

Designing your investigation

When you are designing an experiment, you must consider all the things that may alter your results. These things are called variables.

Variables

All investigations have many variables. A controlled experiment tries to keep as many of the variables the same, or constant, throughout the experiment so that they do not affect the results too much.

But there is at least one variable in the experiment that you do not keep constant. This is the variable that you are testing. It is known as the independent variable.

The independent variable

The independent variable in an experiment is the one that you plan to change. It is also known as the manipulated variable. For example, if you wanted to test the amount of lather or bubbles of soap in water, you could use water at different temperatures. You could also use water from different sources, such as rain, the sea, a dam or a bore. In this example the temperature and the type of water are both independent variables. They are the variables that you are intentionally changing or manipulating.

To keep results as simple as possible, it is a very good idea to use only one independent variable in any experiment. So you would perform two different experiments in this investigation of soap and water. One experiment would find out the effect of different water temperatures, and another would find out the effect of different types of water, on the amount of bubbles produced.

You decide what the independent variable will be so that you can find out its effect on something else. It will cause something else to change that you will measure. This 'something else' is the dependent variable.

The dependent variable

When you change one variable during an experiment, another variable may change in response. This variable is called the dependent variable. Another name for this variable is the responding variable. For example, the variable that responds to changing the temperature of water is the amount of lather or bubbles. So, amount of bubbles is the dependent variable.

But, you can only be sure that the dependent variable is changing because of the independent variable if all the other variables in the experiment are controlled. These are called the controlled variables.

Controlled or constant variables

Controlled variables are kept constant throughout the experiment. For example, in the soap versus temperature experiment, the researcher would keep the following variables constant: the amount of water, the amount of soap, the amount of shaking.

This means that for every trial, you would have the same amount of water, soap and shaking.

As you can see, there are usually a lot of variables that need to be controlled. If these are not controlled, or kept the same during the experiment, then they may affect the result of your experiment. For example, if the amount of soap was different or you had different

amounts of water then the change in the number of bubbles may not be related to the change in temperature.

The control

A controlled experiment has a control. A control is as close as possible to the normal situation. It is used as a standard against which the experimental results are judged. Some experiments do not have a control

Good experimental design

To design a good experiment, you have to know which variable you are changing, and which variable depends on these changes that you make. In other words, you have to know which is the independent variable and which is the dependent one. You must also control all other variables.

You also need to know which variable is which to present your observations in a scientific report. When you are recording the results of a controlled experiment, measurements of the independent variable are usually put into the first column. Results for the dependent variable are in the second column.

This is shown in the table below.

The student measured the water temperature as a particular fuel burned. In this case, time is the independent variables and the water temperature the dependent variable.

Independent variable Time (s)	Dependent variable Water temperature (°C)
0	15
10	16
20	18
30	22
40	28
50	32
60	37

When you learn more about graphing, you will also see that you need to know which is the independent variable and which is the dependent variable to construct a good, scientific graph.

Repeat trials and repetition

A well-designed investigation should be reliable. The reliability of the data can be increased by repeating the procedure. For example, if you wanted to investigate the time it takes for a ball to fall from a table you would do it more than once to make sure that the trial was not an error. You would do the test at least three times and then look at the results. If they are consistent then your results are probably reliable. If the results are different you should continue with the trials until the results are consistent or you can evaluate the design of the experiment.

In some investigations it is not possible to repeat the test because it is destructive testing. For example, the time it takes a seed to germinate cannot be done with the same seed more

than once. In this case the experiment is replicated. For example, ten seeds could be grown in three dishes with each seed acting as a repeat trial.

Experimental design vocabulary

Before you go on make sure that you know the meanings of the following related words.

