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

**The independent variable is the one that is changed by the scientist**. To insure a [fair test](http://www.sciencebuddies.org/science-fair-projects/project_experiment_fair_test.shtml), a good experiment has only one independent variable. As the scientist changes the independent variable, he or she **observes** what happens.

The scientist focuses his or her observations on the **dependent variable** to see how it responds to the change made 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--you observe that 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. In other words, it would not be a fair test. Most experiments have more than one controlled variable. Some people refer to controlled variables as "constant variables."

In a good experiment, the scientist must be able to **measure** the values for each variable. Weight or mass is an example of a variable that is very easy to measure. However, imagine trying to do an experiment where one of the variables is love. There is no such thing as a "love-meter." You might have a **belief** that someone is in love, but you cannot really be sure, and you would probably have friends that don't agree with you. So, love is not measurable in a scientific sense; therefore, it would be a poor variable to use in an experiment.

Examples of Variables

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| --- | --- | --- | --- |
| Question | Independent Variable (What I change) | Dependent Variables  (What I observe) | Controlled Variables  (What I keep the same) |
| How much water flows through a faucet at different openings? | Water faucet opening (closed, half open, fully open) | Amount of water flowing measured in liters per minute | * The Faucet * Water pressure, or how much the water is "pushing"   "Different water pressure might also cause different amounts of water to flow and different faucets may behave differently, so to insure a fair test I want to keep the water pressure and the faucet the same for each faucet opening that I test." |
| Does heating a cup of water allow it to dissolve more sugar? | Temperature of the water measured in degrees Centigrade | Amount of sugar that dissolves completely measured in grams | * Stirring * Type of sugar   "More stirring might also increase the amount of sugar that dissolves and different sugars might dissolve in different amounts, so to insure a fair test I want to keep these variables the same for each cup of water." |
| 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 * See Measuring Plant Growth for more ways to measure plant growth | * Same type of fertilizer * Same size pot for each plant * Same type of plant in each pot * Same type and amount of soil in each pot * Same amount of water and light * Make measurements of growth for each plant at the same time   "The many variables above can each change how fast a plant grows, so to insure a fair test of the fertilizer, each of them must be kept the same for every pot." |