4.4

Statistical Bias

Student Text Pages
236–243

Suggested Timing
80 min

Tools
- scientific calculators

Related Resources
BLM 4-7 Section 4.4 Statistical Bias
BLM 4-8 Section 4.4 Achievement Check Rubric

Link to Prerequisite Skills

Students should complete all the Prerequisite Skills questions before proceeding with this section.

Warm-Up

Define *statistical bias*. Provide examples to help you explain.

Warm-Up Answers

Answers may vary. Examples should focus on errors caused by improper sampling or measurement rather than a statistician's personal bias.

Teaching Suggestions

Warm-Up

- Display the Warm-Up question. Have students complete the Warm-Up question independently. Then, discuss the solutions as a class.

Section Opener

- Discuss the meaning of *statistical bias*. Follow up by having students work through the Investigate.

Investigate

- Students will enjoy the cartoons in this Investigate. The Investigate will provide a good discussion of the various forms of statistical bias and how they can negatively affect the results of surveys and experiments. There is no need to classify the types of statistical bias at this point.

Investigate Answers (page 236–237)

a) Someone is filling out an on-line survey with false information. If many people entered false information, the results of the survey would be inaccurate.

b) The question asked is biased in favour of the football player. Describing the one candidate as "dreamy" and the other as "nerdy" will lead people to support the first candidate.

c) A monkey is completing a survey intended for students. Unless the monkey is a student, the results of this survey may be unreliable.

Examples

- Example 1 highlights errors in sampling methods. Explain to students that a good sample requires a random sampling method and a large number of participants to ensure unbiased results.
- Example 2 draws attention to issues concerning survey response rates. Explain that it is normal for some people not to respond to a survey, but when the response rate is below 80%, or when one group is under-represented compared to their proportion of the population, the results are affected by non-response bias. Pollsters will typically go back and encourage responses from the population as a whole or from the under-represented group(s).

- Example 3 describes how measurement errors can occur due to improper methods of measurement. Stress the importance of being careful when taking and recording measurements. For example, rulers should be aligned, and rounded values should be rounded correctly.
- Example 4 describes two scenarios that promote a response bias. Explain that respondent embarrassment and leading questions can lead to false survey responses.
- While discussing Example 4, you might want to include a discussion of leading questions compared to loaded questions. A leading question, as found in part b), leads the respondent to a specific answer. A loaded question includes an assumption. For example, the question "How often do you cheat on tests?" contains the assumption that the respondent does sometime cheat on tests.
- In each Example, it is important for students to understand the bias present, explain how the bias occurred, and describe how the bias could be prevented.

Key Concepts

- Review the definition of statistical bias and the four main types of statistical bias.

Discuss the Concepts

- The questions can lead to a good class discussion of statistical bias.
- The questions show that bias can be unintentional.

Discuss the Concepts Suggested Answers (page 239)

D1. This situation would involve non-response bias. It may be that only people closely concerned with the issue respond. Others who do not respond may be part of a group that is under-represented.

D2. a) Immigrant families may not know the language used in the survey, leading to non-response bias. This bias could be reduced by translating the survey into a variety of languages.

b) Reducing non-response bias leads to a sample that better represents the population being surveyed. This means the survey will collect more accurate information about the target population.

Practise (A)

- You may wish to use a think-pair-share format for these questions.

Apply (B)

- Students generally have some difficulty with this topic, so you may wish to assign all the questions and spend extra time going through answers.
- All questions provide an excellent opportunity for assessing students' communication skills.
- **Question 11** is an Achievement Check question. You may wish to use **BLM 4-8 Section 4.4 Achievement Check Rubric** to assist you in assessing your students.

Extend (C)

- Assign the Extend questions to students who are not being challenged by the Apply questions.

Common Errors

- Some students may confuse the various types of bias.

R_x Ask students to think about the name given to each type of bias. Have students go through the situations in **questions 5 and 11** to identify the type of bias present and explain how they could identify the type of bias.

Accommodations

Language—add definitions for statistical bias, sampling bias, non-response bias, response bias, and measurement bias to the Word Wall

Spatial—assign the titles Sampling Bias, Non-Response Bias, Response Bias, and Measurement Bias to each corner of the room. Read various biased scenarios to students and have them move to the corner representing the appropriate bias.

Perceptual—have students search the Internet for sample surveys and identify any potential bias in the surveys. Have students explain how to alter the survey to eliminate the bias.

Memory—have students create their own survey question(s) or cartoons depicting one source of bias to share with the class

ESL—provide a partner to assist students when completing the Investigate, and to help students read and understand the Examples and Practice questions. Have students add new terms to their personal math dictionaries.

Achievement Check Answers (page 242)

11. a) Sampling bias. The sample does not reflect the whole population, since not all citizens use convenience stores. The sample should be representative of everyone who would be affected by the proposed bike lane. Going door-to-door in various local areas might provide a more representative sample.

b) Response bias. Students may not want to admit that they did not brush their teeth that day. The question could be changed to a multiple-response format: "For how long did you brush your teeth this morning? a) less than 1 min b) 1 min to 2 min c) more than 2 min." Answer a) would allow students who did not brush to answer the question honestly. Answers b) and c) would count students who actually brushed their teeth for a significant time.

c) Response bias (students want to please their teacher by answering yes) or sampling bias (students have chosen to study mathematics, so this sample does not represent the general population). The sample needs to be more representative and less potentially embarrassing to respondents. Survey a random sample of people on the street, at a mall, or by telephone who represent the whole population.

d) Sampling bias (all students belong to families that have at least one child) or non-response bias. The sample needs to be more representative. Survey a random sample of people on the street, at a mall, or by telephone who represent the whole population.

Literacy Connect

- Have one or two students read the section opener and the Investigate out loud. Ensure students understand what is expected in the Investigate.
- Have one or two students read each Example out loud. Have students discuss their responses in small groups or as a class.
- Encourage students to continue adding new terms to their personal math dictionaries.

Mathematical Process Expectations

Process Expectation	Questions
Problem Solving	4, 8, 9–11, 14, 15
Reasoning and Proving	1–9, 11–15
Reflecting	4, 5
Selecting Tools and Computational Strategies	n/a
Connecting	1–9, 11, 13–15
Representing	n/a
Communicating	1–4, 6–15

Extra Practice

- Use **BLM 4-7 Section 4.4 Statistical Bias** for remediation or extra practice.