**Objectives**

To identify sampling methods
To recognize bias in samples and surveys

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**Common Core State Standards**


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**Lesson Vocabulary**

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

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**Mathematical Practices**

- Probability

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**Math Background**

The statistical information you get about a population depends on the methods you use to sample the population. These methods may cause bias and influence the results of the studies. Understanding these can help to interpret the information more accurately.

**Sample Methods**

- Convenience sample: this may have bias when the members of the population who are conveniently and readily available do not represent all groups evenly.
- Self-selected sample: this may have bias when certain groups of people choose not to volunteer.
- Systematic sample: this may have bias when the method used to order the population does not include everyone.

**Study Methods**

- Observational study: this may introduce bias or inaccuracy depending on the measuring tools and human error.
- Controlled experiment: a double blind can help reduce bias.
- Survey: poorly written survey questions may introduce bias.

**Mathematical Practice**

Construct viable arguments and critique the reasoning of others. In their study of sampling types and methods, students will distinguish skewed data and offer ways to prevent bias while in the process, deciding whether certain arguments based on data make sense.
Problem 1

Q In 1A, what other concerns might you have about how the sample is collected? [Sample: Not everyone reads a newspaper.]

Q What is an example of a location that the reporter could have used in 1B that might have made the likelihood of bias less? [Sample: A grocery store]

EXTENSION

Q If the newspaper drew a conclusion about the public’s opinion on the proposed property tax in a future issue, why would you want to know what sampling method was used? [If the sample is random, then the conclusions reached by the newspaper are more reliable than if the sample is not random.]

Got It?

Q What question could more accurately be answered by the survey sample described in 1a? [Sample: What food do people choose to eat in the mall food court?]

Q For 1b, why would someone choose to use a sample instead of a census? [Sample: It might be too expensive or too time consuming to poll every member of a population.]

Take Note

Q Which study method would be the best to use to test the effectiveness of a new migraine headache pain reliever? Explain. [Controlled experiment; administer the new drug to one group of migraine sufferers and another drug to a control group of migraine sufferers, and then compare the effectiveness.]

Answers

Solve It!

There are about 3333 fish in the lake. You can estimate that for every 3 fish you tagged, there are 97 additional fish. $\frac{100}{3} = 33.\overline{3}$ and $33.\overline{3} \times 100 = 3333$.

Got It?

1. a. Convenience sample; yes, since the location is at the food court, the sample may overrepresent fast food supporters.

b. Sample: population data for the US census

2. Controlled study; if other factors of the volunteers are random, like age, gender, and overall health, the results can be used to make a general conclusion.

3. Answers may vary. Sample: Use a systematic sample. Go to every fifth house in your neighborhood. State the first and last names of the governor and ask a household member to identify the named person. A possible unbiased survey question is, “Who is this person?”.

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.

Q 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.

Q 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.

Q 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?

Notes

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.

- 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?

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?

**Additional Problems**

1. For each situation, what sampling method is used? Does the sample have a bias?

   a. A political candidate wants to know what percent of his constituency favors Referendum A on an upcoming ballot election. His staff asks each person who comes into the candidate’s office for three days whether they support Referendum A.

   b. The manager of a grocery store wants to determine what percent of shoppers use store coupons. He asks every tenth shopper who passes through the store’s door for the next week if he or she intends to use a store coupon on their visit.

   **ANSWERS**

   a. convenience sample; visitors to the office of the candidate may share the candidate’s opinions more than the population as a whole

   b. systematic sample; no

2. 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. Scientists study the effects of the phases of the moon on the levels of low tide and high tide in 200 coastal cities in the U.S. for a period of 12 months.

   b. A pet food company randomly chooses two groups of 20 puppies for a study. One group eats a new brand of dog food and the other group eats an off-brand dog food for a period of 4 weeks. Researchers record muscular and skeletal growth rates in both groups.

   c. For a class project, students in Health class ask every tenth student entering the school if they eat breakfast in the morning.

   **ANSWERS**

   a. observational study; The statistics are reliable since several locations were used and the data were collected for a year.

   b. controlled experiment; The statistics are unreliable since a small sample was used. Other factors may include the breeds of the dogs used in the experiment.

   c. survey; The results are reliable since a random sample was used.
3 Lesson Check

Do you know HOW?
• If students have difficulty identifying the bias of the survey question in Exercise 2, ask them to identify the adjectives in the question.

Do you UNDERSTAND?
• In Exercise 3, if students do not understand the difference between a population and a sample, use the class as an example of a population and a student as an example of a sample.
• For Exercise 4, if students are unsure what makes a sample unbiased, ask them what makes a sample biased.
• If students have difficulty with the reasoning in Exercise 5, pose questions about the fish pond in the Solve It. If you only caught one fish on the second day, and it was tagged, could you conclude that all the fish in the pond were tagged?

Close

Q What should be considered in determining the reliability of a given sample? [the sampling type and sampling method, the survey question or questions asked, and the size of the sample]

Answers

Lesson Check

1. a. convenience sample
   b. Yes; since the location is near the exit of a history museum, the sample may overrepresent people who enjoy learning history and the results will have a bias.
2. Yes; the question is leading and loaded. It suggests the person wants a particular answer.
3. All members of the set are the population. A sample is a subset of the population. Answers may vary. Sample: population: students in a high school; sample: students who like to snowboard.
4. It is important to have as little error as possible in a sample, thus giving an unbiased sample. An unbiased sample is more representative of an entire population.
5. A large sample size would give a better estimate. The size of the sample is important to the reliability of the sample.

Practice and Problem-Solving Exercises

6. Convenience sampling; This sampling method overrepresents shoppers that buy greeting cards.
7. systematic sampling; no bias
8. convenience sampling; If students walk or drive to school, or are involved in after school activities, they are underrepresented by this sampling method.
9. Survey; the statistics can be used to make a general conclusion about the population because the sample is randomly generated, and the survey question does not introduce a bias into the study.
10. Observational study; the statistics are somewhat unreliable in this study because not all library goers have an equally likely chance of being selected. Although the data collected cannot be used to make a general conclusion about the entire population, it may still give the librarian useful information to make her decision.

11. Controlled experiment; the statistics from this study can be used to make a general conclusion about the effectiveness of the plant food for this particular plant type as compared with giving no plant food at all.

12. a. Answers may vary. Sample: systematic sampling; call every 50th listing in the local phone book.
   b. Check students’ work.

13. Answers may vary. Sample: Convenience sampling; interview students at a local high school.

14. Sample: Systematic sampling; contact every 50th homeowner on a list of homeowners in the community.

15. Sample: Self-selected sampling; a newspaper article invites females over the age of 21 to call the paper and express their opinions.

16. Sample: Convenience sampling; contact pediatricians in the community to ask them to have parents of all children under the age of 13 complete a questionnaire.

17. Self-selected sampling; biased because only those who spend time online will respond.

18. Systematic sampling; This sample may have a bias since people with no strong interest in any leisure-time activity may choose not to respond.

19. a. All students at the school
   b. Every tenth student who enters the school building the day of the survey
   c. Answers may vary. Sample answer: A little over half of students favor the new dress code.

20. Answers may vary. Sample answer: Both samples may introduce bias because respondents are not truly random. A convenience sample may allow for a more representative sample than a self-selected sample, because respondents of a self-selected sample may have strong feelings about the study topic, and other members of the sample may not respond because it is not an important topic to them.

21–23. See next page.
Answers

Practice and Problem-Solving Exercises (continued)

21. Answers will vary. Sample answer: No, because you would have to assume that all registered voters will actually vote on Election Day.

22. Answer will vary. Sample answer: Yes, the sample is randomly determined, a reasonable number of surveys were returned, so the statistics can be used to reliably apply to the entire population.

23. a. convenience sample  
   b. observational study  
   c. Answers may vary. Sample answer: The statistics do not necessarily represent the school population because a random sample was not used to conduct the study. Therefore, the statistics are unreliable and should not be used to make a general conclusion about the school population.

24. Check students’ responses.

25. Yes, the question is leading the respondent to a particular desired answer, and it gives statistics that may elicit a strong reaction. Also, it requires the respondent to answer a question about whether a person should wear a safety belt, which may not necessarily influence whether they support the law.