Variables and Hypothesis

Variables

Scientists use an experiment to search for **cause and effect** relationships in nature. In other words, they design an experiment so that changes to one item *cause* something else to vary in a predictable way.

These changing quantities are called **variables**, and an experiment usually has three kinds: independent, dependent, and controlled.

The **independent variable** is the one that is changed by the scientist. In an experiment there is only one independent variable.

As the scientist changes the independent variable, he or she **observes** what happens.

The **dependent variable** changes in response to the change the scientist makes to the independent variable. The new value of the dependent variable is *caused* by and *depends* on the value of the independent variable. For example, if you open a faucet (the independent variable), the quantity of water flowing (dependent variable) changes in response--the water flow increases. The number of dependent variables in an experiment varies, but there is often more than one.

Experiments also have **controlled variables**. Controlled variables are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables. For example, if we want to measure how much water flow increases when we open a faucet, it is important to make sure that the water pressure (the controlled variable) is held constant. That's because both the water pressure and the opening of a faucet have an impact on how much water flows. If we change both of them at the same time, we can't be sure how much of the change in water flow is because of the faucet opening and how much because of the water pressure. Most experiments have more than one controlled variable. Some people refer to controlled variables as "constant variables."

Some Very Simple Examples of Variables

Question	Independent Variable	Dependent Variables	Controlled Variables	Comments
How much water flows through a faucet?	Water faucet opening (closed, 1/2 open, fully open)	Volume of water flowing measured in liters per minute	Water pressure (how much the water is "pushing")	A better measure of the independent variable would be to find area of the opening in the pipe in square centimeters.
How fast does a candle burn?	Time measured in minutes	Height of candle measured in centimeters	• Use same type of candle for every test • Wind--make sure there is none	In this case, time is what causes the dependent variable to change. The scientist simply starts the process, then observes and records data at regular intervals.
Does fertilizer make a plant grow bigger?	Amount of fertilizer measured in grams	• Growth of the plant measured by its height • Growth of the plant measured by the number of leaves	• Same plants • Same soil • Same size pot • Same amount of water and light • Make measurements of growth at the same time	
Does an electric motor turn faster if you increase the voltage?	Voltage of the electricity supplied to the motor measured in volts	Speed of rotation measured in RPMs	• Same motor for every test • Same load on the motor	

Hypothesis

After having thoroughly researched a topic, you should have some prediction about what you think will happen in your experiment. This educated guess concerning the outcome is called your hypothesis.

The hypothesis is worded so that it can be tested in your experiment. Do this by expressing the hypothesis using your independent variable (the variable you change during your experiment) and your dependent variable (the variable that changes in response and *depends* on changes in the independent variable). Not only must you incorporate all these variables in your hypothesis, but you also must express them in a way that you can readily measure.

For example: "My hypothesis is that doubling the opening created by the faucet [independent variable] will double the flow of water [dependent variable]."

Not every question can be answered by the scientific method. The hypothesis is the key. If you can state your question as a testable hypothesis, then you can use the scientific method to obtain an answer.

Is all science accomplished using this same method that is taught in schools and emphasized at science fairs? Should you worry if you end up disproving your hypothesis? Actually, the answers are no it's not, and no don't worry if you disprove your hypothesis. Learn more on the Web in an essay written by a veteran Science Buddies Adviser, Dr. Bruce Weaver.

Your Assignment

Type your variables (carefully labeling each of the three different types) and hypothesis in a word processor.

Grading Yourself

What Makes for Good Variables?	For Good Variables, You Should Answer "Yes" to Every Question
The independent variable is measureable?	Yes / No
You can change the independent variable during the experiment?	Yes / No
You have identified all relevant dependent variables, and they are all caused by and depend on the independent variable?	Yes / No
All dependent variable(s) are measurable?	Yes / No
You have identified all relevant controlled variables?	Yes / No
All controlled variables can be held constant during the experiment?	Yes / No

What Makes a Good Hypothesis?	For a Good Hypothesis, You Should Answer "Yes" to Every Question
The hypothesis is based on information contained in the review of literature?	Yes / No
The hypothesis includes the independent and dependent variables?	Yes / No
You have worded the hypothesis so that it can be tested in the experiment?	Yes / No
If you are doing an engineering or programming project, have you established your design criteria?	Yes / No

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