

11.2 Exercises

Vocabulary and Core Concept Check

- 1. COMPLETE THE SENTENCE** A portion of a population that can be studied in order to make predictions about the entire population is a(n) _____.
- 2. WRITING** Describe the difference between a parameter and a statistic. Give an example of each.
- 3. VOCABULARY** What is a hypothesis in statistics?
- 4. WRITING** Describe two ways you can make an incorrect decision when analyzing a hypothesis.

Monitoring Progress and Modeling with Mathematics

In Exercises 5–8, determine whether the data are collected from a population or a sample. Explain your reasoning.

- 5.** the number of high school students in the United States
- 6.** the color of every third car that passes your house
- 7.** a survey of 100 spectators at a sporting event with 1800 spectators
- 8.** the age of each dentist in the United States

In Exercises 9–12, identify the population and sample. Describe the sample. (See Example 1.)

- 9.** In the United States, a survey of 1152 adults ages 18 and over found that 403 of them pretend to use their smartphones to avoid talking to someone.



- 10.** In the United States, a survey of 1777 adults ages 18 and over found that 1279 of them do some kind of spring cleaning every year.
- 11.** In a school district, a survey of 1300 high school students found that 1001 of them like the new, healthy cafeteria food choices.
- 12.** In the United States, a survey of 2000 households with at least one child found that 1280 of them eat dinner together every night.



In Exercises 13–16, determine whether the numerical value is a parameter or a statistic. Explain your reasoning. (See Example 2.)

- 13.** The average annual salary of some physical therapists in a state is \$76,210.
- 14.** In a recent year, 53% of the senators in the United States Senate were Democrats.
- 15.** Seventy-three percent of all the students in a school would prefer to have school dances on Saturday.
- 16.** A survey of U.S. adults found that 10% believe a cleaning product they use is not safe for the environment.
- 17. ERROR ANALYSIS** A survey of 1270 high school students found that 965 students felt added stress because of their workload. Describe and correct the error in identifying the population and the sample.



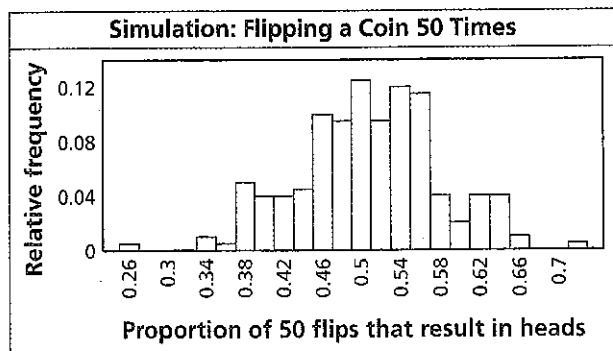
The population consists of all the students in the high school. The sample consists of the 965 students who felt added stress.

- 18. ERROR ANALYSIS** Of all the players on a National Football League team, the mean age is 26 years. Describe and correct the error in determining whether the mean age represents a parameter or statistic.

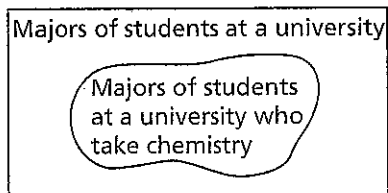


Because the mean age of 26 is based only on one football team, it is a statistic.

19. **MODELING WITH MATHEMATICS** You flip a coin 4 times and do not get a tails. You suspect this coin favors heads. The coin maker claims that the coin does not favor heads. You simulate flipping the coin 50 times by repeatedly drawing 200 random samples of size 50. The histogram shows the results. What should you conclude when you flip the actual coin 50 times and get (a) 27 heads and (b) 33 heads? (See Example 3.)



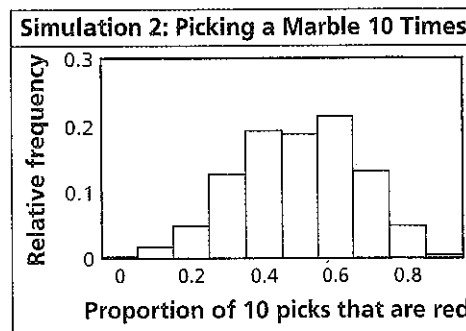
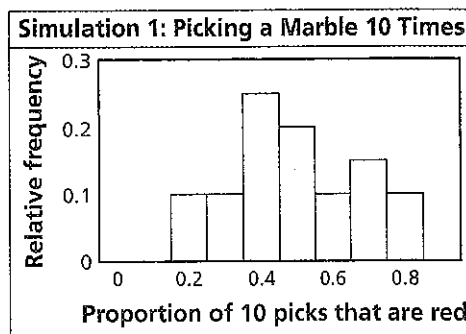
20. **MODELING WITH MATHEMATICS** Use the histogram in Exercise 19 to determine what you should conclude when you flip the actual coin 50 times and get (a) 17 heads and (b) 23 heads.
21. **MAKING AN ARGUMENT** A random sample of five people at a movie theater from a population of 200 people gave the film 4 out of 4 stars. Your friend concludes that everyone in the movie theater would give the film 4 stars. Is your friend correct? Explain your reasoning.
22. **HOW DO YOU SEE IT?** Use the Venn diagram to identify the population and sample. Explain your reasoning.



23. **OPEN-ENDED** Find a newspaper or magazine article that describes a survey. Identify the population and sample. Describe the sample.

24. **THOUGHT PROVOKING** You choose a random sample of 200 from a population of 2000. Each person in the sample is asked how many hours of sleep he or she gets each night. The mean of your sample is 8 hours. Is it possible that the mean of the entire population is only 7.5 hours of sleep each night? Explain.

25. **DRAWING CONCLUSIONS** You perform two simulations of repeatedly selecting a marble out of a bag with replacement that contains three red marbles and three blue marbles. The first simulation uses 20 random samples of size 10, and the second uses 400 random samples of size 10. The histograms show the results. Which simulation should you use to accurately analyze a hypothesis? Explain.



26. **PROBLEM SOLVING** You roll an eight-sided die five times and get a four every time. You suspect that the die favors the number four. The die maker claims that the die does not favor the number four.

- Perform a simulation involving 50 trials of rolling the actual die and getting a four to test the die maker's claim. Display the results in a histogram.
- What should you conclude when you roll the actual die 50 times and get 20 fours? 7 fours?

Maintaining Mathematical Proficiency

Reviewing what you learned in previous grades and lessons

Solve the equation by completing the square. (Section 3.3)

27. $x^2 - 10x - 4 = 0$

28. $3r^2 + 6t = 18$

29. $s^2 + 10s + 8 = 0$

Solve the equation using the Quadratic Formula. (Section 3.4)

30. $n^2 + 2n + 2 = 0$

31. $4z^2 + 28z = 15$

32. $5w - w^2 = -11$

Vocabulary and Core Concept Check

- VOCABULARY** Describe the difference between a stratified sample and a cluster sample.
- COMPLETE THE SENTENCE** A sample for which each member of a population has an equal chance of being selected is a(n) _____ sample.
- WRITING** Describe a situation in which you would use a simulation to collect data.
- WRITING** Describe the difference between an unbiased sample and a biased sample. Give one example of each.

Monitoring Progress and Modeling with Mathematics

In Exercises 5–8, identify the type of sample described. (See Example 1.)

- The owners of a chain of 260 retail stores want to assess employee job satisfaction. Employees from 12 stores near the headquarters are surveyed.
- Each employee in a company writes their name on a card and places it in a hat. The employees whose names are on the first two cards drawn each win a gift card.
- A taxicab company wants to know whether its customers are satisfied with the service. Drivers survey every tenth customer during the day.
- The owner of a community pool wants to ask patrons whether they think the water should be colder. Patrons are divided into four age groups, and a sample is randomly surveyed from each age group.

In Exercises 9–12, identify the type of sample and explain why the sample is biased. (See Example 2.)

- A town council wants to know whether residents support having an off-leash area for dogs in the town park. Eighty dog owners are surveyed at the park.



- A sportswriter wants to determine whether baseball coaches think wooden bats should be mandatory in collegiate baseball. The sportswriter mails surveys to all collegiate coaches and uses the surveys that are returned.
- You want to find out whether booth holders at a convention were pleased with their booth locations. You divide the convention center into six sections and survey every booth holder in the fifth section.
- Every tenth employee who arrives at a company health fair answers a survey that asks for opinions about new health-related programs.
- ERROR ANALYSIS** Surveys are mailed to every other household in a neighborhood. Each survey that is returned is used. Describe and correct the error in identifying the type of sample that is used.



Because the surveys were mailed to every other household, the sample is a systematic sample.

- ERROR ANALYSIS** A researcher wants to know whether the U.S. workforce supports raising the minimum wage. Fifty high school students chosen at random are surveyed. Describe and correct the error in determining whether the sample is biased.

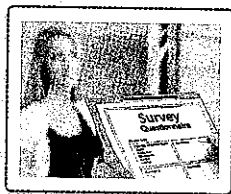


Because the students were chosen at random, the sample is not biased.

In Exercises 15–18, determine whether the sample is biased. Explain your reasoning.

15. Every third person who enters an athletic event is asked whether he or she supports the use of instant replay in officiating the event.
16. A governor wants to know whether voters in the state support building a highway that will pass through a state forest. Business owners in a town near the proposed highway are randomly surveyed.
17. To assess customers' experiences making purchases online, a rating company e-mails purchasers and asks that they click on a link and complete a survey.
18. Your school principal randomly selects five students from each grade to complete a survey about classroom participation.

19. **WRITING** The staff of a student newsletter wants to conduct a survey of the students' favorite television shows. There are 1225 students in the school. Describe a method for selecting a random sample of 250 students to survey. (See Example 3.)



20. **WRITING** A national collegiate athletic association wants to survey 15 of the 120 head football coaches in a division about a proposed rules change. Describe a method for selecting a random sample of coaches to survey.

In Exercises 21–24, identify the method of data collection the situation describes. (See Example 4.)

21. A researcher uses technology to estimate the damage that will be done if a volcano erupts.



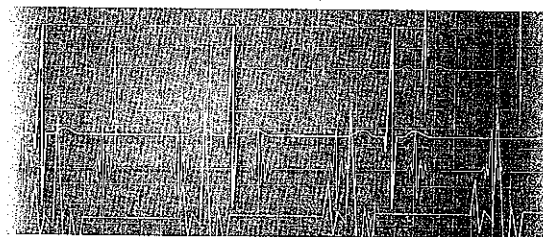
22. The owner of a restaurant asks 20 customers whether they are satisfied with the quality of their meals.
23. A researcher compares incomes of people who live in rural areas with those who live in large urban areas.
24. A researcher places bacteria samples in two different climates. The researcher then measures the bacteria growth in each sample after 3 days.

In Exercises 25–28, explain why the survey question may be biased or otherwise introduce bias into the survey. Then describe a way to correct the flaw. (See Example 5.)

25. "Do you agree that the budget of our city should be cut?"
26. "Would you rather watch the latest award-winning movie or just read some book?"
27. "The tap water coming from our western water supply contains twice the level of arsenic of water from our eastern supply. Do you think the government should address this health problem?"
28. A child asks, "Do you support the construction of a new children's hospital?"

In Exercises 29–32, determine whether the survey question may be biased or otherwise introduce bias into the survey. Explain your reasoning.

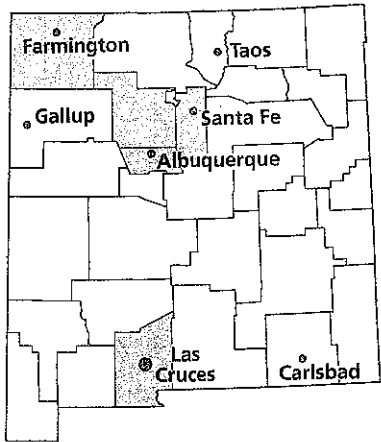
29. "Do you favor government funding to help prevent acid rain?"
30. "Do you think that renovating the old town hall would be a mistake?"
31. A police officer asks mall visitors, "Do you wear your seat belt regularly?"
32. "Do you agree with the amendments to the Clean Air Act?"
33. **REASONING** A researcher studies the effect of fiber supplements on heart disease. The researcher identified 175 people who take fiber supplements and 175 people who do not take fiber supplements. The study found that those who took the supplements had 19.6% fewer heart attacks. The researcher concludes that taking fiber supplements reduces the chance of heart attacks.



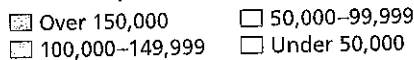
- a. Explain why the researcher's conclusion may not be valid.
- b. Describe how the researcher could have conducted the study differently to produce valid results.

34. **HOW DO YOU SEE IT?** A poll is conducted to predict the results of a statewide election in New Mexico before all the votes are counted. Fifty voters in each of the state's 33 counties are asked how they voted as they leave the polls.

- Identify the type of sample described.
- Explain how the diagram shows that the polling method could result in a biased sample.



Population by County



35. **WRITING** Consider each type of sample listed on page 610. Which of the samples are most likely to lead to biased results? Explain.

36. **THOUGHT PROVOKING** What is the difference between a “blind experiment” and a “double-blind experiment?” Describe a possible advantage of the second type of experiment over the first.

37. **WRITING** A college wants to survey its graduating seniors to find out how many have already found jobs in their field of study after graduation.

- What is the objective of the survey?
- Describe the population for the survey.
- Write two unbiased questions for the survey.

38. **REASONING** About 3.2% of U.S. adults follow a vegetarian-based diet. Two randomly selected groups of people were asked whether they follow such a diet. The first sample consists of 20 people and the second sample consists of 200 people. Which sample proportion is more likely to be representative of the national percentage? Explain.

39. **MAKING AN ARGUMENT** The U.S. Census is taken every 10 years to gather data from the population. Your friend claims that the sample cannot be biased. Is your friend correct? Explain.

40. **OPEN-ENDED** An airline wants to know whether travelers have enough leg room on its planes.



- What method of data collection is appropriate for this situation?
- Describe a sampling method that is likely to give biased results. Explain.
- Describe a sampling method that is *not* likely to give biased results. Explain.
- Write one biased question and one unbiased question for this situation.

41. **REASONING** A website contains a link to a survey that asks how much time each person spends on the Internet each week.

- What type of sampling method is used in this situation?
- Which population is likely to respond to the survey? What can you conclude?

Maintaining Mathematical Proficiency

Reviewing what you learned in previous grades and lessons

Evaluate the expression without using a calculator. (Section 5.1)

42. $4^{5/2}$

43. $27^{2/3}$

44. $-64^{1/3}$

45. $8^{-2/3}$

Simplify the expression. (Section 5.2)

46. $(4^{3/2} \cdot 4^{1/4})^4$

47. $(6^{1/3} \cdot 3^{1/3})^{-2}$

48. $\sqrt[3]{4} \cdot \sqrt[3]{16}$

49. $\frac{\sqrt[4]{405}}{\sqrt[3]{5}}$

Vocabulary and Core Concept Check

1. **COMPLETE THE SENTENCE** Repetition of an experiment under the same or similar conditions is called _____.
2. **WRITING** Describe the difference between the control group and the treatment group in a controlled experiment.

Monitoring Progress and Modeling with Mathematics

In Exercises 3 and 4, determine whether the study is a randomized comparative experiment. If it is, describe the treatment, the treatment group, and the control group. If it is not, explain why not and discuss whether the conclusions drawn from the study are valid.

(See Example 1.)

3. **Insomnia**

New Drug Improves Sleep

To test a new drug for insomnia, a pharmaceutical company randomly divided 200 adult volunteers into two groups. One group received the drug and one group received a placebo. After one month, the adults who took the drug slept 18% longer, while those who took the placebo experienced no significant change.


4. **Dental Health**


Milk Fights Cavities

At a middle school, students can choose to drink milk or other beverages at lunch. Seventy-five students who chose milk were monitored for one year, as were 75 students who chose other beverages. At the end of the year, students in the "milk" group had 25% fewer cavities than students in the other group.

ERROR ANALYSIS In Exercises 5 and 6, describe and correct the error in describing the study.

A company's researchers want to study the effects of adding shea butter to their existing hair conditioner. They monitor the hair quality of 30 randomly selected customers using the regular conditioner and 30 randomly selected customers using the new shea butter conditioner.

5.  The control group is individuals who do not use either of the conditioners.

6.  The study is an observational study.

In Exercises 7–10, explain whether the research topic is best investigated through an experiment or an observational study. Then describe the design of the experiment or observational study. (See Example 2.)

7. A researcher wants to compare the body mass index of smokers and nonsmokers.
8. A restaurant chef wants to know which pasta sauce recipe is preferred by more diners.
9. A farmer wants to know whether a new fertilizer affects the weight of the fruit produced by strawberry plants.
10. You want to know whether homes that are close to parks or schools have higher property values.
11. **DRAWING CONCLUSIONS** A company wants to test whether a nutritional supplement has an adverse effect on an athlete's heart rate while exercising. Identify a potential problem, if any, with each experimental design. Then describe how you can improve it. (See Example 3.)
 - a. The company randomly selects 250 athletes. Half of the athletes receive the supplement and their heart rates are monitored while they run on a treadmill. The other half of the athletes are given a placebo and their heart rates are monitored while they lift weights. The heart rates of the athletes who took the supplement significantly increased while exercising.
 - b. The company selects 1000 athletes. The athletes are divided into two groups based on age. Within each age group, the athletes are randomly assigned to receive the supplement or the placebo. The athletes' heart rates are monitored while they run on a treadmill. There was no significant difference in the increases in heart rates between the two groups.

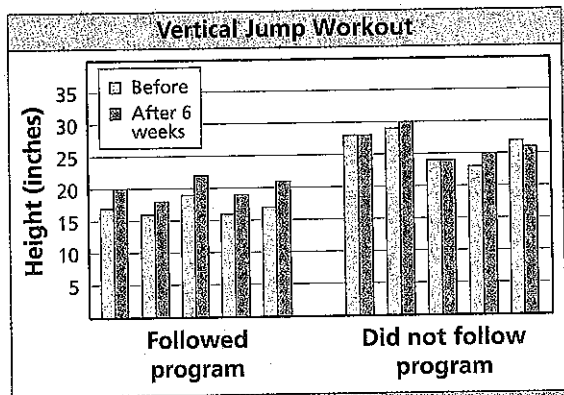
12. **DRAWING CONCLUSIONS** A researcher wants to test the effectiveness of reading novels on raising intelligence quotient (IQ) scores. Identify a potential problem, if any, with each experimental design. Then describe how you can improve it.

- a. The researcher selects 500 adults and randomly divides them into two groups. One group reads novels daily and one group does not read novels. At the end of 1 year, each adult is evaluated and it is determined that neither group had an increase in IQ scores.

- b. Fifty adults volunteer to spend time reading novels every day for 1 year. Fifty other adults volunteer to refrain from reading novels for 1 year. Each adult is evaluated and it is determined that the adults who read novels raised their IQ scores by 3 points more than the other group.



13. **DRAWING CONCLUSIONS** A fitness company claims that its workout program will increase vertical jump heights in 6 weeks. To test the workout program, 10 athletes are divided into two groups. The double bar graph shows the results of the experiment. Identify the potential problems with the experimental design. Then describe how you can improve it.



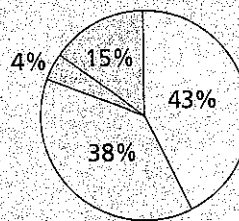
14. **WRITING** Explain why observational studies, rather than experiments, are usually used in astronomy.

15. **MAKING AN ARGUMENT** Your friend wants to determine whether the number of siblings has an effect on a student's grades. Your friend claims to be able to show causality between the number of siblings and grades. Is your friend correct? Explain.

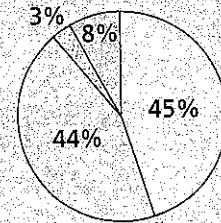
16. **HOW DO YOU SEE IT?** To test the effect political advertisements have on voter preferences, a researcher selects 400 potential voters and randomly divides them into two groups. The circle graphs show the results of the study.

Survey Results

Watching 30 Minutes of TV with No Ads



Watching 30 Minutes of TV with Ads for Candidate B



Legend: Candidate A (white), Candidate B (light gray), Candidate C (medium gray), Undecided (dark gray)

- a. Is the study a randomized comparative experiment? Explain.
- b. Describe the treatment.
- c. Can you conclude that the political advertisements were effective? Explain.

17. **WRITING** Describe the *placebo effect* and how it affects the results of an experiment. Explain how a researcher can minimize the placebo effect.

18. **THOUGHT PROVOKING** Make a hypothesis about something that interests you. Design an experiment that could show that your hypothesis is probably true.

19. **REASONING** Will replicating an experiment on many individuals produce data that are more likely to accurately represent a population than performing the experiment only once? Explain.

Maintaining Mathematical Proficiency

Reviewing what you learned in previous grades and lessons

Draw a dot plot that represents the data. Identify the shape of the distribution. (*Skills Review Handbook*)

20. Ages: 24, 21, 22, 26, 22, 23, 25, 23, 23, 24, 20, 25

21. Golf strokes: 4, 3, 4, 3, 3, 2, 7, 5, 3, 4

Tell whether the function represents *exponential growth* or *exponential decay*. Then graph the function. (*Section 6.1*)

22. $y = 4^x$

23. $y = (0.95)^x$

24. $y = (0.2)^x$

25. $y = (1.25)^x$