You Need to Know** 33

2.1 Review—Rounding Decimal Numbers, Plotting Points on the Number Line 33
2.2 Selecting an Appropriate Numerical Scale 34
2.3 Intervals and Interval Widths 39
2.4 Proportions, Decimal Numbers, and Percentages 41
2.5 Plotting Points in Two Dimensions 43
2.6 Evaluating Expressions 62

CHAPTER 3 **Measures of Center and Variability—The Math You Need to Know** 67

3.1 Review—Ordering Decimal Numbers, Square Roots, Distance between Two Points 67
3.2 Variables and Algebraic Expressions 70
3.3 Summation Notation 72
3.4 Deviations from the Mean, Squared Deviations, Sum of Squared Deviations 73
3.5 Evaluating Expressions 76

CHAPTER 4 **Describing Bivariate Numerical Data—The Math You Need to Know** 81

4.1 Review—Variables, Scatterplots, Linear and Nonlinear Patterns, *z-Scores* 81
4.2 Working with Lines 92
4.3 Linear Models and Using a Line to Make Predictions 106
4.4 Deviations from a Line and the Sum of Squared Deviations 115
4.5 The Least-Squares Line 120
4.6 Evaluating Expressions 122

CHAPTER 5 **Probability—The Math You Need to Know** 133

5.1 Review—Proportions, Decimal Numbers and Percentages, Ordering Decimal Numbers 133
5.2 Sets and Set Notation 135
5.3 Evaluating Expressions 138

CHAPTER 6 **Random Variables and Probability Distributions—The Math You Need to Know** 141

6.1 Review—Powers of Numbers, Square Roots, Intervals, Proportions, Decimals and Percentages, and *z-Scores* 141
6.2 Random Variables 145
6.3 More on Intervals 146
6.4 Equations and Inequalities 149
6.5 Areas Under a Curve 152
6.6 Areas of Rectangles and Areas of Triangles 159
6.7 Solving Simple Equations in One Variable 165
6.8 Working with Factorials (Optional, for those covering the Binomial Distribution) 167
6.9 Evaluating Expressions 169

CHAPTER 7 **How to Read a Statistics Problem** 175

7.1 Chapter Overview 175
7.2 A Strategy for Reading a Statistics Problem 175
7.3 Guided Practice Reading Statistics Problems 176
7.4 On Your Own 180

CHAPTER 8 **Estimating a Population Proportion—The Math You Need to Know** 185

8.1 Evaluating Expressions 185
8.2 Guided Practice—Margin of Error 192
8.3 Guided Practice—Large Sample Confidence Interval for a Population Proportion 194
8.4 Guided Practice—Determining Sample Size 196

CHAPTER 9 **Testing Hypotheses About a Population Proportion—The Math You Need to Know** 199

9.1 Evaluating Expressions 199
9.2 Guided Practice—Large-Sample Hypothesis Test for a Population Proportion 202

CHAPTER 10 **Estimating a Difference in Two Proportions—The Math You Need to Know** 207

10.1 Evaluating Expressions 207
10.2 Guided Practice—Large-Sample Confidence Interval for a Difference in Two Proportions 212

CHAPTER 11 Testing Hypotheses About a Difference in Two Proportions—The Math You Need to Know 217

11.1 Evaluating Expressions 217
11.2 Guided Practice—Large Sample Hypothesis Test for a Difference in Two Proportions 222

CHAPTER 12 Estimating a Population Mean—The Math You Need to Know 227

12.1 Evaluating Expressions 227
12.2 Guided Practice—Margin of Error 234
12.3 Guided Practice—Confidence Interval for a Population Mean 236
12.4 Guided Practice—Determining Sample Size 238

CHAPTER 13 Testing Hypotheses About a Population Mean—The Math You Need to Know 241

13.1 Evaluating Expressions 241
13.2 Guided Practice—One-Sample Hypothesis Test for a Population Mean 243

CHAPTER 14 Estimating a Difference in Means Using Paired Samples—The Math You Need to Know 247

14.1 Evaluating Expressions 247
14.2 Guided Practice—Confidence Interval for a Difference in Means—Paired Samples 251

CHAPTER 15 Testing Hypotheses About a Difference in Means Using Paired Samples—The Math You Need to Know 255

15.1 Evaluating Expressions 255
15.2 Guided Practice—Paired-Samples Hypothesis Test for a Difference in Means 258

CHAPTER 16 Estimating a Difference in Two Means Using Independent Samples—The Math You Need to Know 261

16.1 Evaluating Expressions 261
16.2 Guided Practice—Two-Sample *t* Confidence Interval for a Difference in Means Using Independent Samples 267

CHAPTER 17 Testing Hypotheses About a Difference in Two Means Using Independent Samples—The Math You Need to Know 273

17.1 Evaluating Expressions 273
17.2 Guided Practice—Testing Hypotheses About a Difference in Means Using Independent Samples 278

CHAPTER 18 Chi-Square Tests—The Math You Need to Know 283

18.1 Evaluating Expressions 283
18.2 Guided Practice—Chi-Square Tests 288

CHAPTER 19 **Estimating and Testing Hypotheses About the Slope of a Population Regression Line—The Math You Need to Know** 299

19.1 Evaluating Expressions 299
19.2 Guided Practice—Confidence Interval for the Slope of a Population Regression Line 305
19.3 Guided Practice—Testing Hypotheses About the Slope of a Population Regression Line 307

CHAPTER 20 **Testing Hypotheses About More than Two Means—The Math You Need to Know** 313

20.1 Evaluating Expressions 313
20.2 Guided Practice—One-Way Analysis of Variance 318

Answers to the Odd Exercises 323

Index 333

Preface

Introductory statistics is the required college-level mathematics course for a large and growing number of students. As a consequence, two-year and four-year colleges nationwide are exploring ways to broaden access to introductory statistics courses by rethinking placement and prerequisite policies. To accommodate a group of students that is more diverse with respect to mathematics preparation, many have chosen to implement structures that include a pre- or a co-requisite course for students who need additional support to be successful. These courses are focused on the mathematics background and foundation needed for success in introductory statistics.

This companion text is designed to provide introductory statistics students with the support that they need to be successful by addressing mathematical content, study skills, and a productive mindset. And, because statistics is a subject in which context plays a critical role, a chapter on strategies for reading and understanding statistics problems in context is also included in the text.

The *Statistics Companion* is written to align with the text *Statistics: Learning from Data*, 2nd edition, but can be adapted for use with any introductory statistics textbook or resource.

Organization of the *Statistics Companion*

Chapter 0 is a chapter written by nationally recognized math study skills experts Paul Nolting and Kimberly Nolting. It is designed to help students develop skills necessary for success in college and for the introductory statistics course. This chapter covers content that statistics faculty may not have previously included in their courses, and the authors of this chapter have written helpful suggestions for how to incorporate this content into a prerequisite or a co-requisite support course. The suggestions are included in the "Advice for Instructors" section that follows later in this preface. It is recommended that the material in Chapter 0 be covered during the first two weeks of a semester-long course, teaching it alongside the early mathematics content of Chapters 1 and 2.

Chapters 1 through 6 cover the basic mathematics that provides the foundation needed for the introductory college-level statistics course. These chapters are organized around the ordering of topics in a typical introductory statistics course. This enables a review of the necessary mathematics to be addressed in a supporting, parallel course as it is encountered in the statistics course. If descriptive analysis of bivariate data (correlation and linear regression) is covered before inference, most of the mathematics prerequisites are needed in the first half of the introductory statistics course. With this in mind, there is an assessment of the mathematics introduced in Chapter 1 through Chapter 6 available on the instructor resource site for this text. This assessment can be used midsemester to confirm student mastery of the mathematics content and to identify any areas where additional review might be needed.

Chapter 7 introduces a strategy for reading and understanding statistics problems. Midway through an introductory statistics course, the content transitions from descriptive statistics and probability to inferential statistics. This is where the reading load increases, as nearly every problem students encounter involves context, interpretation, and communication of conclusions. Chapter 7 provides students with a systematic strategy for reading and understanding the types of problems that they will encounter throughout the second half of their statistics course. Depending on how much time is devoted to the co-requisite course (which may range from two hours to four hours per week), if time permits, the material in

this chapter could also be covered earlier because the reading strategies introduced here also apply to problems that students encounter in the descriptive statistics part of the course.

Chapters 8 through 20 are short chapters that focus on support for the material on confidence intervals and hypothesis testing. Because not all statistics textbooks present this material in the same order, we have chosen to break this material up into short chapters that can be taught in any order. Each of these chapters focuses on a specific inference topic, such as estimating a population proportion or testing a hypothesis about a difference in means using independent samples. These chapters open with a section that walks students through evaluating the mathematical expressions they will encounter in the statistics course. The sections that follow provide students with guided practice in applying the reading strategy introduced in Chapter 7, and then solving the types of problems they will see in their statistics course.

Advice for Instructors

In this section, we are fortunate to be able to include contributions from Sue Ann Jones Dobbyn, Paul Nolting, and Kimberly Nolting.

Sue Ann Jones Dobbyn is a faculty member at Pellissippi State Community College in Tennessee, where she teaches a co-requisite support course for introductory statistics. Tennessee was an early adopter of the co-requisite strategy at both two-year colleges and four-year universities, and has seen a significant increase in the number of students passing the college-level statistics course in their first year. Professor Dobbyn shares what she has learned as the co-requisite strategy was implemented and offers recommendations for instructors teaching the co-requisite support course.

Following Sue Ann Jones Dobbyn's recommendations, Paul and Kimberly Nolting offer insight on how the material in Chapter 0 can be integrated into a co-requisite support course.

On Co-requisite Mathematics: Advice to Instructors

Sue Ann Jones Dobbyn

Nationally, over 50% of entering freshmen at two-year colleges require academic remediation, most frequently in mathematics. At four-year institutions the proportion is smaller, around 20%, but still daunting.[1] The state of Tennessee enacted the Complete College Tennessee Act in 2010, which established a progressive reform agenda of the educational system of the state. One of the initiatives at the college level was to move from prerequisite remediation programs to co-requisite programs.

As an Associate Professor at Pellissippi State Community College, I have been involved in the development of co-requisite math courses for the past four years. The Tennessee Board of Regents gave us the following mandate: The co-requisite experience will serve the dual purpose of supporting and illuminating the skills and concepts of the college-level credit-bearing course while also providing instruction for students to remediate those mathematics developmental competencies in which they have a deficiency. In delivering on this mandate, we have consistently focused on the needs of the remedial students, which has affected many of the pedagogical and structural decisions that we made. The results of our efforts have been gratifying: success rates, as defined by receiving an A–C in the college-level course, have increased from 34% (2013) to 60% (Fall 2017). The following recommendations are based on some of the lessons we have learned from piloting the co-requisite format to full-scale implementation.

Recommendation 1: Choose the best materials

At the time that my institution began co-requisite reform, almost no comprehensive materials were available. The original recommendation was simply to pancake remedial algebra modules on top of the college-level course materials. We worried that students would simply feel like they were being forced to take two math courses at the same time. In addition, we were concerned that the order and timing of the remedial algebra topics would not meld with the needs of the college-level class. As a result, we decided to author

1 Complete College America (2012). *Remediation: Higher Education's Bridge to Nowhere*. p. 2.

our own remedial course materials that kept the skill requirements of the college-level course as the driving force.

Ideally, the students in the co-requisite course should see immediately how the content of the remedial course informs and assists them in the college-level course. Examples and exercises should be aligned with the content and timing of the college course but focused on the remedial topic. For example, to construct and analyze frequency tables in a statistics class, students need to be able to convert between fractions, decimals, and percentages, which is a remedial skill. Therefore, questions in the co-requisite class that target this remedial topic should align with the college-level course's treatment of frequency tables.

Fortunately, over the past few years, more authors have developed co-requisite materials that pace the college-level class and reflect its needs. If it is properly used, students in the co-requisite section should see the benefits of this just-in-time approach as they progress through the curriculum. A two-pronged approach that provides supporting instructional materials paired with examples and exercises written in the context of the college-level course has been very effective at my institution. The students in the co-requisite courses have passing rates (grades of A–C) that are almost the same as the college-ready students.

Recommendation 2: Avoid structuring the co-requisite class as a lecture

Although many of us are most comfortable when we are the "sage on the stage," this is probably not the most effective way to conduct the co-requisite classroom. An outline/schedule of topics for the co-requisite mapped to the college-level course should be provided to instructors. However, this type of document shouldn't be used to create lectures on all those topics. While occasional mini-lectures may be needed, they should be in response to some identified issue that is shared by several students. Strategies that work well include class discussion and selective group work on topics of shared difficulty or concern. These active learning techniques also promote positive social interactions that have long-term benefits. The main objectives of the instructor in a mastery-based curriculum are to encourage students to be persistent in their work, to be diligent in their efforts to understand the content problems of individual students, and to help remediate those issues. This job requires that faculty examine carefully and constantly the work of their students. A feedback loop should also be established with the students. A weekly progress report that can be easily filled out by the instructor can effectively communicate progress to the student. The report should reflect the desired schedule of the course in some way and identify where the student stands in relation to the expected pace. In addition, the report may give the student-specific feedback on assessments such as tests.

I think of the role of co-requisite instructor more in terms of coaching. Certainly, some procedures need to be taught when they reflect commonly shared misconceptions or difficulties. But, at most times, the challenge is to encourage students to keep on working and making progress toward completion and help them to see how the co-requisite can help them be successful in the college-level course.

Recommendation 3: Have college-level sections with mixed populations

In reviewing the anecdotal evidence, it seemed clear that one issue encountered by many underprepared students was a feeling of isolation from the college society in general. Of course, this problem was most exacerbated when all remediation was done as prerequisites. However, even in the co-requisite model this isolation can still occur. At Pellissippi State, we made a deliberate choice to offer our co-requisite course linked with college-level sections that include both college-ready students and co-requisite students. This decision has helped us to keep the college-level course at the same level of rigor for both groups. Maintaining the rigor of the college-level course was part of the state's mandate, but it is also simply the right thing to do.

There have been several benefits derived from mixed-population sections. First, it alleviates the possibility of social isolation that plagued remedial students in the prerequisite model. In fact, the co-requisite students often find themselves in the role of peer tutor when their college-ready colleagues have trouble with some underlying algebra skill. This role reversal is not an unusual occurrence in the college-level class with mixed populations.

Another benefit is that both groups begin to see the inherent connections between the prerequisite mathematics and gateway math courses like Introductory Statistics.

Recommendation 4: Assign the same instructor to both courses

Committing college-accredited faculty to both the college-level and co-requisite classes has been somewhat controversial and problematic. Some faculty may object to, or even have difficulty with teaching the co-requisite course topics. Some institutions may have trouble finding enough fully-accredited faculty members to meet the increased teaching load. However, there are many benefits to making this commitment.

Having the same instructor demonstrates that the institution is equally interested in the success of the underprepared student and the college-ready student. The decision makes a subtle, but important, statement about the value of the co-requisite course, as well. In addition, the same instructor can much more easily follow the progress of all the co-requisite students in both courses. The value of this type of knowledge can't be overstated. For example, if the instructor has noted in the college-level class that co-requisite students don't understand how to change a calculator display in scientific notation to standard notation, they can reinforce the procedure needed in the co-requisite session. This type of synthesis is almost impossible if the courses are taught by two different instructors, even if serious efforts are made to formalize communication between these instructors.

Recommendation 5: Use mastery-based learning in the co-requisite course

Since co-requisite students are working off identified deficits, programs that demand mastery at a specifically high level are encouraged. Mastery-based programs can have the benefit of lowering the anxiety associated with testing for these students, since they know in advance that they can review and retest if their first results fall short of the mastery level chosen. In addition, this system helps document that the student has remediated their math deficits.

Of course, there are problems associated with the choice of a mastery-based program. Since the requirements and pace of the college-level course will dictate to some extent the structure of the co-requisite course, the choice to have a mastery basis can result in some students falling behind due to reviewing and retesting. This problem is in some ways unavoidable and can create management issues for the instructor. However, it is also an opportunity to become more involved with the students who struggle. Struggle can be beneficial when it results in encouraging students to use other resources like tutoring centers. The cycle of working toward mastery can help students become more persistent in their efforts to succeed.

In a mastery-based system, students are also empowered to work ahead if they are able. This acceleration can put those students out of sync with the college-level course. However, for ambitious students the problems created usually are not serious. And, of course, the student always has the option to simply slow down the pace in the co-requisite course. Most students who choose to accelerate understand the choice they are making.

Recommendation 6: Make additional resources available

Co-requisite instructors need to understand the resources available to students that can assist them in their efforts to complete their education. At my institution, we require that underprepared students spend time each week in one of our tutoring centers. This requirement forces them to schedule time dedicated to working on their course. It also makes it easier for them to develop relationships with people whose job is to help students succeed. Properly trained tutors help students become better learners by coaching them in problem-solving techniques and encouraging them to be persistent in their efforts. Developing a relationship with math tutors today may lead to the widespread utilization of tutors in other subject areas as well.

One of the initiatives that we have developed at my institution has been the training and use of supplemental instructors (SI) in the co-requisite classrooms. The SIs are current undergraduate students who have previously made an A in the college-level course and agree to conduct regularly scheduled tutoring sessions for the co-requisite students. This system has the advantage of guaranteeing that the tutoring time is focused on the specific course. Also, the students often develop a strong and productive relationship with

the supplemental instructor. Peer tutors frequently teach far more than math by discussing and encouraging good study skills and academic discipline.

Virtual tutoring is another strategy in which we are investing time and effort. The state of Tennessee has recently begun a program called *Reconnect Now* that is targeted specifically for adult learners. One of the issues with adult learners is fitting a college educational schedule into an adult life that includes families and full-time jobs. In response, we have begun offering co-requisite courses in a "weekend college" format. A vital addition to this initiative has been to make tutoring available in a virtual setting since many of these adult learners need tutoring during the evening hours or on weekends when the traditional tutoring centers are closed. So far, we have been able to staff the virtual tutoring hours using faculty who have taught or are teaching the college-level course.

Recommendation 7: Consider incorporating other high-impact practices

There are many other high-impact practices that can be positively utilized in co-requisite classes. One initiative at my institution has been the incorporation of service learning projects as part of the student experience. It is possible to identify projects that are relevant to college math courses in many cases. For example, the TSA at our local airport requested help analyzing survey data. This task had clear relevance to a statistics course, and with guidance the students were capable of performing the work. It may require some out-of-the-box thinking, but service projects allow students to apply what they are learning to real-world settings. In addition, many institutions now acknowledge these service learning experiences on student transcripts.

The incorporation of growth mindset training is another opportunity that can enhance co-requisite courses. Underprepared students often have low opinions of their own ability to succeed academically, especially in mathematics. Countering this nonacademic barrier with good information about how the brain works and how persistence and practice can improve skills is possible. In addition, training for instructors and tutors in giving productive feedback can be valuable as we attempt to maximize the effectiveness of our courses. Resources for conducting this type of intervention with faculty and with students are widely available from sources like mindsetworks.com.

In the end, faculty and students have the same goal: success in both the remedial component of the class and the college-level course. Making the transition to the co-requisite model of remediation does require significant effort from all the stakeholders at an institution, from the faculty to the registrars. However, the benefits at Pellissippi State have included both higher retention rates and higher success rates.

Recommendation 8: Use projects to address critical-thinking competencies in the college-level course

In the state of Tennessee, one of the remedial competency points centers around the development of critical thinking. In order to address this competency, we have developed projects for our entry-level courses. In the case of Introductory Statistics, we have utilized large data sets to design semester-long capstone projects with social justice themes that reinforce the concepts and procedures of the course while encouraging critical thinking through the continued use of interpretive questions. In the liberal arts (general studies) math course, themed projects are used that reflect the varied topics of the course, such as logic, consumer finance, probability/statistics, and modeling.

Projects of this type allow us to incorporate group learning and discussion. It can be challenging to manage a group-learning project. Typically, we suggest that the instructor introduce a set of ground rules for productive discussion and interaction. These rules emphasize respect for other's opinions, including being non-judgmental, giving equal time to all group members' expressions, and keeping verbal exchanges civil. Instructors need to be attentive to these interactions and be prepared to intervene if the discussion becomes too heated.

In addition, many of the projects are enhanced by bringing in and sharing other materials like articles, research papers, and maps. As difficult as group projects sometimes can be, they are worth the effort. These projects are an opportunity to show how very relevant mathematics is to our everyday life. They are also a chance to educate students in current events and show how mathematics interacts with other disciplines.

Advice on Incorporating Chapter 0 Smart Study Strategies

Paul D. Nolting and Kimberly Nolting

After looking at any statistics textbook for the first time, students quickly realize that there is a lot to learn and that their statistics course will not be like other mathematics courses they may have taken. There is an immense amount of information to learn. In addition, students must learn how to apply this information immediately. To accomplish these skills, students need to develop study plans that help the brain learn how to gather and organize information to analyze and synthesize. In addition, it is important to learn the concepts of statistical vocabulary and the relationships between them. As important, students must learn how to study in a way that puts all concepts into long-term memory because as the curriculum progresses, it grows in complexity. The easier it is to pull information from long-term memory, the more available mental energy for the brain to understand and organize more complex information. A study plan helps to use time wisely, allows the brain to work efficiently, and minimizes learning anxiety.

The study strategies suggested in this chapter are also innovative teaching instructions. When instructors use study strategies as teaching strategies, students are more likely to also value them. Here are a few examples. (More study strategies can be found in *Math Study Skills Workbook*, 5th edition, by Dr. Paul Nolting, either online or by contacting Cengage.)

Study Strategy	Teaching Strategy
Skim the assigned reading material. Look at the learning objectives listed to get an overview of what you will learn. As you skim the chapter, circle novel words that you do not understand with a pencil. This step is to simply get an overview of what you will be learning. These two skimming exercises should only take 5–10 minutes.	During the first or second class, work through these two steps in class. While modeling the steps, you are also introducing the statistics content.
After skimming, read again to familiarize yourself with the material enough to prepare for the next class. Remember, this step will help you encode and keep new information presented in class in short-term memory long enough to record it in your notes. Mark the concepts and words that you do not understand. Another option is to write the vocabulary words in your vocabulary list. If you do not clearly understand a word or concept, make sure you ask about them in class.	Include at least a portion of the chapter 0 material, so students can see how the skimming helps with taking notes.
Figure out which learning objective(s) each problem is helping you learn. Write down the objective number. This will help you use your homework when reviewing for a test. Also record the concepts and formulas by the homework problem.	Take 10 minutes to model this strategy in class. Assign one homework problem to each small group in class. The small group takes 5 minutes to decide which learning objective the problem is linked to and explain why. Each group reports back.
Make sure your notes have all the correct information. One of the most common challenges for students is cognitive overload during statistics classes. When on overload, it is easy to miss pertinent information. Find at least two classmates willing to share notes. Take a few minutes to take pictures of each other's notes with your phones right after class. There is only one caution: Make sure their notes are correct.	Allow time at the end of class for students to practice this. It also provides time for them to meet other students and begin building study support groups.

Study Strategy	Teaching Strategy
Form a study group of three or four students within the first two weeks of class. Keep it small.	Encourage study groups. Help students form them. For instance, hand out a weekly schedule grid that is hour by hour. They can highlight the times they are most available for study groups. Collect and see which students share similar available times. Let them have 5 minutes at the end of class to meet in selected time slots. Think of places they can meet. If you are teaching a co-requisite section attached to the academic class, provide times for students to study in their small groups. This is particularly good when reviewing for a test.

It is also wise to attach a type of student incentive for following through with study strategies. For instance, ask them to use a vocabulary list during the weeks before the first test. Tell them to follow the guidelines in the study strategy chapter. If they turn in a complete list of vocabulary words, using the guidelines, they can receive extra points on the test. These points are just enough that it could mean the difference between a B+ and A−. If they receive grades for smaller quizzes, perhaps the incentive is dropping the lowest quiz. Be creative.

Acknowledgments

The authors would like to express our thanks and gratitude to the following people who made this book possible:

Catherine Van Der Laan, our product manager at Cengage, for her support of this project.

Michael Lepera and Spencer Arritt, our content managers at Cengage, for their helpful suggestions and for keeping us on track.

Elinor Gregory, the learning designer.

Lori Hazzard and Ed Dionne, our project managers at MPS Limited.

Stephen Miller, for his careful and complete work on the huge task of creating the student and instructor solutions manuals.

Roger Lipsett, for his attention to detail in checking the accuracy of examples and solutions.

Mike Saver, the Marketing Manager.

Richard Camp, the copy editor and Heather Mann, the proofreader for the book.

MPS Limited, for producing the artwork used in the book.

Sue Ann Jones Dobbyn, for her valuable advice to instructors that appears in the preface.

Paul Nolting and Kimberly Nolting, for sharing their expertise in the area of study skills in authoring Chapter 0 of this book.

Many people provided invaluable comments and suggestion as this text was being developed.

Reviewers

Anna Tivy, Ventura College
Adam Heck, Southern Adventist University
Roberto Colson, University of Texas Rio Grande Valley
Sabrina Ripp, Tulsa Community College
Shannon Solis, San Jacinto College

Francis Nkansah, Bunker Hill Community College
Ryan Kasha, Valencia College
Sam Ofori, Cleveland State Community College
Jordan Bertke, Central Piedmont Community College

And last, but certainly not least, we thank our families, friends, and colleagues for their continued support.

Roxy Peck and Tom Short

0 Smart Study Strategies

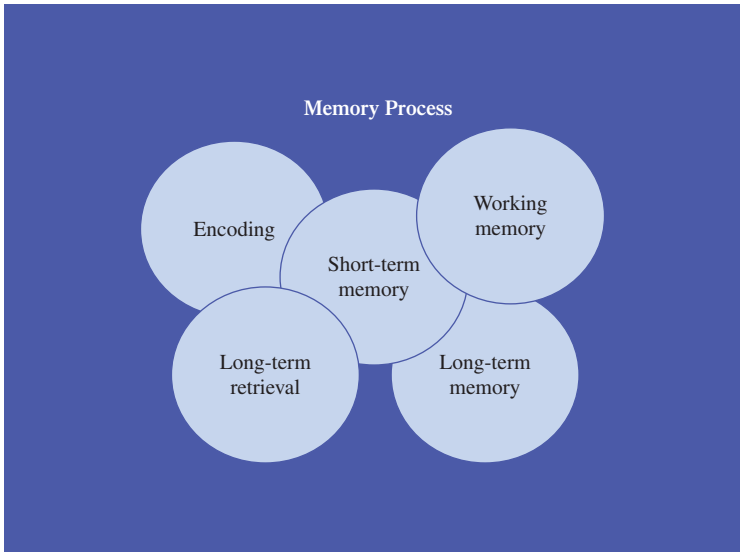
0.1 The Learning and Memory Process
0.2 The Study Plan for Statistics
0.3 Productive Self-Concept through Mindfulness
0.4 Putting It All Together

This chapter was written by Paul Nolting and Kimberly Nolting

This chapter is the starting line for designing a study plan. First, it focuses on how the brain learns and then suggests study strategies that help the brain process, understand, organize, and store and retrieve information. Often you will see page references to ***Math Study Skills Workbook, 5th edition***, by Dr. Paul Nolting, where you can find additional study suggestions in more detail. You can find this resource online. Second, this chapter focuses on the impact that self-image and emotions have on successful academic study. You will learn strategies to help manage self-talk and thoughts that discourage devoting time to studying when it gets tough. You will also learn strategies that develop a positive self-image as a student. Do not wait until you get behind in classes to try these productive study strategies. Start now.

SECTION 0.1 The Learning and Memory Process

The brain is complex. The more neuroscience experts learn, the more they understand how the brain is immensely intricate. Through all their discoveries, several basic processes remain the same. In order to learn, the brain must complete the following process: encoding, short-term memory, working memory, long-term memory, and long-term retrieval. Even though these are discussed in a sequential manner, the brain processes with immense speed and uses these processes almost simultaneously.



(Kimberly Nolting PowerPoint presentation: "Exploring Learning," 2018)

Encoding is the initial biological step for gathering information through the five senses. For example, the eye sees a new formula on the white board. The retina takes in novel visual information and sends it to the optic nerve, which transfers it to the brain. The brain transforms it into a group of neurons, which are then sent to another area in the brain. Our brain encodes everything but must choose which information to attend to. It lasts for less than a second.

After encoding, the ***short-term memory*** holds information for no more than 30 seconds. It is able to hold small portions of information during these 30 seconds. Another brain function called attention decides whether to discard or send information on to the working memory. The short-term memory also holds on to information that is retrieved from the long-term memory to assist in learning new concepts. The short-term memory depends primarily on acoustic and visual code for storing information.

Study Plan Application Activity

1. Evaluate how well you listen and record information in class. Also, think about how you currently read the textbook and record information during independent study time. Examine how you encode information from online sources and record it. **Write out these descriptions**.
2. What interferes with your concentration during class and study times? **Answer**.
3. What do your class notes look like? **Answer**.

Working memory is the mental storage and work space for the brain to create understanding and to organize the new concepts to send into long-term memory. It is important for reasoning and decision making. New information in working memory is either organized for long-term memory or decays after a short time (10–15 seconds). While in working memory, the new information must be attended to actively or rehearsed.

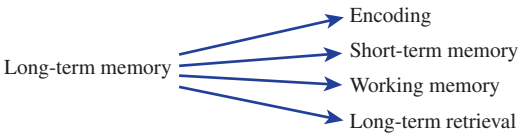
Working memory requires attention, temporary storage of information, and manipulation of information. The brain must arrange the neurons containing new information into clusters by creating new clusters of information or attaching the neurons of new information with others that are retrieved from the long-term memory.

Working memory is where and when learning takes place. It is important to develop study strategies to ensure that you allow the brain to do what it must in order to create understanding. Most of the working memory activities take place studying outside of class, completing homework, and during class discussions.

Study Plan Application Activity

1. Describe your typical study habits. When? Where? How long are your study sessions? **Answer.**
2. What strategies do you use to organize the information you learn? **Answer.**
3. What strategies do you use to memorize information? **Answer.**
4. What strategies do you use to practice analyzing information? Evaluating information? Understanding concepts of vocabulary and relationships between these concepts? **Answer.**

Long-term memory stores schemas (clusters of neurons that hold information) that were developed in working memory. It has large capacity and time endurance. One of the most important aspects of long-term memory is that it influences the quality of encoding, short-term memory, working memory, and long-term retrieval. This is why it is important to use strategies to organize information while learning it. The more organized a file cabinet is, the easier to find files quickly and when you need them. In the same way, the more organized the information that enters the long-term memory, the easier it is to retrieve.



Long-term retrieval involves recalling information from long-term memory into either short-term memory while encoding and/or working memory where the brain needs information from long-term memory to understand new information, answer questions, or apply to new situations. Remember the clusters of neurons formed in working memory and stored in long-term memory? During retrieval, the brain replays these patterns and decides which long-term memories to retrieve given any situation.

Study Plan Application Activity

1. What strategies do you use to organize the information you learn? **Answer.**
2. What strategies do you use to practice retrieving information from long-term memory? **Answer.**

Conclusion

It is now time to see ways each stage of learning affects the other stages. For example, since short-term memory is very limited in time and how much information it can hold, it is important to make sure that the information is recorded when first encoded. Most of your study time should be devoted to working memory, where information is studied long enough and organized to place into long-term memory. Otherwise, you will forget it because it is discarded. Your long-term retrieval is minimal.

The more time you study and ask questions regarding the information you learn, the easier it is to retrieve. It is also important to practice retrieving information for accuracy, effectiveness, and the speed at which you can retrieve it. You retrieve information during all the other stages of memory/learning and during tests. The memory stages, although separate entities when we learn about them, act collaboratively within seconds and minutes.

SECTION 0.2 The Study Plan for Statistics

The following study strategies are based on the way the brain learns. Each study strategy assists in several stages of the learning process. None of the following strategies are busy work, because there is not a single student who has time for busy work! The study strategies are organized based on the primary stage of the learning process we believe it aids. Some strategies will be repeated because they help with several stages of learning.

Strategies to Improve Listening

Active listening is intensive. Your brain uses every stage of learning throughout the entire class. Cognitive overload, also known as "brain fog," may happen in statistics classes. The following strategies will help you encode and hold on to the information long enough to record it in your notes. In addition, these strategies will free up more mental energy for thinking (working memory) while in class.

1. Warm up at least 5–10 minutes before class. Review your notes and homework. This helps with the attention required of you as soon as the instructor begins class. It will also speed up retrieving information from long-term memory that is necessary to learn new statistical concepts in class.
2. If you have questions about the previous class meeting, find time to ask the instructor or colleagues from class during your study times. Otherwise, ask them in class if the instructor provides time for review before moving on with the new material. Prepare them ahead of time, so you won't waste class time with vague questions.

3. The night before class, preview the chapter that contains the material to be covered the next day. Spend some time thinking about the new concepts and how they relate to what you have learned already. You do not have to understand everything. If you note that some concepts appear confusing, plan to ask questions when the instructor presents them in class. Write these questions down, so you won't forget to ask them. Make sure you write the answers down when the instructor answers them.
4. Come to class with completed homework even if you do not turn it in.
5. Make sure you have studied everything up to the next class. At least review it. It may not be easy to retrieve, but at least understand the concepts.
6. Sit where you have the least distractions, can see the board, and can hear the instructor.
7. For more suggestions, read pages 48–49 and 56 in the *Math Study Skills Workbook, 5th edition.*

Strategies to Record Information during Class

Remember that encoding and short-term memory last just moments. Unless you have time to record, rehearse, and discuss it in class, most of the information is out the classroom window.

1. Make sure you complete all the strategies mentioned above.
2. The goal of efficient note-taking is to use the least amount of words to record the greatest amount of information. Never write complete sentences; instead, use short phrases. There are times during statistics classes when mapping is the best technique to use. When the information seems complicated, ask the instructor to design a map or visual to help put the pieces of information together.
3. Always record what is written on the board. And don't forget to write down what the instructor says about the information placed on the board. Not writing down the instructor's comments is a common mistake, but doing so is important because the instructor comments are the explanations of what is on the board.
4. Make sure to capture all the vocabulary words and definitions. If the definitions are long, capture the key words and then fill in after class. If you have time, it is quite helpful to preview the vocabulary before class, even writing the words down along with the textbook definition. Then all you have to do is add what the instructor uses as a definition.
5. Record any questions that the instructor says are important when thinking about different statistical methods. The critical-thinking aspect of statistics is important for solving problems and designing your own research.
6. If you experience cognitive overload, note when it happened in your notes. Then you can make sure you find the information you missed when working with a tutor or on your own.
7. Just because you may understand what is discussed in class does not mean you will remember it, particularly any of the details. Our brain loses information as hours and days pass unless it is rehearsed and studied.

Strategies to Transform Class Notes into Study Tools

In college, students are responsible for the majority of learning. Students are responsible for learning more at a faster pace. Thus, studying involves more than glancing at notes and textbooks. Class notes are important because they contain what the instructor views as significant to learn. They also include the instructor's unique perspective on what you must learn. Organizing class notes into study tools will help in the following ways. First, organizing notes helps to see how the details work with one another. While organizing class notes, you spend time working with the information in the working memory, where the learning takes place. The process of reorganization is itself profitable study time.

Second, the more organized the information, the easier it is for the working memory to organize it and send it into long-term memory. Third, organized study tools help you retrieve information from long-term memory.

1. Make sure your notes have all the correct information. One of the most common challenges for students is cognitive overload during statistics classes. When on overload, it is easy to miss pertinent information. Find at least two classmates willing to share notes. Take a few minutes to take pictures of each other's notes with your phones right after class. There is only one caution: make sure their notes are correct!
2. Use the textbook and other online resources to fill in gaps.
3. Develop a vocabulary resource. The following matrix works well in statistics because it makes you think about how the concepts behind the vocabulary relate to one another and how they are used in statistics. Use a complete 8×11 page for it because as you learn more about statistics, you will want to fill in more information. See page 55 in the *Math Study Skills Workbook* for more ideas. When the vocabulary words involve graphs, include a sample graph for each one.

Vocabulary Word	Definition	What Does It Tell Us?*	What Does It Not Tell Us?*	What Situations Is It Best Used In?*
mode				
mean				
median				

*Note that these questions may be different with various vocabulary words.

4. Maintain a journal of statistical formulas. Once again, use an entire 8×11 page for each formula because you will learn more information about it throughout the course. You may find that this will take more than one page for each formula. The following is an example of one page from a statistical formula journal. Instructions are included in the example of what to include.

Sample Standard Deviation

Is a measure that is used to quantify the amount of variability in a sample consisting of numerical data.

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Leave space for other information instructor presents in class regarding the standard deviation throughout the course.

Answer specific questions that are important for the formula like
What does it tell us? What does it not tell us?

Write out a sample standard deviation word problem.

Complete the standard deviation formula.

Continue to add problems that use the formula but are more involved as you continue to learn more.

5. Use your phone to take pictures of each formula and record information about the formula, so you can review on the go. For more information about reworking your notes, refer to pages 57–59 in the *Math Study Skills Book*.

How to Use the Textbook When Studying

Often students use the textbook as the last resort when they do not understand something. However, it is a useful tool in all the stages of learning. First, previewing the textbook in

preparation for the next class assists in encoding, taking notes, and thinking actively during class. Strategies for this have already been discussed. Second, using the textbook to fill in class notes is helpful. Again, this has already been discussed. Third, studying the content of a chapter helps to put the pieces together in the working memory. Auditory learners should read the sections of a chapter out loud. Fourth, reviewing the chapter for 20 minutes each day helps move the information into long-term memory. Memorizing how a concept looks on a page can help in longer-term retrieval, particularly if you are a visual learner. Finally, reviewing the chapter learning objectives, conclusions, and practice tests can make sure you are learning what is important. If you want more suggestions, refer to pages 64–67 in the *Math Study Skills Workbook, 5th edition.*

The following strategies are designed to help you with the statistics textbook you are currently using.

1. Skim the assigned reading material. Look at the learning objectives listed to get an overview of what you will learn. As you skim the chapter, circle novel words that you do not understand with a pencil. This step is to simply get an overview of what you will be learning. These two skimming exercises should only take 5–10 minutes.

2. After skimming, read again to familiarize yourself with the material enough to prepare for the next class. Remember, this step will help you encode and keep new information presented in class in short-term memory long enough to record it in your notes. Mark the concepts and words that you do not understand. Another option is to write the vocabulary words in your vocabulary list. If you do not clearly understand a word or concept, make sure you ask about it in class.

3. After class, study the textbook chapter. Put all your concentration into reading. At this point, you are reading to learn.

   a. During this reading, also rework your notes into some of the learning tools mentioned in this study strategy chapter (such as using the textbook and other online resources to fill in any gaps in your notes, and creating a vocabulary resource and journal of statistical formulas).
   b. Sometimes, it is best to study the textbook chapter in sections because you are using the working memory at this stage of learning. Working memory requires a respectable amount of mental energy.
   c. Pay attention to the examples. Do not skip them. The examples help conceptualize what you need to learn. Copy and work out the examples in the learning tool you have selected.
   d. Erase the circles around the words you now understand.

4. Remember the learning objectives you previewed while skimming the chapter? It is time to reread them. Make sure you understand what the verbs mean in each objective. For example, consider the following learning objective:

   Evaluate *whether conclusions drawn from a study are appropriate, given a description of the statistical study.*

   Achieving this objective requires knowing the different types of statistical studies and thinking about the relationship between how data are collected and the types of conclusions that can be drawn.

   Make sure your learning tools contain all the information you need to understand, memorize, and use for answering specific questions that the instructor might ask on a test to make sure you have attained this learning objective.

5. Finally, skim and review the chapter several times throughout the week to keep the information fresh and to practice retrieving it from long-term memory. Take only 5–10 minutes to do this. Maybe just use this step for the sections that you do not completely understand.

6. If you get completely lost in a chapter, do the following:

   a. Go back to the previous page and reread the information to maintain a train of thought.

b. Read ahead to the next page to discover if any additional information better explains the misunderstood material.
c. Locate and review any diagrams, examples, or rules that explain the misunderstood material.
d. Read the misunderstood paragraph(s) several times aloud to better understand the meaning.
e. Refer to your class notes for a better explanation.
f. Refer to another statistics textbook or resource.
g. Define exactly what you do not understand and call a classmate.
h. Visit a tutor.

7. Recall important material. If you cannot recall the material, look for the information in the textbook.

8. Reflect on what you have read. Combine what you already know with the latest information that you just read.

9. Write anticipated test questions. Use the learning objectives as a guide to writing appropriate test questions.

The textbook is your friend. The more time you spend studying with the textbook, the more comfortable it will be. Make sure you read the textbook before the next class and identify what to listen for in class. This strategy is mentioned in the previous section on improving listening in class. Also, take time now and then just to read it with no goal in mind except to refresh.

Completing Homework

Homework is not limited to completing assigned exercises. All the suggestions so far are study strategies that are vital in preparation for completing homework problems. Completing assigned exercises is not the time to learn the concepts for the first time. The purpose of homework problems is to increase critical-thinking skills such as application, synthesis, and evaluation. Each problem is meant to help you learn specific concepts and applications.

The following strategies will help you turn homework time into study and test preparation time.

1. Figure out which learning objective(s) each problem is helping you learn. Write down the objective number. This will help you use your homework when reviewing for a test.

2. Also record the concepts and formulas by the homework problem.

3. Write out the questions you must answer to complete a problem. For example, if you are using the textbook *Statistics: Learning from Data, 2nd edition,* there are four questions on page 15 that you should be able to answer to evaluate whether a sample has been selected in a reasonable way. There is also a discussion of types of bias. The descriptions of these types of bias can be turned into questions you can ask as you complete homework problems. Here is an example of how to do this with one of the four questions mentioned on page 15.

Was the sample selected in a reasonable way?	Does the method of selecting a sample exclude important groups in the population, making it so that the sample does not represent the entire population to be studied? Are members of the sample volunteers or self-selected?

It always helps to have specific questions to ask when completing homework. This helps you be flexible if a test question is slightly different than what you have completed

before. While studying statistics, always ask, "What questions need to be answered to solve this problem?" Check the discussions for information that should be turned into questions to ask while completing homework. Always write these questions down.

This strategy is extremely important because it helps the working memory organize and make sense of the information you must learn.

4. Here are basic steps for completing homework.

   a. Review the textbook before beginning homework.
   b. Review class notes before beginning homework.
   c. Complete homework as neatly as possible.
   d. Write down every step of a problem.
   e. Understand why each step in a problem is taken.
   f. Always finish homework with successful completion of a problem.
   g. Make up note cards containing hard-to-remember problems.
   h. Do not fall behind.

Online Homework

Completing online homework is similar. The steps described above are also important for online homework. However, students tend to ignore writing down notes about important concepts they discover while solving online problems. Take notes!

Also, write down important online problems, so you will have easy access to them when you find a few extra moments to study. If you show your work online, take pictures of the steps with your phone. For difficult problems, record how you solved them in your notes.

Making Time to Study

Finding time to study for your classes is one of the major challenges in college, particularly when a test is looming over you. This is one more reason students studying statistics need to spend more time studying and completing homework as it is due. It is almost impossible to cram for a statistics exam.

1. Compile your vocabulary resource on a regular basis. Use the chart system as illustrated earlier. You can use large note cards if you want.

2. Make time to study and review throughout the weeks, not just before tests. Use a large note card and write one learning objective from the textbook on each card. Write the vocabulary words (without definitions) that relate to the learning objective. Write a sample problem and other pertinent information. These are review cards, so use short phrases that can be used just as reminders. While reviewing, if you forget some of the information, refer to your reworked class notes and problems.

3. Keep up with your formula journal. Then make review cards with just the formula on one side and a brief descriptive reminder on the back. This is just for review to keep information in long-term memory.

Developing Review Strategies for Statistics Exams

Preparing for a test starts after the first class, not a few days before the test. Ideally, the week before a test should involve practicing test questions within the time limit of the exam. Understanding all the information is not enough. You must be able to answer all the test questions within a certain amount of time. The following strategies will help you get to that point a week before the test.

1. As you study between classes, study as if preparing for a test or quiz. Design a study plan using the above strategies, and review the resource tools and homework with notes on a regular basis.

2. It is also necessary to practice unfamiliar problems on a regular basis. Ask your instructor for resources for additional practice problems.

3. When you are confident that you know how to complete a certain type of problem, begin solving unfamiliar problems under a timed setting. Ask your instructor for reasonable time allotments for certain types of problems. Do this throughout the weeks, not a few days before the exam.

4. Ask the instructor what type of questions will be on the test. Many statistics exams include complicated multiple-choice questions. These questions usually require more than recall, and many involve application and critical thinking.

5. The first test is always a challenge because students do not know what it will be like. One of the best strategies is to do the following:

- **a.** Form a study group of three or four students within the first few weeks of class. Keep it small.
- **b.** Let the instructor know about the study group.
- **c.** Ask for some examples of the types of questions that he/she typically asks. Tell the instructor you do not want questions that will appear on the exam. Tell the instructor you want just a few examples, so that the study group can make up its own practice questions.
- **d.** As a study group, review the material that the exam will cover and design similar test questions. This will help you begin thinking like the instructor thinks, which is a great advantage, particularly on the first exam.
- **e.** If you are using the textbook *Statistics: Learning from Data*, *2nd edition,* review the *Explorations in Statistical Thinking* sections at the end of each chapter.
- **f.** If you are using the textbook *Statistics: Learning from Data*, *2nd edition,* continually review the *Are You Ready to Move On* questions at the end of each chapter. If your exam will include a take-home portion to assess how well you can use the statistical technology, review the *Technology Notes* section. It is important to review how to use the appropriate technology so that you do not waste time looking up how to do something while completing a take-home exam.

6. It is difficult to design a complete practice test because of all the information and level of sophisticated thinking the exams require. There is a solution.

- **a.** If you concentrate on the *Critical Thinking* portions of each chapter and work with a study group, you will acquire the mindset of a statistician while reviewing material.
- **b.** Meet with your study group at least once a week to review what you have learned. Design quiz questions every week. Several recent studies in the growing area of neuro-education have discovered that taking quizzes a short time after initial learning significantly improves subsequent retrieval of facts and ideas, as well as overall understanding of topics and the ability to solve related problems.
- **c.** Save these quizzes and review them the week before the test.
- **d.** Understand the concept of number sense. This means if the answer does not look right, you may have made a mistake. In other words, test answers should make sense. For example, you were asked to calculate the mean of ten numbers that range from 1 to 15. If your answer is 65, number sense tells you that the answer is outside the range of data values and so it is not a possible value for the mean. This does not make sense. Maybe the answer is 6.5. In any case, you should check your calculations to see where the error occurred. This is number sense.
- **e.** For more test-taking suggestions, refer to pages 103–114 in the *Math Study Skills Workbook, 5th edition.*