



# The Four Question Research Strategy: The Next Steps in Experimental Design

From: Cothron, Giese, and Rezba, *Students and Research*, 2000.

Your responses recorded on the Four Question Research Strategy Worksheet contain several important parts of your experimental design.

## Step 1. Identifying the Independent Variable

An independent variable is the part of an experiment that the experimenter changes on purpose. In Question 3, you listed several potential ways to change your research materials. You need to select one of the ways you listed in Question 3. This will be your independent variable in your experimental design.



In the popcorn example, you might choose to vary the amount of oil used to pop the popcorn. The *amount of oil* is your independent variable.

## Step 2. Deciding on the Levels of the Independent Variable

Once you have decided on the variable you will change, you need to decide how you will change it. Here is where you decide on the number of levels and the amount of each level.



In the popcorn example, you chose to vary the amount of oil used to pop the popcorn. Here is where you decide on how many different amounts of oil you want to use (the levels). So you might decide to have five levels for your independent variable and use *0 ml, 10 ml, 20 ml, 30 ml, and 40 ml of oil*.

## Step 3. Knowing what variables you need to control

Here you need to establish what you need to do to understand whether changing the independent variable made any difference. Here you need to identify a comparison group where the independent variable is not changed.



In the popcorn example, the control group is the set of *popcorn kernels that receive no oil (0 ml)*.

## Step 4. Identifying the Dependent Variable

In Question 4, you identified several possibilities for how you might change the set of materials you have in order to see an action in your experiment. Here is where you select one of the ways in which your research interest is changed (same independent variable that you chose in Question 3).



In the popcorn example, you identified ways that you might vary the amount of oil to affect the popcorn. You can choose any variable you listed here, for instance, the *number of kernels popped*. This will become the dependent variable for your experimental design.

A part of Step 4 is operationally defining, if need be, your dependent variable.



In the popcorn example, you will need to define exactly what you consider a “popped kernel” to be.

## Step 5. Composing a Hypothesis

A hypothesis is a prediction of the effect that changes in the independent variable will have on the dependent variable. It can be written as an “if-then” statement in the following way: If the [independent variable] changes [in this way], then the [dependent variable] will [respond this way]



In the popcorn example, a possible hypothesis would be: If the amount of oil is increased when popcorn is popped, then the number of popped kernels will increase.

## Step 6. Identifying Constants

In Step 3, you brainstormed all the potential independent variables you could choose from. Since you chose one of those variables as your independent variable, all the others should be held constant. To change a potential independent variable to a constant, you need to assign it a specific value – amount, time, brand, etc.



In the popcorn example, you would need to identify the brand of popcorn, amount kernels used, the age of the popcorn, popcorn storage, type/kind of oil, brand of popper, heating and cooking time.

## Step 7. Repeated Trials

You need to decide how many times to gather data for each level of independent variable. Here you need to consider the amount of variation in the object you are researching and the consequences of coming to a wrong conclusion. The more trials for each level of independent variable, the more confident you can be in your results and conclusion.



In the popcorn example, three trials at each of the independent variable levels would give better results than only one trial with each amount of oil.

## Step 8. Identifying Safety Concerns/Procedures

You need to identify how you will handle any safety issues.



In the popcorn example, the kernels will be extremely hot immediately after popping, so you should identify how you will handle the kernels safely.