Students will recognize the purposes and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each and evaluate reports based on data.

**Example 1**

Suppose a graduate school researcher is considering three studies related to math and music.

1. One study involves asking a random sample of high school students in a large school district whether they listen to music while doing math homework.
2. A second study involves asking a random sample of students at a large university whether they are majoring in math and whether they also play a musical instrument or sing.
3. A third study involves a group of adult participants where half will be randomly assigned either to listen to classical music for 15 minutes before taking a logical reasoning test or to listen to white noise for 15 minutes before taking the same test.

1. Which study appears to look for an association between two variables without actively manipulating either one? What are those variables?
2. Which study appears to be looking for evidence that one variable actually influences another variable? What are those variables, and which one is manipulated to see if it influences the other?
3. Which study appears to be simply measuring a variable in a population? What is that variable?

---

Statistical research takes various forms depending on whether the purpose of the research is:

- (a) to measure a variable in a population,
- (b) to see if there is evidence of an association between two variables,
- (c) or to determine whether one variable actually influences another variable.
Think Pair Share

Describe the type of result or conclusion the researcher might obtain from each study.

**Study 1:** proportion - Survey

**Study 2:** association - Observational study

**Study 3:** cause & effect - Experiment

---

A survey measures characteristics of interest about a population using a sample selected from the population. As you saw in a previous lesson, a sample needs to be representative of the population in order for the measurements obtained from the sample to be accurate. Random sampling is generally the best way to ensure representation. Even when random sampling is used, a survey’s results can have errors. Some of the sources of errors are:

- **Biased questions:** The wording of questions in a survey can influence the way people respond to questions. Survey questions need to be worded in a neutral, unbiased way.
- **Interviewer effect:** If an interviewer asks the questions in a survey, the person being interviewed may give inaccurate responses to avoid being embarrassment.
- **Nonresponse:** Some people may be difficult to contact, or they may simply refuse to participate once contacted. If nonresponse rates are higher for certain subgroups of a population, then those subgroups will be underrepresented in the survey results.

---

Example 2

Explain why the results of each survey are likely to be inaccurate, and then suggest a way to improve the accuracy of the survey.

a) The owner of a business, conducts interviews with a random sample of employees to have them rate how satisfied they are with their jobs.

b) A teacher conducts one-on-one interviews with a random sample of her students to get feedback on her teaching methods

---

Example 2

Explain why the results of each survey are likely to be inaccurate, and then suggest a way to improve the accuracy of the survey.

a) The owner of a business, conducts interviews with a random sample of employees to have them rate how satisfied they are with their jobs.

Since the interviewer is the owner of the business, the employees may not be completely open about any job dissatisfaction they may have. The employees may feel that their job security is at risk. A better survey would involve a neutral interviewer or allow the employees to respond anonymously.

b) A teacher conducts one-on-one interviews with a random sample of her students to get feedback on her teaching methods.

Since the interviewer is the teacher, students may not be open about any dissatisfaction they may have with her teaching methods. The students may feel that how the teacher grades them will be influenced by their responses. A better survey would allow the students to respond anonymously.
In an observational study, researchers determine whether an existing condition, called a factor, in a population is related to a characteristic of interest. For instance, an observational study might be used to find the incidence of heart disease among those who smoke. In the study, being a smoker is the factor, and having heart disease is the characteristic of interest.

In an experiment, researchers create a condition by imposing a treatment on some of the subjects of the experiment. For instance, an experiment might be conducted by having some people with eczema take a vitamin E pill daily, and then observing whether their symptoms improve. In the experiment, taking the vitamin E pill is the treatment, and improvement of symptoms is the characteristic of interest.

Vocabulary

In an observational study, researchers determine whether an existing condition, called a factor, in a population is related to a characteristic of interest. For instance, an observational study might be used to find the incidence of heart disease among those who smoke. In the study, being a smoker is the factor, and having heart disease is the characteristic of interest.

In an experiment, researchers create a condition by imposing a treatment on some of the subjects of the experiment. For instance, an experiment might be conducted by having some people with eczema take a vitamin E pill daily, and then observing whether their symptoms improve. In the experiment, taking the vitamin E pill is the treatment, and improvement of symptoms is the characteristic of interest.

Generally, an experiment is preferred over an observational study because an experiment allows researchers to manipulate one variable to see its effect on another. However, there may be practical or unethical reasons against performing an experiment. For example, it would be unethical to ask people to smoke in order to study the effects of smoking on their health. Instead, an observational study should be performed using people who already smoke.