

Experiments and Observational Studies

Key Concept

The design of a research project is greatly influenced by the extent to which the research environment can be controlled. In an *experiment*, the researcher changes the environment by imposing a treatment. In an *observational study*, the researcher gathers data without modifying the environment that is being studied. Students will learn to distinguish experiments and observational studies and use this lens to evaluate published reports.

Key Question: Example 1

What should you look for in determining whether a study is an experiment or an observational study?

Check to see if a treatment is applied to some individuals. If so, the study is an experiment. If not, it is an observational study.

Differentiated Instruction

Example 1 You may want to give advanced learners additional vocabulary that they can use to help them characterize the studies in this example. Tell students that a *response variable* is a variable that measures the outcome of a study. An *explanatory variable* is a variable that explains or causes changes in a response variable. Have students relate response variables and explanatory variables to dependent variables and independent variables. Then ask them to identify the response variables and explanatory variables for the studies in Example 1.

Key Question: Example 2

How could this study be conducted as a randomized comparative experiment?

Randomly choose 50 students to be in the control group and 50 students to be in the treatment group. For one year, give milk at lunchtime to the students in the treatment group and let students in the control group choose any other beverage. Keep all other conditions identical for the two groups.

Avoiding Common Errors

Example 2 Students may notice that the study in Example 2 involves two groups of individuals and jump to the conclusion that the study is an experiment. Remind students that in an experiment, a treatment is *imposed* on individuals. In this example, students were free to choose a beverage at lunch.

Key Question: Example 3

In the observational study that is described in the solution to the example, what assumptions do you make about the two groups of individuals?

You assume that the individuals in the two groups live under nearly identical conditions, with the exception of the amount of time they listen to an MP3 player with earphones.

Closing the Lesson

Have students answer the following question: What is the difference between an *experiment* and an *observational study*?

An experiment imposes a treatment on individuals to collect data on their response to the treatment. An observational study observes individuals and measures variables without controlling the individuals or their environment in any way.

Teaching Strategy

Exercise 10 As a variation on this exercise, consider having students look through magazines, newspapers, Web sites, and other sources to find published reports that are examples of experiments and observational studies. Prompt students to look for sources of bias in poorly designed experiments and have them evaluate the validity of the studies' results. You could have students share their findings on a bulletin board that is divided into the good (well-designed studies), the bad (poorly-designed studies), and the ugly (misleading data displays or other misrepresentations of results).

Homework Help

Example 1: Exs. 1–3

Example 2: Ex. 4

Example 3: Exs. 5–7

Enrichment: Exs. 8–10

Homework Check

To quickly check student understanding of key concepts, go over the following exercises: 2, 3, 4, 7.

ANSWERS

✓ Check Answers

1. Experiment; a treatment (a new Web site) is applied to some individuals (users of the Web site).
2. Yes; the treatment is the new Web site; the treatment group consist of users of the new site; the control group consist of users of the old site.
3. Experiment; randomly choose a treatment group that will be given 1000 mg of vitamin C each day and randomly choose a control group that will not be given the vitamin. Monitor the individuals' cholesterol levels.
- b. Use a randomized comparative experiment in which individuals are randomly assigned to a treatment group that takes the fiber supplements and a control group that does not take the supplements.
9. In astronomy, the individuals being studied are planets, stars, or other objects that are impossible to control.
10. *Sample answer:* Experiment: Does taking a daily calcium supplement increase bone density?
Observational Study: Do redwood trees grow more slowly after being struck by lightning?

Exercise Answers

1. Observational study; the researcher gathers data without controlling the individuals or applying a treatment.
2. Observational study; the researcher gathers data without controlling the individuals or applying a treatment.
3. Experiment; the farmer applies a treatment (new fertilizer) to some individuals (strawberry plants).
4. No; individuals were not randomly assigned to control/treatment groups. The conclusion may not be valid since there may be other reasons why people who wake up early have fewer accidents (e.g., they may drive at a time when there are fewer cars on the road).
5. Observational study; randomly choose homes that are close to parks and schools and randomly choose homes that are not close to parks and schools. Monitor property values in both groups.
6. Experiment; randomly choose a treatment group of dogs that will get dog food with Omega-3 fatty acids and randomly choose a control group of dogs that will get dog food without Omega-3 fatty acids. Monitor the shininess of the dog's coats in both groups.
7. Experiment; randomly choose a treatment group of flowers that will get sprayed twice a day and randomly choose a control group of flowers that will not get sprayed. Monitor the length of time the flowers stay fresh in each group.
8. a. People who take fiber supplements may be more likely to do other things (exercise, have healthy eating habits, etc.) that reduce their incidence of heart attacks.