Scientific Method Steps

The exact number of steps to the scientific method depends on how you break up the steps, but here is an overview of the basics:

1. Make observations.
2. Propose a hypothesis.
3. Design and perform an experiment to test the hypothesis.
4. Analyze your data to determine whether to accept or reject the hypothesis.
5. If necessary, propose and test a new hypothesis.

If you are having trouble designing an experiment or even getting an idea for a project, start with the first step of the scientific method: make observations.

Scientific Method Step 1: Make Observations

A lot of people think that the scientific method starts with forming a hypothesis. The reason for this misconception may be because many observations are made informally. After all, when you are looking for a project idea, you think through all of the things you have experienced (observations you have made) and try to find one that would be suitable for an experiment. Although the informal variation of Step 1 works, you will have a richer source of ideas if you pick a subject and write down observations until a test-able idea comes up. For example, let's say you want to do an experiment, but you need an idea. Take what is around you and start writing down observations. Write down everything! Include colors, timing, sounds, temperatures, light levels... you get the idea.

Scientific Method Step 2: Formulate a Hypothesis

A scientific hypothesis is the initial building block in the scientific method. Many describe it as an “educated guess,” based on prior knowledge and observation, as to the cause of a particular phenomenon. It is a suggested solution for an unexplained occurrence that does not fit into current accepted scientific theory. A hypothesis is the inkling of an idea that can become a theory, which is the next step in the scientific method.

The basic idea of a hypothesis is that there is no pre-determined outcome. For a hypothesis to be termed a scientific hypothesis, it has to be something that can be supported or refuted through carefully crafted experimentation or observation.

A key function in this step in the scientific method is deriving predictions from the hypotheses about the results of future experiments, then performing those experiments to see whether they support the predictions.

Scientific Method Step 3: Design an Experiment

There are many different ways to test a single hypothesis. If I wanted to test the hypothesis, 'the rate of grass growth is not dependent on quantity of light', I would have grass exposed to no light (a control group... identical in every way to the other experimental groups except for the variable being tested), and grass with light. I could complicate the experiment by having differing levels of light, different types of grasses, etc. Let me stress that the control group can only differ from any experimental groups with respect to the *one* variable. For example, in all fairness I could not compare grass in my yard in the shade and grass in the sun... there are other variables between the two groups besides light, such as moisture and probably pH of the soil (where I am it is more acidic near the trees and buildings, which is also where it is shady). Keep your experiment simple.

Scientific Method Step 4: Test the Hypothesis

In other words, perform an experiment! Your data might take the form of numbers, yes/no, present/absent, or other observations. It is important to keep data that 'looks bad'. Many experiments have been sabotaged by researchers throwing out data that didn't agree with preconceptions. Keep all of the data! You can make notes if something exceptional occurred when a particular data point was taken. Also, it is a good idea to write down observations related to your experiment that aren't directly related to the hypothesis. These observations could include variables over which you have no control, such as humidity, temperature, vibrations, etc., or any noteworthy happenings.

Step 5: Accept or Reject the Hypothesis

For many experiments, conclusions are formed based on informal analysis of the data. Simply asking, 'Does the data fit the hypothesis', is one way to accept or reject a hypothesis. However, it is better to apply a statistical analysis to data, to establish a degree of 'acceptance' or 'rejection'. Mathematics is also useful in assessing the effects of measurement errors and other uncertainties in an experiment.

Independent Variable: The independent variable is what you change when performing an experiment. It is what you are trying to test. For example if someone wants to know if salt water affects the growth rate of a plant. The person then has five different plants and each plant gets a different amount of salt. The independent variable is the amount of salt that is used.

Dependent Variable: The dependent variable is what is changed as a result of the independent variable. In the example above of changing the amount of salt a plant receives, the independent variable is the amount of salt. The factor that would change as a result would be the growth of the plant. Therefore the dependent variable would be the growth rate of the plant.

Control: It is important to have a group when testing that is left under normal conditions so that there is something to compare your experimental group to. This is known as the control group. In the example of changing the amount of salt a plant receives there would need to be a plant that does not receive any salt so that the scientist can compare what happens under normal conditions.

Questions

1. Why would it be necessary to make observations before forming a hypothesis?

2. What is your definition of a hypothesis?

3. What are some important steps when designing an experiment?

4. Why is it important to test the hypothesis instead of just guessing what will happen?

5. Why is it important to have a control group when testing a hypothesis?