Sixth Edition

Business Statistics

In Practice

Bowerman

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Business Statistics in Practice

SIXTH EDITION

with major contributions by

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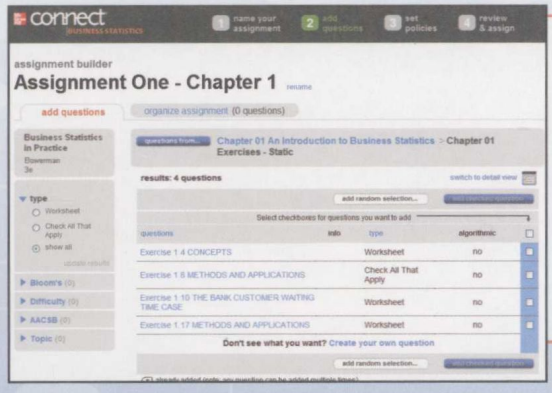

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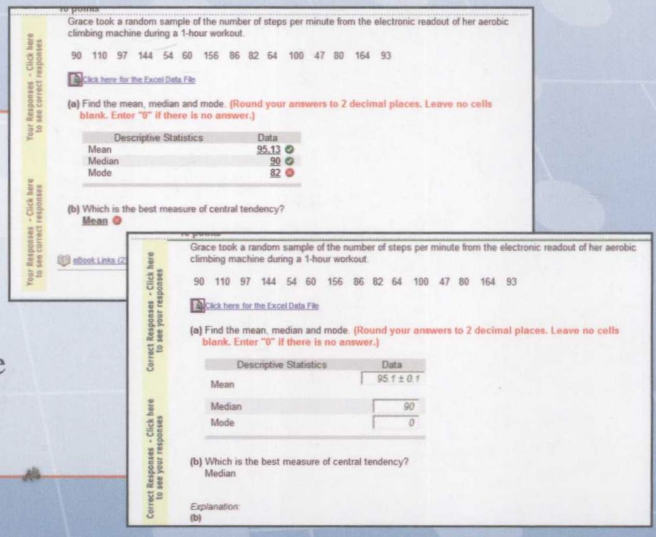

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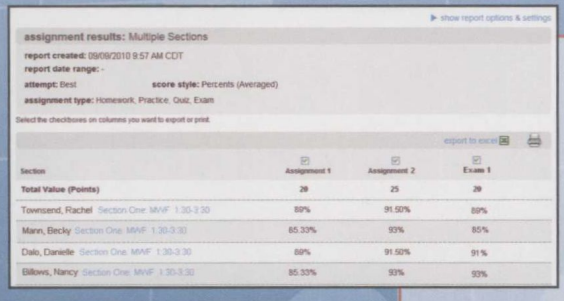

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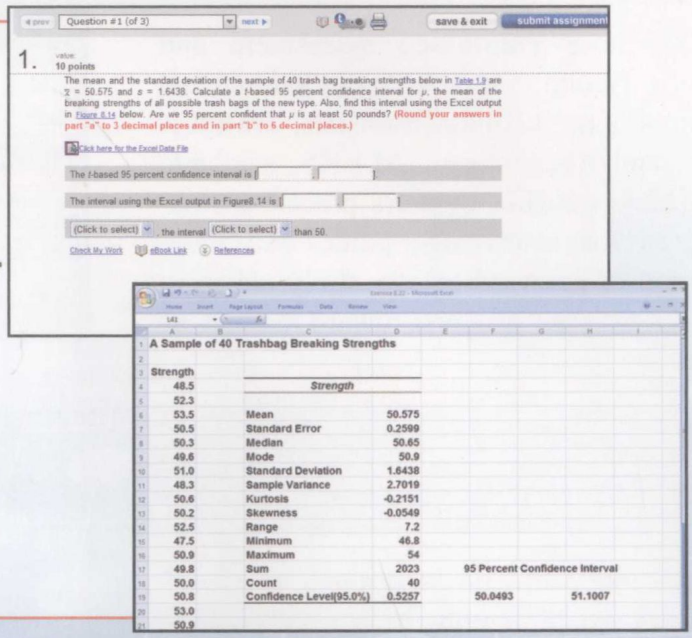

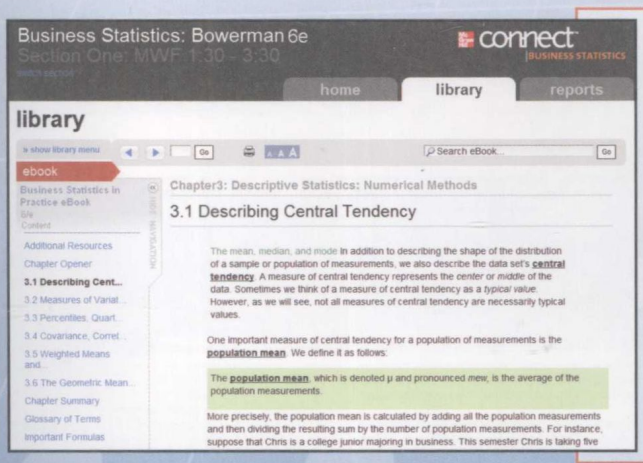

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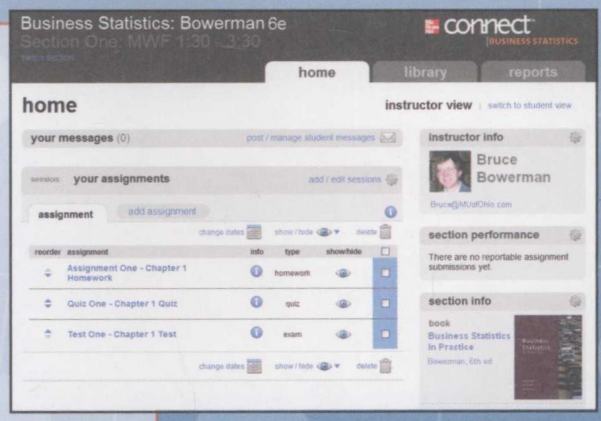

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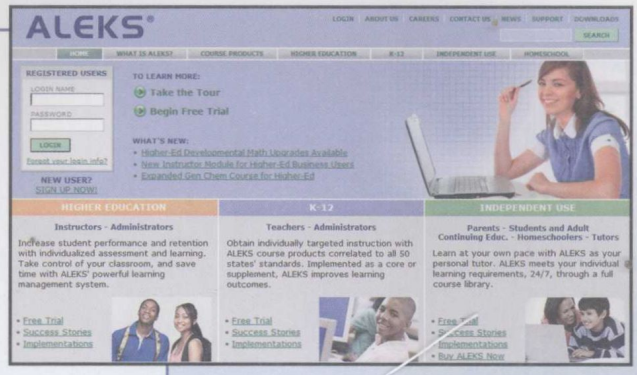

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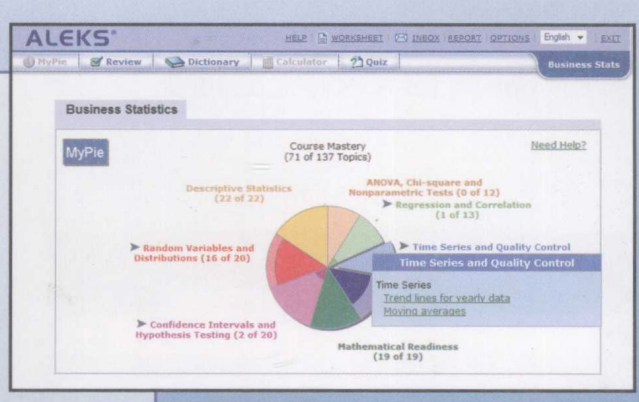

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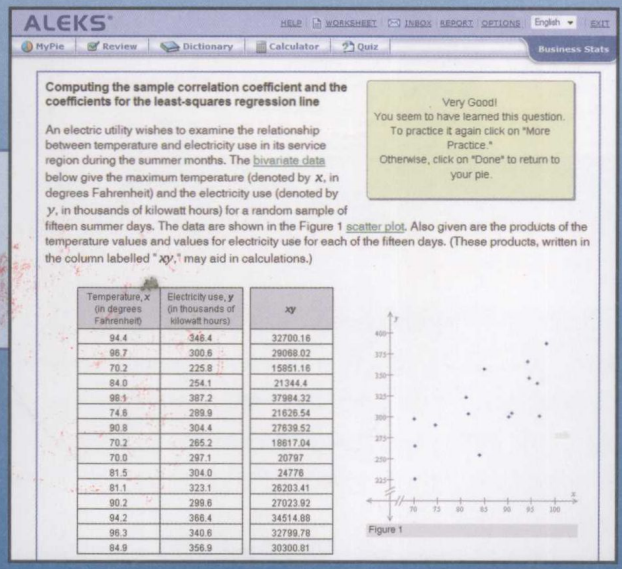

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About the Authors

Bruce L. Bowerman Bruce L. Bowerman is professor of decision sciences at Miami University in Oxford, Ohio. He received his Ph.D. degree in statistics from Iowa State University in 1974, and he has over 40 years of experience teaching basic statistics, regression analysis, time series forecasting, survey sampling, and design of experiments to both undergraduate and graduate students. In 1987 Professor Bowerman received an Outstanding Teaching award from the Miami University senior class, and in 1992 he received an Effective Educator award from the Richard T. Farmer School of Business Administration. Together with Richard T. O'Connell, Professor Bowerman has written 16 textbooks. These include *Forecasting and Time Series: An Applied Approach; Forecasting, Time Series, and Regression: An Applied Approach* (also coauthored with Anne B. Koehler); and *Linear Statistical Models: An Applied Approach.* The first edition of *Forecasting and Time Series* earned an Outstanding Academic Book award from *Choice* magazine. Professor Bowerman has also published a number of articles in applied stochastic processes, time series forecasting, and statistical education. In his spare time, Professor Bowerman enjoys watching movies and sports, playing tennis, and designing houses.

Richard T. O'Connell Richard T. O'Connell is associate professor of decision sciences at Miami University in Oxford, Ohio. He has more than 35 years of experience teaching basic statistics, statistical quality control and process improvement, regression analysis, time series forecasting, and design of experiments to both undergraduate and graduate business students. He also has extensive consulting experience and has taught workshops dealing with statistical process control and process improvement for a variety of companies in the Midwest. In 2000 Professor O'Connell received an Effective Educator award from the Richard T. Farmer School of Business Administration. Together with Bruce L. Bowerman, he has written 16 textbooks. These include *Forecasting and Time Series: An Applied Approach; Forecasting, Time Series, and Regression: An Applied Approach* (also coauthored with Anne B. Koehler); and *Linear Statistical Models: An Applied Approach.* Professor O'Connell has published a number of articles in the area of innovative statistical education. He is one of the first college instructors in the United States to integrate statistical process control and process improvement methodology into his basic business statistics course. He (with Professor Bowerman) has written several articles advocating this approach. He has also given presentations on this subject at meetings such as the Joint Statistical Meetings of the American Statistical Association and the Workshop on Total Quality Management: Developing Curricula and Research Agendas (sponsored by the Production and Operations Management Society). Professor O'Connell received an M.S. degree in decision sciences from Northwestern University in 1973, and he is currently a member of both the Decision Sciences Institute and the American Statistical Association. In his spare time, Professor O'Connell enjoys fishing, collecting 1950s and 1960s rock music, and following the Green Bay Packers and Purdue University sports.

Emily S. Murphree Emily S. Murphree is Associate Professor of Statistics in the Department of Mathematics and Statistics at Miami University in Oxford, Ohio. She received her Ph.D. degree in statistics from the University of North Carolina and does research in applied probability. Professor Murphree received Miami's College of Arts and Science Distinguished Educator Award in 1998. In 1996, she was named one of Oxford's Citizens of the Year for her work with Habitat for Humanity and for organizing annual Sonia Kovalevsky Mathematical Sciences Days for area high school girls. Her enthusiasm for hiking in wilderness areas of the West motivated her current research on estimating animal population sizes.

FROM THE

In *Business Statistics in Practice, Sixth Edition,* we provide a modern, practical, and unique framework for teaching the first course in business statistics. As in previous editions, this edition uses real or realistic examples, continuing case studies, and a business improvement theme to teach business statistics. Moreover, we believe this sixth edition features significantly simplified explanations, an improved topic flow, and a judicious use of the best, most interesting examples. We now discuss the attributes and new features that we think make this book an effective learning tool. Specifically, the book includes:

- **Continuing case studies that tie together different statistical topics.** These continuing case studies span not only individual chapters but also groups of chapters. Students tell us that when new statistical topics are developed using familiar data from previous examples, their "fear factor" is reduced. For example, because the descriptive statistics chapters describe data sets associated with the marketing research, car mileage, payment time, and trash bag case studies, students feel more comfortable when these same studies are used as part of the initial discussions of sampling distributions, confidence intervals, and hypothesis testing. Similarly, because the simple linear regression chapter employs a data set relating Tasty Sub Shop restaurant revenue to population in the area, students feel more comfortable when the multiple regression chapter extends this case study and relates Tasty Sub Shop revenue to both population and business activity in the area. Of course, to keep the examples from becoming tired and overused, we introduce new case studies throughout the book.
- **Business improvement conclusions that explicitly show how statistical results lead to practical business decisions.** When appropriate, we conclude examples and case studies with a practical business improvement conclusion. To emphasize the text's theme of business improvement, icons BI are placed in the page margins to identify when statistical analysis has led to an important business conclusion. Each conclusion is also highlighted in yellow for additional clarity.
- **New chapter introductions that list learning objectives and preview the case study analysis to be carried out in each chapter.**
- **A shorter and more intuitive introduction to business statistics in Chapter 1.** Chapter 1 introduces data (using a new home sales example that illustrates the value of data), discusses data sources, and gives an intuitive presentation of sampling. The technical discussion of how to select random and other types of samples has been moved to Chapter 7 (Sampling and Sampling Distributions), but the reader has the option of reading the sampling discussion in Chapter 7 immediately after completing Chapter 1.
- **A streamlined discussion of the graphical and numerical methods of descriptive statistics in Chapters 2 and 3.** The streamlining has been accomplished by rewriting some explanations, using fewer examples, and focusing on the best, most interesting examples.
- **An improved discussion of probability and probability distributions.** In response to reviewer requests, we have moved the discussion of Bayes' Theorem (formerly in the decision theory chapter) and counting rules (formerly in an appendix) to optional sections in Chapter 4 (Probability). We have also moved the hypergeometric distribution (formerly in an appendix) to an optional section in Chapter 5 (Discrete Probability Distributions). In addition, we have simplified the overall discussions of discrete and continuous probability distributions, introduced continuous probability distributions using a more intuitive approach, and improved the explanation of the exponential distribution.
- **A simplified, unique, and more inferentially oriented approach to sampling distributions.** In previous editions, we have introduced sampling distributions by using the game show and stock return cases. Although many reviewers liked this approach, others preferred the introduction to sampling distributions to be more oriented toward statistical inference. In this new edition, we begin with a unique and realistic example of estimating the mean

AUTHORS

mileage of a population of six preproduction cars. Because four of the six cars will be taken to auto shows and not be subjected to testing (which could harm their appearance), the true population mean mileage is not known and must be estimated by using a random sample of two cars that will not be taken to auto shows. Expanding from this small example, we generalize the discussion and show the sampling distribution of the sample mean when we select a random sample of five cars from the first year's production of cars. The effect of sample size on the sampling distribution is then considered, as is the Central Limit Theorem.

- **A simpler discussion of confidence intervals employing a more graphical approach.** We have completely rewritten and shortened the introduction to confidence intervals, using a simpler, more graphical approach. We have also added other new graphics throughout the chapter to help students more easily construct and interpret confidence intervals.
- **A simpler and more streamlined discussion of hypothesis testing.** This discussion includes an improved explanation of how to formulate null and alternative hypotheses, new graphics, and a shorter, five-step hypothesis testing procedure. This procedure shows how to use the book's hypothesis testing summary boxes to implement both the critical value and *p*-value methods of hypothesis testing.
- **A new and better flowing discussion of simple and multiple regression analysis.** Previous editions intertwined two case studies through the basic discussion of simple regression and intertwined two case studies through the basic discussion of multiple regression. The book now employs a single new case, The Tasty Sub Shop Case, throughout the basic explanation of each technique. Based partly on how the real Quiznos restaurant chain suggests that business entrepreneurs evaluate potential sites for Quiznos restaurants, the Tasty Sub Shop case considers an entrepreneur who is evaluating potential sites for a Tasty Sub Shop restaurant. In the simple regression chapter, the entrepreneur predicts Tasty Sub Shop revenue by using population in the area. In the multiple regression chapter, the entrepreneur predicts Tasty Sub Shop revenue by using population and business activity in the area. After the basic explanations of simple regression and multiple regression are completed, a further example illustrating each technique is presented. (The fuel consumption case of previous editions is now an exercise.) All discussions have been simplified and improved, and there is a new presentation of interaction in the model-building chapter.
- **Increased emphasis on Excel (and to some extent, MINITAB) throughout the text.** Previous editions included approximately equal proportions of Excel, MINITAB, and MegaStat (an Excel add-in) outputs throughout the main text. Because three different types of output might seem overwhelming, we now include approximately equal proportions of Excel and MINITAB outputs throughout the main text. (MegaStat outputs appear in the main text only in advanced chapters where there is no viable way to use Excel.) There are now many more Excel outputs (which often replace the former MegaStat outputs) in the main text, and there are also more MINITAB outputs. The end-of-chapter appendices still show how to use all three software packages, and there are MegaStat outputs included in the end-of-chapter appendices that illustrate how to use MegaStat.

In conclusion, note that following this preface we give "A Tour of This Text's Features." This tour gives specific examples of the continuing case studies, business improvement conclusions, graphics, and other teaching pedagogies that we think make this text an effective learning tool. Also note that we give a summary of the specific chapter-by-chapter changes in the text on page xxii.

Bruce L. Bowerman
Richard T. O'Connell
Emily S. Murphree

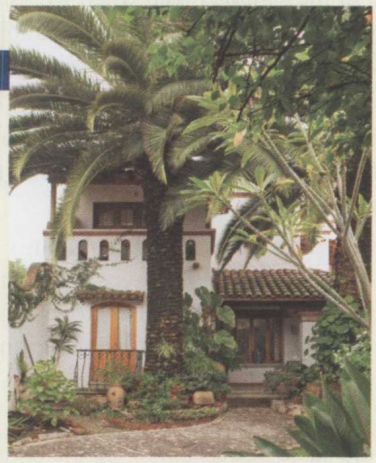
A TOUR OF THIS

Chapter Introductions

Each chapter begins with a list of the section topics that are covered in the chapter, along with chapter learning objectives and a preview of the case study analysis to be carried out in the chapter.

CHAPTER 1

An Introduction to Business Statistics



Learning Objectives

When you have mastered the material in this chapter, you will be able to:

- LO1 Explain what a variable is.
- LO2 Describe the difference between a quantitative variable and a qualitative variable.
- LO3 Describe the difference between cross-sectional data and time series data.
- LO4 Construct and interpret a time series (runs) plot.
- LO5 Identify the different types of data sources: existing data sources, experimental studies, and observational studies.
- LO6 Describe the difference between a population and a sample.
- LO7 Distinguish between descriptive statistics and statistical inference.
- LO8 Explain the importance of random sampling.
- LO9 Identify the ratio, interval, ordinal, and nominative scales of measurement (Optional).

Chapter Outline

1.1 Data
1.2 Data Sources
1.3 Populations and Samples
1.4 Three Case Studies That Illustrate Sampling and Statistical Inference
1.5 Ratio, Interval, Ordinal, and Nominative Scales of Measurement (Optional)

The subject of **statistics** involves the study of how to collect, analyze, and interpret data. **Data** are facts and figures from which conclusions can be drawn. Such conclusions are important to the decision making of many professions and organizations. For example, **economists** use conclusions drawn from the latest data on unemployment and inflation to help the government make policy decisions. **Financial planners** use recent trends in stock market prices and economic conditions to make investment decisions. **Accountants** use **sample data** concerning a company's *actual sales revenues* to assess whether the company's *claimed sales revenues* are valid. **Marketing professionals** help businesses decide which products to develop and market by using data that reveal consumer preferences. **Production supervisors** use manufacturing data to evaluate, control, and improve product quality. **Politicians** rely on data from public opinion polls to formulate legislation and to devise campaign strategies. **Physicians and hospitals** use data on the effectiveness of drugs and surgical procedures to provide patients with the best possible treatment.

In this chapter we begin to see how we collect and analyze data. As we proceed through the chapter, we introduce several case studies. These case studies (and others to be introduced later) are revisited throughout later chapters as we learn the statistical methods needed to analyze them. Briefly, we will begin to study three cases:

C

The Cell Phone Case. A bank estimates its cellular phone costs and decides whether to outsource management of its wireless resources by studying the calling patterns of its employees.

The Marketing Research Case. A bottling company investigates consumer reaction to a new bottle design for one of its popular soft drinks.

The Car Mileage Case. To determine if it qualifies for a federal tax credit based on fuel economy, an automaker studies the gas mileage of its new midsize model.

1.1 Data

LO1 Explain what a variable is.

Data sets, elements, and variables We have said that data are facts and figures from which conclusions can be drawn. Together, the data that are collected for a particular study are referred to as a **data set.** For example, Table 1.1 is a data set that gives information about the new homes sold in a Florida luxury home development over a recent three-month period. Potential buyers in this housing community could choose either the "Diamond" or the "Ruby" home model design and could have the home built on either a lake lot or a treed lot (with no water access).

In order to understand the data in Table 1.1, note that any data set provides information about some group of individual **elements,** which may be people, objects, events, or other entities. The information that a data set provides about its elements usually describes one or more characteristics of these elements.

Any characteristic of an element is called a **variable.**

For the data set in Table 1.1, each sold home is an element, and four variables are used to describe the homes. These variables are (1) the home model design, (2) the list (asking) price, (3) the (actual) selling price, and (4) the type of lot on which a home was built. Moreover, each home model design came with "everything included"—specifically, a complete, luxury interior package and a choice of one of three different architectural exteriors. Therefore, because there were no interior or exterior options to purchase, the (actual) selling price of a home depended solely on the home model design and whatever price reduction (based partially on the lot type) that the community developer (builder) was willing to give.

TABLE 1.1 A Data Set Describing Five Home Sales HomeSales

Home	Model Design	List Price	Selling Price	Lot Type
1	Diamond	$494,000	$494,000	Lake
2	Ruby	$447,000	$398,000	Treed
3	Diamond	$494,000	$440,000	Treed
4	Diamond	$494,000	$469,000	Treed
5	Ruby	$447,000	$447,000	Lake

Continuing Case Studies and Business Improvement Conclusions

The main chapter discussions feature real or realistic examples, continuing case studies, and a business improvement theme. The continuing case studies span not only individual chapters but also groups of chapters and tie together different statistical topics. To emphasize the text's theme of business improvement, icons BI are placed in the page margins to identify when statistical analysis has led to an important business improvement conclusion. Each conclusion is also highlighted in yellow for additional clarity. For example, in Chapters 1 and 3 we consider **The Cell Phone Case:**

TABLE 1.4 A Sample of Cellular Usages (in minutes) for 100 Randomly Selected Employees CellUse

75	485	37	547	753	93	897	694	797	477
654	578	504	670	490	225	509	247	597	173
496	553	0	198	507	157	672	296	774	479
0	822	705	814	20	513	546	801	721	273
879	433	420	521	648	41	528	359	367	948
511	704	535	585	341	530	216	512	491	0
542	562	49	505	461	496	241	624	885	259
571	338	503	529	737	444	372	555	290	830
719	120	468	730	853	18	479	144	24	513
482	683	212	418	399	376	323	173	669	611

EXAMPLE 3.5 The Cell Phone Case C

Remember that if the cellular cost per minute for the random sample of 100 bank employees is over 18 cents per minute, the bank will benefit from automated cellular management of its calling plans. Last month's cellular usages for the 100 randomly selected employees are given in Table 1.4 (page 9), and a dot plot of these usages is given in the page margin. If we add together the usages, we find that the 100 employees used a total of 46,625 minutes. Furthermore, the total cellular cost incurred by the 100 employees is found to be $9,317 (this total includes base costs, overage costs, long distance, and roaming). This works out to an average of $9,317/46,625 = $.1998, or 19.98 cents per minute. Because this average cellular cost per minute exceeds 18 cents per minute, the bank will hire the cellular management service to manage its calling plans.

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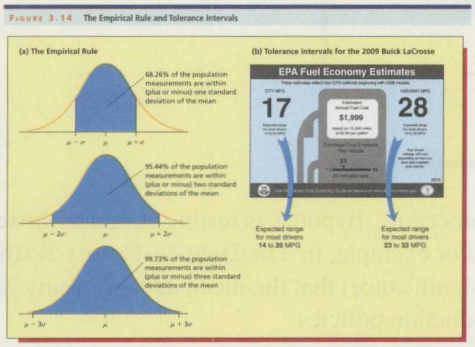
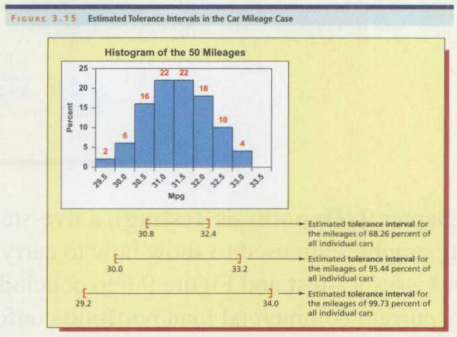
TEXT'S FEATURES

Figures and Tables

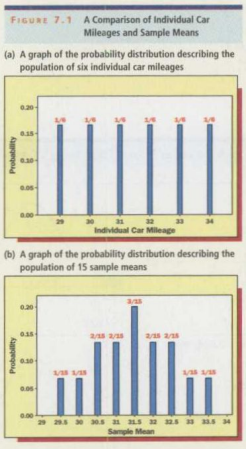
Throughout the text, charts, graphs, tables, and Excel and MINITAB outputs are used to illustrate statistical concepts. For example:

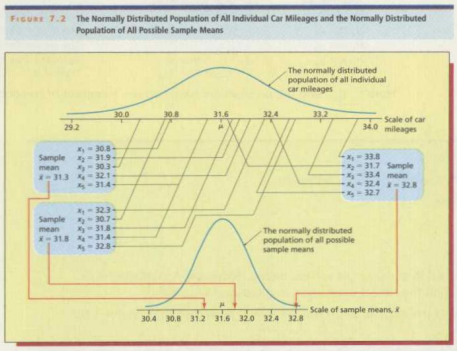
- In Chapter 3 (**Descriptive Statistics: Numerical Methods**), the following figures are used to help explain the **empirical rule**. Moreover, in **The Car Mileage Case** an automaker uses the empirical rule to find estimates of the "typical," "lowest," and "highest" mileage that a new midsize car should be expected to get in combined city and highway driving. In actual practice, real automakers provide similar information broken down into separate estimates for city and highway driving—see the Buick LaCrosse new car sticker in Figure 3.14.

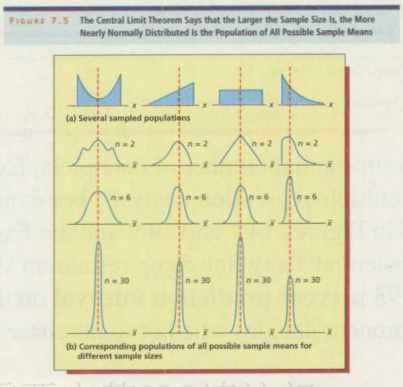


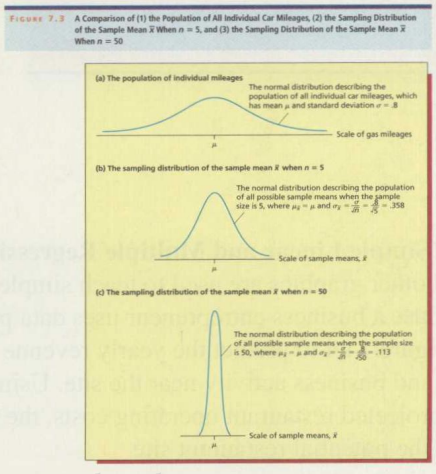


- In chapter 7 (**Sampling and Sampling Distributions**), the following figures (and others) are used to help explain the **sampling distribution of the sample mean** and the **Central Limit Theorem**. In addition, the figures describe different applications of random sampling in **The Car Mileage Case**, and thus this case is used as an integrative tool to help students understand sampling distributions.









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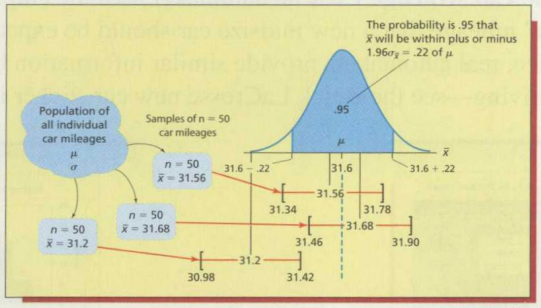
- In Chapter 8 (**Confidence Intervals**), the following figure (and others) are used to help explain the meaning of a **95 percent confidence interval** for the population mean. Furthermore, in **The Car Mileage Case** an automaker uses a confidence interval procedure specified by the Environmental Protection Agency (EPA) to find the EPA estimate of a new midsize model's true mean mileage. This estimate shows that the new midsize model's manufacturer deserves a federal tax credit.

FIGURE 8.2 Three 95 Percent Confidence Intervals for μ



- In Chapter 9 (**Hypothesis Testing**), a five-step hypothesis testing procedure, hypothesis testing summary boxes, and many graphics are used to show how to carry out hypothesis tests. For example, in **The Debt-to-Equity Ratio Case** a bank uses a ***t*-test** and Figure 9.6 to conclude (at the .01 level of significance) that the mean debt-to-equity ratio of its current commercial loan portfolio conforms to its new risk reduction policies.

A *t* Test about a Population Mean: σ Unknown

Define the test statistic

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

and assume that the population sampled is normally distributed or the sample size is large (at least 30). We can test $H_0: \mu = \mu_0$ versus a particular alternative hypothesis at level of significance α by using the appropriate critical value rule, or, equivalently, the corresponding *p*-value.

Alternative Hypothesis	Critical Value Rule: Reject H_0 if	*p*-Value (reject H_0 if *p*-value $< \alpha$)
$H_a: \mu > \mu_0$	$t > t_\alpha$	The area under the *t* distribution curve to the right of *t*
$H_a: \mu < \mu_0$	$t < -t_\alpha$	The area under the *t* distribution curve to the left of *t*
$H_a: \mu \neq \mu_0$	$\lvert t \rvert > t_{\alpha/2}$—that is, $t > t_{\alpha/2}$ or $t < -t_{\alpha/2}$	Twice the area under the *t* distribution curve to the right of $\lvert t \rvert$

Here t_α, $t_{\alpha/2}$, and the *p*-values are based on $n - 1$ degrees of freedom.

The Five Steps of Hypothesis Testing

1 State the null hypothesis H_0 and the alternative hypothesis H_a.
2 Specify the level of significance α.
3 Select the test statistic.

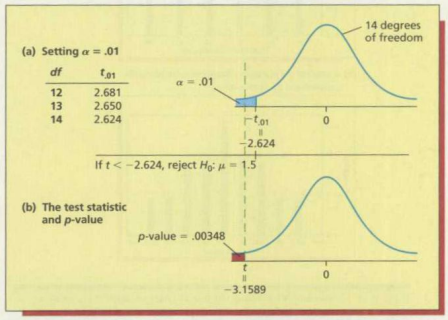
Using a critical value rule:

4 Use the summary box to find the critical value rule corresponding to the alternative hypothesis. Use the specified value of α to find the critical value given in the critical value rule.
5 Collect the sample data, compute the value of the test statistic, and decide whether to reject H_0. Interpret the statistical results.

Using a *p*-value:

4 Collect the sample data, compute the value of the test statistic, and compute the *p*-value. (Use the summary box to find the *p*-value corresponding to the alternative hypothesis.)
5 Reject H_0 at level of significance α if the *p*-value is less than α. Interpret the statistical results.

FIGURE 9.6 Testing $H_0: \mu = 1.5$ versus $H_a: \mu < 1.5$ by Using a Critical Value and the *p*-Value




```
Test of mu = 1.5 vs < 1.5
                                                  95% Upper
Variable    N     Mean    StDev   SE Mean     Bound       T       P
Ratio      15   1.3433   0.1921    0.0496    1.4307   -3.16   0.003
```

- In Chapters 13 and 14 (**Simple Linear and Multiple Regression**), a substantial number of data plots, Excel and MINITAB outputs, and other graphics are used to teach simple and multiple regression analysis. For example, in **The Tasty Sub Shop Case** a business entrepreneur uses data plotted in Figures 14.1 and 14.2 and the Excel and MINITAB outputs in Figure 14.4 to predict the yearly revenue of a potential Tasty Sub Shop restaurant site on the basis of the population and business activity near the site. Using the **95 percent prediction interval** on the MINITAB output and projected restaurant operating costs, the entrepreneur decides whether to purchase a Tasty Sub Shop franchise for the potential restaurant site.

TEXT'S FEATURES

FIGURE 14.1 Plot of y (Yearly Revenue) versus x_1 (Population Size)

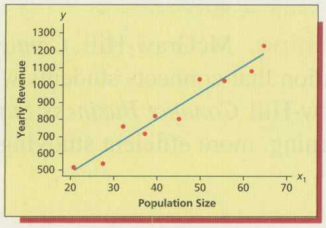


FIGURE 14.2 Plot of y (Yearly Revenue) versus x_2 (Business Rating)

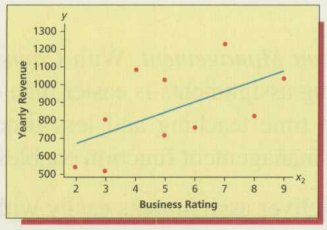


FIGURE 14.4 Excel and MINITAB Outputs of a Regression Analysis of the Tasty Sub Shop Revenue Data in Table 14.1 Using the Model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon$

(a) The Excel output

Regression Statistics	
Multiple R	0.9905
R Square	0.9810 [8]
Adjusted R Square	0.9756 [9]
Standard Error	36.6856 [7]
Observations	10

ANOVA

	df	SS	MS	F	Significance F
Regression	2	486355.7 [10]	243177.8	180.689 [13]	9.46E-07 [14]
Residual	7	9420.8 [11]	1345.835		
Total	9	495776.5 [12]			

	Coefficients	Standard Error [4]	t Stat [5]	P-value [6]	Lower 95% [19]	Upper 95% [19]
Intercept	125.289 [1]	40.9333	3.06	0.0183	28.4969	222.0807
population	14.1996 [2]	0.9100	15.60	1.07E-06	12.0478	16.3517
bus_ratio	22.8107 [3]	5.7692	3.95	0.0055	9.1686	36.4527

(b) The MINITAB output

```
The regression equation is
revenue = 125 + 14.2 population + 22.8 bus_rating

Predictor        Coef    SE Coef [4]      T [5]      P [6]
Constant      125.29 [1]     40.93       3.06      0.018
population   14.1996 [2]      0.91       15.6      0.000
bus_rating    22.811 [3]     5.769       3.95      0.006

S = 36.6856 [7]          R-Sq = 98.1% [8]     R-Sq(adj) = 97.6% [9]

Analysis of Variance

Source          DF        SS          MS          F          P
Regression       2  486356 [10]      243178  180.69 [13]  0.000 [14]
Residual Error   7      9421 [11]        1346
Total            9  495777 [12]

Predicted Values for New Observations

New Obs      Fit [15]     SE Fit [16]          95% CI [17]          95% PI [18]
      1         956.6              15  (921.0,992.2)        (862.8,1050.4)

Values of Predictors for New Observations

New Obs  population  bus_rating
      1        47.3           7
```

[1] b_0 [2] b_1 [3] b_2 [4] s_{b_1} = standard error of the estimate b_1 [5] t statistics [6] p-values for t statistics [7] s = standard error [8] R^2 [9] Adjusted R^2 [10] Explained variation [11] SSE = Unexplained variation [12] Total variation [13] F(model) statistic [14] p-value for F(model) [15] $\hat{y}$ = point prediction when x_1 = 40 and x_2 = 10 [16] $s_{\hat{y}}$ = standard error of the estimate $\hat{y}$ [17] 95% confidence interval when x_1 = 40 and x_2 = 10 [18] 95% prediction interval when x_1 = 40 and x_2 = 10 [19] 95% confidence interval for β_i

Exercises

Many of the exercises in the text use real data. Data sets are identified by an icon in the text and are included on the Online Learning Center (OLC): www.mhhe.com/bowerman6e. Exercises in each section are broken into two parts—"Concepts" and "Methods and Applications"—and there are supplementary and Internet exercises at the end of each chapter.

2.7 Below we give pizza restaurant preferences for 25 randomly selected college students.

DS PizzaPizza

Godfather's	Little Caesar's	Papa John's	Pizza Hut	Domino's	Papa John's
Papa John's	Papa John's	Pizza Hut	Pizza Hut	Papa John's	Domino's
Little Caesar's	Domino's	Domino's	Godfather's	Pizza Hut	Papa John's
Pizza Hut	Pizza Hut	Papa John's	Papa John's	Godfather's	Papa John's
Domino's					

a Find the frequency distribution and relative frequency distribution for these data.
b Construct a percentage bar chart for these data.
c Construct a percentage pie chart for these data.
d Which restaurant is most popular with these students? Least popular?

Chapter Ending Material and Excel/MINITAB/MegaStat® Tutorials

The end-of-chapter material includes a chapter summary, a glossary of terms, important formula references, and comprehensive appendices that show students how to use Excel, MINITAB, and MegaStat.

Chapter Summary

We began this chapter by presenting and comparing several measures of **central tendency.** We defined the **population mean** and we saw how to estimate the population mean by using a **sample mean.** We also defined the **median** and **mode,** and we compared the mean, median, and mode for symmetrical distributions and for distributions that are skewed to the right or left. We then studied measures of **variation** (or *spread*). We defined the **range, variance,** and **standard deviation,** and we saw how to estimate a population variance and standard deviation by using a sample. We learned that a good way to interpret the standard deviation when a population is (approximately) normally distributed is to use the **empirical rule,** and we studied **Chebyshev's Theorem,** which gives us intervals containing reasonably large fractions of the population units no matter what the population's shape might be. We also saw that, when a data set is highly skewed, it is best to use **percentiles** and **quartiles** to measure variation, and we learned how to construct a **box-and-whiskers plot** by using the quartiles.

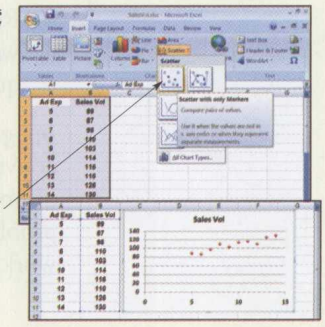
After learning how to measure and depict central tendency and variability, we presented several optional topics. First, we discussed several numerical measures of the relationship between two variables. These included the **covariance,** the **correlation coefficient,** and the **least squares line.** We then introduced the concept of a **weighted mean** and also explained how to compute descriptive statistics for **grouped data.** Finally, we showed how to calculate the **geometric mean** and demonstrated its interpretation.

Glossary of Terms

box-and-whiskers display (box plot): A graphical portrayal of a data set that depicts both the central tendency and variability of the data. It is constructed using Q_1, M_d, and Q_3. (pages 123, 124)
central tendency: A term referring to the middle of a population or sample of measurements. (page 101)
normal curve: A bell-shaped, symmetrical relative frequency curve. We will present the exact equation that gives this curve in Chapter 6. (page 113)
outer fences (in a box-and-whiskers display): Points located $3 \times IQR$ below Q_1 and $3 \times IQR$ above Q_3. (page 124)

Construct a scatter plot of sales volume versus advertising expenditure as in Figure 2.24 on page 67 (data file: SalesPlot.xlsx):

- Enter the advertising and sales data in Table 2.20 on page 67 into columns A and B—advertising expenditures in column A with label "Ad Exp" and sales values in column B with label "Sales Vol." **Note: The variable to be graphed on the horizontal axis must be in the first column** (that is, the left-most column) and **the variable to be graphed on the vertical axis must be in the second column** (that is, the rightmost column).
- Click in the range of data to be graphed, or select the entire range of the data to be graphed.
- Select **Insert : Scatter : Scatter with only Markers**
- The scatter plot will be displayed in a graphics window. Move the plot to a chart sheet and edit appropriately.



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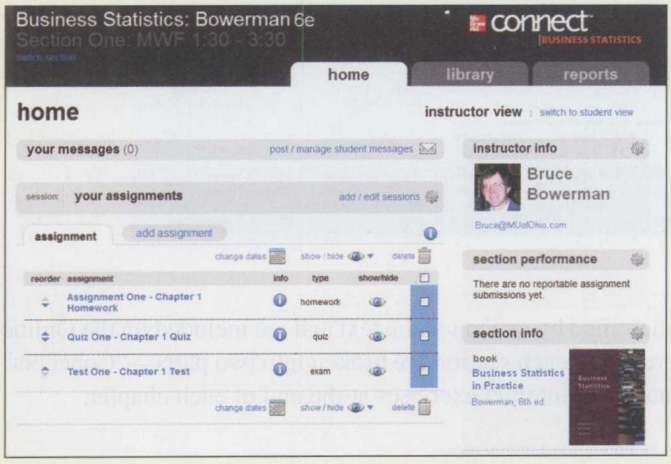

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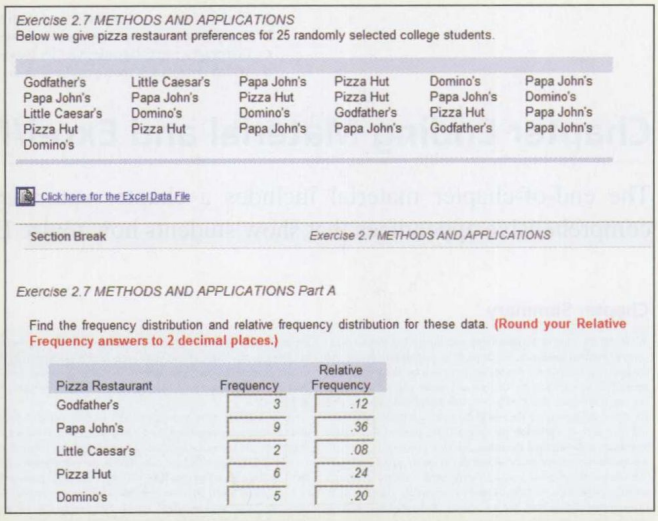
- Reinforce classroom concepts with practice tests and instant quizzes.



Integration of Excel Data Sets. A convenient feature is the inclusion of an Excel data file link in many problems using data sets in their calculation. This allows students to easily launch into Excel, work the problem, and return to Connect to key in the answer.

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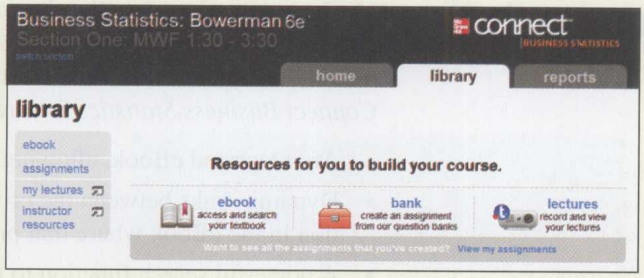

- eBook
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- Test Bank
- Solutions Manual
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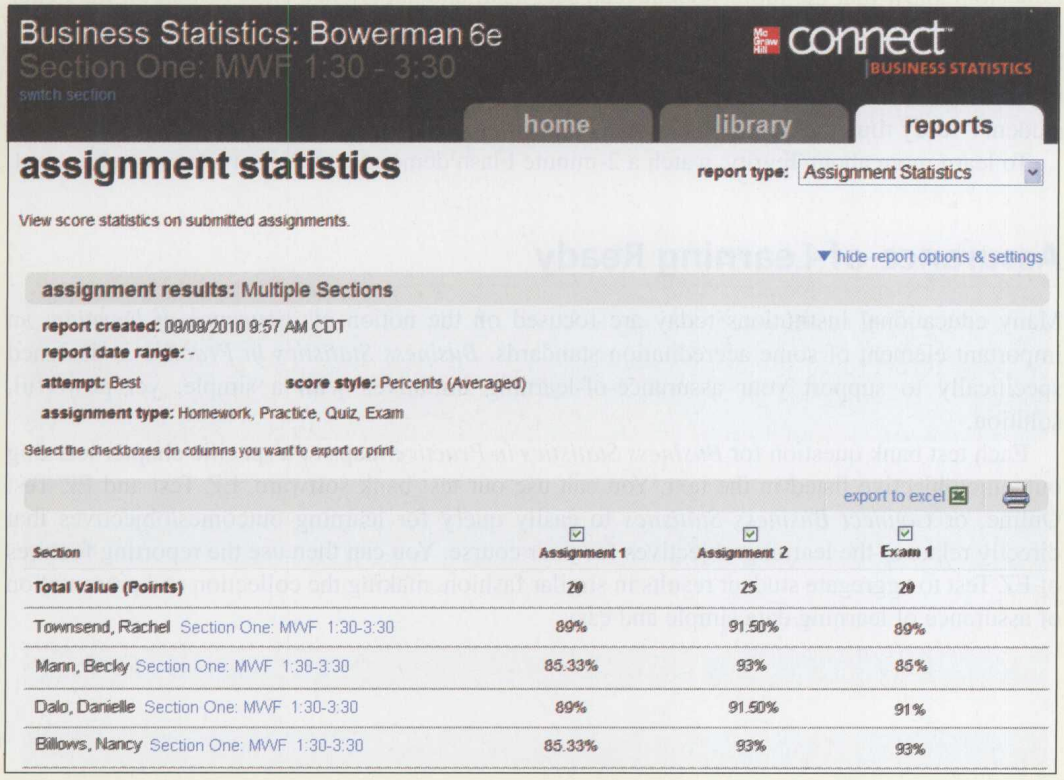

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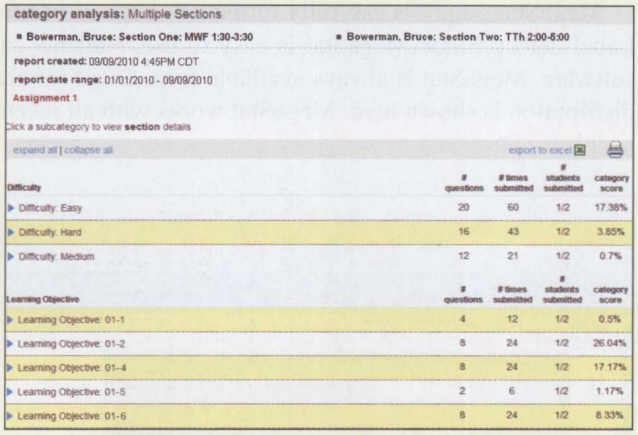

category analysis: Multiple Sections

■ Bowerman, Bruce: Section One: MWF 1:30-3:30 ■ Bowerman, Bruce: Section Two: TTh 2:00-5:00

report created: 09/09/2010 4:45PM CDT

report date range: 01/01/2010 - 09/09/2010

Assignment 1

Click a subcategory to view **section** details

expand all | collapse all export to excel

Difficulty	# questions	# times submitted	# students submitted	category score
Difficulty: Easy	20	60	1/2	17.38%
Difficulty: Hard	16	43	1/2	3.85%
Difficulty: Medium	12	21	1/2	0.7%

Learning Objective	# questions	# times submitted	# students submitted	category score
Learning Objective: 01-1	4	12	1/2	0.5%
Learning Objective: 01-2	8	24	1/2	26.04%
Learning Objective: 01-4	8	24	1/2	17.17%
Learning Objective: 01-5	2	6	1/2	1.17%
Learning Objective: 01-6	8	24	1/2	8.33%

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