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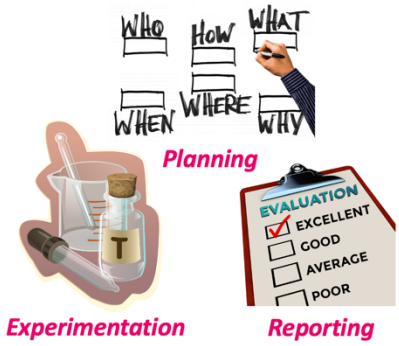

Scientific Investigation

Scientific investigations have three distinct phases:

1. Planning
2. Conducting the experiment and data collection
3. Reporting or writing up the findings of the experiment

To develop a well-organized and workable plan, it is necessary to go through several steps that are well-thought of. This is to ensure that appropriate equipment and information available to help the experimentation and data collection process run as smoothly as possible.

Making Observations

A good scientific investigation plan always starts with making a keen observation of one's surroundings. Observation allows scientists to be curious of their surroundings. This curiosity will lead them to further investigate their observations.

Identifying Problem

The information gathered through observations serve as a basis for identifying a problem to start an investigation. This problem serves as the focus of the investigation and may arise from research that was previously done, or from observations from previous experiments.

Formulating Hypothesis

To provide a tentative answer to a problem, scientists formulate a hypothesis. A **hypothesis** is an educated guess that aims to answer a given problem. It must be measurable and answer the original question that is asked.

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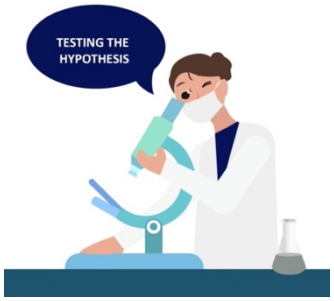
A good hypothesis is:

- ✓ based on research,
- ✓ is easy to measure, and
- ✓ a clear cause and effect relationship.

The sentence format *"If… is changed, then … will happen."* is often used to formulate a hypothesis.

Testing the Hypothesis / Experimenting

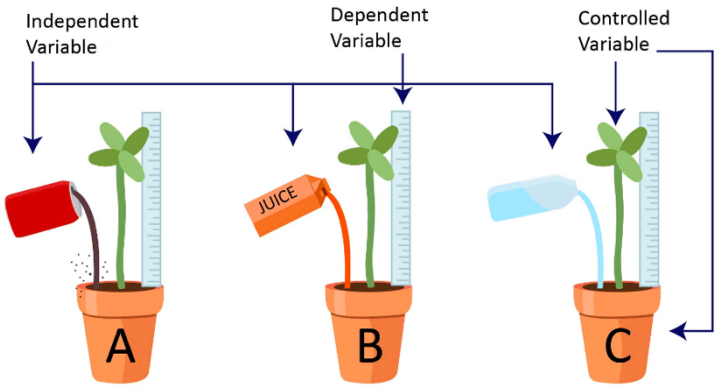


To find out whether the given tentative answer solves the problem, an experiment is conducted to test the hypothesis. Scientists use an experiment to search for cause and effect. There are many factors that could be changed to test the reaction of another. These changing factors are known as variables.

Identifying and Controlling Variables

A **variable** is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three types of variables namely the **independent**, **dependent**, and **controlled** variables.

- The independent variable is the one that is changed by the scientist. To ensure a fair test, a good experiment has only one independent variable.
  - *In this example, the independent variable is the kind of liquid that is added to the plants.*
- The dependent variable is the one that is changed by the scientist. It is the result of the changes that happened to the independent variable.
  - *In this example, the dependent variable is the height of the growing plant.*
- The controlled variables are quantities or items that are kept constant throughout the experiment.
  - *Some controlled variables in this example are the type of plant, kind of soil, kind and size of pot.*



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Writing a Method

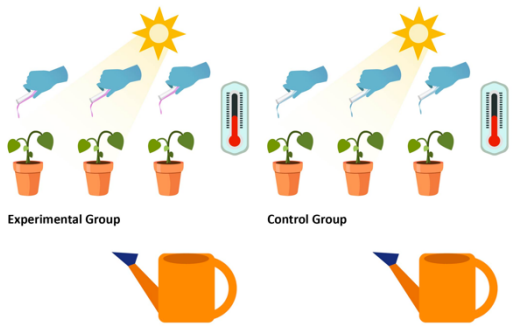
Once variables are clearly identified and controlled, it is now time to write a method or a step-by-step description of how to carry out the experiment. A method should be clear and have enough details that someone else could follow the steps easily and arrive at the same results as the first experimenter.

A good method includes the following:

- ✓ A list of equipment that will be used
- ✓ A diagram that shows the experiment set up
- ✓ How and when to change the independent variable
- ✓ How and when to measure the dependent variable
- ✓ How to control any other variables that may impact the results
- ✓ Number of times that the experiment will be repeated to get valid results

Determining Experimental and Control Groups

In scientific experiments, there are experimental and control groups. An experimental group is a set up that is exposed to the conditions of the experiment while a control group has conditions that are maintained throughout the experiment. Each experimental group is given one treatment of an independent variable.



Experimental groups are observed for changes to see if the independent variable has any effect on the dependent variable. On the other hand, the control group is given the normal treatment, so that the results from the experimental groups can be compared.

Collecting Data and Results

Once the written method has been finalized, conduct the experiment and collect data to use in the final phase of the investigation. The collection of data is crucial in determining whether the hypothesis answers the problem or not.

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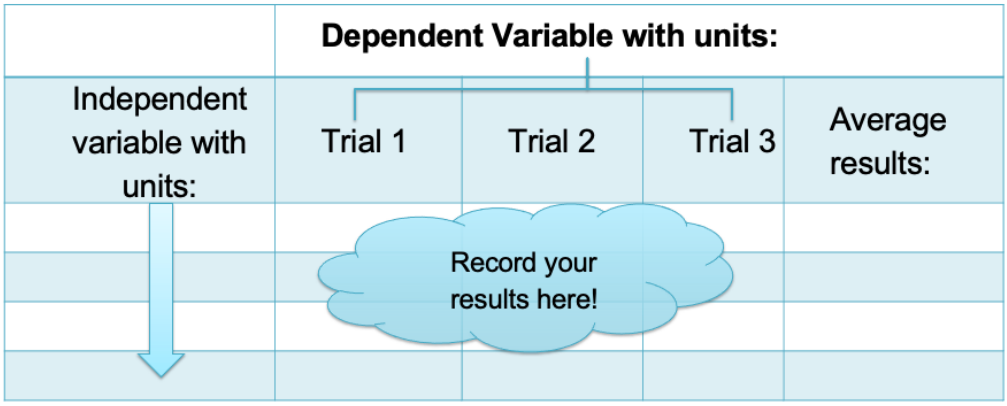
Consider the following in carrying out an experiment:

- ✓ Equipment – all equipment is in working condition, clean and dry
- ✓ Lab safety – wear correct safety equipment and follow safety regulations
- ✓ Lab procedures – use correct procedures for heating, measuring, and transferring substances
- ✓ Documentation – have an accurate way to record the results

In recording results, both qualitative and quantitative observations must be recorded and analyzed. Qualitative results can be quickly noted down as descriptions while a raw data table, chart, or groups may be used to present the quantitative results which have been obtained through measurements.

Here is a sample table that is often used in recording results and observations:



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