Types of Variable

All experiments examine some kind of variable(s). A variable is not only something that we measure, but also something that we can manipulate and something we can control for. To understand the characteristics of variables and how we use them in research, this guide is divided into three main sections. First, we illustrate the role of dependent and independent variables. Second, we discuss the difference between experimental and non-experimental research. Finally, we explain how variables can be characterised as either categorical or continuous.

Dependent and Independent Variables

An independent variable, sometimes called an experimental or predictor variable, is a variable that is being manipulated in an experiment in order to observe the effect on a dependent variable, sometimes called an outcome variable.

Imagine that a tutor asks 100 students to complete a maths test. The tutor wants to know why some students perform better than others. Whilst the tutor does not know the answer to this, she thinks that it might be because of two reasons: (1) some students spend more time revising for their test; and (2) some students are naturally more intelligent than others. As such, the tutor decides to investigate the effect of revision time and intelligence on the test performance of the 100 students. The dependent and independent variables for the study are:

Dependent Variable: **Test Mark** (measured from 0 to 100)

Independent Variables: **Revision time** (measured in hours) **Intelligence** (measured using IQ score)

The dependent variable is simply that, a variable that is dependent on an independent variable(s). For example, in our case the test mark that a student achieves is dependent on revision time and intelligence. Whilst revision time and intelligence (the independent variables) may (or may not) cause a change in the test mark (the dependent variable), the reverse is implausible; in other words, whilst the number of hours a student spends revising and the higher a student's IQ score may (or may not) change the test mark that a student achieves, a change in a student's

test mark has no bearing on whether a student revises more or is more intelligent (this simply doesn't make sense).

Therefore, the aim of the tutor's investigation is to examine whether these independent variables - revision time and IQ - result in a change in the dependent variable, the students' test scores. However, it is also worth noting that whilst this is the main aim of the experiment, the tutor may also be interested to know if the independent variables - revision time and IQ - are also connected in some way.

In the section on experimental and non-experimental research that follows, we find out a little more about the nature of independent and dependent variables.

Experimental and Non-Experimental Research

- **Experimental research**: In experimental research, the aim is to manipulate an independent variable(s) and then examine the effect that this change has on a dependent variable(s). Since it is possible to manipulate the independent variable(s), experimental research has the advantage of enabling a researcher to identify a cause and effect between variables. For example, take our example of 100 students completing a maths exam where the dependent variable was the exam mark (measured from 0 to 100), and the independent variables were revision time (measured in hours) and intelligence (measured using IQ score). Here, it would be possible to use an experimental design and manipulate the revision time of the students. The tutor could divide the students into two groups, each made up of 50 students. In "group one", the tutor could ask the students not to do any revision. Alternately, "group two" could be asked to do 20 hours of revision in the two weeks prior to the test. The tutor could then compare the marks that the students achieved.
- **Non-experimental research**: In non-experimental research, the researcher does not manipulate the independent variable(s). This is not to say that it is impossible to do so, but it will either be impractical or unethical to do so. For example, a researcher may be interested in the effect of illegal, recreational drug use (the independent variable(s)) on certain types of behaviour (the dependent variable(s)). However, whilst possible, it would be unethical to ask individuals to take illegal drugs in order to study what effect this had on certain behaviours. As such, a researcher could ask both drug and non-drug users to complete a

questionnaire that had been constructed to indicate the extent to which they exhibited certain behaviours. Whilst it is not possible to identify the cause and effect between the variables, we can still examine the association or relationship between them.In addition to understanding the difference between dependent and independent variables, and experimental and non-experimental research, it is also important to understand the different characteristics amongst variables. This is discussed next.

Categorical and Continuous Variables

Categorical variables are also known as discrete or qualitative variables. Categorical variables can be further categorized as either nominal, ordinal or dichotomous.

- **Nominal** variables are variables that have two or more categories, but which do not have an intrinsic order. For example, a real estate agent could classify their types of property into distinct categories such as houses, condos, co-ops or bungalows. So "type of property" is a nominal variable with 4 categories called houses, condos, co-ops and bungalows. Of note, the different categories of a nominal variable can also be referred to as groups or levels of the nominal variable. Another example of a nominal variable would be classifying where people live in the USA by state. In this case there will be many more levels of the nominal variable (50 in fact).
- **Dichotomous** variables are nominal variables which have only two categories or levels. For example, if we were looking at gender, we would most probably categorize somebody as either "male" or "female". This is an example of a dichotomous variable (and also a nominal variable). Another example might be if we asked a person if they owned a mobile phone. Here, we may categorise mobile phone ownership as either "Yes" or "No". In the real estate agent example, if type of property had been classified as either residential or commercial then "type of property" would be a dichotomous variable.
- **Ordinal** variables are variables that have two or more categories just like nominal variables only the categories can also be ordered or ranked. So if you asked someone if they liked the policies of the Democratic Party and they could answer either "Not very much", "They are OK" or "Yes, a lot" then you have an ordinal variable. Why? Because you have 3 categories, namely "Not very much", "They are OK" and "Yes,

a lot" and you can rank them from the most positive (Yes, a lot), to the middle response (They are OK), to the least positive (Not very much). However, whilst we can rank the levels, we cannot place a "value" to them; we cannot say that "They are OK" is twice as positive as "Not very much" for example.

Continuous variables are also known as quantitative variables. Continuous variables can be further categorized as either interval or ratiovariables.

- **Interval** variables are variables for which their central characteristic is that they can be measured along a continuum and they have a numerical value (for example, temperature measured in degrees Celsius or Fahrenheit). So the difference between 20C and 30C is the same as 30C to 40C. However, temperature measured in degrees Celsius or Fahrenheit is NOT a ratio variable.
- **Ratio** variables are interval variables, but with the added condition that 0 (zero) of the measurement indicates that there is none of that variable. So, temperature measured in degrees Celsius or Fahrenheit is not a ratio variable because 0C does not mean there is no temperature. However, temperature measured in Kelvin is a ratio variable as 0 Kelvin (often called absolute zero) indicates that there is no temperature whatsoever. Other examples of ratio variables include height, mass, distance and many more. The name "ratio" reflects the fact that you can use the ratio of measurements. So, for example, a distance of ten metres is twice the distance of 5 metres.

Ambiguities in classifying a type of variable

In some cases, the measurement scale for data is ordinal, but the variable is treated as continuous. For example, a Likert scale that contains five values - strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree - is ordinal. However, where a Likert scale contains seven or more value - strongly agree, moderately agree, agree, neither agree nor disagree, disagree, moderately disagree, and strongly disagree - the underlying scale is sometimes treated as continuous (although where you should do this is a cause of great dispute).

It is worth noting that how we categorise variables is somewhat of a choice. Whilst we categorised gender as a dichotomous variable (you are either

male or female), social scientists may disagree with this, arguing that gender is a more complex variable involving more than two distinctions, but also including measurement levels like genderqueer, intersex and transgender. At the same time, some researchers would argue that a Likert scale, even with seven values, should never be treated as a continuous variable.