Doing a Fair Test: Variables for Beginners

It is important for an experiment to be a **fair test**. You conduct a fair test by making sure that you change one factor at a time while keeping all other conditions the same.

For example, let's imagine that we want to measure which is the fastest toy car to coast down a sloping ramp. If we gently release the first car, but give the second car a push start, did we do a fair test of which car was fastest? No! We gave the second car an unfair advantage by pushing it to start. That's not a fair test! The only thing that should change between the two tests is the car; we should start them down the ramp in exactly the same way.

Let's pretend we're doing an experiment to see if fertilizer makes a plant grow to be larger than a plant that doesn't receive fertilizer. We put seeds of the same kind in three pots with fertilizer and rich soil. But, we run out of soil so we put the seeds without fertilizer in three pots filled with sand. We put all six pots in the same location and water each one with the same amount of water every other day. The plants with soil and fertilizer grow to be much larger than the ones grown in sand without fertilizer. Is that a fair test of whether fertilizer makes a plant grow to be larger? No! We changed two things (type of soil and fertilizer) so we have no idea whether the plants with fertilizer grew to be larger because of the fertilizer or whether the other plants were stunted by being grown in sand. It wasn't a fair test! All of the plants should have been in the same kind of soil.

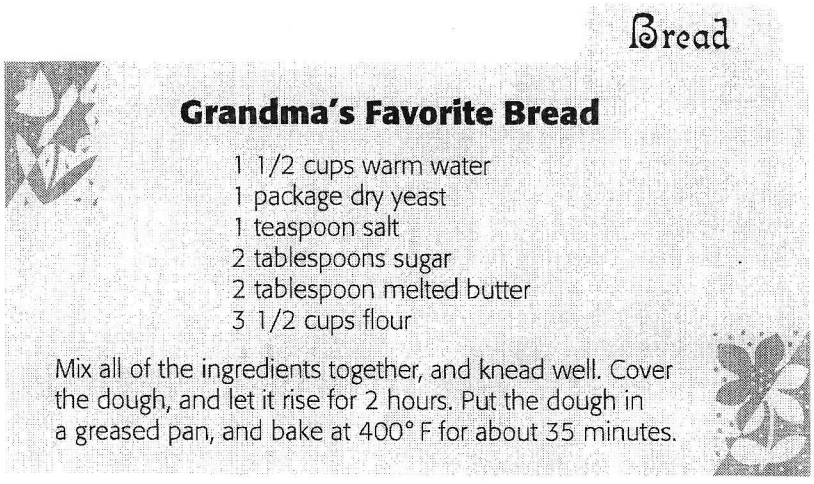
Conducting a fair test is one of the most important ingredients of doing good, scientifically valuable experiments. To insure that your experiment is a fair test, you must **change only one factor at a time while keeping all other conditions the same.**

Scientists call the changing factors in an experiment **variables.**

EXPERIMENTING SKILLS

Understanding Variables

Malcolm used his grandmother's recipe to bake a loaf of bread.



Unfortunately, Malcolm's bread collapsed while it was cooking. "Shucks!" he thought, "What could have gone wrong?" What could Malcolm change the next time he makes the bread? Two examples are given for you.

He could add more salt.

He could take the bread out of the oven sooner.

Varying Your Variables

A **factor** is anything in an experiment that can influence its outcome. A **variable** is a factor in an experiment that can be changed. For example, because you can change the amount of salt in the bread recipe, the amount of salt is a variable.

Malcolm's grandmother suggested that he added too little flour or too much liquid. Therefore, Malcolm thought about changing one of the following three variables:

- the amount of water
- the amount of melted butter
- the amount of flour

In science class, Malcolm learned to change only one variable at a time. Why is that important?

Scientists strive to perform controlled experiments. A **controlled experiment** tests only one factor at a time. In a controlled experiment, there is a control group and one or more experimental groups. All of the factors for the control group and the experimental groups are the same except for one. The one factor that differs is called the changed variable. Because the variable is the only factor that differs between the control group and the experimental group, scientists can be more certain that the changed variable is the cause of any differences that they observe in the outcome of the experiment.

Malcolm tried reducing the amount of water to 1 cup. Thus, he made the amount of water the changed variable. What factors did Malcolm control? (Hint: There are several of them! Refer to the recipe.)

As it happened, Malcolm chose the right variable to change. With less water, the bread came out perfect. He concluded that only 1 cup of water should be added.

Inputs and Outputs

The **outcome** describes the results of your experiment. For instance, when you bake bread, the outcome is the quality of the loaf of bread. Often an outcome is something that you have to measure. Following is an example.

> Henry and Eliza conducted an experiment using plant fertilizer. They added different amounts of fertilizer to seven pots of bean sprouts. The pots were the same size and had the same type and amount of soil. They were given the same amount of seeds, light, and water. To find out how the fertilizer affected the growth of the sprouts, Henry and Eliza calculated the average height of the bean sprouts in each pot. Here are the factors in their experiment:

Changed variable: amount of fertilizer

Controlled factors: size of pots, amount of light, amount of water, amount of soil, number of seeds

Outcome: average height of bean sprouts

Your Turn

Identify the changed variable, controlled factors, and outcomes in the following examples:

1. In a recent study, middle school students were given a math exam after various amounts of sleep. One group slept 8 hours or more, and the second group slept fewer than 8 hours. The students had similar skills in math. They ate the same meals the previous day. The study results showed that students who slept 8 hours or more scored better on the exam, while students who slept less than 8 hours scored worse.

   Changed variable: _____

   Controlled factors: _____

   Outcome: _____

2. Our science club built a catapult out of craft sticks, glue, and a rubber band. We wanted to determine what size rubber band was best for launching a gumball across the classroom. If the rubber band was too small, the gumball wouldn't travel very far. If it was too big, it would be too loose to work well. We found that a rubber band with a circumference of 11 cm shoots the gumball the farthest.

   Changed variable: _____

   Controlled factors: _____

   Outcome: _____

TROUBLESHOOTING

Remember that variables are things that can be changed. In each scenario, ask yourself what *could* have been done differently.

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**. 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, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she **observes** what happens. To read more about performing a fair test, visit www.sciencebuddies.org and you will find the "Variables for Beginners" link on the Project Guide page.

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

Examples of Variables

Question	Independent Variable	Dependent Variables	Controlled Variables