



Variables in Your Science Fair Project

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 ensure 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

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	<ul style="list-style-type: none"> • The Faucet • Water pressure, or how much the water is "pushing" <p>"Different water pressure might also cause different amounts of water to flow and different faucets may behave differently, so to ensure a fair test I want to keep the water pressure and the faucet the same for each faucet opening that I test."</p>
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	<ul style="list-style-type: none"> • Stirring • Type of sugar <p>"More stirring might also increase the amount of sugar that dissolves and different sugars might dissolve in different amounts, so to ensure a fair test I want to keep these variables the same for each cup of water."</p>
Does fertilizer make a plant grow bigger?	Amount of fertilizer measured in grams	<ul style="list-style-type: none"> • Growth of the plant measured by its height • Growth of the plant measured by the number of leaves • See Measuring Plant Growth (http://www.sciencebuddies.org/science-fair-projects/project_ideas/PlantBio_measuring_growth.shtml) for more ways to measure plant growth 	<ul style="list-style-type: none"> • 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 <p>"The many variables above can each change how fast a plant grows, so to ensure a fair test of</p>

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
			the fertilizer, each of them must be kept the same for every pot."
Does an electric motor turn faster if you increase the voltage?	Voltage of the electricity measured in volts	Speed of rotation measured in revolutions per minute (RPMs)	<ul style="list-style-type: none"> • Same motor for every test • The motor should be doing the same work for each test (turning the same wheel, propeller or whatever) <p>"The work that a motor performs has a big impact on its speed, so to ensure a fair test I must keep that variable the same."</p>

Time as an Example of an Independent Variable

In some experiments, time is what causes the dependent variable to change. The scientist simply starts the process, then observes and records data at regular intervals.

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
How fast does a candle burn?	Time measured in minutes	Height of candle measured in centimeters at regular intervals of time (for example, every five minutes)	<ul style="list-style-type: none"> • Use same type of candle for every test • Wind—make sure there is none

The Independent Variable for Surveys and Tests of Different Groups

When a scientist performs a test or survey on different groups of people or things, those groups define the independent variable. For example:

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
Who listens to music the most: teenagers or their parents?	The groups receiving the survey: teenagers or parents	The amount of time that each person listens to music per day measured in hours	Ask the question in exactly the same way to each individual

Either/Or (Binary) Variables

Sometimes a variable simply represents an either/or (binary) condition. For example, something might be either present or not present during an experiment.

Question	Independent Variable (What I change)	Dependent Variables (What I observe)	Controlled Variables (What I keep the same)
Is a classroom noisier when the teacher leaves the room?	Teacher location: The teacher is either in the room or not in the room. "The teacher's location is an either/or situation"	Loudness measured in decibels	<ul style="list-style-type: none"> • Same classroom • Same students • Same time of day
Do bicycle fenders keep the rider dry when riding through a puddle?	Fenders: The bicycle either has fenders or it does not "Many engineering projects have alternative designs with independent variables like this one (with and without fenders)."	The rider either gets wet or does not "Dependent variables can represent either/or situations, too."	<ul style="list-style-type: none"> • Same type of bike and tires (except for the fenders!) • Riding at the same speed • Same size and depth of puddle

Sample

Here is a sample containing the **variables and hypothesis** (http://www.sciencebuddies.org/science-fair-projects/project_sample_variables.shtml).

Science Fair Project Variables Checklist

What Makes for Good Variables?	For Good Variables, You Should Answer "Yes" to Every Question
Is the independent variable measurable?	Yes / No
Can you change the independent variable during the experiment?	Yes / No
Have you identified all relevant dependent variables, and are they all caused by and dependent on the independent variable?	Yes / No
Are all dependent variable(s) measurable?	Yes / No
Have you identified all relevant controlled variables?	Yes / No
Can all controlled variables be held at a steady value during the experiment?	Yes / No

You can find this page online at: http://www.sciencebuddies.org/science-fair-projects/project_variables.shtml



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