11-8 Samples and Surveys

Content Standards

S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Also S.IC.3, S.IC.4, S.IC.6

Objectives To identify sampling methods
To recognize bias in samples and surveys

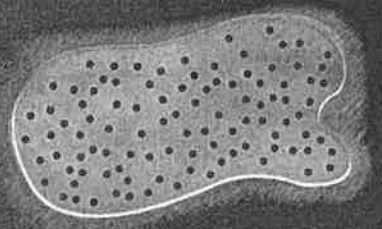
What happened to the other fish you tagged?

MATHEMATICAL PRACTICES

SOLVE IT!

Getting Ready!

One day, you catch 100 fish at random from a lake. You tag the fish and then release them back into the lake. The next day you again catch 100 fish at random, as shown on the map. The red dots indicate the fish that have your tags. What can you conclude? Justify your conclusion.



Lesson Vocabulary
- population
- sample
- convenience sample
- self-selected sample
- systematic sample
- random sample
- bias
- observational study
- controlled experiment
- survey

A **population** is all the members of a set. A **sample** is part of a population. If you determine a sample carefully, the statistics for the sample can be used to make general conclusions about the larger population.

Essential Understanding You can get good statistical information about a population by studying a sample of the population.

Suppose you want to know what percent of all voters in your city favor a tax increase to pay for school improvements. It likely would be impossible to ask an opinion of every voter. So instead you select a sample of the voters to estimate the percentage who favor the idea.

You can define different sample types by the methods used to select them.

take note **Key Concepts** **Sampling Types and Methods**

For a **convenience sample**, select any members of the population who are conveniently and readily available.

For a **self-selected sample**, select only members of the population who volunteer for the sample.

For a **systematic sample**, order the population in some way, and then select from it at regular intervals.

In a **random sample**, all members of the population are equally likely to be chosen.

Samples vary in how well they reflect a population. A sample has a *bias* when a part of a population is overrepresented or underrepresented. A **bias** is a systematic error introduced by the sampling method.

Problem 1 Analyzing Sampling Methods

Public Opinion A newspaper wants to find out what percent of the city population favors a property tax increase to raise money for local parks. What is the sampling method used for each situation? Does the sample have a bias? Explain.

Think
Who are the people in the sample?
The people in the sample are only those who might be selected. In this case, only those who visit the website.

A **A newspaper article on the tax increase invites readers to express their opinions on the newspaper's website.**

This is a self-selected sample. It might have a bias, depending on who visits the website. The people who respond may overrepresent or underrepresent some views. For example, some property owners who are against the tax might organize a campaign to get friends and neighbors to visit the website.

B **A reporter interviews people leaving the city's largest park.**

This is a convenience sample, since it is convenient for the reporter to stay in one place. Because the location is near a park, the sample may overrepresent park supporters and the results will have a bias.

C **A survey service calls every 50th listing from the local phone book.**

This is a systematic sample because the phone listing is ordered alphabetically. The regular sampling interval is every 50 listings. This sample may have a bias if there is some link between people who are listed (or not listed) in a phone book and people who pay property taxes.

Got It? 1. **a.** To survey the eating habits of the community, employees of a local television station interview people visiting a food court in the mall. What sampling method are they using? Does the sample have a bias? Explain.
b. Reasoning A poll of every person in the population is a *census*. What is a situation that requires a census instead of a sample?

One way to collect sample information is to perform a study.

Take Note **Key Concepts** **Study Methods**

In an **observational study**, you measure or observe members of a sample in such a way that they are not affected by the study.

In a **controlled experiment**, you divide the sample into two groups. You impose a treatment on one group but not on the other "control" group. Then you compare the effect on the treated group to the control group.

In a **survey**, you ask every member of the sample a set of questions.

A poorly designed study can result in unreliable statistics. You should always analyze a study's methods before making general conclusions about the population.

Problem 2 Analyzing Study Methods

Which type of study method is described in each situation? Should the sample statistics be used to make a general conclusion about the population?

A Researchers randomly choose two groups from 10 volunteers. Over a period of 8 weeks, one group eats ice cream before going to sleep, and the other does not. Volunteers wear monitoring devices while sleeping, and researchers record dream activity.

This is an example of a controlled experiment. The statistics for this study are based on such a small sample that the findings are unreliable as a general conclusion.

B Students in a science class record the height of bean plants as they grow.

This is an observational study. The statistics may provide a general conclusion about the growth rate of a bean plant. However, soil type, amount of sunlight and water, fertilizer, and other factors could affect the growth rate.

Think
How can you tell if a sample is a random sample?
In a random sample, each group of the same size is equally likely to be chosen.

C Student council members ask every tenth student in the lunch line if they like the cafeteria food.

This is a survey. The results are not reliable because people waiting in line are more likely to enjoy the cafeteria food than those who brought their lunch from home.

Got It? 2. A pharmaceutical company asks for volunteers to test a new drug to treat high blood pressure. Half of the volunteers will be given the drug, and half will be given a placebo. The researcher will monitor the blood pressure of each volunteer. Which type of study method is the researcher using? Should the sample statistics be used to make a general conclusion about the effectiveness of the drug in the larger population? Explain.

Problem 3 Designing a Survey

Sports During the 2008 Olympic Games, a U.S. swimmer won more medals than any other swimmer in history. What sampling method could you use to find the percent of students in your school who recognize that swimmer from a photograph? What is an example of a survey question that is likely to yield information that has no bias?

Think
How do you think of a survey question that has no bias?
Keep it simple. The simplest question is likely to be the least biased.

A possible sampling method is to question every 10th student entering school in the morning. This is a systematic sampling. It usually contains the least bias. A possible unbiased survey question is, "Who is pictured in this photograph?".

Got It? 3. What sampling method could you use to find the percent of residents in your neighborhood who recognize the governor of your state by name? What is an example of a survey question that is likely to yield information that has no bias?

Lesson Check

Do you know HOW?

1. To investigate a community's reading habits, a newspaper conducts a poll from a table near the exit of a history museum.
   a. What is the sampling method?
   b. Does the sampling method have any bias? Explain.
2. A survey asks, "Aren't handmade gifts always better than tacky purchased gifts?" Does this survey question have any bias? Explain.

Do you UNDERSTAND? MATHEMATICAL PRACTICES

3. **Vocabulary** What is the difference between a population and a sample? Give an example of each.
4. **Writing** What does it mean to have an unbiased sample? Why does it matter?
5. **Reasoning** Would a large or small sample tend to give a better estimate of how the total population feels about a topic? Explain.

Practice and Problem-Solving Exercises MATHEMATICAL PRACTICES

A Practice

Identify the sampling method. Then identify any bias in each method. See Problem 1.

6. A supermarket wants to find the percent of shoppers who use coupons. A manager interviews every shopper entering the greeting card aisle.
7. A maintenance crew wants to estimate how many of 3000 air filters in a 30-story office building need replacing. The crew examines five filters chosen at random on each floor of the building.
8. The student government wants to find out how many students have after-school jobs. A pollster interviews students selected at random as they board buses at the end of the school day.

See Problem 2.

For Exercises 9–11, identify the type of study method described in each situation and explain whether the sample statistics can be used to make a general conclusion about the population.

9. A list of students is randomly generated from the school database. Information for every student is entered into the database, and each student has an equally likely chance of being selected. The students selected are asked how much time they spend on household chores each week.
10. The local librarian collects data about the types of books that are checked out so that she can place a new book order accordingly. She records the type of book checked out by every other person each day for three weeks.
11. **Gardening** A gardener tests a new plant food by planting seeds from the same package in the same soil and location. Each plant is given the same amount of water, but one plant is given food and the other is given no food at all. He records the growth and flowering rates of each plant.

See Problem 3.

12. a. **Energy** What sampling method could you use to find the percent of adults in your community who support building more nuclear power plants?
    b. What is an example of a survey question that is likely to yield unbiased information?

Apply **A university researcher is studying the effect of watching television on residents of the city. Describe a sampling method that can be used for each population.**

13. all teenagers

14. all homeowners

15. all women over the age of 21

16. all children under the age of 13

17. Think About a Plan An online advertisement asks you to participate in a survey. The survey asks how much time you spend online each week. What sampling method is the survey using? Identify any bias in the sampling method.

- What population is likely to see the survey?
- What population is likely to respond to the survey?

18. Entertainment A magazine publisher mails a survey to every tenth person on a subscriber list. The survey asks for three favorite leisure activities. What sampling method is the survey using? Identify any bias in the sampling method.

19. Student government members survey every tenth student who enters the school building and asks whether students favor the school's new dress code. The sample statistics show that 54% favor the new dress code, 42% oppose the dress code, and 4% have no opinion.

a. What is the population?

b. What is the sample?

c. What general conclusion can be made about the population?

20. Compare and Contrast Describe how a convenience sample and a self-selected sample are alike and how they are different.

21. Elections In a recent election, a survey of randomly selected registered voters was conducted to determine which candidate was likely to win. 48% of respondents said that they would vote for candidate A, 46% would vote for candidate B, and 6% were undecided. Based on the sampling results, can you make a general conclusion that it is more likely that candidate A will win the election? Explain.

22. Customer Satisfaction A car dealership conducts a satisfaction survey. They randomly select a sample of 500 customers from a list of 5000 new customers in the past year. Of the 500 surveys sent, 300 are returned. The statistics show that the dealership is achieving a high level of customer satisfaction. Can the owner of the dealership assume this is true overall? Explain.

23. For a class project, a student studies the likelihood that students turn in their homework each day. For each of her classes, she observes the teacher collect homework. She records the number of students who turn in homework, and the number who do not. The resulting data show that 86% of students turned in homework on time and 5% of students did not turn in any homework at all during the week.

a. What type of sampling method was used?

b. What type of study was performed?

c. Can the student use these statistics to make a general conclusion about all students in her school? Explain.

Challenge

24. Open Ended The government uses a variety of methods to estimate how the general public is feeling about the economy. A researcher wants to conduct a study to determine whether people who live in his state are representative of the latest government results. What type of study should the researcher use? Explain.

25. In a recent telephone survey, respondents were asked questions to determine whether they supported the new law that required every passenger to wear a seat belt while in a moving vehicle. The first question was, "According to the National Highway Traffic Safety Administration, wearing seat belts could prevent 45% of the fatalities suffered in car accidents. Do you think that everyone should wear safety belts?" Does this question introduce a bias into the survey? Explain.

Standardized Test Prep

SAT/ACT

26. To determine the most popular brands of tea consumed by Americans, a survey is conducted in a busy downtown location at lunchtime. Which of the following is NOT a potential bias in the sampling method?

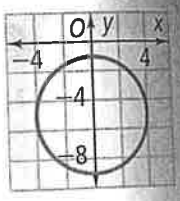
(A) Urban office employees are not representative of the general population.

(B) The results could be influenced by national brand teas available in the area.

(C) A lunchtime survey does not reflect peoples' tastes at other times of the day.

(D) The survey must include call-in and online responses.

27. Which is the equation for the graph of the circle at the right?



(F) $x^2 + (y - 5)^2 = 16$

(G) $x^2 + (y + 5)^2 = 16$

(H) $(x - 5)^2 + y^2 = 16$

(I) $(x + 5)^2 + y^2 = 16$

Short Response

28. What is the sum of the infinite geometric sequence? Show your work.

$\frac{2}{5}, \frac{4}{25}, \frac{8}{125}, \ldots$

Mixed Review

Find the mean and the standard deviation for each data set. See Lesson 11-7.

29. 0, 1, 1, 1, 2, 2, 2, 3, 3, 4, 5, 10

30. 1, 1, 2, 2, 3, 4, 5, 6, 8, 9, 10, 10, 12

Find the inverse of each function. Is the inverse a function? See Lesson 6-7.

31. $f(x) = 2x + 5$

32. $f(x) = x^2$

33. $f(x) = \frac{5x^2}{9}$

34. $f(x) = 3\sqrt{x}$

Get Ready! To prepare for Lesson 11-9, do Exercises 35–38.

Evaluate each expression. See Lesson 11-1.

35. ${}_4C_2$

36. ${}_3C_3$

37. ${}_5C_2$

38. ${}_{12}C_7$