

Lesson 23: Experiments and the Role of Random Assignment

Classwork

Exercises 1–4: Experiments

Two studies are described below. One is an observational study, while the other is an experiment.

Study A:

A new dog food, specially designed for older dogs, has been developed. A veterinarian wants to test this new food against another dog food currently on the market to see if it improves dogs' health. Thirty older dogs were randomly assigned to either the "new" food group or the "current" food group. After they were fed either the "new" or "current" food for six months, their improvement in health was rated.

Study B:

The administration at a large school wanted to determine if there was a difference in the mean number of text messages sent by ninth-grade students and by eleventh-grade students during a day. Students in a random sample of 30 ninth-grade students were asked how many text messages they sent per day. Students in another random sample of 30 eleventh-grade students were asked how many text messages they sent per day. The difference in the mean number of texts per day was determined.

1. Which study is the experiment? Explain. Discuss the answer with your partner.
2. In your own words, describe what a subject is in an experiment.
3. In your own words, describe what a response variable is in an experiment.
4. In your own words, describe what a treatment is in an experiment.

Exercises 5–9: Random Selection and Random Assignment

Take another look at the two studies described above. Study A (the dog food study) is an experiment, while study B (text messages) is an observational study. The term *random sample* implies that a sample was randomly selected from a population. The terms *random selection* and *random assignment* have very different meanings.

Random selection refers to randomly selecting a sample from a population. Random selection allows generalization to a population and is used in well-designed observational studies. Sometimes, but not always, the subjects in an experiment are randomly selected.

Random assignment refers to randomly assigning the subjects in an experiment to treatments. Random assignment allows for cause-and-effect conclusions and is used in well-designed experiments.

In study B, the data were collected from two random samples of students.

5. Can the results of the survey be generalized to all ninth-grade and all eleventh-grade students at the school? Why or why not? Discuss the answer with your partner.

6. Suppose there really is a difference in the mean number of texts sent by ninth-grade students and by eleventh-grade students. Can we say that the grade level of the students is the cause of the difference in the mean number of texts sent? Why or why not? Discuss the answer with your partner.

In study A, the dogs were randomly assigned to one of the two types of food.

7. Suppose the dogs that were fed the new food showed improved health. Can we say that the new food is the cause of the improvement in the dogs' health? Why or why not? Discuss the answer with your partner.

8. Can the results of the dog food study be generalized to all dogs? To all older dogs? Why or why not? Discuss the answer with your partner.

The table below summarizes the differences between the terms *random selection* and *random assignment*.

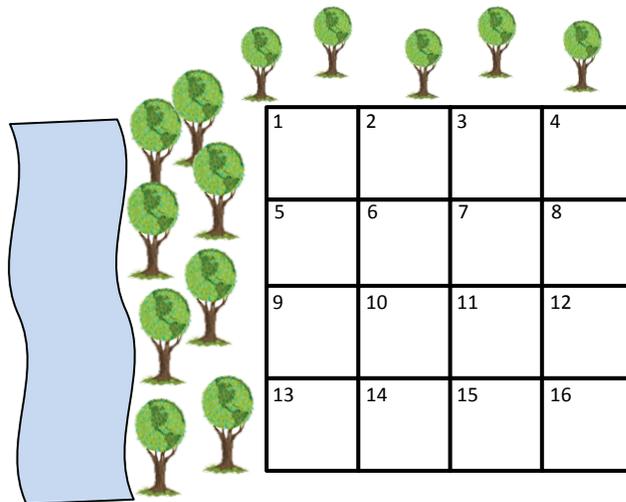
9. For each statement, put a check mark in the appropriate column(s), and explain your choices.

	Random Selection	Random Assignment
Used in Experiments		
Used in Observational Studies		
Allows Generalization to the Population		
Allows a Cause-and-Effect Conclusion		

Exercises 10–17

What is the purpose of random assignment in experiments? To answer this, consider the following investigation:

A researcher wants to determine if the yield of corn is different when the soil is treated with one of two different types of fertilizers, fertilizer A and fertilizer B. The researcher has 16 acres of land located beside a river that has several trees along its bank. There are also a few trees to the north of the 16 acres. The land has been divided into 16 one-acre plots. (See the diagram below.) These 16 plots are to be planted with the same type of corn but can be fertilized differently. At the end of the growing season, the corn yield will be measured for each plot, and the mean yields for the plots assigned to each fertilizer will be compared.



10. For the experiment, identify the following, and explain each answer:

a. Subjects (Hint: not always people or animals)

b. Treatments

c. Response variable

Next, you need to assign the plots to one of the two treatments. To do this, follow the instructions given by your teacher.

11. Write A (for fertilizer A) or B (for fertilizer B) in each of the 16 squares in the diagram so that it corresponds to your random assignment of fertilizer to plots.

Let's investigate the results of the random assignment of the fertilizer types to the plots.

12. On the diagram above, draw a vertical line down the center of the 16 plots of land.
13. Count the number of plots on the left side of the vertical line that will receive fertilizer A. Count the number of plots on the right side of the vertical line that will receive fertilizer A.

Left _____ Right _____

14. On the diagram above, draw a horizontal line through the center of the 16 plots of land.
15. Count the number of plots above the horizontal line that will receive fertilizer A. Count the number of plots below the horizontal line that will receive fertilizer A.

Above _____ Below _____

In experiments, random assignment is used as a way of ensuring that the groups that receive each treatment are as much alike as possible with respect to other factors that might affect the response.

16. Explain what this means in the context of this experiment.
17. Suppose that, at the end of the experiment, the mean yield for one of the fertilizers is quite a bit higher than the mean yield for the other fertilizer. Explain why it would be reasonable to say that the type of fertilizer is the cause of the difference in yield and not the proximity to the river or to the northern trees.

Lesson Summary

- An *experiment* is an investigation designed to compare the effect of two or more treatments on a response variable.
- A *subject* is a participant in the experiment.
- The *response variable* is a variable that is not controlled by the experimenter and that is measured as part of the experiment.
- The *treatments* are the conditions to which subjects are randomly assigned by the experimenter.
- *Random selection* refers to randomly selecting a sample from a population.
 - Random selection allows for generalization to a population.
- *Random assignment* refers to randomly assigning subjects to treatment groups.
 - Random assignment allows for cause-and-effect conclusions.
 - The purpose of random assignment in an experiment is to create similar groups of subjects for each of the treatments in the experiment.

Problem Set

For Problems 1 through 5, identify (i) the subjects, (ii) the treatments, and (iii) the response variable for each experiment.

1. A botanist was interested in determining the effects of watering (three days a week or daily) on the heat rating of jalapeño peppers. The botanist wanted to know which watering schedule would produce the highest heat rating in the peppers. He conducted an experiment, randomly assigning each watering schedule to half of 12 plots that had similar soil and full sun. The average final heat rating for the peppers grown in each plot was recorded at the end of the growing season.
2. A manufacturer advertises that its new plastic cake pan bakes cakes more evenly. A consumer group wants to carry out an experiment to see if the plastic cake pans do bake more evenly than standard metal cake pans. Twenty cake mixes (same brand and type) are randomly assigned to either the plastic pan or the metal pan. All of the cakes are baked in the same oven. The rating scale was then used to rate the evenness of each cake.
3. The city council of a large city is considering a new law that prohibits talking on a cell phone while driving. A consumer rights organization wants to know if talking on a cell phone while driving distracts a person's attention, causing that person to make errors while driving. An experiment is designed that uses a driving simulator to compare the two treatments: driving while talking on a cell phone and driving while not talking on a cell phone. The number of errors made while driving on an obstacle course will be recorded for each driver. Each person in a random sample of 200 licensed drivers in the city was asked to participate in the experiment. All of the drivers agreed to participate in the experiment. Half of the drivers were randomly assigned to drive an obstacle course while talking on a phone. The remaining half were assigned to drive the obstacle course while not talking on a phone.

4. Researchers studied 208 infants whose brains were temporarily deprived of oxygen as a result of complications at birth (*The New England Journal of Medicine*, October 13, 2005). An experiment was performed to determine if reducing body temperature for three days after birth improved their chances of surviving without brain damage. Infants were randomly assigned to usual care or whole-body cooling. The amount of brain damage was measured for each infant.
5. The head of the quality control department at a printing company would like to carry out an experiment to determine which of three different glues results in the greatest binding strength. Copies of a book were randomly assigned to one of the three different glues.
6. In Problem 3, suppose that drivers who talked on the phone while driving committed more errors on the obstacle course than drivers who did not talk on the phone while driving. Can we say that talking on the cell phone while driving is the cause of the increased errors on the obstacle course? Why or why not?
7. Can the results of the experiment in Problem 3 be generalized to all licensed drivers in the city? Why or why not?
8. In Problem 4, one of the treatment groups was to use usual care for the infants. Why was this treatment group included in the experiment?
9. In Problem 5, why were copies of only one book used in the experiment?