

1

Introduction to Statistics

LEARNING OBJECTIVES

After reading this chapter, you should be able to:

1. Distinguish between descriptive and inferential statistics.
2. Explain how samples and populations, as well as a sample statistic and population parameter, differ.
3. Describe three research methods commonly used in behavioral science.
4. State the four scales of measurement and provide an example for each.
5. Distinguish between qualitative and quantitative data.
6. Determine whether a value is discrete or continuous.
7. Enter data into SPSS by placing each group in separate columns and each group in a single column (coding is required).

CHAPTER OUTLINE

1.1 Descriptive and Inferential Statistics

Statistics: A branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations. Two types of statistics are descriptive statistics and inferential statistics.

- *Descriptive statistics:* Procedures used to summarize, organize, and make sense of a set of scores or observations.
 - Data are multiple measurements typically numeric in form; a single observation is referred to as a datum or raw score.
 - Descriptive statistics can be presented as a graphical, tabular, or summary display.
- *Inferential statistics:* Procedures used that allow researchers to *infer* or generalize observations made with samples to the larger population from which they were selected.
 - *Population parameter:* A characteristic, usually numeric, that describes a population.
 - *Sample statistic:* A characteristic, usually numeric, that describes a sample.

1.2 Statistics in Research

Experimental method: An experiment is any study that controls the conditions under which observations are made to isolate cause-and-effect relationships between two variables. To conduct an experiment, we must meet three requirements: *randomization*, *manipulation*, and *comparison*.

- *Randomization* consists of using random assignment to ensure that all participants in the study have an equal probability of being assigned to a group.
- *Manipulation* consists of creating the levels of the independent variable. Each level is a group—hence, manipulation allows us to create groups to which the participants will be randomly assigned.
- *Comparison* involves the use of a control group that does not receive the manipulation believed to cause changes in a dependent variable. This allows us to compare the control group to the group that received the manipulation, thereby allowing us to determine whether the manipulation is actually causing changes in the dependent variable.

Independent variable (IV): The variable that is manipulated in an experiment. By manipulating the IV, we create the different groups in a study.

Dependent variable (DV): The variable that is measured in each group or level of the independent variable. The dependent variable must be *operationally defined*, meaning that it is defined by the specific process or manner by which it was observed or measured.

Quasi-experimental method: A quasi-experiment is a research design that includes a quasi-independent variable and/or lacks a comparison or control group.

- A quasi-independent variable is any variable with preexisting levels. For example, if we group participants by gender (men, women), then the variable is a quasi-independent variable—the participants were men or women before the study began; hence, the researcher did not manipulate or create the gender groups in the study.

Correlational method: The measurement of pairs of scores, called data points, examines the extent to which two variables are related. No variable is manipulated to create different groups to which participants can be randomly assigned. Instead, two variables are measured for each participant, and the extent to which those variables are related is measured. Hence, correlations lack the control needed to demonstrate cause and effect.

1.3 Scales of Measurement

Scales of measurement are the rules that describe how a number was measured and the extent to which it is informative. Four scales of measurement are *nominal*, *ordinal*, *interval*, and *ratio*.

Nominal scales: Measurements where a value is used to represent something or someone.

- Nominal values are typically coded, or converted to numeric values for later statistical analysis.

Ordinal scales: Measurements where values convey order or rank alone. Ordinal scale data simply indicate that one value is greater than or less than another value.

Interval scales: Measurements with two defining principles—equidistant scales and no true zero.

- *Equidistance* refers to intervals with values that are distributed in equal units.
- A *true zero* refers to a scale where 0 indicates the absence of something. An interval scale lacks a true zero. Examples of scales without a true zero include rating scales, temperature, and measures of latitude and longitude.

Ratio scales: Measurements with two defining principles—equidistant scales and a true zero.

- Examples of scales with a true zero include weight, height, time, and calories.

1.4 Types of Data

Continuous variables are measured along a continuum, such that they can be measured at any point beyond the decimal point. Continuous variables can be measured in whole or fractional units.

Discrete variables are measured in categories or whole units and are *not* measured along a continuum. Discrete data are not measured in fractional units.

Quantitative variables vary by amount, can be continuous or discrete, and are measured in numeric units.

Qualitative variables vary by class, can only be discrete, and are used to describe nonnumeric aspects of phenomena.

1.5 Research in Focus: Types of Data and Scales of Measurement

When a research study includes a qualitative variable, researchers will often also include quantitative variables because these can be more informative. For example, in their study on social networking, Jones, Blackey, Fitzgibbon, and Chew (2010) interviewed college students and recorded their qualitative responses. In addition, they also measured quantitative variables by having students rate how often they used certain social software technologies. Because quantitative variables are more widely measured in the behavioral sciences, this book describes statistical procedures for quantitative variables on each scale of measurement.

1.6 SPSS in Focus: Entering and Defining Variables

SPSS can be used to enter and define variables. All variables are defined in the variable view tab. The values recorded for each variable are listed in the data view tab. Data can be entered by column or by row in the data view tab.

TIPS AND CAUTIONS FOR STUDENTS

- *Dependent and independent variables:* To identify the independent variable (IV) and dependent variable (DV) in an experiment, start by determining the hypothesis that is being tested in the experiment. Then ask, what is being measured in each group to test this hypothesis? The dependent variable is typically measured in numeric units. To determine the independent variable, refer back to the groups. Determine what the researcher thinks is causing or is associated with changes in the DV. The different groups are the levels of the independent variable.

Note that a quasi-independent variable is a variable that is preexisting. This type of variable is used in a quasi-experimental or a correlational research design. Unlike an experiment, the levels of a quasi-independent variable are preexisting, meaning that the researcher did not manipulate the levels of that variable.

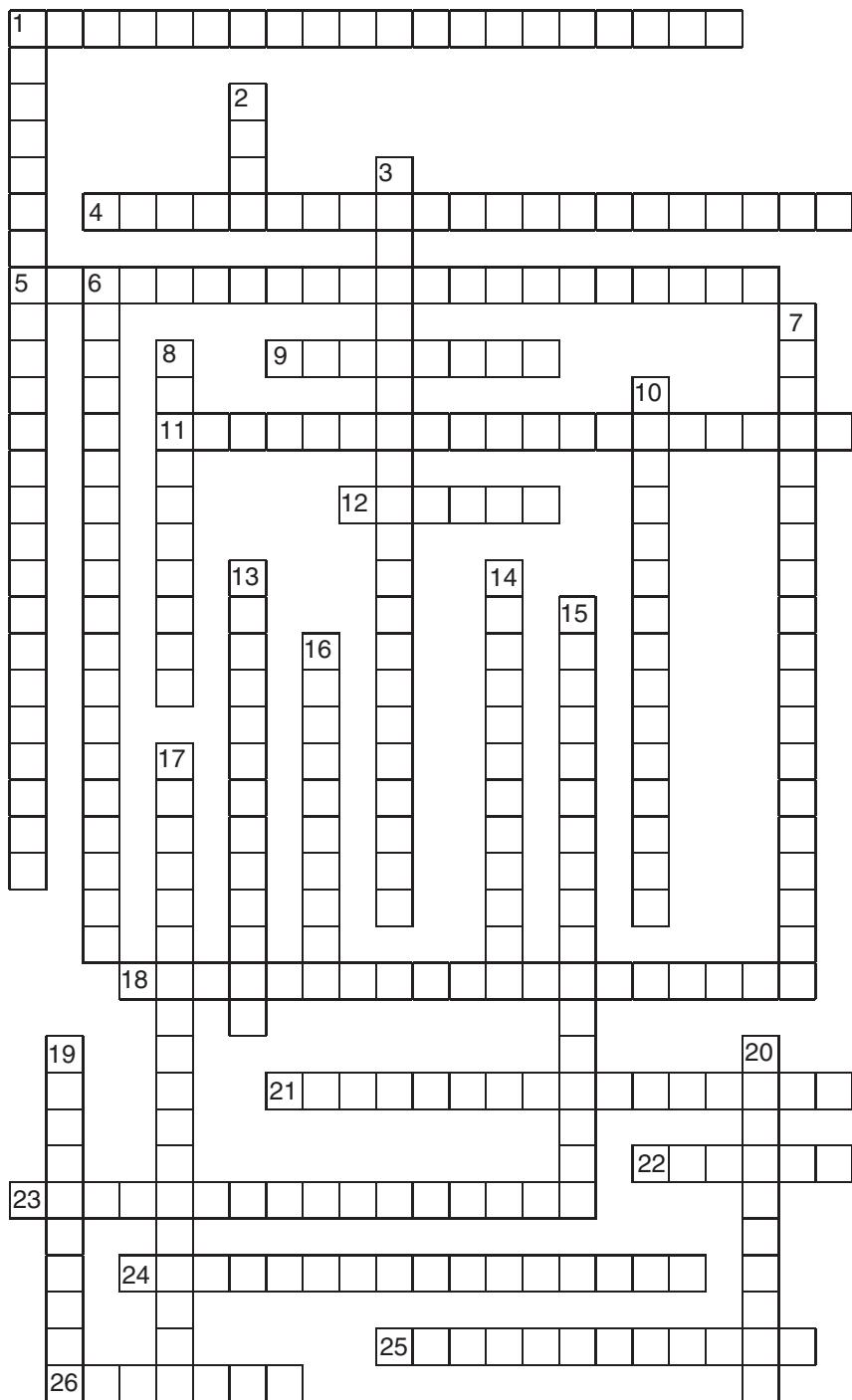
- *Scales of measurement:* When determining the scale of measurement a variable is measured on, first assess whether the variable is categorical. If it is categorical, then it is likely on a nominal scale. If it is a ranked value or one that indicates only that one value is larger than another, then it is likely on an ordinal scale. Interval scale measures are typically rating scales, where participants indicate their level of agreement or opinion regarding items in a survey. To distinguish an interval scale from a ratio scale, assess whether the scale has a true zero. If 0 indicates the absence of the variable you are measuring, then it has a true zero and is on a ratio scale; if not, then it does not have a true zero and is on an interval scale.

KEY TERM WORD SEARCHES

B	R	A	N	D	O	M	A	S	S	I	G	N	M	E	N	T	V	R	H	M	B	Q	E	J	R	O	N	H	W	X	O	X	P	F	Q	R	F	R				
B	F	B	E	L	E	O	J	J	S	Z	F	Y	H	I	K	A	C	Y	U	P	J	F	R	S	L	I	I	H	T	M	V	E	Q	C	L	X	E	A				
V	I	E	U	I	R	Z	G	S	T	A	T	I	S	T	I	C	S	P	F	F	O	T	H	W	L	V	W	M	T	S	F	B	B	Z	M	J	T	R	F			
V	Z	P	O	P	U	L	A	T	O	N	C	Y	Y	C	M	L	O	X	Z	S	E	S	C	C	F	T	N	H	E	H	O	K	K	H	P	G	C	V				
W	A	I	F	P	J	N	O	M	I	N	A	L	S	C	A	L	E	G	C	Q	U	F	K	Z	G	Z	N	N	A	M	Y	Z	U	S	V	L	M	X				
K	R	R	N	Q	M	F	J	T	B	R	N	P	J	W	Z	P	Y	H	D	X	F	B	P	X	K	T	C	I	C	B	D	N	T	D	L	W	K	C	E			
T	E	Q	I	M	Y	W	N	Y	D	C	A	F	T	N	O	H	W	U	U	E	D	X	J	X	G	S	X	D	T	M	S	X	A	O	M	U	O	T				
O	R	I	B	A	W	U	Z	G	C	W	J	Z	F	V	P	S	C	O	R	E	P	B	Q	Z	H	K	H	K	U	A	S	C	C	O	D	I	N	G	T			
M	G	B	N	L	B	S	Z	T	R	U	E	Z	R	O	P	Z	U	S	I	E	C	S	G	C	K	R	D	V	N	E	I	O	Q	I	S	Y	Y					
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B	D	Y	Y	S	D	P	B	R	D	O	R	N	N	P	L	I	D	V	H	U	J	I	A	A	E	H	W	C	N	L	D	S	M	R	U	C	L	H	O			
D	Q	G	X	L	A	H	E	T	A	E	E	B	C	Z	K	M	M	E	W	U	L	T	B	L	N	N	V	M	Y	F	W	Y	Q	N	U	K	E	O	W			
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Q	N	D	A	O	G	M	P	S	D	Q	I	C	J	B	O	A	Q	F	B	X	K	J	T	Q	G	T	M	M	V	G	P	U	Y	G	E	K	F					
W	G	U	R	S	J	E	Y	L	I	E	N	O	R	N	Q	P	S	B	H	U	V	E	D	I	Q	D	A	A	V	Z	X	D	S	X	Y	M	O	M				
M	Z	W	S	T	I	W	N	R	E	S	N	L	I	A	C	T	W	W	D	F	H	Z	C	O	C	B	T	T	A	B	V	H	W	N	R	F	H	Z				
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B	L	C	X	H	N	Y	R	N	Z	U	O	T	K	V	A	A	I	H	V	X	L	Q	U	T	U	D	P	P	V	Z	E	L	A	E	T	W	E	E				
T	O	Z	X	V	F	L	R	D	D	N	B	R	A	X	A	Z	L	V	C	M	L	G	V	S	E	K	I	Y	A	Y	Y	Z	B	V	G	A	L	Q				
T	N	R	B	N	F	G	O	M	E	E	B	K	G	T	H	R	C	E	E	S	C	S	V	W	Y	R	T	S	N	R	B	E	D	U	L	V	S	Q	B			
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O	K	I	J	Z	V	S	Q	J	G	K	J	X	N	Q	W	Y	T	U	B	T	X	T	J	U	J	O	Q	F	L	O	E	G	E	B	D	A	E	G	W			
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P	Z	B	P	U	S	Y	X	W	M	L	X	D	K	Z	H	E	T	Z	Z	V	T	J	F	R	A	S	U	B	J	A	Z	A	O	D	C	T	H	U				
Z	M	H	V	K	O	P	E	R	A	T	I	N	O	N	A	T	I	O	N	D	E	F	I	T	O	R	S	E	L	K	A	R	U	B								
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V	W	E	O	D	C	O	N	I	N	U	O	S	N	U	O	S	N	U	E	Y	W	J	J	P	Y	C	D	Z	Z	V	U	O	F	B	A	S						
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P	C	N	V	H	V	S	U	D	Z	T	U	D	Q	I	N	F	E	R	T	I	A	L	S	T	A	T	I	S	T	I	C	S	O	A	F	M						
E	K	S	B	Z	J	N	A	Z	M	F	M	F	C	V	S	A	K	F	U	Z	D	F	O	J	X	G	H	X	E	F	D	C	I	V	T	Z	O	C	D			
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D	P	I	M	O	A	D	A	T	U	M	I	R	W	U	O	V	W	A	B	C	F	A	Y	N	G	X	K	X	S	E	W	T	Y	V	T	F	F	Y	Y			
M	X	P	H	G	T	S	A	L	M	X	P	H	A	K	M	H	A	L	L	F	F	Q	U	N	T	I	T	A	T	I	V	E		D	A	T	A	L				
R	A	W	S	C	O	R	E	U	K	E	O	S	A	B	J	Q	X	S	A	M	P	L	E	B	O	F	P	T	S	U	O	X	Y	L	V	O	O	T				
O	I	L	E	U	O	R	D	I	N	A	L	S	C	A	L	E	M	S	H	L	V	X	C	E	Z	Z	K	D	G	R	G	M	F	X	O	I	Q	X				

STATISTICS	SCALES OF MEASUREMENT
DESCRIPTIVE STATISTICS	NOMINAL SCALE
DATA	CODING
RAW SCORE	ORDINAL SCALE
INFERRENTIAL STATISTICS	INTERVAL SCALE
POPULATION	EQUIDISTANT SCALE
POPULATION PARAMETER	TRUE ZERO
SAMPLE	RATIO SCALE
OPERATIONAL DEFINITION	QUALITATIVE DATA
SCIENCE	QUANTITATIVE DATA
INDEPENDENT VARIABLE	CONTINUOUS DATA
DEPENDENT VARIABLE	DISCRETE DATA
QUASI-INDEPENDENT	SAMPLE STATISTIC
VARIABLE EXPERIMENT	DATUM
RANDOM ASSIGNMENT	SCORE

CROSSWORD PUZZLES



ACROSS

- 1 Data that vary by amount.
- 4 A description of some observable event in terms of the specific process or manner by which it was observed or measured.
- 5 Procedures used to summarize, organize, and make sense of a set of scores or observations.
- 9 Describes values where the value 0 truly indicates nothing.
- 11 A characteristic (usually numeric) that describes a population.
- 12 A set of selected individuals, items, or data taken from a population of interest.
- 18 Data that vary by class.
- 21 Values whose intervals are distributed in equal units.
- 22 The procedure of converting a nominal value to a numeric value.
- 23 Data measured in whole units or categories that are not distributed along a continuum.
- 24 A random procedure used to ensure that participants in a study have an equal chance of being assigned to a particular group or condition.
- 25 Measurements where values convey order or rank alone.
- 26 The study of phenomena, such as behavior, through strict observation, evaluation, interpretation, and theoretical explanation.

DOWN

- 1 A variable with levels that are not randomly assigned to participants.
- 2 Measurements or observations that are typically numeric (plural).
- 3 Procedures used that allow researchers to infer or generalize observations made with samples to the larger population from which they were selected.
- 6 Refers to how the properties of numbers can change with different uses.
- 7 The variable that remains unchanged or independent between conditions being observed in an experiment.
- 8 The set of all individuals, items, or data of interest. This is the group about which scientists will generalize.
- 10 A characteristic (usually numeric) that describes a sample.
- 13 Measurements where the values have no true zero and the distance between each value is equidistant.
- 14 Measurements where a number is assigned to represent something or someone.
- 15 The variable that is believed to change in the presence of the independent variable.
- 16 A research design in which observations are made under strictly controlled conditions that allow researchers to isolate cause-and-effect relationships between variables.
- 17 Data measured along a continuum at any place beyond the decimal point.
- 19 A branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations.
- 20 Measurements where a set of values has a true zero and are equidistant.

PRACTICE QUIZZES

LO 1: Distinguish between descriptive and inferential statistics.

1. The two general types of statistics are:
 - a. summary; descriptive
 - b. descriptive; inferential
 - c. interpretive; analytical
 - d. simple; complex
2. A researcher summarizes a set of data by describing the score that occurred most often. What type of statistics did the researcher use to summarize these data?
 - a. descriptive
 - b. inferential
 - c. analytical
 - d. professional
3. To study NCAA athletes at a local college, a researcher measures behavior in a portion of all athletes at the college. What type of statistics can the research use to draw conclusions about the behavior of all athletes at the college?
 - a. descriptive
 - b. parameter
 - c. inferential
 - d. professional
4. An instructor records the average grade on an exam in her class. What type of statistics did the instructor use to summarize exam grades in her class?
 - a. descriptive
 - b. parameter
 - c. inferential
 - d. professional

LO 2: Explain how samples and populations, as well as a sample statistic and population parameter, differ.

5. A researcher selects a _____ and uses inferential statistics to draw conclusions about the larger _____.
 - a. sample; statistic
 - b. parameter; population
 - c. population; sample
 - d. sample; population

6. A professor is interested in studying the attitudes of students in her class. She has all of the students in her class fill out a survey and records their responses. In this example, the professor:
 - a. failed to identify the population of interest
 - b. measured data in the sample of students
 - c. measured data in the population of students
 - d. did not have enough data to draw conclusions about the population of interest
7. A characteristic in a population is called a _____, whereas a characteristic in a sample is called a _____.
 - a. population parameter; sample statistic
 - b. sample statistic; population parameter
 - c. sample parameter; population statistic
 - d. population statistic; sample parameter
8. Most students selected at random to a sample are women. The characteristic that most of the sample consists of women is an example of a(n):
 - a. population parameter
 - b. sample statistic
 - c. inferential statistic
 - d. statistical anomaly

LO 3: Describe three research methods commonly used in behavioral science.

9. The research method used to demonstrate that one variable causes changes in a dependent variable is called the:
 - a. experimental method
 - b. quasi-experimental method
 - c. correlational method
 - d. investigative method
10. A researcher measures the number of hours spent studying among students living on-campus and off-campus at a local college. In this study, location (on-campus, off-campus) is the _____ and hours spent studying is the _____.
 - a. independent variable; dependent variable
 - b. dependent variable; independent variable
 - c. quasi-independent variable; dependent variable
 - d. dependent variable; quasi-independent variable

11. A researcher conducts a study that includes a quasi-independent variable and lacks a comparison group. What type of research method is described?
 - a. experimental method
 - b. quasi-experimental method
 - c. counterintuitive method
 - d. investigative method

12. The _____ is a research method where two variables are measured for each participant, and the extent to which those variables are related is measured.
 - a. experimental method
 - b. quasi-experimental method
 - c. correlational method
 - d. investigative method

LO 4: State the four scales of measurement and provide an example for each.

13. State the scales of measurement from least to most informative:
 - a. ratio, interval, ordinal, nominal
 - b. nominal, ordinal, interval, ratio
 - c. ordinal, interval, nominal, ratio
 - d. nominal, ratio, ordinal, interval

14. A health psychologist studies food intake by recording two measures: the type of food consumed (high fat, low fat) and the number of calories consumed. Which is a nominal scale measure?
 - a. the weight of the food
 - b. the type of food consumed
 - c. the number of calories consumed
 - d. both b and c

15. An interval scale:
 - a. has no true zero
 - b. is distributed on an equidistant scale
 - c. is the most informative scale of measurement
 - d. both a and b

16. In science, researchers often go out of their way to measure variables on which scale of measurement because it is the most informative?
 - a. nominal
 - b. ordinal
 - c. interval
 - d. ratio

17. To investigate studying behavior among college students, a researcher measures the following variables: the duration of study time (in minutes per week), the number of breaks a student takes during a study session, and the time of day of studying (morning, afternoon, or night). Which is not a ratio scale of measurement?
- duration of study time
 - number of breaks taken
 - time of day of studying
 - both b and c

LO 5: Distinguish between qualitative and quantitative data.

- A qualitative variable varies by _____; a quantitative variable varies by _____.
- a. class; amount
b. amount; class
c. counting; measuring
d. measuring; counting
- Qualitative variables tend to be on which scale of measurement?
 - nominal
 - ratio
 - interval
 - lateral
- A researcher places a participant in a room filled with 10 strangers. To measure social behavior, he records the number of different people the participant talks to and the time (in seconds) spent talking. The number of people the participant talks to is a _____ variable; the time (in seconds) spent talking is a _____ variable.
 - quantitative; qualitative
 - qualitative; quantitative
 - qualitative; qualitative
 - quantitative; quantitative
- A researcher records the number of times a person repeats a compulsive behavior. What type of data was measured?
 - qualitative
 - quantitative

LO 6: Determine whether a value is discrete or continuous.

- A continuous variable:
 - is measured along a continuum
 - can be measured at any place beyond the decimal point
 - can be measured in whole units or fractional units
 - all of the above

23. A discrete variable:
- is measured in whole units or categories
 - can be measured at any place beyond the decimal point
 - can be measured in fractional units
 - is measured along a continuum
24. A researcher places a participant in a room filled with 10 strangers. To measure social behavior, he records the number of different people the participant talks to, and the time (in seconds) spent talking. The number of people the participant talks to is a _____ variable; the time (in seconds) spent talking is a _____ variable.
- categorical; discrete
 - continuous; discrete
 - discrete; continuous
 - discrete; categorical
25. A researcher records the family relationship (brother, son, father, cousin, etc.) of the people who stay in regular contact with loved ones in a nursing home. What type of measure is family relationship?
- quantitative and discrete
 - qualitative and discrete
 - qualitative and continuous
 - quantitative and continuous

SPSS IN FOCUS

Entering and Defining Variables

Follow the General Instructions Guide to complete this exercise. Also, an example for following these steps is provided in the SPSS in Focus section (Section 1.6) of the book. Complete and submit the SPSS grading template and a printout of the data view.

Exercise 1.1: The Time It Takes to Enter Data

A researcher conducts a hypothetical study regarding the time it takes undergraduate and graduate students to enter statistical data into SPSS. After the researcher completes a hypothetical study with 20 participants, he records the time it took undergraduate and graduate students to correctly enter the data into SPSS. The time (in seconds) that it took each student to enter the data is given below. Enter these data into SPSS in two ways:

1. Enter these data by column using SPSS and appropriately label each group.
2. Enter these data by row using SPSS and appropriately code each group/label each column.

Undergraduate Student	Graduate Student
28	18
34	32
22	27
19	21
14	14
27	32
28	25
28	24
31	25
20	25

With regard to the SPSS exercise, answer the following questions:

Enter data by column:

State whether you used the **data view** or **variable view** to complete the following:

Naming variables _____

Entering the values for each variable _____

State the following values for the data you entered in SPSS:

The number of values entered (overall) _____

The number of values entered in each group _____

The number of groups _____

Enter data by row:

With regard to the SPSS exercise, answer the following questions:

State whether you used the **data view** or **variable view** to complete the following:

Naming variables _____

Coding variables _____

Entering the values for each variable _____

State the following values for the data you entered in SPSS:

The number of values entered (overall) _____

The number of values entered in each group _____

The number of groups _____

CHAPTER SUMMARY ORGANIZED BY LEARNING OBJECTIVE

LO 1–2: Distinguish between descriptive and inferential statistics; explain how samples and populations, as well as a sample statistic and population parameter, differ.

- Statistics is a branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations. **Descriptive statistics** are procedures used to make sense of observations by summarizing them numerically. **Inferential statistics** are procedures used to help the researcher *infer* whether observations made with samples are reflective of the population.
- A **population** is a set of all individuals, items, or data of interest. A characteristic that describes a population is referred to as a **population parameter**. A **sample** is a set of selected individuals, items, or data taken from a population of interest. A characteristic that describes a sample is referred to as a **sample statistic**.

LO 3: Describe three research methods commonly used in behavioral science.

- The experimental design uses randomization, manipulation, and comparison to control variables to demonstrate cause-and-effect relationships. The quasi-experimental design is structured similar to an experiment but lacks randomization or a comparison group.
- The correlational method is used to measure pairs of scores for each individual and examine the relationship between the variables.

LO 4: State the four scales of measurement and provide an example for each.

- The **scales of measurement** refer to how the properties of numbers can change with

different uses. They are characterized by three properties: order, differences, and ratios. There are four scales of measurement: **nominal**, **ordinal**, **interval**, and **ratio**. Nominal values are typically coded (e.g., seasons, months, gender), ordinal values indicate order alone (e.g., rankings, grade level), interval values have equidistant scales and no true zero (e.g., rating scale values, temperature), and ratio values are also equidistant but have a true zero (e.g., weight, height, calories).

LO 5–6: Distinguish between qualitative and quantitative data; determine whether a value is discrete or continuous.

- A **continuous variable** is measured along a continuum, whereas a **discrete variable** is measured in whole units or categories. Hence, continuous but not discrete variables are measured at any place beyond the decimal point. A **quantitative variable** varies by amount, whereas a **qualitative variable** varies by class. Examples for different types of variables are given in Table 1.3.

SPSS LO 7: Enter data into SPSS by placing each group in separate columns and by placing each group in a single column (coding is required).

- SPSS can be used to enter and define variables. All variables are defined in the **variable view tab**. The values recorded for each variable are listed in the **data view tab**. Data can be entered by column or by row in the data view tab. Listing data by row requires coding the variable. Variables are coded in the **variable view tab** in the **values column** (for more details, see Section 1.6).

