

Essential Question:

How do we incorporate good experimental design
in investigations?

Experiments



Objectives

Distinguish between good and poor experimental design.

Identify independent, dependent, and controlled variables.

Write research questions, hypotheses, and conclusions for an experiment in the correct format.

Identify operational definitions for an experiment.



“Bad” Experimental Design

An experiment is done to test the effectiveness of a new weight loss drug. The actual drug is given to a group of 20 men who are between the ages of 50 - 60. A fake drug (placebo) is given to a group of 30 women who are between the ages of 20 - 30. The amount of weight lost by each group is compared after a month.



“Bad” Experimental Design

A study is done to determine the causes of heart attacks. A scientist notices that ice cream sales increase in the summer months. He also notices that the number of heart attacks also increases during the summer months. He determines that the increase in ice cream sales must cause the increase in heart attacks.



“Bad” Experimental Design

An experiment is done to figure out how to make a skateboard that can go the fastest. A group of students make five different skateboards that each have a different wheel size, board length, and board shape. They randomly choose five students from a class and run one race using the boards. The winning board is determined to be the “ultimate” combination of wheel size, board length, and board shape.



Experimental Design

- A good experiment is an experiment that tests what you want to test and **controls** for everything else.
- A good experiment allows you to draw conclusions about **cause and effect** relationships.
- Good **experimental design** provides enough information to allow others to repeat your experiment to verify your results.

Questions

- A **research question** is written to express what is trying to be answered by the experiment.
 - It is written in the form of: **How does** (one observed trait) **affect** (a second observed trait)?



Research Question

- Research questions only focus on the two traits, or variables, that will be compared by the experiment
 - Variables are factors or conditions that can change in an experiment.
 - They may affect the outcome of an experiment.



Types of Variables

- Manipulated or Independent variable
 - The thing that is changed by the experimenter
- ResponDing or Dependent variable
 - The thing that will be measured to determine the relationship among variables



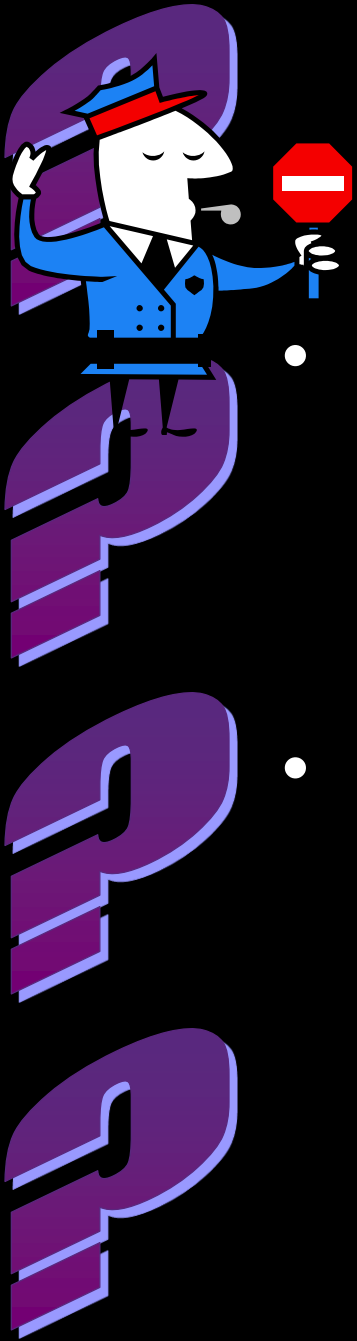
Types of Variables

- The research question is written in the form of: How does (manipulated) affect (responding)?
- Controlled variables
 - The things that must be kept the same in order to accurately determine the relationship between the dependent and independent variable



Types of Variables

- The descriptions of how the variables will be **measured** are called **operational definitions**
- Operational definitions tell what type of **tools** or instruments are used to take the measurements and what **units** the variables will be measured in.
- Including operational definitions in experimental design allows for **replication** by other scientists



STOP

- Complete the Experiments quiz in Moodle.
- Write your answers in the space provided on your sheet.

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Word Splash

Write a complete sentence that demonstrates the relationships among the following vocabulary terms:

Dependent

Controlled

Responding

Independent

Manipulated

Operational Definition

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

What is the dependent variable in this experiment?

The distance the plane flies.

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

What is the manipulated variable in this experiment?

The mass of the plane.

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

What is the independent variable in this experiment?

The mass of the plane.

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

What is the responding variable in this experiment?

The distance the plane flies.

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

What is the operational definition of the responding variable?

The distance the plane flies will be measured in centimeters using a meter stick

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

Write a research question for the experiment.

How does the mass of the plane affect the distance the plane flies?

Hypotheses

- An educated guess of how the manipulated variable will affect the responding variable is called a **hypothesis**
 - A hypothesis must be **testable**
 - A hypothesis is written in the form: **IF** (manipulated) increases **THEN** responding (increases/decreases).

Concept Check

A study is done to determine if the mass of a paper airplane affects the distance it will fly.

Write a hypothesis for the experiment.

If the mass of the plane increases, then the distance the plane flies decreases.

Multiple Trials

- To better ensure accuracy, multiple trials of the experiment should be conducted before data is analyzed.
- For each trial, the independent variable should be changed throughout the complete range before the next trial begins.
- Completing trials in this manner reduces the chances of inaccurate results.



Conclusions

- A conclusion is a judgment based on the results of an experiment.
 - It is written to parallel the hypothesis and takes the form: As the “MANIPULATED” INCREASED THE “RESPONDING” (increased/decreased).

Conclusions

- If you were *correct* in your hypothesis then we say: “The experiment supports the hypothesis.”
- If you were *incorrect* in your hypothesis then we say: “The experiment refutes the hypothesis.”