

**IN CLASS ACTIVITY****Different Sampling Methods**

The following question was recently asked by the Gallup Organization: In general, are you satisfied or dissatisfied with the way things are going in the country?

- (a) Number the students in the class from 1 to  $N$ , where  $N$  is the number of students. Obtain a simple random sample and have them answer this question. Record the number of satisfied responses and the number of dissatisfied responses.
- (b) Divide the students in the class by gender. Treat each gender as a stratum. Obtain a simple random sample from each stratum and have them answer this question. Record the number of satisfied responses and the number of dissatisfied responses.
- (c) Treat each row of desks as a cluster. Obtain a simple random sample of clusters and have each student in the selected clusters answer this question. Record the number of satisfied responses and the number of dissatisfied responses.
- (d) Number the students in the class from 1 to  $N$ , where  $N$  is the number of students. Obtain a systematic sample and have the selected students answer this question. Record the number of satisfied responses and the number of dissatisfied responses.
- (e) Were there any differences in the results of the survey? State some reasons for any differences.

**1.4 ASSESS YOUR UNDERSTANDING****Concepts and Vocabulary**

1. Describe a circumstance in which stratified sampling would be an appropriate sampling method.
2. Which sampling method does not require a frame?
3. Why are convenience samples ill advised?
4. A(n) \_\_\_\_\_ is obtained by dividing the population into groups and selecting all individuals from within a random sample of the groups.
5. A(n) \_\_\_\_\_ is obtained by dividing the population into homogeneous groups and randomly selecting individuals from each group.
6. *True or False:* When taking a systematic random sample of size  $n$ , every group of size  $n$  from the population has the same chance of being selected.
7. *True or False:* A simple random sample is always preferred because it obtains the same information as other sampling plans but requires a smaller sample size.
8. *True or False:* When conducting a cluster sample, it is better to have fewer clusters with more individuals when the clusters are heterogeneous.
9. *True or False:* Inferences based on voluntary response samples are generally not reliable.
10. *True or False:* When obtaining a stratified sample, the number of individuals included within each stratum must be equal.

**Skill Building**

*In Problems 11–22, identify the type of sampling used.*

11. To estimate the percentage of defects in a recent manufacturing batch, a quality-control manager at Intel selects every 8th chip that comes off the assembly line starting with the 3rd until she obtains a sample of 140 chips.
12. To determine the prevalence of human growth hormone (HGH) use among high school varsity baseball players, the State Athletic Commission randomly selects 50 high schools. All members of the selected high schools' varsity baseball teams are tested for HGH.
13. **NW** To determine customer opinion of its boarding policy, Southwest Airlines randomly selects 60 flights during a certain week and surveys all passengers on the flights.
14. A member of Congress wishes to determine her constituency's opinion regarding estate taxes. She divides her constituency into three income classes: low-income households, middle-income households, and upper-income households. She then takes a simple random sample of households from each income class.
15. In an effort to identify if an advertising campaign has been effective, a marketing firm conducts a nationwide poll by randomly selecting individuals from a list of known users of the product.
16. A radio station asks its listeners to call in their opinion regarding the use of U.S. forces in peacekeeping missions.

17. A farmer divides his orchard into 50 subsections, randomly selects 4, and samples all the trees within the 4 subsections to approximate the yield of his orchard.
18. A school official divides the student population into five classes: freshman, sophomore, junior, senior, and graduate student. The official takes a simple random sample from each class and asks the members' opinions regarding student services.
19. A survey regarding download time on a certain website is administered on the Internet by a market research firm to anyone who would like to take it.
20. The presider of a guest-lecture series at a university stands outside the auditorium before a lecture begins and hands every fifth person who arrives, beginning with the third, a speaker evaluation survey to be completed and returned at the end of the program.
21. To determine his DSL Internet connection speed, Shawn divides up the day into four parts: morning, midday, evening, and late night. He then measures his Internet connection speed at 5 randomly selected times during each part of the day.
22. 24 Hour Fitness wants to administer a satisfaction survey to its current members. Using its membership roster, the club randomly selects 40 club members and asks them about their level of satisfaction with the club.
23. A salesperson obtained a systematic sample of size 20 from a list of 500 clients. To do so, he randomly selected a number from 1 to 25, obtaining the number 16. He included in the sample the 16th client on the list and every 25th client thereafter. List the numbers that correspond to the 20 clients selected.
24. A quality-control expert wishes to obtain a cluster sample by selecting 10 of 795 clusters. She numbers the clusters from 1 to 795. Using Table I from Appendix A, she closes her eyes and drops a pencil on the table. It points to the digit in row 8, column 38. Using this position as the starting point and proceeding downward, determine the numbers for the 10 clusters selected.

### Applying the Concepts

**25. Stratified Sampling** The Future Government Club wants to sponsor a panel discussion on the upcoming national election. The club wants to have four of its members lead the panel discussion. To be fair, however, the panel should consist of two Democrats and two Republicans. From the list of current members of the club, obtain a stratified sample of two Democrats and two Republicans to serve on the panel.

Democrats		Republicans	
Bolden	Motola	Blouin	Ochs
Bolt	Nolan	Cooper	Pechtold
Carter	Opacian	De Young	Redmond
Debold	Pawlak	Engler	Rice
Fallenbuchel	Ramirez	Grajewski	Salihar
Haydra	Tate	Keating	Thompson
Khoury	Washington	May	Trudeau
Lukens	Wright	Niemeyer	Zenkel

**26. Stratified Sampling** The owner of a private food store is concerned about employee morale. She decides to survey the managers and hourly employees to see if she can learn about work environment and job satisfaction. From the list of workers at the store, obtain a stratified sample of two managers and four hourly employees to survey.

Managers		Hourly Employees		
Carlisle	Oliver	Archer	Foushi	Massie
Hills	Orsini	Bolcerek	Gow	Musa
Kats	Ullrich	Bryant	Grove	Nickas
Lindsey	McGuffin	Cole	Hall	Salazar
		Dimas	Houston	Vaneck
		Ellison	Kemp	Weber
		Everhart	Lathus	Zavodny

27. **Systematic Sample** The human resource department at a certain company wants to conduct a survey regarding worker morale. The department has an alphabetical list of all 4,502 employees at the company and wants to conduct a systematic sample.
  - (a) Determine  $k$  if the sample size is 50.
  - (b) Determine the individuals who will be administered the survey. More than one answer is possible.
28. **Systematic Sample** To predict the outcome of a county election, a newspaper obtains a list of all 945,035 registered voters in the county and wants to conduct a systematic sample.
  - (a) Determine  $k$  if the sample size is 130.
  - (b) Determine the individuals who will be administered the survey. More than one answer is possible.
29. **Which Method?** The mathematics department at a university wishes to administer a survey to a sample of students taking college algebra. The department is offering 32 sections of college algebra, similar in class size and makeup, with a total of 1,280 students. They would like the sample size to be roughly 10% of the population of college algebra students this semester. How might the department obtain a simple random sample? A stratified sample? A cluster sample? Which method do you think is best in this situation?
30. **Good Sampling Method?** To obtain students' opinions about proposed changes to course registration procedures, the administration of a small college asked for faculty volunteers who were willing to administer a survey in one of their classes. Twenty-three faculty members volunteered. Each of these faculty members gave the survey to all the students in one course of their choosing. Would this sampling method be considered a cluster sample? Why or why not?
31. **Sample Design** The city of Naperville is considering the construction of a new commuter rail station. The city wishes to survey the residents of the city to obtain their opinion regarding the use of tax dollars for this purpose. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.
32. **Sample Design** A school board at a local community college is considering raising the student services fees. The board wants to obtain the opinion of the student body before proceeding. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.

- 33. Sample Design** Target wants to open a new store in the village of Lockport. Before construction, Target's marketers want to obtain some demographic information regarding the area under consideration. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.
- 34. Sample Design** The county sheriff wishes to determine if a certain highway has a high proportion of speeders traveling on it. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.
- 35. Sample Design** A pharmaceutical company wants to conduct a survey of 30 individuals who have high cholesterol. The company has obtained a list from doctors throughout the country of 6,600 individuals who are known to have high cholesterol. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.
- 36. Sample Design** A marketing executive for Coca-Cola, Inc., wants to identify television shows that people in the Boston area who typically drink Coke are watching. The executive has a list of all households in the Boston area. Design a sampling method to obtain the individuals in the sample. Be sure to support your choice.
- 37. Putting It Together: Comparing Sampling Methods** Suppose a political strategist wants to get a sense of how American adults aged 18 years or older feel about health care and health insurance.
- In a political poll, what would be a good frame to use for obtaining a sample?
  - Explain why simple random sampling may not guarantee that the sample has an accurate representation of registered Democrats, registered Republicans, and registered Independents.
  - How can stratified sampling guarantee this representation?
- 38. Putting It Together: Thinking about Randomness** What is random sampling? Why is it necessary for a sample to be obtained randomly rather than conveniently? Will randomness guarantee that a sample will provide accurate information about the population? Explain.
- 39.** Research the origins of the Gallup Poll and the current sampling method the organization uses. Report your findings to the class.
- 40.** Research the sampling methods used by a market research firm in your neighborhood. Report your findings to the class. The report should include the types of sampling methods used, number of stages, and sample size.

## 1.5 BIAS IN SAMPLING

### Objective



1 Explain the sources of bias in sampling



### 1 Explain the Sources of Bias in Sampling

#### Note to Instructor

If you are pressed for time, this section can be given to the students as a reading assignment with light in-class coverage.

#### Definition

If the results of the sample are not representative of the population, then the sample has **bias**.

#### In Other Words

The word *bias* could mean to give preference to selecting some individuals over others. It could also mean that certain responses are more likely to occur in the sample than in the population.

There are three sources of bias in sampling:

1. Sampling bias
2. Nonresponse bias
3. Response bias

#### Sampling Bias

**Sampling bias** means that the technique used to obtain the individuals to be in the sample tends to favor one part of the population over another. Any convenience sample has sampling bias because the individuals are not chosen through a random sample. For example, a voluntary response sample will have sampling bias because the opinions of individuals who decide to be in the sample are probably not representative of the population as a whole.

Sampling bias also results due to *undercoverage*. **Undercoverage** occurs when the proportion of one segment of the population is lower in a sample than it is in the population. Undercoverage can result because the frame used to obtain the sample is incomplete or not representative of the population. Recall that the frame is the list of all individuals in the population under study. Sometimes, obtaining the