Solutions for Essentials of Statistics for the Behavioral Sciences 10th Edition by Gravetter

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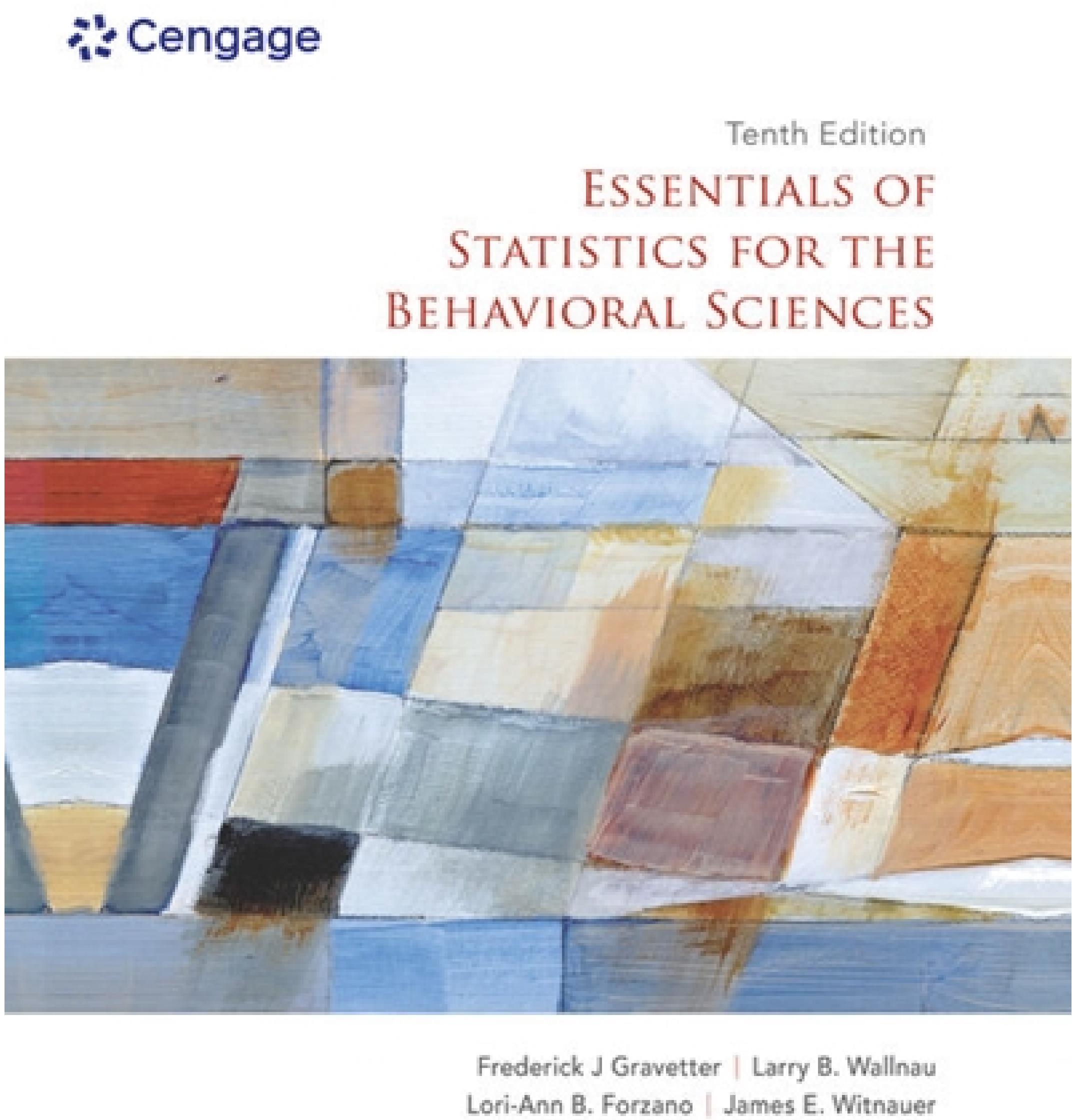

Solutions

Chapter 1: Introduction to Statistics

Chapter Outline

1.1 Statistics and Behavioral Science
- Definitions of Statistics
- Populations and Samples
- Variables and Data
- Parameters and Statistics
- Descriptive and Inferential Statistical Methods
- Statistics in the Context of Research

1.2 Observations, Measurement, and Variables
- Observations and Measurements
- Constructs and Operational Definitions
- Discrete and Continuous Variables
- Scales of Measurement

1.3 Three Data Structures, Research Methods, and Statistics
- Data Structure 1. One Group with One or More Separate Variables Measured for Each Individual: Descriptive Research
- Relationships Between Variables
- Data Structure 2. One Group with Two Variables Measured for Each Individual: The Correlational Method
- Data Structure 3. Comparing Two (or More) Groups of Scores: Experimental and Nonexperimental Methods
- Experimental and Nonexperimental Methods
- The Experimental Method
- Nonexperimental Methods: Nonequivalent Groups and Pre-Post Studies

1.4 Statistical Notation
- Scores
- Summation Notation

Learning Objectives and Chapter Summary

1. Define the terms population, sample, parameter, and statistic, and describe the relationship between them; identify examples of each.
2. Define the two general categories of statistics, descriptive and inferential statistics, and describe how they are used to summarize and make decisions about data.
3. Describe the concept of sampling error and explain how sampling error creates the fundamental problem that inferential statistics must address.
4. Explain why operational definitions are developed for constructs and identify the two components of an operational definition.
5. Describe discrete and continuous variables and identify examples of each.
6. Define real limits and explain why they are needed to measure continuous variables.
7. Compare and contrast the four scales of measurement (nominal, ordinal, interval, and ratio) and identify examples of each.
8. Describe, compare, and contrast correlational, experimental and nonexperimental research, and identify the data structures associated with each.
9. Define independent, dependent, and quasi-independent variables and recognize examples of each.
10. Identify what is represented by each of the following symbols: X, Y, N, n, and Σ.
11. Perform calculation

The following synthesizes the key ideas and takeaways from this chapter:

1. Students should be familiar with the terminology and special notation of statistical analysis.

Statistical Terms	Measurement Terms	Research Terms
population	constructs	descriptive research
sample	operational definition	correlational method
variable	discrete variable	experimental method
data	continuous variable	individual differences
data set	real limits	independent variable
datum	upper real limit	dependent variable
score/raw score	lower real limit	control condition
parameter	nominal scale	experimental condition
statistic	ordinal scale	quasi-independent variable
descriptive statistics	interval scale	
inferential statistics	ratio scale	
sampling error		

Figure 1.2 is useful for introducing the concepts of population and sample, and the related concepts of parameter and statistic. Figure 1.3 helps differentiate descriptive statistics that focus on the sample data and inferential statistics that generalize from samples to populations.

2. Students should learn how statistical techniques fit into the general process of science.

Although the concept of sampling error is not critical at this time in the course, it is a useful way to introduce and justify the need for inferential statistics. Figure 1.2 is a simple demonstration of the concept that sample statistics are representative of but not identical to the corresponding population parameters, and that two different samples will tend to have different statistics. The idea that differences can occur just by chance is an important concept. After the concept of sampling error is established, Figure 1.3 shows the overall research process and identifies where descriptive and inferential statistics are used.

Statistical techniques are mostly used near the end of the research process, after the researcher has obtained research results and needs to organize, summarize, and interpret the data. Chapter 1 includes discussion of two aspects of research that precede statistics: (1) the process of measurement, and (2) the idea that measurements take place in the context of a research study. The discussion includes the different scales of measurement and the information they provide, as well as an introduction to continuous and discrete variables. Research studies are described in terms of the kinds of data they produce: correlational studies that produce data suitable for computing correlations (see Figure 1.5), and experimental studies that produce groups of scores to be compared, usually looking for mean differences (see Figure 1.6). Other types of research (nonexperimental) that also involve comparing groups of scores are discussed (see Figure 1.7).

3. Students should learn the notation—particularly summation notation—that will be used throughout the rest of the book.

There are three key concepts important to using summation notation:

1. Summation is a mathematical operation, just like addition or multiplication, and the different mathematical operations must be performed in the correct order (see Order of Mathematical Operations in Section 1.4).
2. In statistics, mathematical operations usually apply to a set of scores that can be presented as a column of numbers.
3. Each operation, except for summation, creates a new column of numbers. Summation calculates the sum for the column.

Other Lecture Suggestions

1. Early in the first class, I acknowledge that
   a. Most students are not there by choice. (No one picked statistics as an elective because it looked like a fun class.)
   b. Many students have some anxiety about the course.

However, I also try to reassure them that the class will probably be easier and more enjoyable (less painful) than they would predict, *provided* they follow a few simple rules:

a. Keep up. In statistics, each bit of new material builds on the previous material. As long as you have mastered the old material, then the new stuff is just one small step forward. On the other hand, if you do not know the old material, then the new stuff is totally incomprehensible. (For example, try reading Chapter 10 on the first day of class. It will make no sense at all. However, by the time we get to Chapter 10, you will have enough background to understand it.) Keeping up means coming to class, asking questions, and doing homework on a regular basis. If you are getting lost, then get help immediately.

b. Test yourself. It is very easy to sit in class and watch an instructor work through examples. Also, it is very easy to complete homework assignments if you can look back at example problems in the book. Neither activity means that you really know the material. For each chapter, try one or two of the end-of-chapter problems without looking back at the examples in the book or checking your notes. Can you really do the problems on your own? If not, pay attention to where you get stuck in the problem, so you will know exactly what you still need to learn.

2. Give students a list of variables (for example, items from a survey such as age, gender, education level, income, and occupation), and ask them to identify the scale of measurement most likely to be used and whether the variable is discrete or continuous.

3. Describe a nonexperimental or correlational study and have students identify reasons that you cannot make a cause-and-effect conclusion from the results. For example, a researcher finds that children in the local school who regularly eat a nutritious breakfast have higher grades than students who do not eat a nutritious breakfast. Does this mean that a nutritious breakfast *causes* higher grades? Or a researcher finds that employees who regularly use the company's new fitness center have fewer sick days than employees who do not use the center. Does this mean that using the fitness center *causes* people to be healthier?

For either example, describe how the study could be made into an experiment by:

a. beginning with equivalent groups (random assignment).

b. manipulating the independent variable (note that doing so introduces the ethical question of forcing people to eat a nutritious breakfast).

c. controlling other variables (i.e., the rest of the children's diet).

4. After introducing some basic applications of summation notation, present a simple list of scores (1, 3, 5, 4) and a relatively complex expression containing summation notation, for example, $\Sigma(X - 1)^2$. Ask the students to compute the answer. You are likely to obtain several different responses.

Note that this is not a democratic process—the most popular answer is not necessarily correct. There is only one correct answer because there is only one correct sequence for performing the calculations. Have the class identify the step-by-step sequence of operations specified by the expression. (First, subtract 1 from each of the scores. Second, square the resulting values. Third, sum the squared numbers.) Then apply the steps, one by one, to compute the answer. As a variation, present a list of steps and ask students to write the mathematical expression corresponding to the series of steps.

Answers to Even-Numbered Problems

2. A population is the entire group of individuals of interest. A sample is a relatively small group selected from the population. The research begins with a question about the population. However, the population is usually too large for every individual to participate in the research study. Therefore, the individuals in the sample are the actual participants and the results from the sample are then generalized to the population.

4. Descriptive statistics are used to simplify and summarize data. Inferential statistics use sample data to make general conclusions about populations.

6. A parameter is a characteristic, usually a numerical value, which describes a population. A statistic is a characteristic, usually numerical, that describes a sample. Although sample statistics are generally good estimates of certain population parameters, they are not perfect. Therefore, there typically is some discrepancy between the statistics from a sample and the corresponding parameters of the population. This naturally occurring discrepancy is called sampling error.

8. Honesty is an internal attribute or characteristic that cannot be observed or measured directly. Honesty could be operationally defined by identifying and observing external behaviors associated with being honest, such as the physiological responses to questions measured by a polygraph ("lie detector"). Or, participants could be given a questionnaire asking how they behave or feel in situations for which honesty might have an influence.

10. The variable of height is continuous so there are an infinite number of possible values within the real limits of the score. The score of 70 inches, rounded to the nearest whole inch, has the following real limits: $69.5 \leq X < 70.5$

12. 70 degrees Celsius is not twice as warm as 35 degrees Celsius because temperature in Celsius is an interval scale (and not a ratio scale). Because zero degrees Celsius does not represent a complete absence of heat (i.e., Celsius uses an arbitrary zero), it is incorrect to say that 70 degrees Celsius is twice as warm as 35 degrees Celsius.

14. The goal of an experiment is to demonstrate the existence of a cause-and-effect relationship between two variables. To accomplish the goal, an experiment must *manipulate* an independent variable and *control* other, extraneous variables.

16. This is not an experiment because no independent variable is manipulated. They are comparing two preexisting groups of individuals based on their level of experiencing video game violence.

18. This is not an experiment because there is no manipulation. Instead, the study is comparing two preexisting groups (American and Canadian students).

20. a. The independent variable is the percentage of sucrose (32% vs.-2%) in the solution consumed by subjects prior to pairings of flavor with 8% sucrose. The dependent variable is the amount of flavored solution (i.e., cherry or grape) consumed by rats.

b. Amount consumed in ounces is a ratio scale because a value of zero represents a complete absence of consumption.
c. Amount consumed is a continuous variable.
d. $2.45 \leq X < 2.55$

22. a. The independent variable is whether or not the signs were posted and the dependent variable is how much the stairs were used.
b. Posted versus not posted is measured on a nominal scale.

24. a. $n\Sigma(X - 1) = 50$.
b. $\Sigma X - 3^{2 = 15 - }3^2 = 15 - 9 = 6$.
c. $\frac{\Sigma(X-2)}{n} = \frac{5}{5} = 1$
d. $\Sigma(X - 4)^{2 = 15}$

26. a. $\Sigma X = 0$
b. $\Sigma Y = 14$
c. $\Sigma(X + Y) = 14$
d. $\Sigma XY = 4$

28. a. ΣXY
b. $\Sigma X \Sigma Y$
c. $\Sigma(Y\text{-}X)$
d. ΣX

30. a. $\Sigma X^{2 = 82}$
b. $(\Sigma X)^{2 = 324}$
c. $\Sigma(X - 3) = 3$
d. $\Sigma(X - 3)^{2 = 19}$

32. a. $n\Sigma X^2 = 340$
b. $(\Sigma Y)^2 = 625$
c. $\Sigma XY = -52$
d. $\Sigma X \Sigma Y = 0$

CHAPTER 1 Introduction to Statistics

1. a. The population consists of all high school students in the United States.
   b. The sample is the group of 100 students who were measured in the study.
   c. The average number is a statistic. Notice that you might be more specific and say "descriptive" statistic. Inferential statistic or parameter would be incorrect because the calculated average describes only the data measured in the sample.

3. a. The population consists of all college students in the United States.
   b. The sample consists of the 100 students who participated in the study.
   c. The group that received decaffeinated coffee is in a control condition (that is, no caffeine).
   d. The group that received the caffeinated coffee is in an experimental condition.
   e. The sample contains 100 participants (50 in each group). The population is either infinitely large or too large for it to be practical to measure all members. If you said that the population consisted of 100 students, you might have mistakenly thought that the population consisted of everyone in the study.
   f. The average calculated after the memory test is a "statistic" or, more specifically, "descriptive statistic." "Inferential statistic" or "parameter" would be incorrect because the average describes only the data in the sample.

5. a. Statistic (or descriptive statistic)
   b. Parameter

7. a. The average score in the afternoon was 80 and the average score in the morning was 76, so you might be tempted to think that there is some real advantage for testing in the afternoon. However, the difference between means could be due to random chance alone—sampling error. Based on the descriptive statistics given in this sample, we just don't know whether an advantage exists or not.
   b. Inferential statistics

9. Age: ratio scale and continuous. Although people usually report whole-number years, the variable is the amount of time and time is infinitely divisible.

   Income: ratio scale and discrete. Income is determined by units of currency. For U.S. dollars, the smallest unit is the penny and there are no intermediate values between 1 cent and 2 cents.

   Dependents: ratio scale and discrete. Family size consists of whole-number categories with no intermediate values.

   Social Security: nominal scale and discrete. Social security numbers are essentially names that are coded as 9-digit numbers. There are no intermediate values between two consecutive social security numbers.

11. a. An ordinal scale provides information about the direction of difference (greater or less) between two measurements.
    b. An interval scale provides information about the magnitude of the difference between two measurements.
    c. A ratio scale provides information about the ratio of two measurements, which allow comparisons such as "twice as much."

13. A correlational study has only one group of individuals and measures two (or more) different variables for each individual. Other research methods evaluating relationships between variables compare two (or more) different groups of scores.

15. a. This is not an experiment because no independent variable is manipulated and participants are not randomly assigned to groups that receive different amounts of milkfat.
    b. It is possible that participants in the reduced milkfat (skim or 1% milk) group (that is, children who regularly drank reduced-fat milk) also tended to be more sedentary.
    c. Possibility 1: A researcher could randomly assign participants to groups that receive different amounts of milkfat.

    Possibility 2: A researcher could assign participants to two groups that receive different amounts of milkfat, holding constant characteristics like the amount of physical activity by participants in each group.

    Possibility 3: A researcher could assign participants to two groups that receive different amounts of milkfat, matching the two groups in the amount of physical activity.

17. a. Loneliness is a continuous variable. If it is measured with ratings of 1 to 4, it may appear to be discrete but it could be measured with a 1 to 40 rating, which means that each category could be further divided. The UCLA Loneliness Scale is an interval scale of measurement because a value of zero does not represent a complete absence of loneliness.
    b. $n = 86$
    c. This is an experimental study because participants were randomly assigned to groups.
    d. The group that was instructed to post more status updates is an experimental group.

19. a. The dependent variable is the number of correct answers on the test, which is a measure of knowledge of the material.
    b. Knowledge is a continuous variable. If it is measured with a 10-question test, it may appear to be discrete but it could be measured with a 100-question test, which means that each category can be further divided.
    c. Ratio scale. Zero is absolute, which means a complete absence of correct answers.

21. a. This study used the experimental method because participants were randomly assigned to groups that received different instructions.

b. The independent variable was the instructions received by participants (that is, being told that their group waited and the other didn't versus being told that their group didn't wait and the other group waited). The dependent variable was whether or not children chose to wait for a larger reward.

23. a. $\Sigma X = 15$

b. $(\Sigma X)^2 = (15)^2 = 225$. Note that if you answered 65, you were incorrect because you squared the scores before summing them.

c. $\Sigma X - 3 = 15 - 3 = 12$. Note that if your answer was 3, you were incorrect because you subtracted 3 from each score before summing.

d. $\Sigma(X - 3) = (4 - 3) + (2 - 3) + (6 - 3) + (3 - 3) = (1) + (-1) + (3) + (0) = 3$. Note that if your answer was 12, you were incorrect because you summed the scores before subtracting 3.

25. a. $\Sigma(X - 4)^2 = 158$

b. $(\Sigma X)^2 = (-2)^2 = 4$

c. $\Sigma X^2 = 62$

d. $\Sigma(X + 3) = 13$

27. a. $\Sigma XY = 2$

b. $\Sigma X \Sigma Y = 56$

c. $\Sigma Y = 7$

d. $n = 4$

29. a. $(\Sigma X)^2$

b. ΣX^2

c. $\Sigma(X - 2)$

d. $\Sigma(X - 1)^2$

31. a. $n\Sigma X^2 = 195$

b. $(\Sigma Y)^2 = 361$

c. $\Sigma XY = 22$

d. $\Sigma X \Sigma Y = 209$