2.1 Exercises

Basic Concepts

1. What are the two fundamental problems of measurement?
2. When measurements are used to help solve a problem, what desirable characteristics should the measurements possess?
3. Name and briefly describe three measurement systems commonly used in business.
4. When you encounter any type of data, what three questions should you ask to determine the quality of the measurements?
5. What is the scientific method?
6. What is a confounding variable?
7. How does statistics interact with the steps in the scientific method?
8. Name and briefly describe the two main branches of statistics.
9. What is the decision-making method?
10. What is different between the scientific method and the decision-making method?
11. Are problems that can be solved by collecting data always the result of a system malfunction? Explain.
12. Give an example of how statistics can be used to improve a process.
13. What are fuzzy concepts? What are the measurement problems associated with fuzzy concepts?
14. Give an example of a tool that has been widely accepted as an instrument used to measure a fuzzy concept.
15. What are the two ways of obtaining data?
16. What are the dangers of making conclusions based on poorly collected data?
17. How do you treat the problem of a confounding variable?
18. Explain the difference between the control group and the experimental group in a controlled experiment.
19. What is an explanatory variable?
20. What is a response variable?
21. What is bias? How can it be controlled?
22. What is a completely randomized design? What are the advantages of using a completely randomized design?
23. What is a before and after study?
24. What is the placebo effect? Give an example.
25. What is a double blind study?
26. How do observational studies differ from controlled experiments?
27. What kinds of problems can be associated with an observational study?
28. Researchers use surveys for two main purposes. Name and give an example of each.

Exercises

29. Specify whether the following variables are well-defined or not. Justify your answer.

- **a.** Height
- **b.** Weight
- **c.** Hot
- **d.** Temperature
- **e.** Beauty

30. A researcher has developed a test that reportedly measures intelligence. The test includes questions such as:

$$\textit{What is the lowest common denominator of the fractions } \frac{5}{32} \textit{ and } \frac{6}{9}?$$

Who invented the digital computer?

Is it reasonable to measure intelligence with these questions? Discuss.

31. A hotel manager is interested in getting feedback from guests. Two variables of interest to the manager are cleanliness and aesthetics of the rooms. Discuss what problems you would encounter when measuring those variables.

32. Suppose you want to determine the proportion of college students in the state of Virginia that pays more than $500 per year on textbooks. Using the scientific method, how would you conduct the experiment?

33. The manager of an electronics company was interested in determining the reason for the increase in sales volume over the last three years. The manager randomly selected data on the advertising budget, number of salespeople, and average product costs. When examining the data, the manager found that her average product costs were fairly stable but the advertising budget steadily increased over the last two years along with the number of salespeople. Are there any confounding variables in this study? If so, what are they and why do you consider them confounding?

34. A company that produces bulbs for projectors wanted to conduct an experiment to determine the length of life of its bulbs. The company's leading competitor's bulbs have an average life of 1000 hours. The company sampled its bulbs and found that the average life of the bulbs was 1200 hours. Thus, the company has concluded and advertises that its bulbs last longer than the competition by at least 100 hours. Were the results of this experiment an example of descriptive or inferential statistics? Explain your answer.

35. The health and social problems associated with obesity can be a severe hindrance in attaining many of life's goals. Methods for treating obesity were compared in "One Year Behavioral Treatment of Obesity: Comparison of Moderate and Severe Caloric Restriction and the Effect of Weight Maintenance Therapy," in the *Journal of Consulting and Clinical Psychology*. In the study, a group of 25 women, each of whom was at least 25 kilograms (kg) overweight, were randomly split into two groups. The first group received behavior therapy and was placed on a 1200 calorie per day diet for a period of one year. The second group received behavior therapy and was placed on a 420 calorie per day diet for the first 16 weeks of the year. Then they returned to a 1200 calorie per day diet for the remainder of the year. At the end of a 26-week period, the average weight lost was 11.86 kg for the first group and 21.45 kg for the second group. But after 52 weeks, the average weight lost was 10.94 kg for the first group and 12.18 kg for the second group.

- **a.** Why is this study an example of a controlled experiment?
- **b.** What is the explanatory variable?
- **c.** What is the response variable?

d. Is there a control group in the study? Explain.

e. Suppose that the data were gathered from an observational study instead of from a controlled experiment. How would this affect the conclusions that might be made from the study?

36. An article appearing in the *New England Journal of Medicine* investigated whether the academic performance of asthmatic children being treated with the drug Theophylline was inferior to a non-asthmatic group. In one part of the study, 72 children were identified as being treated for asthma. For each child with asthma, a non-asthmatic sibling was also identified. (The use of sibling controls allows for control of family environment and certain genetic factors on academic achievement.) All 144 children were then given a test to measure academic achievement. There were no significant differences on the test between the two groups.

a. Why is this study an example of a controlled experiment?

b. What is the explanatory variable?

c. What is the response variable?

d. Is there a control group in the study? Explain.

e. Suppose that the data were gathered from an observational study instead of from a controlled experiment. How would this affect the conclusions that might be made from the study?

37. A small clinical pilot study was conducted by a research team from Harvard Medical School and the School of Public Health. Fifteen individuals in the early stages of Multiple Sclerosis were fed bovine myelin, a substance containing two antigens thought to be the target of the immune system's attack in Multiple Sclerosis. Another fifteen were given a placebo. In the study, fewer members of the group fed bovine myelin had major attacks of the disease.

Source: Science, Vol. 259, No. 5099

a. Which phase of the Scientific Method best describes this study?

b. Is this an observational study or a controlled experiment?

c. What is the response variable?

d. What is the explanatory variable?

e. Which group is the treatment group?

f. Which group is the control group?

38. London scientists conducted a study to determine if chocolate can trigger migraines. Twelve migraine-prone subjects were given a peppermint-laced chocolate candy and eight migraine-prone subjects were given a peppermint-laced placebo made of carob, peppermint, and vegetable fat. Five subjects from the group given chocolate developed a migraine headache within one day. No one from the group given the placebo developed a migraine in the same time period.

Source: Self magazine

a. Which phase of the Scientific Method best describes this study?

b. Is this an observational study or a controlled experiment?

c. What is the response variable?

d. What is the explanatory variable?

e. Which group is the treatment group?

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39. Jacob normally plays basketball three days a week and has begun to develop patellar tendinitis, which is inflammation in the patellar tendon and results in nagging knee pain. In an effort to relieve his knee pain, Jacob decides to take a week away from playing basketball and rest his knee. However, after about four days, his friend offers him an analgesic rub and insists that his knee will feel better in two to three days. After using the analgesic rub for a couple of days, Jacob's knee begins to feel better. Did the analgesic rub work? Explain how confounding variables might have played a role on Jacob's knee getting better.

40. The Nurse's Health Study conducted on 87,245 women at Boston's Brigham and Women's Hospital revealed that women who eat a cup of beta carotene-rich food a day have 40 percent fewer strokes and 22 percent fewer heart attacks than those who consume a quarter of a cupful per day.

Source: Self magazine

- **a.** Which phase of the Scientific Method best describes this study?
- **b.** Is this an observational study or a controlled experiment?
- **c.** What is the response variable?
- **d.** What is the explanatory variable?
- **e.** Which group is the treatment group?
- **f.** Which group is the control group?

41. A religious group conducted a survey with two of the questions asking "Do you go to church?" and "Are you happy?" After conducting the survey, the group concluded that those who go to church are generally happier than those that do not go to church. Do you think going to church makes one happier? Describe how confounding variables could play a role with the conclusion drawn by the religious group.

42. In May 2011, Internet Explorer reversed its trend in the United States and gained usage share (the percentage of users using a particular Internet browser). In June of 2011, the trend reversal became global. Internet Explorer gained 0.57% in June across all operating systems with Internet Explorer 8.0 gaining 0.86% globally. The gains for Internet Explorer came primarily at the expense of Mozilla Firefox (−0.51%). Google Chrome's pace of usage share gains slowed to +0.2% for June. The gains for IE were the largest in Europe and Asia:

Internet Explorer in Europe: +0.88%

Internet Explorer in Asia: +0.81%

This increase may be the result of a marketing campaign. In early June, Microsoft launched their "Confidence" campaign aimed at showing the security features of Internet Explorer 8.

Source: netmarketshare.com

- **a.** Are the results stated above likely to have come from an observational study?
- **b.** How can Microsoft (and other companies) benefit from this information?

43. A survey was conducted by an investment firm asking participants the following questions: "Are you financially secure?" and "Do you independently make decisions about your investments?" After analyzing the data from the survey, the firm concluded that people who make investment decisions independently tend to be not as financially secure as those who make decisions with the help of an investment advisor. What confounding variables could have played a role in this conclusion?