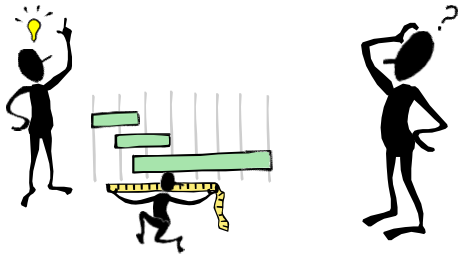
Strathmore UNIVERSITY

# Lesson 2: Introducing Variables in Research

## What is a Variable?



## DEFINITION

- Variables are ***the things that are changing in a given research***.
- A variable is *any factor, trait, or condition* that can *exist in differing* amounts or types.
- In order to be a variable, ***a variable must vary*** (e.g., not be a constant), that is, it must take on different values, levels, intensities, or states.
- A Research experiment usually has three kinds of variables: ***independent, dependent, and controlled***.

## Types of Variables:

**1. INDEPENDENT Variable *(also called the manipulated variable)***

- the ***one*** that is ***changed by the researcher***.
- *Why just one?* Well, if you changed more than one variable it would be hard to figure out which change is causing what you observe. E.g. what if our research question was: *"How does the size of a dog affect how much food it eats?"*; then, during your feeding experiments you *changed both the size of the dog and the time of day* the dogs were fed.
  - *The data might get a bit confusing— did the larger dog eat less food than the smaller dog because of his size or because it was the middle of the day and dogs prefer to eat more in the morning?*

**2. DEPENDENT Variable *(also called the responding variable)***

- **A variable that is *observed or measured*, and that *is influenced or changed by the independent variable.***
- **There can be one or more dependent variables in a research.**
- are *the things that the researcher focuses* on in the research *to see how they respond* to the change made to the independent variable.
- In our dog example, the *dependent variable is how much the dogs eat.* This is what we are ***observing*** and ***measuring***.
- It is called the "dependent" variable because we are *trying to figure out whether its value depends on the value of the independent variable.*
- **If there is a direct link** between the two types of variables *(independent and dependent)* then you may be uncovering a *cause and effect (Causal)* relationship.

**3. CONTROLLED/CONSTANT Variables The factors or conditions that are kept the same *(unchanged)* in a research.**

- **There can be many controlled variables in a research.**
- Controlled variables are ***quantities that a researcher wants to remain constant***, and must observe them as carefully as the dependent variables.
- For example, *in the dog experiment example*, you would need to **control**:
  - **how hungry the dogs are** at the start of the experiment,
  - the **type of food** you are feeding them, and
  - whether the food was a **type that they liked**.
- **Why?** If you did not, then other explanations could be given for differences you observe in how much they eat.
- E.g.: maybe the little dog eats more because it is hungrier that day, maybe the big dog does not like the dog food offered, or maybe all dogs will eat more wet dog food than dry dog food.
- So, *you should keep all the other variables the same* (you control them) *so that you can see only the effect of the one variable (the independent variable)* that you are trying to test.

## EXAMPLES OF VARIABLES IN RESEARCH

| Research Study Question | Independent Variable (What I change) | Dependent Variables (What I observe) | Controlled Variables (What I keep the same) |
|---|---|---|---|
| ***Is a classroom noisier when the lecturer leaves the room?*** | **Lecturer location:** The lecturer is either in the room or not in the room. | **Loudness**, measured in decibels. | •**Same classroom**<br>•**Same students**<br>•**Same time of day** |
| ***Does heating a cup of water allow it to dissolve more sugar?*** | **Temperature of the water** | **Amount of sugar that dissolves**<br>Ccompletely (*measured in grams)* | • **Stirring**<br>• **Type of sugar**<br>*(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 ,keep these variables the same for each cup of water.")* |

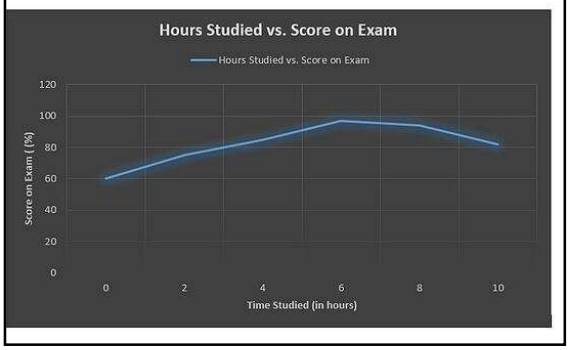
## How to Plot Variables on a Graph

- There is a standard method for graphing the independent and dependent variable.
- The ***x-axis*** is the ***independent variable***, while the ***y-axis*** is the ***dependent variable***.
- You can use the **DRY MIX acronym** to help remember how to graph variables:

DRY MIX
**D** = dependent variable
**R** = responding variable
**Y** = graph on the vertical or y-axis

**M** = manipulated variable
**I** = independent variable
**X** = graph on the horizontal or x-axis

*See example on the next slide.*




- The graph shows how the number of hours a student studies affects the score she got on an exam.
- From the graph, it looks like studying up to six hours helped her raise her score, but as she studied more than that her score dropped slightly.
- The ***amount of time spent studying*** is the ***independent variable***, because it's what she changed, so it's on the **x-axis.**
- ***The score she got on the exam*** is the ***dependent variable***, because it's what changed as a result of the independent variable, and it's on the **y-axis**.

## Practice

**Identify variables for the following experiments.**

Students of different ages were given the same jigsaw puzzle to put together. They were timed to see how long it took to finish the puzzle.

- **Independent Variable:** ***Ages of the students*** (Different ages were tested by the researcher)
- **Dependent Variable:** ***The time it takes to put the puzzle together***. (The time can be observed and measured by the researcher).
- **Constant/Controlled Variable:** ***Same puzzle.*** All of the participants were tested with the same puzzle. It would not have been a fair test if some had an easy 30 piece puzzle and some had a harder 500 piece puzzle.

Another example:

An investigation was done with an electromagnetic system made from a battery and wire wrapped around a nail. Different sizes of nails were used. The number of paper clips the electromagnet could pick up was measured.

- **Independent Variable:** ***Size of the nails*** (Different nail sizes were used by the researcher)
- **Dependent Variable:** ***Number of paper clips picked up.*** The number of paper clips can be observed and counted (measured).
- **Constant/Controlled Variable:** ***Battery, wire, type of nail.*** All these should remain the same.

One more:

The higher the temperature of water, the faster an egg will boil.

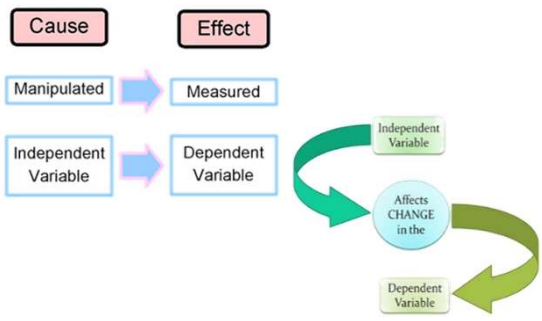
- **Independent variable** – ***temperature of water***
- **Dependent variable** – ***time to cook an egg***
- **Controlled variable** – ***type of egg***

Last one:

The temperature of water was measured at different depths of a pond.

- **Independent variable** – ***depth of the water***
- **Dependent variable** – ***temperature***
- **Controlled variable** – ***thermometer***

## Summary




**4. Extraneous Variables**

- When we conduct research experiments, there are other variables that can affect our results, if we do not control them.
- ***Extraneous variables are variables, which are not the independent variable***, but could affect the results of the research experiment. *i.e. Extraneous variables affect the IV.*
- A researcher must ensure that it is *the manipulation of the independent variable that has caused/brought about the changes in the dependent variable.*
- Therefore, ***all the other variables that could affect the dependent variable to change must be controlled***.
- Extraneous variables make it difficult to detect the effect of the independent variable because they add variability or "noise" to the data.
- One way **to control extraneous variables is to make them constant.**

## THERE ARE THREE (3) TYPES OF EXTRANEOUS VARIABLES:

### 1. Situational Extraneous Variables

- These are ***aspects of the environment*** that might affect a research participant's behavior, *e.g. noise*, *temperature*, *lighting conditions*, etc.
- Situational variables **should be controlled** so they are the same for all participants. ***The researcher should ensure that aspects of the environment are the same for all participants*** during a research experiment.

### 2. Participant / Person Extraneous Variables:

- Are the ***characteristics of the individuals*** participating in the research that might affect their actions. These variables include age, gender, health status, mood, background, etc.
- Participant extraneous variables ***can be controlled by minimizing differences between participants*** (e.g. using participants of the same age, same IQ etc.), OR, ***using random allocation to the conditions of the independent variable***.
- **Example:** selecting participants with very specific characteristics, such as 20-year-old, female, right-handed, 3rd year students. OR, selecting a group of participants as male, left-handed, 3rd years, and the other group of participants as female, right-handed, 3rd years,

### 3. Researcher Effects-Extraneous Variables:

- Many times, ***the researcher unconsciously conveys to participants how they should behave*** - this is called researcher bias.
- The researcher might do this by giving unintentional clues to the participants about what the research is about and how they expect them to behave. This affects the participants' behavior. The researcher is often totally unaware of the influence which s/he is exerting and the cues may be very subtle but they may have an influence nevertheless.
- Also, the personal attributes (e.g. age, gender, accent, manner etc.) of the researcher can affect the behavior of the participants.
- Researcher extraneous variables ***can be controlled by adopting the same researcher in different experiments or ensuring that the researchers use a standard procedure of conducting the experiment.***

### 4. Statistical Control:

- There may be situations, when all the above mentioned methods to control the extraneous variables do not show any significant outcome.
- It brings the entire research into question as then causal inferences are difficult to make. Another method that may work to bring down the effect of extraneous variables is the method of ***statistical control***.
- Among the various statistical tools and techniques, Analysis of Covariance ( ANOVA) helps in reducing the impact of the extraneous factors on the research.

### Example of Extraneous Variables in a given Research

- *Suppose we wanted to measure the effects of **Alcohol (IV)** on **driving ability (DV)** we would have to **try to ensure that extraneous variables did not affect the results.***
- The **Extraneous variables** could include:
  1. *Familiarity with the car:* Some people may drive better because they have driven this make of car before.
  2. *Used to drinking:* The effects of alcohol on some people may be less than on others because they are used to drinking.
  3. *Full stomach:* The effect of alcohol on some subjects may be less than on others because they have just had a big meal.
  4. *Familiarity with the test:* Some people may do better than others because they know what to expect on the test. (Similar to how people "know" how to "beat" the system.)

- **If these extraneous variables are not controlled they may become confounding variables,** because they could go on to affect the results of the experiment.

## CONFOUNDING VARIABLES:

- If an Extraneous variable cannot be controlled, it becomes what is known as a ***confounding variable***.
- This type of variable ***distorts both the Independent and Dependent Variables*** in a given research.
- To *confound means to confuse*, and this effect is exactly why confounding variables are undesirable. Because they differ across conditions—just like the independent variable—they provide an alternative explanation for any observed difference in the dependent variable
- Confounding variables are often seen in flaws in procedures or equipment. e.g. *if you use faulty equipment to measure, then this will distort both the IV and DV.*

### Example of Confounding Variable in a given Research

**AN OLD CLASSIC: MURDER AND ICE CREAM**

It is known that throughout the year, murder rates and ice cream sales are highly positively correlated. That is, as murder rates rise, so does the sale of ice cream. There are three possible explanations for this correlation:

**Possibility #1**: Murders cause people to purchase ice cream. One could imagine a world where this is true. Perhaps when one is murdered, they are resurrected as zombies who primarily feed on ice cream.

**Possibility #2**: Purchasing ice cream causes people to murder or get murdered. Again, one could imagine a world where this is true. Perhaps when one eats ice cream, those without ice cream become jealous and murder those with ice cream.

**Possibility #3**: There is a third **variable—a confounding variable**—which causes the increase in **BOTH** ***ice cream*** sales **AND** ***murder rates.*** For instance, **the weather**.

- When it's cold and rainy, people stay at home rather than go outside and murder people. They also probably don't eat a lot of ice cream. When it's hot and, people spend more time outside interacting with each other, and hence are more likely to get into the kinds of situations that lead to murder. They are also probably buying more ice cream.
- In this example, ***the weather*** is a variable that **confounds** the relationship between *ice cream sales* and *murder rates*.
- You may also recognize this as the so-called *third variable problem*, which refers to the fact that any time we observe a relationship among two variables, there's always the possibility that some third variable which we don't know about is responsible for ("confounding") the relationship.

### HOW TO REDUCE CONFOUNDING VARIABLES

- Make sure you identify all of the possible confounding variables in your research.
- Make a list of everything you can think of and one by one, consider whether those listed items might influence the outcome of your study. Usually, someone has done a similar study before you.
- So check the academic databases for ideas about what to include on your list. Once you have figured out the variables, use one of the following techniques to reduce the effect of those confounding variables:

1. Bias can be eliminated with ***random samples.***
2. ***Introduce control variables*** to control the confounding variables.