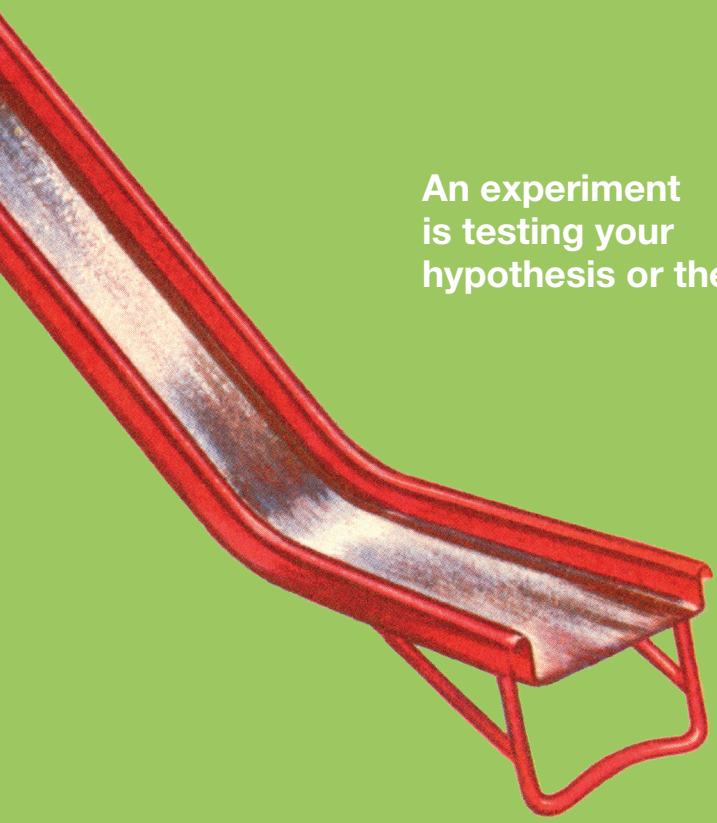
Section



An experiment
is testing your
hypothesis or theory

Q

What is an experiment?

A

An experiment is an accepted method of collecting data to test your hypothesis or theory. Experiments are rigorous, systematic and follow accepted processes.

An experiment is a way of carrying out research under controlled conditions

By isolating a specific independent variable, you can manipulate it to observe and measure the effect on the dependent variable, thereby testing your hypothesis or theory.

In practice there may be other variables you should be aware of and either control or investigate at the same time. Prior knowledge of the subject area will guide you as to what you should be looking for.

It is vital to conduct an experiment with as little bias and prejudice as possible, whilst showing you have thoroughly examined your hypothesis or theory and drawn correct assumptions from the data you have collected. The only way to do this is to follow the established methods in your discipline correctly and systematically.

AN EXPERIMENT TESTS A HYPOTHESIS OR THEORY

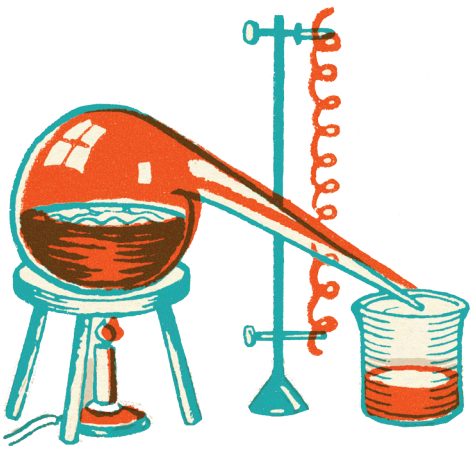
An experiment is the most efficient, scientifically accepted, method of testing your hypothesis or theory. A hypothesis, sometimes called the alternate or experimental hypothesis, is usually a statement, often tentatively made, about a possible relationship between two or more variables. Your hypothesis would commonly predict what you expect the outcome of your experiment to show. This hypothesis is often balanced by a null hypothesis, which predicts there is no relationship between the variables you have specified. Your hypothesis should be testable, precise and, typically, based on a specific property or relationship of the variables you are investigating.

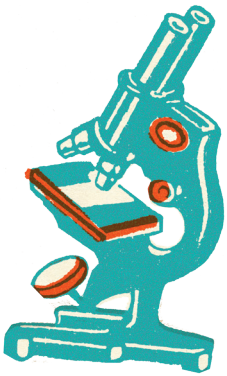
A hypothesis is usually derived from a research question, but it is never a question itself, it is always a testable statement.

- Research question – Do students who revise achieve better grades?
- Hypothesis – Students who revise achieve better grades.
- Null hypothesis – Students who revise do not achieve better grades.

MAINTAINING CONTROL

In an ideal world you would be able to conduct all experiments in a laboratory or under completely controlled conditions. This would enable you to have absolute certainty over any possible cause and effect relationship. In the real world, it is not often feasible to study your subject in these conditions, so you have to attempt to maintain as much control as manageable whilst recognising as many of the limitations or possible variables as you can.





WHAT IS A VARIABLE?

A variable is anything and everything that can vary in an experiment, some of which you will be able to manipulate or modify. There are different types of variables.

- Independent variable – this is the one, or more, things you are manipulating during your experiment.
- Dependent variable – the one you observe to measure the effect of the independent variable.
- Controlled/Constant variables – the things you are controlling or keeping constant in order to ensure they do not affect your experiment.
- Extraneous variables – something that happens which you didn't plan for and so failed to plan for it to be controlled.
- Confounding variables – something that alters or influences both the independent and dependent variable to confound the actual relationship, or give a spurious relationship.

EXPERIMENTS NEED TO BE OBJECTIVE

Experiments need to be objective, which means you need to minimise bias and reduce prejudice as much as you can. The best way of doing this is to approach your experiment systematically and with as much prior knowledge as possible. Engaging with a standardised process, such as the scientific method if it is appropriate for your area, should help you to focus on the facts and filter out any conscious or unconscious bias and prejudice you may have.

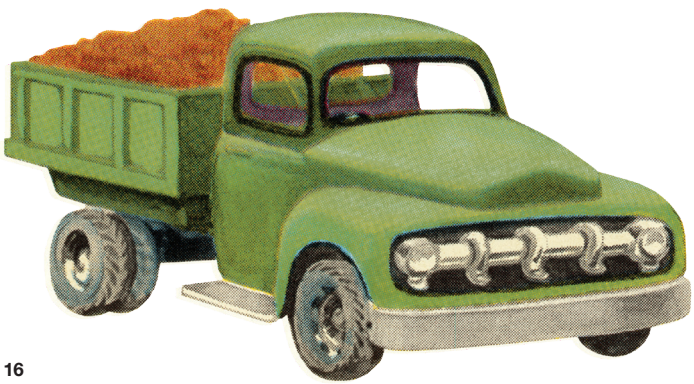
When you are planning your next experiment, check to find out what the usual systems are for your subject area and ensure you stick to them.

CHECKPOINT

KNOW YOUR VARIABLES

For your next experiment, please have a go at identifying the variables in your experiment and completing the following checkpoint task.

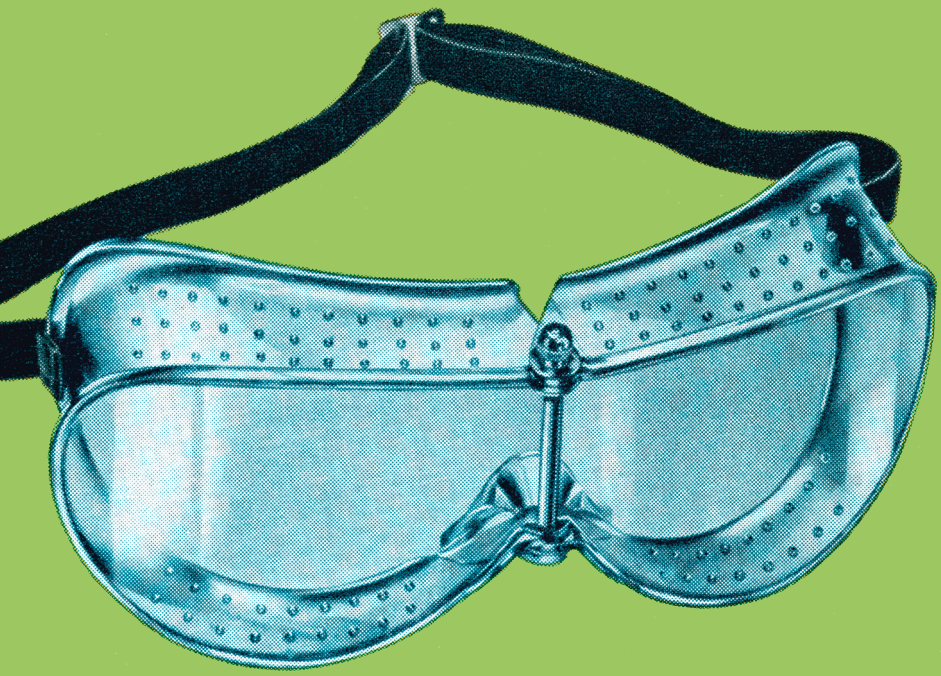
In this example, the experiment is based on the final weight of strawberries and its relationship to the amount of fertiliser applied to the soil during the growing period of the strawberry plant.



Variable type	Example	Now it's your opportunity to have a go!
Independent variable:	Amount of fertiliser	
Dependent variable:	Weight of the strawberry	
Controlled/ Constant variables:	Sunlight, temperature, water, wind, bugs, disease, etc.	
Confounding variables:	Other soil properties/ variations, individual genetic differences between the plants, not hulling the strawberries equally, etc.	
Anything else that could influence your variables:	Incorrect weighing of the amount of fertiliser, incorrect weighing of the mass of the strawberry, etc.	

Section 2

You need a well-designed experiment



Q

Why do I need to do an experiment for my research?

A

A clearly defined, well-constructed experiment is recognised as the only efficient and scientific method of collecting evidence supporting your interpretation of your hypothesis or theory.

Correctly conducted experiments are the most efficient, scientifically recognised method of gathering evidence to support your hypothesis or theory

Experiments must adhere to specific protocols to ensure the results are accepted as being valid and not caused by some other extraneous variable. By conducting an experiment, you will have to ensure your experiment does too, and this supports your evidence in being accepted as a valid contribution to your area of research.

Carrying out an experiment correctly, not only shows your evidence is valid, but also shows you have engaged with the proper behaviours and conduct appropriate to your subject. This can only be achieved when you know your subject in depth and have thoroughly planned your experiment.

We have all these ideas about the natural world, how people interact, what is happening around us, what is happening inside us, how does one thing interact or affect another, and so on. However, **to turn these theories into knowledge that we can trust we need valid and reliable evidence.** To do this we conduct an experiment, but conducting an experiment can be a daunting task to undertake. Although, with the proper planning and adherence to appropriate protocols, the results will usually make it worth the effort.

THE PRIMARY ROLE OF AN EXPERIMENT IS TO TEST YOUR HYPOTHESIS OR THEORY

Irrelevant of the area of research you are engaging with, an experiment allows you to investigate whether your ideas about how something works or interacts with something else is a correct theory that matches what happens. This knowledge can then help to spur you, or others, on to develop further theories and knowledge. Experiments are a recognised part of science and, more specifically, part of what is called the scientific method.

YOUR EXPERIMENT WILL HELP YOU UNDERSTAND IF YOU ARE CORRECT IN YOUR ASSUMPTIONS

The scientific method is the process of gathering empirical data in an effort to test a hypothesis or theory. It's generally accepted there are five stages in the scientific method. However, it is possible to find this presented in more or fewer stages, depending on where you find your information, although it is still the same process.

THE SCIENTIFIC METHOD

The stages are broadly broken down into:

1. making an observation or finding a topic of interest
2. formulating hypotheses
3. making deductions from the hypotheses
4. testing the deductions via an experiment
5. modifying the hypotheses if necessary.

Sometimes you may need to repeat this cycle until you arrive at a satisfactory end-point.

Including an appropriate and properly performed experiment in your research is the best way to gather evidence supporting your hypothesis or theory, but it is also the best way to show you are a credible researcher in your chosen field. Just make sure you conduct it correctly, that it is appropriate to your area of research and you adhere to the proper codes of conduct.

DO IT YOURSELF

CREATING YOUR HYPOTHESIS

Looking back at the previous section, we can construct a hypothesis and a null hypothesis related to the variables from the experiment you envisaged and listed.

The easiest way to start formulating your hypothesis is to complete the following sentence but with your own choice of variables and consider what relationship are you identifying.

If … [I do this/ independent variable]

…, then

… [this/ dependent variable]

… will happen.

Write in your hypothesis below:

If …, then

… will happen.

DO IT YOURSELF

TEST YOUR APPROACH

2 When you consider this sentence, including your variables, it will help to highlight the relationship between the two variables. This helps you to create your hypothesis, and your null hypothesis, which is the statement showing there is no relationship between the two variables.

3 Examples of both of these variables are shown in the steps below.

Steps	Example	Your go!
Basic idea	If I add more fertiliser to the soil (independent variable) then the mass of strawberries at the end of the experiment will alter (dependent variable).	
Hypothesis	There is a relationship between the amount of fertiliser added to the soil and the final mass of strawberries produced.	
Null hypothesis	There is no relationship between the amount of fertiliser added to the soil and the final mass of strawberries produced.	

CHECKPOINT

THE SCIENTIFIC METHOD

What is the correct sequence of the scientific method?

Put them in the correct order below.

formulating hypotheses

making an observation or finding a topic of interest

modifying the hypotheses if necessary.

making deductions from the hypotheses

testing the deductions via an experiment

1 .....

2 .....

3 .....

4 .....

5 .....

CHECKPOINT

ANSWERS

1 making an observation or finding a topic of interest

2 formulating hypotheses

3 making deductions from the hypotheses

4 testing the deductions via an experiment

5 modifying the hypotheses if necessary.