**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.