# Chapter 1 – Data Collection

## OUTLINE

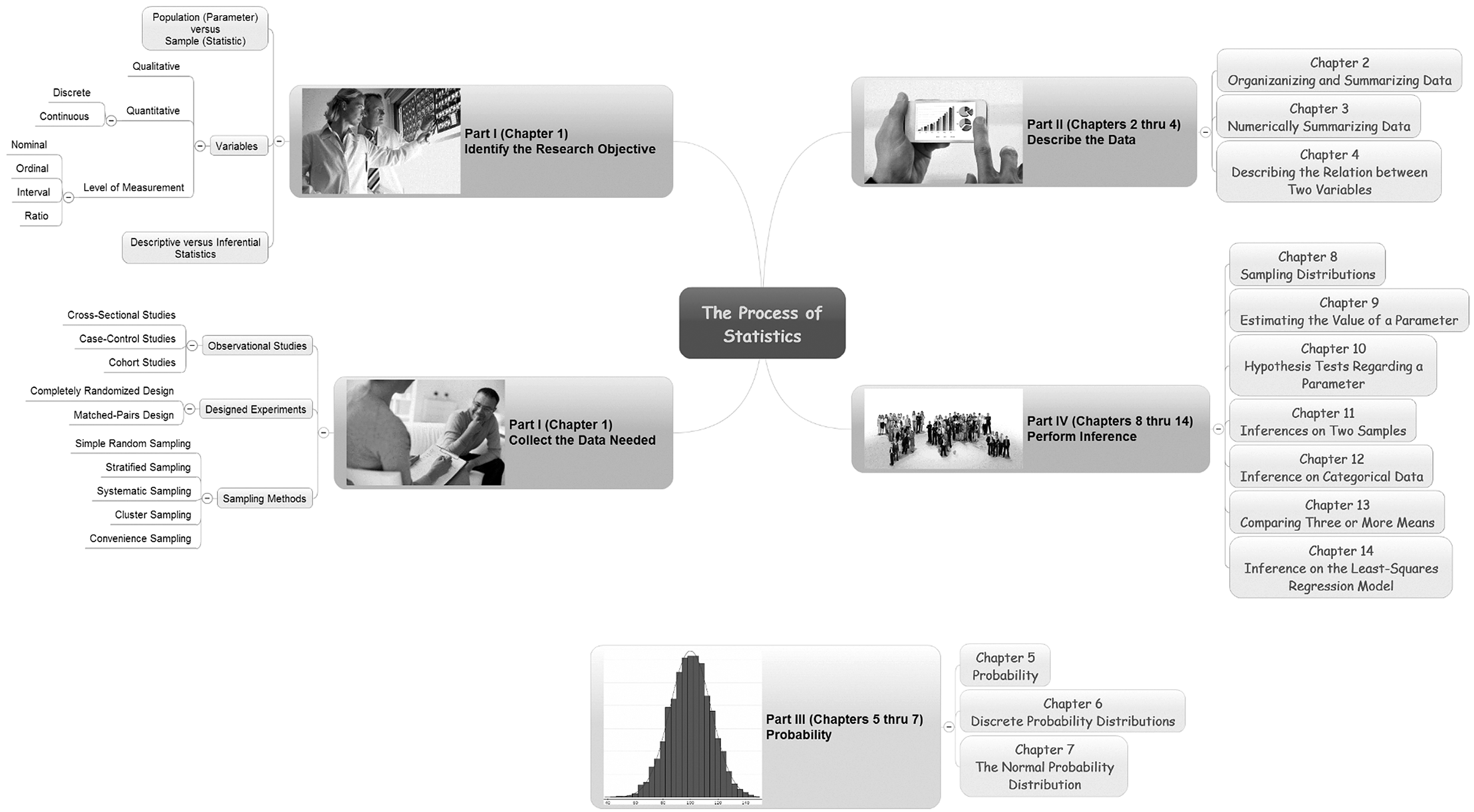
* 1. Introduction to the Practice of Statistics
  2. Observational Studies versus Designed Experiments
  3. Simple Random Sampling
  4. Other Effective Sampling Methods
  5. Bias in Sampling
  6. The Design of Experiments

## Putting It Together

Statistics plays a major role in many aspects of our lives. It is used in sports, for example, to help a general manager decide which player might be the best fit for a team. It is used in politics to help candidates understand how the public feels about various policies. And statistics is used in medicine to help determine the effectiveness of new drugs.

Used appropriately, statistics can enhance our understanding of the world. Used inappropriately, it can lend support to inaccurate beliefs. Understanding statistical methods will provide you with the ability to analyze and critique studies and the opportunity to become an informed consumer of information.

Understanding statistical methods will also enable you to distinguish solid analysis from bogus “facts.”



## Section 1.1 Introduction to the Practice of Statistics

### Objectives

1. Define Statistics and Statistical Thinking
2. Explain the Process of Statistics
3. Distinguish between Qualitative and Quantitative Variables
4. Distinguish between Discrete and Continuous Variables
5. Determine the Level of Measurement of a Variable

#### Objective 1: Define Statistics and Statistical Thinking

Objective 1, Page 1

 *Answer the following as you watch the video.*

1. Write the definition of statistics below.
2. Data describes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of individuals and can be either \_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_.

**Note:** Data varies. Consider the students in your class. Is everyone the same height? No. Does everyone have the same color hair? No. So, within groups there is variation. Now consider yourself. Do you eat the same amount of food (as measured by calories) each day? No. Do you sleep the same number of hours each day? No. So, even considering individuals there is variation. One goal of statistics is to describe and understand sources of variation.

#### Objective 2: Explain the Process of Statistics

Objective 2, Page 1

 *Answer the following while watching the animation.*

1. What is the entire group to be studied called?
2. What do we call a person or object that is a member of the population being studied?

Objective 2, Page 1 (continued)

1. Give the definition of a sample.
2. What do we call a numerical summary of a sample?
3. What do we call a numerical summary of a population?
4. Give the definition of descriptive statistics.
5. Give the definition of inferential statistics.
6. In the $100 experiment, what is the population? What is the sample?

Population:

Sample:

Objective 2, Page 1 (continued)

1. Is the statement an example of descriptive statistics or inferential statistics? Circle the correct answer.
   1. The percent of students in the survey who would return the money to the owner is 78%.

Descriptive statistics

Inferential statistics

* 1. We are 95% confident that between 74% and 82% of all students would return the money.

Descriptive statistics

Inferential statistics

1. Is the given measure a statistic or a parameter? Circle the correct answer.
   1. The percentage of all students on your campus who own a car is 48.2%.

Statistic

Parameter

* 1. Suppose a random sample of 100 students is obtained, and from this sample we find that 46% own a car.

Statistic

Parameter

Objective 2, Page 7

 *Fill in the following steps while watching the video.*

**The Process of Statistics**

1. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** A researcher must determine the question(s) he or she wants answered. The question(s) must be detailed so that it identifies the population that is to be studied.
2. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Conducting research on an entire population is often difficult and expensive, so we typically look at a sample. This step is vital to the statistical process because if the data are not collected correctly, the conclusions drawn are meaningless. Do not overlook the importance of appropriate data collection.
3. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Descriptive statistics allow the researcher to obtain an overview of the data and can help determine the type of statistical methods the researcher should use.
4. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Apply the appropriate techniques to extend the results obtained from the sample to the population and report a level of reliability of the results.

Objective 2, Page 8

**Example 1** ***The Process of Statistics: Gun Ownership***

The AP – National Constitution Center conducted a national poll to learn how adult Americans feel existing gun-control laws infringe on the second amendment to the U.S. Constitution.

The following statistical process allowed the researchers to conduct their study.

1. Identify the research objective.
2. Collect the information needed to answer the question posed in (1).
3. Describe the data.
4. Perform inference.

#### Objective 3: Distinguish between Qualitative and Quantitative Variables

Objective 3, Page 1

Define the following terms.

1. Qualitative variable:
2. Quantitative variable:

Objective 3, Page 2

**Example 2** ***Distinguishing between Qualitative and Quantitative Variables***

Determine whether the following variables are qualitative or quantitative.

1. Gender
2. Temperature
3. Number of days during the past week that a college student studied
4. Zip code

#### Objective 4: Distinguish between Discrete and Continuous Variables

Objective 4, Page 1

Define the following terms.

1. Discrete variable:
2. Continuous variable:

Objective 4, Page 2

**Example 3** ***Distinguishing between Discrete and Continuous Variables***

Determine whether the quantitative variables are discrete or continuous.

1. The number of heads obtained after flipping a coin five times.
2. The number of cars that arrive at a McDonald’s drive-through between 12:00 P.M. and 1:00 P.M.
3. The distance a 2011 Toyota Prius can travel in city driving conditions with a full tank of gas.

Objective 4, Page 4

Define the following terms.

1. Data:
2. Qualitative data:
3. Quantitative data:
4. Discrete data:
5. Continuous data:

Objective 4, Page 5

**Example 4** ***Distinguishing between Variables and Data***

The following table presents a group of selected countries and information regarding these countries as of September, 2010.

| **Country** | **Government Type** | **Life Expectancy (years)** | **Population (in millions)** |
| --- | --- | --- | --- |
| Australia | Federal parliamentary democracy | 81.63 | 21.3 |
| Canada | Constitutional monarchy | 81.23 | 33.5 |
| France | Republic | 80.98 | 64.4 |
| Morocco | Constitutional monarchy | 75.47 | 31.3 |
| Poland | Republic | 75.63 | 38.5 |
| Sri Lanka | Republic | 75.14 | 21.3 |
| United States | Federal republic | 78.11 | 307.2 |

Identify the individuals, variables, and data.

#### Objective 5: Determine the Level of Measurement of a Variable

Objective 5, Page 1

List the characteristics used to determine what level of measurement a variable is.

1. Nominal:
2. Ordinal:

Objective 5, Page 1 (continued)

1. Interval:
2. Ration:

Objective 5, Page 2

**Example 5 *Determining the Level of Measurement of a Variable***

For each of the following variables, determine the level of measurement.

1. Gender
2. Temperature
3. Number of days during the past week that a college student studied
4. Letter grade earned in your statistics class

## Section 1.2 Observational Studies versus Designed Experiments

### Objectives

1. Distinguish between an Observational Study and a Designed Experiment
2. Explain the Various Types of Observational Studies

#### Objective 1: Distinguish between an Observational Study and a Designed Experiment

Objective 1, Page 1

*Answer the following as you watch the video.*

1. Why is the Danish study mentioned in the video an observational study and not a designed experiment?
2. Why is the “rat” study mentioned in the video a designed experiment and not an observational study?
3. What is the response variable in each study, and what is the explanatory variable?

Objective 1, Page 2

*Answer the following after watching the video.*

1. In research, we wish to determine how varying an explanatory variable affects …
2. What does an observational study measure? Does an observational study attempt to influence the value of the response variable or explanatory variable?

OBJECTIVE 1, PAGE 2 (CONTINUED)

1. Explain how you would determine if a study is a designed experiment.

Objective 1, Page 4

*Watch the video and answer the following.*

1. Why is the influenza study mentioned in the video an observational study and not a designed experiment?
2. List some changes that could be made to investigate the effectiveness of the flu shot with a designed experiment.
3. List some lurking variables in the influenza study.
4. What are some variables (besides getting a flu vaccine) that may play a role in whether one contracts pneumonia or influenza?

Objective 1, Page 4 (continued)

1. Define confounding in a study.
2. What is a lurking variable?
3. Do observational studies allow a researcher to claim causality?

Objective 1, Page 7

1. List some reasons why an observational study would be conducted if causation cannot be claimed.

Objective 1, Page 8

1. Define: Confounding variable

Objective 1, Page 9

1. What is the big difference between lurking variables and confounding variables?

#### Objective 2: Explain the Various Types of Observational Studies

Objective 2, Page 1

*Answer the following while watching the video.*

1. Define: Cross-sectional studies
2. Define: Case-control studies
3. List some difficulties that may occur and affect the outcomes of a case-control study.
4. List some of the advantages of performing a case-control study over a cross-sectional study.
5. Define: Cohort studies
6. List an advantage of using a cohort study.
7. List two disadvantages of using a cohort study.

Objective 2, Page 2

**Example 1** ***What Type of Study?***

Determine whether each of the following studies depict an observational study or an experiment. If the researchers conducted an observational study, determine the type of the observational study.

1. Researchers wanted to assess the long-term psychological effects of children evacuated during World War II. They obtained a sample of 169 former evacuees and a control group of 43 people who were children during the war but were not evacuated. The subjects’ mental states were evaluated using questionnaires. It was determined that the psychological well being of the individuals was adversely affected by evacuation. (Source: Foster D, Davies S, and Steele H (2003) The evacuation of British children during World War II: a preliminary investigation into the long-term psychological effects. Aging & Mental Health (7)5.)
2. Xylitol has proven effective in preventing dental carries (cavities) when included in food or gum. A total of 75 Peruvian children were given milk with and without xylitol and were asked to evaluate the taste of each. Overall, the children preferred the milk flavored with xylitol. (Source: Castillo JL, et al (2005) Children’s acceptance of milk with xylitol or sorbitol for dental carries prevention. BMC Oral Health (5)6.)
3. A total of 974 homeless women in the Los Angeles area were surveyed to determine their level of satisfaction with the healthcare provided by shelter clinics versus the healthcare provided by government clinics. (Source: Swanson KA, Andersen R, Gelberg L (2003) Patient satisfaction for homeless women. Journal of Women’s Health (12)7.)
4. The Cancer Prevention Study II (CPS-II) is funded and conducted by the American Cancer Society. Its goal is to examine the relationship among environmental and lifestyle factors on cancer cases by tracking approximately 1.2 million men and women. Study participants completed an initial study questionnaire in 1982 providing information on a range of lifestyle factors such as diet, alcohol and tobacco use, occupation, medical history, and family cancer history. These data have been examined extensively in relation to cancer mortality. Vital status of study participants is updated biennially. Cause of death has been documented for over 98% of all deaths that have occurred. Mortality follow-up of the CPS-II participants is complete through 2002 and is expected to continue for many years. (Source: American Cancer Society)

Objective 2, Page 3

1. It is not always possible to conduct an experiment. Explain why we could not conduct an experiment to investigate the perceived link between high tension wires and leukemia (on humans).

Objective 2, Page 6

1. There is no point in reinventing the wheel. List some agencies that regularly collect data that are available to the public.

Objective 2, Page 7

1. What is a census?
2. Why is the U.S. Census so important?

## Section 1.3 Simple Random Sampling

### Objective

* 1. Obtain a Simple Random Sample

Introduction, Page 1

Observational studies can be conducted by administering a survey. When administering a survey, the researcher must first identify the population that is to be targeted.

1. Define: Random sampling

For the results of a survey to be reliable, the characteristics of the individuals in the sample must be representative of the characteristics of the individuals in the population.

The key to obtaining a sample representative of a population is to let chance or randomness play a role in dictating which individuals are in the sample, rather than convenience.

If convenience is used to obtain a sample, the results of the survey are meaningless.

Introduction, Page 2

1. Why are the survey results from the sample taken outside Fenway Park not likely to be reliable?
2. Why are the results of a survey of students in your statistics class likely to be misleading when trying to determine what proportion of students on your campus work?

Introduction, Page 3

1. List the four basic sampling techniques.

#### Objective 1: Obtain a Simple Random Sample

Objective 1, Page 1

1. What is a simple random sample?

The number of individuals in the sample is always less than the number of individuals in the population.

Objective 1, Page 2

**Example 1** ***Illustrating Simple Random Sampling***

Sophie has four tickets to a concert. Six of her friends, Yolanda, Michael, Kevin, Marissa, Annie, and Katie, have all expressed an interest in going to the concert. Sophie decides to randomly select three of her six friends to attend the concert.

1. List all possible samples of size *n* = 3 from the population of size *N* = 6. Once an individual is chosen, he/she cannot be chosen again.
2. Comment on the likelihood of the sample containing Michael, Kevin, and Marissa.

Objective 1, Page 5

How do we select the individuals in a simple random sample?

Typically, each individual in the population is assigned a unique number between 1 and *N*, where *N* is the size of the population. Then *n* distinct random numbers are selected, where *n* is the size of the sample. To number the individuals in the population, we need a frame**–** a list of all the individuals within the population.

Objective 1, Page 6

*Answer the following after watching the animation.*

1. What is the frame in this animation?
2. Explain why a second sample of 5 students will most likely be different than the first sample of 5 students?
3. Explain why inferences based on samples vary.

Objective 1, Page 8

**Example 2 *Obtaining a Simple Random Sample***

The accounting firm of Senese and Associates has grown. To make sure their clients are still satisfied with the services they are receiving, the company decides to send a survey out to a simple random sample of 5 of its 30 clients.

**TABLE 3**

* + 1. ABC Electric
    2. Brassil Construction
    3. Bridal Zone
    4. Casey's Glass House
    5. Chicago Locksmith
    6. DeSoto Painting
    7. Dino Jump
    8. Euro Car Care
    9. Farrell's Antiques
    10. First Fifth Bank
    11. Fox Studios
    12. Haynes Hauling
    13. House of Hair
    14. John's Bakery
    15. Logistics Management, Inc.
    16. Lucky Larry's Bistro
    17. Moe's Exterminating
    18. Nick's Tavern
    19. Orion Bowling
    20. Precise Plumbing
    21. R&Q Realty
    22. Ritter Engineering
    23. Simplex Forms
    24. Spruce Landscaping
    25. Thors, Robert DPS
    26. Travel Zone
    27. Ultimate Electric
    28. Venetian Gardens Restaurant
    29. Walker Insurance
    30. Worldwide Wire

## Section 1.4 Other Effective Sampling Methods

### Objectives

* 1. Obtain a Stratified Sample
  2. Obtain a Systematic Sample
  3. Obtain a Cluster Sample

Introduction, Page 1

1. What is the goal of sampling?

#### Objective 1: Obtain a Stratified Sample

Objective 1, Page 1

1. Explain how to obtain a stratified sample.

Objective 1, Page 2

**Example 1** ***Obtaining a Stratified Sample***

The president of DePaul University wants to conduct a survey to determine the community’s opinion regarding campus safety. The president divides the DePaul community into three groups: resident students, nonresident (commuting) students, and staff (including faculty) so that he can obtain a stratified sample.

Suppose there are 6,204 resident students, 13,304 nonresident students, and 2,401 staff, for a total of 21,909 individuals in the population. What percent of the DePaul community is made up of each group?

The president wants to obtain a sample of size 100, with the number of individuals selected from each stratum weighted by the population size. How many individuals should be selected from each stratum?

To obtain the stratified sample, construct a simple random sample within each group.

#### Objective 2: Obtain a Systematic Sample

Objective 2, Page 1

1. Explain how to obtain a systematic sample.

**Note:** Because systematic sampling does not require a frame, it is a useful technique when you cannot gather a list of the individuals in the population.

Objective 2, Page 2

**Example 2 *Obtaining a Systematic Sample without a Frame***

The manager of Kroger Food Stores wants to measure the satisfaction of the store’s customers. Design a sampling technique that can be used to obtain a sample of 40 customers.

Objective 2, Page 4

*Answer the following after watching the video.*

1. What can result from choosing a value of *k* that is too small?
2. What can result from choosing a value of *k* that is too large?

Objective 2, Page 5

 *Answer the following after watching the second video after Example 2.*

1. Explain how to determine the value of *k* if the population size *N* is known.

Objective 2, Page 7

1. List the five steps in obtaining a systematic sample.

Step 1

Step 2

Step 3

Step 4

Step 5

#### Objective 3: Obtain a Cluster Sample

Objective 3, Page 1

1. What is a cluster sample?

Objective 3, Page 2

**Example 3 *Obtaining a Cluster Sample***

A sociologist wants to gather data regarding household income within the city of Boston. Obtain a sample using cluster sampling.

Objective 3, Page 3

1. If the clusters have homogeneous individuals, is it better to have more clusters with fewer individuals in each cluster or fewer clusters with more individuals in each cluster?
2. If the clusters have heterogeneous individuals, is it better to have more clusters with fewer individuals in each cluster or fewer clusters with more individuals in each cluster?

Objective 3, Page 5

1. Define: Convenience sampling

Objective 3, Page 6

**Note:** The most popular convenience samples are those in which the individuals in the sample are self-selected**,** meaning the individuals themselves decide to participate in the survey. Self-selected surveys are also called voluntary response samples.

Objective 3, Page 7

1. Define: Multistage sampling
2. List the two stages Nielsen Media Research uses to investigate TV viewing habits.

Objective 3, Page 8

1. How many stages does the Census Bureau use for the Current Population Survey? What are those stages?

Objective 3, Page 9

Researchers need to know how many individuals they must survey to draw conclusions about the population within some predetermined margin of error. They must find a balance between the reliability of the results and the cost of obtaining these results. The bottom line is that time and money determine the level of confidence researchers will place on the conclusions drawn from the sample data. The more time and money researchers have available, the more accurate the results of the statistical inference.

Objective 3, Page 10

 *Watch the animation for a summary of simple random sampling, systematic sampling, stratified sampling, and cluster sampling.*

## Section 1.5 Bias in Sampling

### Objective

1. Explain the Sources of Bias in Sampling

#### Objective 1: Explain the Sources of Bias in Sampling

Objective 1, Page 1

1. Define: Bias
2. List the three sources of bias in sampling:

Objective 1, Page 2

 *Answer the following after watching the video.*

1. What is sampling bias?
2. Does a convenience sample have sampling bias?
3. What is under coverage?

Objective 1, Page 3

 *Answer the following after watching the video.*

1. When does nonresponse bias exist?
2. List two causes of nonresponse bias.
3. List one tool that can be used to control nonresponse bias?

Objective 1, Page 4

 *Answer the following after* *watching the video.*

1. Under what conditions does response bias exist?

**Note:** Response bias can occur through interviewer error, misrepresented answers, wording of questions, ordering of questions or words, type of question, or data-entry error.

**Note:** An open questionallows the respondent to choose his or her response (free response).

**Note:** A closed question requires the respondent to choose from a list of predetermined responses (multiple choice).

Objective 1, Page 7

**Note: Can a Census Have Bias?**

A question on a census form could be misunderstood, thereby leading to response bias in the results. It is often difficult to contact each individual in a population. For example, the U.S. Census Bureau is challenged to count each homeless person in the country, so the census data published by the U.S. government likely suffers from nonresponse bias.

Objective 1, Page 8

Define the following terms.

1. Nonsampling Error:
2. Sampling error:

## Section 1.6 The Design of Experiments

### Objectives

1. Describe the Characteristics of an Experiment
2. Explain the Steps in Designing an Experiment
3. Explain the Completely Randomized Design
4. Explain the Matched-Pairs Design

Introduction, Page 1

 *Watch the video for a review of the language used in observational studies.*

Review the definitions of cross-sectional studies, case-control studies, and cohort studies.

* In observational studies, we cannot make statements of *causality* between the explanatory variable(s) and the response variable.
* The response variable measures the outcome of the study.
* The explanatory variable is the variable whose impact we want to see has on the response variable.

#### Objective 1: Describe the Characteristics of an Experiment

Objective 1, Page 1

 *Define the following terms after watching the video.*

1. Experiment:
2. Factor:
3. Treatment:

Objective 1, Page 1 (continued)

*Define the following terms after watching the video.*

1. Experimental unit:
2. Control group:
3. Placebo:
4. Blinding:
5. Single-blind:
6. Double-blind:

Objective 1, Page 2

The use of placebos in designed experiments is a way to form a control group in a designed experiment.

1. What is the placebo effect?

Objective 1, Page 3

Recall confounding in a study occurs when the effects of two or more explanatory variables are not separated. In designed experiments, confounding may occur as a result of a confounding variable, which is an explanatory variable that was considered in a study whose effect cannot be distinguished from a second explanatory variable in the study.

Objective 1, Page 6

**Example 1 *The Characteristics of an Experiment***

Lipitor is a cholesterol-lowering drug made by Pfizer. In the Collaborative Atorvastatin Diabetes Study (CARDS), the effect of Lipitor on cardiovascular disease was assessed in 2838 subjects, ages 40 to 75, with type 2 diabetes, without prior history of cardiovascular disease. In this placebo-controlled, double-blind experiment, subjects were randomly allocated to either Lipitor 10 mg daily (1428) or placebo (1410) and were followed for 4 years. The response variable whether there was an occurrence of any major cardiovascular event or not.

Lipitor significantly reduced the rate of major cardiovascular events (83 events in the Lipitor group versus 127 events in the placebo group). There were 61 deaths in the Lipitor group versus 82 deaths in the placebo group.

* + 1. What does it mean for the experiment to be placebo-controlled?
    2. What does it mean for the experiment to be double-blind?
    3. What is the population for which this study applies? What is the sample?

Objective 1, Page 6 (continued)

* + 1. What are the treatments?
    2. What is the response variable? Is it qualitative or quantitative?

#### Objective 2: Explain the Steps in Designing an Experiment

Objective 2, Page 1

**Steps in Conducting a Designed Experiment**

Fill in each step.

***Step 1***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The statement of the problem should be as explicit as possible and should provide the experimenter with direction. The statement must also identify the response variable and the population to be studied. Often, the statement is referred to as the *claim.*

***Step 2***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The factors are usually identified by an expert in the field of study. In identifying the factors, ask, “What things affect the value of the response variable?” After the factors are identified, determine which factors to fix at some predetermined level, which to manipulate, and which to leave uncontrolled.

***Step 3***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

As a general rule, choose as many experimental units as time and money allow. Techniques exist for determining sample size, provided certain information is available.

Objective 2, Page 1 (continued)

***Step 4****:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Factors can be dealt with in two ways - control or randomize.

Controlmeans to either set the factor at one value throughout the experiment or set the level of the factor at various levels).

Randomizemeans to randomly assign the experimental units to various treatment groups.

***Step 5****:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Replicationoccurs when each treatment is applied to more than one experimental unit.

***Step 6****:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Inferential statisticsis a process in which generalizations about a population are made on the basis of results obtained from a sample.

Objective 2, Page 2

List the six steps for the Lipitor study in Example 1 (Objective 1, Page 6)

**Step 1:** *Identify the Problem to be Solved*

**Step 2*:*** *Determine the Factors That Affect the Response Variable*

**Step 3:** *Determine the Number of Experimental Units*

**Step 4:** *Determine the Level of Each Factor*

**Step 5*:*** *Conduct the Experiment*

**Step 6:** *Test the Claim*

#### Objective 3: Explain the Completely Randomized Design

Objective 3, Page 1

1. What is a completely randomized design?

Objective 3, Page 2

**Example 2 *A Completely Randomized Design***

A farmer wishes to determine the optimal level of a new fertilizer on his soybean crop. Design an experiment that will assist him.

Objective 3, Page 3

Sketch the experimental design from Example 2 (Objective 3, Page 2).

1. Explain why this experimental design is a completely randomized design.

#### Objective 4: Explain the Matched-Pairs Design

Objective 4, Page 1

1. What is a matched-pairs design?

The pairs are selected so that they are related in some way.

There are only two levels of treatment in a matched-pairs design.

Objective 4, Page 2

**Example 3 *A Matched-Pairs Design***

An educational psychologist wants to determine whether listening to music has an effect on a student’s ability to learn. Design an experiment to help the psychologist answer the question.