50. Most people can roll their tongues, but many can't. The ability to roll the tongue is genetically determined. Suppose we are interested in determining what proportion of students can roll their tongues. We test a simple random sample of 400 students and find that 317 can roll their tongues. The margin of error for a 95% confidence interval for the true proportion of tongue rollers among students is closest to

(a) 0.0008. (c) 0.03. (e) 0.05.
(b) 0.02. (d) 0.04.

51. You want to design a study to estimate the proportion of students at your school who agree with the statement, "The student government is an effective organization for expressing the needs of students to the administration." You will use a 95% confidence interval, and you would like the margin of error to be 0.05 or less. The minimum sample size required is

(a) 22. (b) 271. (c) 385. (d) 769. (e) 1795.

52. A newspaper reporter asked an SRS of 100 residents in a large city for their opinion about the mayor's job performance. Using the results from the sample, the C% confidence interval for the proportion of all residents in the city who approve of the mayor's job performance is 0.565 to 0.695. What is the value of C?

(a) 82 (b) 86 (c) 90 (d) 95 (e) 99

Exercises 53 and 54 refer to the following setting. The following table displays the number of accidents at a factory during each hour of a 24-hour shift (1 = 1:00 A.M.).

Hour	Number of accidents	Hour	Number of accidents
1	5	13	21
2	8	14	12
3	17	15	10
4	31	16	1
5	24	17	0
6	18	18	1
7	12	19	3
8	7	20	21
9	1	21	23
10	0	22	18
11	2	23	11
12	14	24	2

53. **Accidents happen** (1.2, 3.1)

(a) Construct a plot that displays the distribution of the number of accidents effectively.

(b) Construct a plot that shows the relationship between the number of accidents and the time when they occurred.

(c) Describe something that the plot in part (a) tells you about the data that the plot in part (b) does not.

(d) Describe something that the plot in part (b) tells you about the data that the plot in part (a) does not.

54. **Accidents happen** (1.3) Plant managers are concerned that the number of accidents may be significantly higher during the midnight to 8:00 A.M. shift than during the 4:00 P.M. to midnight shift. What would you tell them? Give appropriate statistical evidence to support your conclusion.

8.3 Estimating a Population Mean

WHAT YOU WILL LEARN By the end of the section, you should be able to:

- State and check the Random, 10%, and Normal/Large Sample conditions for constructing a confidence interval for a population mean.
- Explain how the *t* distributions are different from the standard Normal distribution and why it is necessary to use a *t* distribution when calculating a confidence interval for a population mean.
- Determine critical values for calculating a *C*% confidence interval for a population mean using a table or technology.
- Construct and interpret a confidence interval for a population mean.
- Determine the sample size required to obtain a *C*% confidence interval for a population mean with a specified margin of error.

- In practice, we use the sample proportion $\hat{p}$ to estimate the unknown parameter p. We therefore replace the standard deviation of $\hat{p}$ with its **standard error** when constructing a confidence interval. The $C\%$ **confidence interval** for p is

$$\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

where z^* is the standard Normal **critical value** with $C\%$ of its area between $-z^*$ and z^*.

- When constructing a confidence interval, follow the four-step process:

STEP 4

STATE: What *parameter* do you want to estimate, and at what *confidence level*?

PLAN: Identify the appropriate inference *method*. Check *conditions*.

DO: If the conditions are met, perform *calculations*.

CONCLUDE: *Interpret* your interval in the context of the problem.

- The sample size needed to obtain a confidence interval with approximate margin of error ME for a population proportion involves solving

$$z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \le ME$$

for n, where $\hat{p}$ is a guessed value for the sample proportion, and z^* is the critical value for the confidence level you want. Use $\hat{p} = 0.5$ if you don't have a good idea about the value of $\hat{p}$.

8.2 TECHNOLOGY CORNER

TI-Nspire Instructions in Appendix B; HP Prime instructions on the book's Web site.

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Section 8.2 Exercises

For Exercises 27 to 30, check whether each of the conditions is met for calculating a confidence interval for the population proportion p.

27. **Rating school food** Latoya wants to estimate what proportion of the seniors at her boarding high school like the cafeteria food. She interviews an SRS of 50 of the 175 seniors living in the dormitory. She finds that 14 think the cafeteria food is good. pg 494

28. **High tuition costs** Glenn wonders what proportion of the students at his school believe that tuition is too high. He interviews an SRS of 50 of the 2400 students at his college. Thirty-eight of those interviewed think tuition is too high.

29. **AIDS and risk factors** In the National AIDS Behavioral Surveys sample of 2673 adult heterosexuals, 0.2% had both received a blood transfusion and had a sexual partner from a group at high risk of AIDS. We want to estimate the proportion p in the population who share these two risk factors.

30. **Whelks and mussels** The small round holes you often see in sea shells were drilled by other sea creatures, who ate the former dwellers of the shells

Whelks often drill into mussels, but this behavior appears to be more or less common in different locations. Researchers collected whelk eggs from the coast of Oregon, raised the whelks in the laboratory, then put each whelk in a container with some delicious mussels. Only 9 of 98 whelks drilled into a mussel.[11] The researchers want to estimate the proportion p of Oregon whelks that will spontaneously drill into mussels.

98% confidence Find z^* for a 98% confidence interval using Table A or your calculator. Show your method.

93% confidence Find z^* for a 93% confidence interval using Table A or your calculator. Show your method.

Going to the prom Tonya wants to estimate what proportion of her school's seniors plan to attend the prom. She interviews an SRS of 50 of the 750 seniors in her school and finds that 36 plan to go to the prom.

(a) Identify the population and parameter of interest.

(b) Check conditions for constructing a confidence interval for the parameter.

(c) Construct a 90% confidence interval for p. Show your method.

(d) Interpret the interval in context.

Reporting cheating What proportion of students are willing to report cheating by other students? A student project put this question to an SRS of 172 undergraduates at a large university: "You witness two students cheating on a quiz. Do you go to the professor?" Only 19 answered "Yes."[12]

(a) Identify the population and parameter of interest.

(b) Check conditions for constructing a confidence interval for the parameter.

(c) Construct a 99% confidence interval for p. Show your method.

(d) Interpret the interval in context.

Binge drinking In a recent National Survey of Drug Use and Health, 2312 of 5914 randomly selected full-time U.S. college students were classified as binge drinkers.[13]

(a) Calculate and interpret a 99% confidence interval for the population proportion p that are binge drinkers.

(b) A newspaper article claims that 45% of full-time U.S. college students are binge drinkers. Use your result from part (a) to comment on this claim.

STEP 4

36. **Teens' texting** A Pew Internet and American Life Project survey found that 392 of 799 randomly selected teens reported texting with their friends every day.

(a) Calculate and interpret a 95% confidence interval for the population proportion p that would report texting with their friends every day.

(b) Is it plausible that the true proportion of American teens who text with their friends every day is 0.45? Use your result from part (a) to support your answer.

37. **Binge drinking** Describe a possible source of error that is not included in the margin of error for the 99% confidence interval in Exercise 35.

38. **Teens' texting** Describe a possible source of error that is not included in the margin of error for the 95% confidence interval in Exercise 36.

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STEP 4

39. **How common is SAT coaching?** A random sample of students who took the SAT college entrance examination twice found that 427 of the respondents had paid for coaching courses and that the remaining 2733 had not.[14] Construct and interpret a 99% confidence interval for the proportion of coaching among students who retake the SAT.

STEP 4

40. **2010 begins** In January 2010 a Gallup Poll asked a random sample of adults, "In general, are you satisfied or dissatisfied with the way things are going in the United States at this time?" In all, 256 said that they were satisfied and the remaining 769 said they were not. Construct and interpret a 90% confidence interval for the proportion of adults who are satisfied with how things are going.

41. **Equality for women?** Have efforts to promote equality for women gone far enough in the United States? A poll on this issue by the cable network MSNBC contacted 1019 adults. A newspaper article about the poll said, "Results have a margin of sampling error of plus or minus 3 percentage points."[15]

(a) The news article said that 65% of men, but only 43% of women, think that efforts to promote equality have gone far enough. Explain why we do not have enough information to give confidence intervals for men and women separately.

(b) Would a 95% confidence interval for women alone have a margin of error less than 0.03, about equal to 0.03, or greater than 0.03? Why? (You see that the news article's statement about the margin of error for poll results is a bit misleading.)

42. **A TV poll** A television news program conducts a call-in poll about a proposed city ban on handgun ownership. Of the 2372 calls, 1921 oppose the ban.

The station, following recommended practice, makes a confidence statement: "81% of the Channel 13 Pulse Poll sample opposed the ban. We can be 95% confident that the true proportion of citizens opposing a handgun ban is within 1.6% of the sample result." Is the station's conclusion justified? Explain.

43. **Can you taste PTC?** PTC is a substance that has a strong bitter taste for some people and is tasteless for others. The ability to taste PTC is inherited. About 75% of Italians can taste PTC, for example. You want to estimate the proportion of Americans who have at least one Italian grandparent and who can taste PTC.

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(a) How large a sample must you test to estimate the proportion of PTC tasters within 0.04 with 90% confidence? Answer this question using the 75% estimate as the guessed value for $\hat{p}$.

(b) Answer the question in part (a) again, but this time use the conservative guess $\hat{p} = 0.5$. By how much do the two sample sizes differ?

44. **School vouchers** A national opinion poll found that 44% of all American adults agree that parents should be given vouchers that are good for education at any public or private school of their choice. The result was based on a small sample.

(a) How large an SRS is required to obtain a margin of error of 0.03 (that is, ±3%) in a 99% confidence interval? Answer this question using the previous poll's result as the guessed value for $\hat{p}$.

(b) Answer the question in part (a) again, but this time use the conservative guess $\hat{p} = 0.5$. By how much do the two sample sizes differ?

45. **Election polling** Gloria Chavez and Ronald Flynn are the candidates for mayor in a large city. We want to estimate the proportion p of all registered voters in the city who plan to vote for Chavez with 95% confidence and a margin of error no greater than 0.03. How large a random sample do we need? Show your work.

46. **Starting a nightclub** A college student organization wants to start a nightclub for students under the age of 21. To assess support for this proposal, they will select an SRS of students and ask each respondent if he or she would patronize this type of establishment. What sample size is required to obtain a 90% confidence interval with an approximate margin of error of 0.04? Show your work.

47. **Teens and their TV sets** According to a Gallup Poll report, 64% of teens aged 13 to 17 have TVs in their rooms. Here is part of the footnote to this report:

These results are based on telephone interviews with a randomly selected national sample of 1028 teenagers in the Gallup Poll Panel of households, aged 13 to 17. For results based on this sample, one can say . . . that the maximum error attributable to sampling and other random effects is ±3 percentage points. In addition to sampling error, question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of public opinion polls.[16]

(a) We omitted the confidence level from the footnote. Use what you have learned to determine the confidence level, assuming that Gallup took an SRS.

(b) Give an example of a "practical difficulty" that could lead to biased results for this survey.

48. **Gambling and the NCAA** Gambling is an issue of great concern to those involved in college athletics. Because of this concern, the National Collegiate Athletic Association (NCAA) surveyed randomly selected student athletes concerning their gambling-related behaviors.[17] Of the 5594 Division I male athletes in the survey, 3547 reported participation in some gambling behavior. This includes playing cards, betting on games of skill, buying lottery tickets, betting on sports, and similar activities. A report of this study cited a 1% margin of error.

(a) The confidence level was not stated in the report. Use what you have learned to find the confidence level, assuming that the NCAA took an SRS.

(b) The study was designed to protect the anonymity of the student athletes who responded. As a result, it was not possible to calculate the number of students who were asked to respond but did not. How does this fact affect the way that you interpret the results?

Multiple choice: Select the best answer for Exercises 49 to 52.

49. A Gallup Poll found that only 28% of American adults expect to inherit money or valuable possessions from a relative. The poll's margin of error was ±3 percentage points at a 95% confidence level. This means that

(a) the poll used a method that gets an answer within 3% of the truth about the population 95% of the time.

(b) the percent of all adults who expect an inheritance is between 25% and 31%.

(c) if Gallup takes another poll on this issue, the results of the second poll will lie between 25% and 31%.

(d) there's a 95% chance that the percent of all adults who expect an inheritance is between 25% and 31%.

(e) Gallup can be 95% confident that between 25% and 31% of the sample expect an inheritance.