**Surveys, Experiments, and Observational Studies**

MCC9-12.S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each

MCC9-12.S.IC.4 Use data from a sample survey to estimate a population mean or proportion develop a margin of error through the use of simulation models for random sampling.

**Vocabulary**

- **Individuals** – People, animals, or objects that are described by data.
- **Variables** – Characteristics used to describe individuals.
- **Treatment Group** – Experiment group that receives treatment
- **Control Group** – Experiment group that does not receive treatment that is used for comparison.
SAMPLE TO POPULATION

Based on a sample, we extrapolate the results of a statistic to try to estimate the parameters of the population. We do this by setting up a proportion.

\[
\frac{\text{statistic}}{\text{sample size}} = \frac{(\text{estimated parameter})}{\text{population}}
\]

Example 1

A car factory just manufactured a load of 6,000 cars. The quality control team randomly chooses 60 cars and tests the air conditioners. They discover that 2 of the air conditioners do not work. How many of the manufactured cars do you expect to have broken air conditioners?

\[
\frac{6000}{60} = \frac{2}{x} \quad \Rightarrow \quad x \approx \frac{.0003 \times 6000}{200} \quad \text{broken a/c}
\]
Example 2

In a survey of 40 employees at a company, 18 said they were unhappy with their pay. The company has 180 employees. How many employees do you expect are unhappy with their pay?

\[
\frac{(180)(18)}{40} = \frac{x}{180} \cdot 180
\]

\[
(18 \times 180) = (40) \times x
\]

\[x \approx 81\] unhappy employees

Types of Studies

A survey chooses a sample of a population and interviews them to collect desired data.

Ask 50 shoppers at the mall what their favorite store is.

An experiment imposes a treatment on individuals to collect data on their responses.

A researcher adds acetone to gasoline to measure its effect on fuel efficiency.

An observational study observes individuals and measures variables without controlling the individuals or their environment in any way.

A researcher wants to find out if poor nutrition affects eyesight, but it would be unethical to deliberately subject some individuals to poor nutrition.
Randomized controlled experiment

In a controlled experiment, two groups are studied under conditions that are identical except for one variable.

Randomized comparative experiment

Often, to demonstrate a cause and effect hypothesis, an experiment must show two things. First, that a phenomenon occurs with the treatment; and second, that the phenomenon does not occur in the absence of the treatment.

In a randomized comparative experiment, the individuals are assigned to the control group or the treatment group at random, in order to minimize bias. An experiment that is not a randomized comparative experiment may be subject to bias, and any conclusions drawn from the experiment may not be valid.
Example 3

Explain whether each situation is an experiment or an observational study.

A researcher wants to know if a soil additive makes a fern grow more quickly. He grows one specimen in treated soil and one in untreated soil.

The researcher applies a treatment, so the situation is an experiment.

Example 4

Explain whether each situation is an experiment or an observational study.

To find out whether car accidents are more likely on rainy days, a researcher records the weather conditions during 50 randomly selected accidents for the past year.

The researcher gathers data without controlling the individuals or applying a treatment. The situation is an example of an observational study.
Example 5
Describe the treatment, the treatment group, and the control group.

One hundred arthritis sufferers reported the severity of their symptoms daily for a month. Fifty of the subjects were given Epsom salt to bathe in at least every other day. At the end of the month, 30% of the subjects who used Epsom salt reported a decrease in severity of their symptoms, compared to 5% in the other group.

The treatment is bathing in Epsom salt.
The treatment group consists of the fifty subjects who bathe in the Epsom salt
The control group consists of the fifty subjects who did not.

Example 6
Decide whether the following research topic is best addressed through an experiment or an observational study.

Does using tanning beds at least twice a month affect the likelihood of developing skin diseases?

The treatment may affect health, so it is not ethical to assign individuals to a treatment group. Perform an observational study. Randomly choose one group of people who already use tanning beds at least twice a month and another group which does not. Monitor the incidence of skin diseases in both groups.
Example 7

Classify each method as a survey, experiment, or observational study. Explain which would be the most reliable.

<table>
<thead>
<tr>
<th>Method A:</th>
<th>Method B:</th>
<th>Method C:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose 50 people who have at least one serving of soy a day and 50 who don’t, and check their cholesterol levels.</td>
<td>Randomly choose 100 people. Ask how many servings of soy they have a week, and ask if their cholesterol levels are high.</td>
<td>Randomly choose 50 people to eat at least one serving of soy a day, and 50 people not to, and monitor their cholesterol levels.</td>
</tr>
</tbody>
</table>

Observational study | Survey | Experiment