5

IDENTIFYING VARIABLES

In this chapter you will learn about

- What variables and concepts are and how they are different
- How to turn concepts into operational variables
- Types of variables from the viewpoint of causation, the study design and unit of measurement
- Types of measurement scales: nominal or classificatory, ordinal or ranking, interval and ratio

Keywords

active variables, attribute variables, categorical variables, causation, constant variables, continuous variables, dependent variables, dichotomous, extraneous variables, independent variables, interval scale, intervening variables, measurement scales, nominal scale, ordinal scale, polytomous, ratio scale, unit of measurement.

At the end of this chapter, you should have an understanding of

- Different types of variables from various perspectives
- Place of variables in research
- How to convert concepts into variables
- Different types of measurement scale

If it exists, it can be measured. (Babbie 1989: 105)

In the process of formulating a research problem in quantitative research, there are two important considerations that you should keep in mind: whether or not you are researching a concept(s) in the process of undertaking your study; and whether or not you are testing a hypothesis. Both concepts and hypotheses place additional responsibility on you in terms of their operationalisation. Concepts need to be operationalised in behavioural terms, and hypotheses need to be constructed and their outcome communicated in a specific manner. In the previous chapter, we established that concepts are highly subjective as their understanding may vary from person to person. It follows, therefore, that as such they may not be uniformly (and thus accurately) measurable. In a research study it is important that the concepts used should be operationalised in measurable terms so that the extent of variation in respondents' understanding is reduced if not eliminated. Using techniques to operationalise concepts, and knowledge about variables and their measurement, play an important role in reducing this variability and 'fine-tuning' your research problem.

What is a variable?

Whether we accept it or not, we all make value judgements constantly in our daily lives: 'This food is *excellent*'; 'I did not sleep *well* last night'; 'I do not *like* this'; and 'I think this is *wonderful*'. These are all judgements based upon our *own* preferences, indicators or assessment. Because they explain feelings or preferences, the basis on which they are made may vary markedly from person to person. There is no uniform yardstick with which to measure them. A particular food may be judged 'excellent' by one person but 'awful' by another, and something else could be wonderful to one person but ugly to another. When people express these feelings or preferences, they do so on the basis of certain criteria in their minds, or in relation to their expectations. If you were to question them you would discover that their

judgement is based upon indicators and/or expectations that lead them to conclude and express a particular opinion.

Let us consider this in a professional context:

- 'This programme is *effective*.'
- 'This programme is *not effective*.'
- 'We are providing a *quality* service to our clients.'
- 'This is a *waste of time*.'
- 'In this institution women are *discriminated* against.'
- 'There is no *accountability* in this office.'
- 'This product is not doing *well*.'

These are not preferences per se; they are judgements that require a sound basis on which to proclaim. For example, if you want to find out if a programme is effective, if a service is of quality or if there is discrimination, you need to be careful that such judgements have a rational and sound basis. This warrants the use of a measuring mechanism and it is in the process of measurement that knowledge about variables plays an important role.

An image, perception or concept that is capable of measurement – hence capable of taking on different values – is called a **variable**. According to Kerlinger (1986: 27), 'A variable is a property that takes on different values. Putting it redundantly, a variable is something that varies … A variable is a symbol to which numerals or values are attached.' Black and Champion (1976: 34) define variables as 'rational units of analysis that can assume any one of a number of designated sets of values'. A variable, then, is a concept that can be measured on any one of the four types of **measurement scale**, which have varying degrees of precision in measurement (measurement scales are discussed later in this chapter).

However, there are some who believe that scientific methods are incapable of measuring feelings, preferences, values and sentiments. In the author's opinion most of these things can be measured, though there are situations where they must be measured indirectly through appropriate indicators rather than directly. These feelings and judgements are based upon observable behaviours in real life, though the extent to which the behaviours reflect their judgements may vary from person to person. In the words of Cohen and Nagel (1966: 352):

> There are, indeed, a great many writers who believe that scientific method is inherently inapplicable to such judgements as estimation or value, as 'This is beautiful', 'This is good' or 'This ought to be done' … all judgements of the latter type express nothing but feelings, tastes or individual preferences, such judgements cannot be said to be true or false (except as descriptions of the personal feelings of the one who utters them) … Almost all human discourse would become meaningless if we took the view that every moral or aesthetic judgement is no more true or false than any other.

The difference between a concept and a variable

The main difference between a **concept** and a variable is measurability. Concepts are mental images or perceptions and therefore their meanings vary markedly from

Table 5.1 Examples of concepts and variables

Concepts	Variables
• Effectiveness • Satisfaction • Impact • Excellent • High achiever • Self-esteem • Rich • Domestic violence • Extent and pattern of alcohol consumption • etc.	• Gender (male/female) • Attitude • Age (*x* years, *y* months) • Income ($ –– per year) • Weight (–– kg) • Height (–– cm) • Religion (Catholic, Protestant, Jewish, Muslim) • etc.
– Subjective impression – No uniformity as to its understanding among different people – As such cannot be measured	– Measurable, though the degree of precision varies from scale to scale and from variable to variable (e.g. attitude – subjective, income – objective)

individual to individual, whereas variables are measurable, though, of course, with varying degrees of accuracy depending upon the measurement scale used. A concept as such cannot be measured, whereas a variable can be subjected to measurement by crude/refined or subjective/objective units of measurement. Concepts are subjective impressions which, if measured as such, would cause problems in comparing responses obtained from different respondents. According to Young (1966: 18):

> **Each collaborator must have the same understanding of the concepts if the collaborative data are to be similarly classified and the findings pooled and tested, or reproduced. Classification and comparison demand uniform and precise definitions of categories expressed in concepts.**

It is therefore important for the concepts to be converted into variables (either directly or through a set of indicators) as they can be subjected to measurement, even though the degree of precision with which they can be measured markedly varies from one measurement scale (*nominal*, *ordinal*, *interval* and *ratio*) to another. Table 5.1 gives examples of concepts and variables to illustrate the differences between them.

Converting concepts into variables

If you are using a concept in your study, you need to consider its operationalisation – that is, how it will be measured. In most cases, to operationalise a concept you first need to go through the process of identifying indicators – a set of criteria reflective of the concept – which can then be converted into variables. The choice of indicators for a concept might vary with the researcher, but those selected must have a logical link with the concept.

Some concepts, such as 'rich' (in terms of wealth), can easily be converted into indicators and then variables. For example, to decide objectively if a person is 'rich', one first needs to decide upon the indicators of wealth. Assume that we decide upon income and assets as the indicators. Income is already a variable since it can be measured in some unit of currency, say dollars; therefore, you do not need to convert this into a variable. Although the assets owned by an individual are indicators of his/her 'richness', they still belong to the category of concepts. You need to look further at the indicators of assets. For example, house, boat, car and investments are indicators of assets. Converting the value of each one into dollars will give the total value of the assets owned by a person. Next, fix a level, based upon available information on income distribution and an average level of assets owned by members of a community, which acts as the basis for classification. Then analyse the information on income and the total value of the assets to make a decision about whether the person should be classified as 'rich'. The operationalisation of other concepts, such as the 'effectiveness' or 'impact' of a programme, may prove more difficult. Table 5.2 shows some examples that will help you to understand the process of converting concepts into variables. Note that in these examples only some of the indicators have been picked up. Also, the values set for decision levels are arbitrary and have no empirical validity.

One of the main differences between quantitative and qualitative research studies is in the area of variables. In qualitative research, as it usually involves studying perceptions, beliefs, or feelings, you do not make any attempt to establish uniformity in them across respondents and hence measurements and variables do not carry much significance. On the other hand, in quantitative studies, as the emphasis is on exploring commonalities in the study population, measurements and variables play an important role.

Types of variable

A variable can be classified in a number of ways. The classification developed here results from looking at variables in three different ways (see Figure 5.1):

- the causal relationship;
- the study design;
- the unit of measurement.

From the viewpoint of causal relationship

In studies that attempt to investigate a causal relationship or association, four sets of variables may operate (see Figure 5.2):

- variables that are responsible for *bringing about change* in a phenomenon, situation or circumstance;
- *outcome* variables, which are the effects, impacts or consequences of a change variable;
- variables which *affect or influence* the link between cause-and-effect variables; and
- *connecting* or *linking* variables, which in certain situations are necessary to complete the relationship between cause-and-effect variables.

Table 5.2 Converting concepts into variables

Concepts → Indicators → Variables

Concepts →	Indicators →	Variables	
		Variables	**Decision level (working definitions)**
Rich/poor	1 Income 2 Value of all assets	1 Total income per year 2 Total value of: home(s); car(s); boat; investments	Considered rich: 1 if income is > 200,000 p.a. 2 if total value of assets is > 2,000,000
High academic achievement	1 Performance in examinations 2 Performance in practical work/field placements 3 Performance in tutorial presentations 4 Overall performance etc.	1 Marks in examinations 2 Marks in practical work/field placements 3 Marks in tutorial presentations 4 Overall marks	Considered high achiever: 1 if > 85% 2 if > 85% 3 if > 85% 4 if > 85%
Effectiveness (of a health programme)	1 Changes in the utilisation pattern of services 2 Changes in the morbidity pattern of the community 3 Changes in the illness episodes in a specific period 4 Changes in child mortality rates 5 Changes in the nutritional status of children (weight, height, illness episodes etc.)	1 Increase or decrease in the number of patients per month 2 (a) Changes in the morbidity pattern (b) Changes in morbidity typology 3 Increase or decrease in the number of illness episodes in a month 4 Changes in age-specific death rate 5 Increase or decrease in the crude death rate in the community 6 Changes in the weight, height and illness episodes among children up to 5 years of age in the community	Considered effective if: 1 after a year, the number of patients increases by 25% 2 changes in the morbidity pattern are significant, as judged by a group of experts 3 after a year, the number of illness episodes falls by 30% 4 the crude death rate falls by 0.05 by the end of the year, or any change considered significant by a group of experts 5 there is a significant increase in weight and height and significant reduction in the illness episodes among children under 5 as judged by a group of experts

In research terminology, change variables are called **independent variables**, outcome/effect variables are called **dependent variables**, the unmeasured variables affecting the cause-and-effect relationship are called **extraneous variables**, and the variables that link a cause-and-effect relationship are called **intervening variables**. To give a little more detail:

1. **Independent variable** – the cause supposed to be responsible for bringing about change(s) in a phenomenon or situation.
2. **Dependent variable** – the outcome or change(s) brought about by introduction of an independent variable.
3. **Extraneous variable** – several other factors operating in a real-life situation may affect or effect changes in the dependent variable. These factors, not measured in the study, may increase or decrease the magnitude or strength of the relationship between independent and dependent variables.
4. **Intervening variable** – sometimes called the confounding variable (Grinnell 1988: 203), it links the independent and dependent variables. In certain situations the relationship between an independent and a dependent variable cannot be established without the intervention of another variable. The cause, or independent, variable will have the assumed effect only in the presence of an intervening variable.

To explain this typology, let us consider some examples. Suppose you want to study the relationship between smoking and cancer. You assume that smoking is a cause of cancer. Studies have shown that there are many factors affecting this relationship, such as the number of cigarettes or the amount of tobacco smoked every day; the duration of smoking; the age of the smoker; dietary habits; and the amount of exercise taken by the individual. All of these factors may affect the extent to which smoking might cause cancer. These variables may either increase or decrease the magnitude of the relationship.

In this example the extent of smoking is the independent variable, incidence of cancer is the dependent variable, and all the variables that might affect this relationship, either positively or negatively, are extraneous variables. See Figure 5.3.

Let us take another example. Suppose you want to study the effects of a marriage counselling service on marital problems among clients of an agency providing such a service. Figure 5.4 shows the sets of variables that may operate in studying the relationship between counselling and marriage problems.

In studying this relationship, it is assumed that the counselling service will influence the extent of marital problems. Thus, the type of counselling service is the independent variable and the extent of marriage problems is the dependent variable. The magnitude or strength of this relationship can be affected, positively or negatively, by a number of other factors that are not the focus of the study. These extraneous variables might be the birth of a child; improvement in a couple's economic situation; the couple's motivation to change the situation; the involvement of another person; self-realisation; and pressure from relatives and friends. Extraneous variables that work both ways can increase or decrease the strength of the relationship.

The example in Figure 5.5 should help you to understand intervening variables. Suppose you want to study the relationship between fertility and mortality. Your aim is to explore what happens to fertility when mortality declines. The history of demographic transition has shown that a reduction in the fertility level follows a decline in the mortality

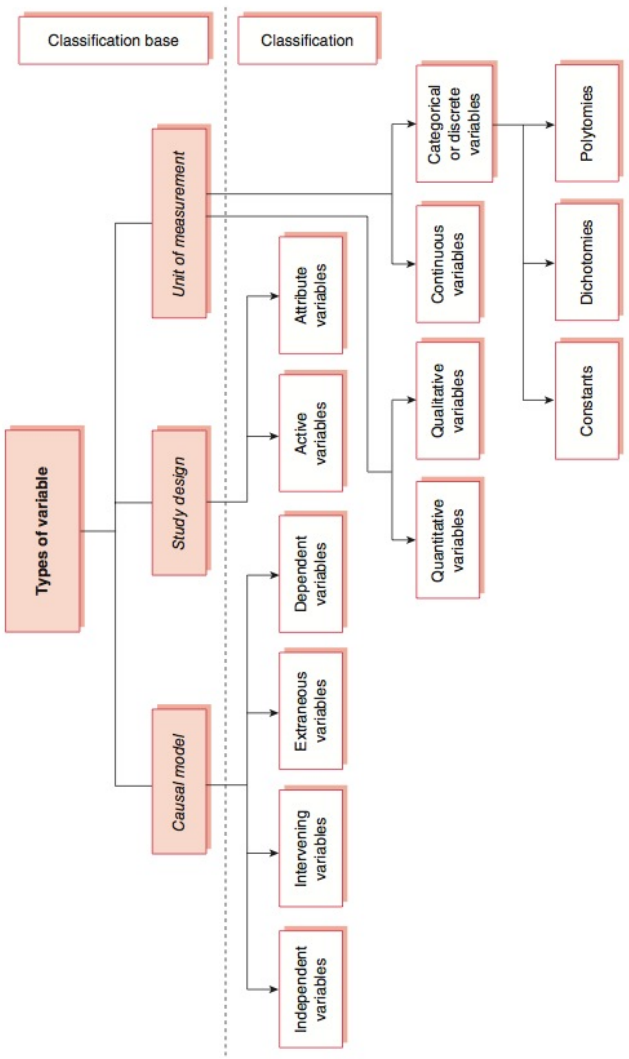

Figure 5.1 Types of variable

Note: Classification across a classification base is not mutually exclusive but classification within a classification base is. Within a study an independent variable can be an active variable, or a quantitative or a qualitative variable, and it can also be a continuous or a categorical variable, but it cannot be a dependent, an extraneous or an intervening variable.

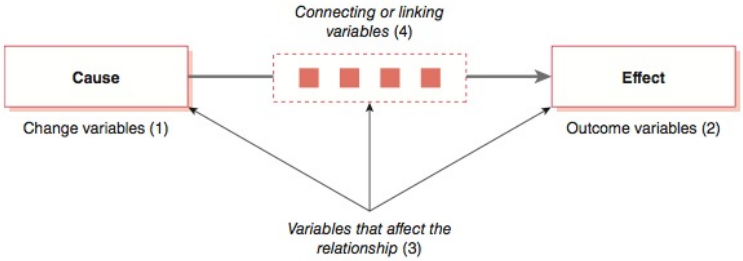

Figure 5.2 Types of variable in a causal relationship

level, though the time taken to attain the same level of reduction in fertility varies markedly from country to country. As such, there is no direct relationship between fertility and mortality. With the reduction in mortality, fertility will decline only if people attempt to limit their family size. History has shown that for a multiplicity of reasons (the discussion of which is beyond the scope of this book) people have used one method or another to control their fertility, resulting in lower fertility levels. It is thus the intervention of contraceptive methods that completes the relationship: the greater the use of contraceptives, the greater the decline in the fertility level, and the sooner the adoption of contraceptive methods by people, the sooner the decline. The extent of the use of contraceptives

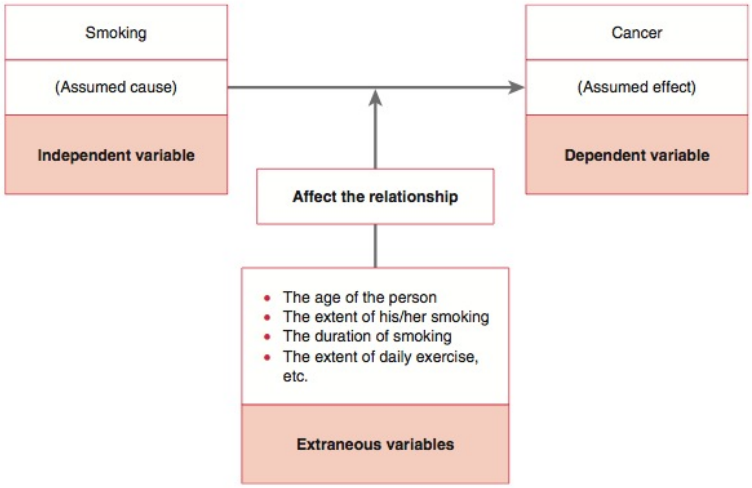

Figure 5.3 Independent, dependent and extraneous variables in a causal relationship

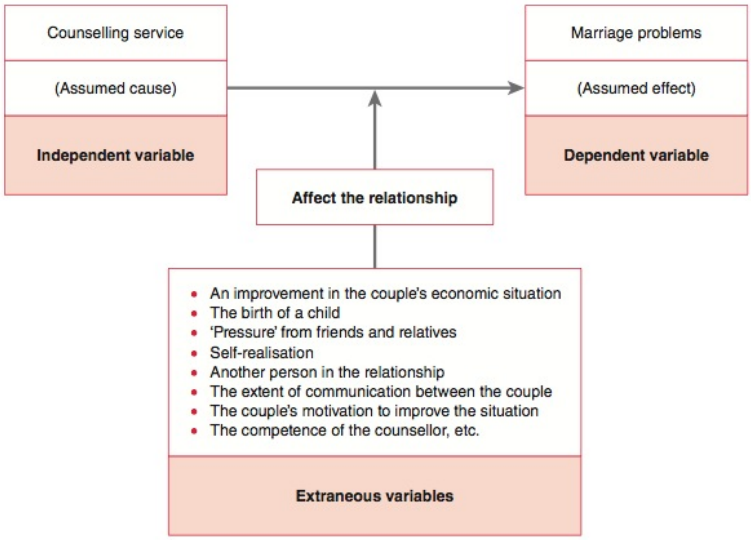

Figure 5.4 Sets of variables in counselling and marriage problems

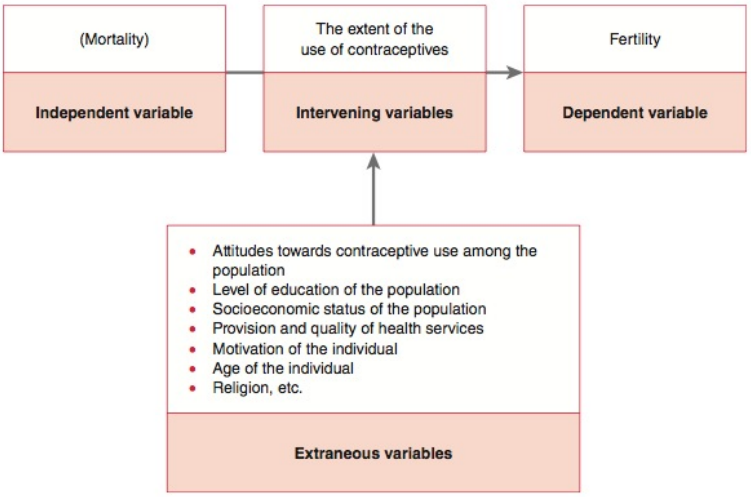

Figure 5.5 Independent, dependent, extraneous and intervening variables

is also affected by a number of other factors, for example attitudes towards contraception, level of education, socioeconomic status and age, religion, and provision and quality of health services. These are classified as extraneous variables.

In this example, decline in mortality is assumed to be the cause of a reduction in fertility, hence the mortality level is the independent variable and fertility is the dependent variable. But this relationship will be completed only if another variable intervenes – that is, the use of contraceptives. A reduction in mortality (especially child mortality) increases family size, and an increase in family size creates a number of social, economic and psychological pressures on families, which in turn create attitudes favourable to a smaller family size. This change in attitudes is eventually operationalised in behaviour through the adoption of contraceptives. If people do not adopt methods of contraception, a change in mortality levels will not be reflected in fertility levels. The population explosion in developing countries is primarily due to lack of acceptance of contraceptives. The extent of the use of contraceptives determines the level of the decline in fertility. The extent of contraceptive adoption by a population is dependent upon a number of factors. As mentioned earlier, in this causal model, the fertility level is the dependent variable, the extent of contraceptive use is the intervening variable, the mortality level is the independent variable, and the unmeasured variables such as attitudes, education, age, religion and the quality of services are all extraneous variables. Without the intervening variable the relationship between the independent and dependent variables will not be complete.

From the viewpoint of the study design

A study that examines association or causation may be a controlled/contrived experiment, a quasi-experiment or an *ex post facto* or non-experimental study. In controlled experiments the independent (cause) variable may be introduced or manipulated either by the researcher or by someone else who is providing the service. In these situations there are two sets of variables (see Figure 5.6):

- **Active variables** – those variables that can be manipulated, changed or controlled.
- **Attribute variables** – those variables that cannot be manipulated, changed or controlled, and that reflect the characteristics of the study population, for example age, gender, education and income.

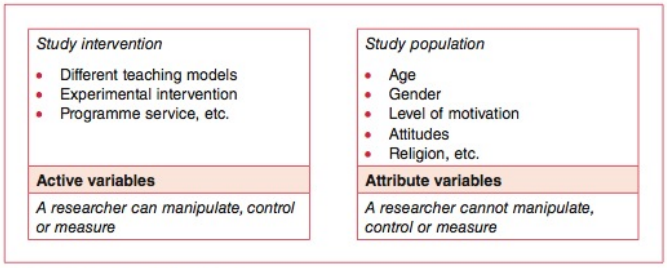

Figure 5.6 Active and attribute variables

Suppose a study is designed to measure the relative effectiveness of three teaching models (A, B and C). The structure and contents of these models could vary and any model might be tested on any population group. The contents, structure and testability of a model on a population group may also vary from researcher to researcher. On the other hand, a researcher has no control over characteristics of the student population such as their age, gender or motivation to study. These characteristics of the study population are called attribute variables. However, a researcher does have the ability to control and/or change the teaching models. S/he can decide what constitutes a teaching model and on which group of the student population it should be tested (if randomisation is not used).

From the viewpoint of the unit of measurement

From the viewpoint of the unit of measurement, there are two ways of categorising variables:

- whether the unit of measurement is categorical (as in nominal and ordinal scales) or continuous in nature (as in interval and ratio scales);
- whether it is qualitative (as in nominal and ordinal scales) or quantitative in nature (as in interval and ratio scales).

On the whole there is very little difference between categorical and qualitative, and between continuous and quantitative, variables. The slight difference between them is explained below.

Categorical variables are measured on nominal or ordinal measurement scales, whereas for continuous variables the measurements are made on either an interval or a ratio scale. There are three types of categorical variables:

- constant variable – has only one category or value, for example taxi, tree and water;
- dichotomous variable – has only two categories, as in male/female, yes/no, good/bad, heads/tails, up/down and rich/poor;
- polytomous variable – can be divided into more than two categories, for example religion (Christian, Muslim, Hindu); political parties (Labour, Liberal, Conservative); and attitudes (strongly favourable, favourable, uncertain, unfavourable, strongly unfavourable).

Continuous variables, on the other hand, have continuity in their measurement, for example age, income and attitude score. They can take any value on the scale on which they are measured. Age can be measured in years, months and days. Similarly, income can be measured in dollars and cents.

In many ways qualitative variables are similar to categorical variables as both use either nominal or ordinal measurement scales. However, there are some differences. For example, it is possible to develop categories on the basis of measurements made on a continuous scale, such as measuring the income of a population in dollars and cents and then developing categories such as 'low', 'middle' and 'high' income. The measurement of income in dollars and cents is classified as the measurement of a continuous variable, whereas its subjective measurement in categories such as 'low', middle' and 'high' groups is a qualitative variable.

Table 5.3 Categorical/continuous and quantitative/qualitative variables

Categorical					
Constant	**Dichotomous**	**Polytomous**	**Continuous**	**Qualitative**	**Quantitative**
• water • tree • taxi	• yes/no • good/bad • rich/poor • day/night • male/female • hot/cold	Attitudes • strongly agree • agree • uncertain • disagree • strongly disagree Political parties • Labour • Liberal • Conservative Age[a] • old • child • young Income[b] • high • middle • low	Income ($) Age (years) Weight (kg)	Gender • female • male Educational level • high • average • low Age[a] • old • young • child Income • high • middle • low Temperature[c] • hot • cold	Educational level: ____ no. of years completed Age:[a] ____ years/months Income:[b] ____ $ per year Temperature:[c] ____ °C or °F

[a] Can be classified in qualitative categories, e.g. old, young, child; or quantitatively on a continuous scale, e.g. in years, months and days.
[b] Can be measured quantitatively in dollars and cents as well as qualitatively in categories such as high, middle and low.
[c] Can be measured quantitatively in degrees on different scales (Celsius, Fahrenheit) or in qualitative categories such as hot and cold.

Although this distinction exists, for most practical purposes there is no real difference between categorical and qualitative variables or between continuous and quantitative variables. Table 5.3 shows similarities and differences among the various types of variable.

For a beginner it is important to understand that the way a variable is measured determines the type of analysis that can be performed, the statistical procedures that can be applied to the data, the way the data can be interpreted and the findings that can be communicated. You may not realise at the beginning that the style of your report is entirely dependent upon the way the different variables have been measured – that is, the way a question has been asked and its response recorded. The way you measure the variables in your study determines whether a study is 'qualitative' or 'quantitative' in nature. It is therefore important to know about the measurement scales for variables.

Types of measurement scale

The frame into which we wish to make everything fit is one of our own construction; but we do not construct it at random, we construct it by measurement so to speak; and that is why we can fit the facts into it without altering their essential qualities. (Poincaré 1952: xxv)

Measurement is central to any enquiry. In addition to the ideology and philosophy that underpin each mode of enquiry, the most significant difference between qualitative and quantitative research studies is in the types of measurement used in collecting information from the respondents. Qualitative research mostly uses descriptive statements to seek answers to the research questions, whereas in quantitative research these answers are usually sought on one of the measurement scales (nominal, ordinal, interval or ratio). If information is not collected using one of the scales at the time of data collection, it is transformed into variables by using these measurement scales at the time of analysis. Measurement on these scales could be either in the form of qualitative categories or through a precise unit of measurement. Those scales which have a unit of measurement (interval and ratio) are considered to be more refined, objective and accurate. On the other hand, nominal and ordinal scales are considered subjective and hence not as accurate as they do not have a unit of measurement per se. The greater the refinement in the unit of measurement of a variable, the greater the confidence placed in the findings by others, other things being equal. One of the main differences between the physical and the social sciences is the units of measurement used and the degree of importance attached to them. In the physical sciences measurements have to be absolutely accurate and precise, whereas in the social sciences they may vary from the very subjective to the very quantifiable. Within the social sciences the emphasis on precision in measurement varies markedly from one discipline to another. An anthropologist normally uses very 'subjective' units of measurement, whereas an economist or an epidemiologist emphasises 'objective' measurement.

MEASUREMENT SCALES

There are two main classification systems in the social sciences for measuring different types of variable. One was developed by S. S. Stevens (in 1946; see Stevens 1951) and the other by Duncan (1984). According to Smith (1991: 72), 'Duncan (1984) has enumerated, in increasing order of interest to scientists, five types of measurement: nominal classification, ordinal scaling, cardinal scaling, ratio scaling, and probability scaling'. Duncan (1984: viii) writes about Stevens's classification as follows:

> The theory of scale types proposed in 1946 by S. S. Stevens focused on nominal, ordinal, interval, and ratio scales of measurement. Some of his examples of these types – notably those concerning psychological test scores – are misleading.

However, Bailey (1978: 52) considers that 'S. S. Stevens constructed a widely adopted classification of levels of measurement'. As this book is written for the beginner and as Stevens's classification is simpler, this is what is used for discussion in this chapter. Stevens classified the different types of measurement scale into four categories:

- nominal or classificatory scale;
- ordinal or ranking scale;
- interval scale;
- ratio scale.

Table 5.4 summarises the characteristics of the four scales.

Table 5.4 Characteristics and examples of the four measurement scales

Measurement scale	Examples	Characteristics of the scale
Nominal or classificatory	Tree, house, taxi, etc. Gender: male/female Attitude: agree/disagree Political parties • Labour • Liberal • Democrats • Greens Psychiatric disorders • Schizophrenic • Paranoid • Manic-depressive, etc. Religions • Christian • Islam • Hindu, etc.	Each subgroup has a characteristic/property which is common to all classified within that subgroup
Ordinal or ranking	Income • above average • average • below average Socioeconomic status • upper • middle • lower Attitudes • strongly agree • agree • uncertain • disagree • disagree Likert attitudinal scale (see Chapter 10)	This has the characteristics of a nominal scale, e.g. individuals, groups, characteristics classified under a subgroup have a common characteristic PLUS • Subgroups have a relationship with one another • They are arranged in relation to their respective magnitude either in ascending or descending order
Interval	Temperature • Celsius • Fahrenheit Thurstone attitudinal scale (see Chapter 10):	This has all the characteristics of an ordinal scale (which also includes a nominal scale) PLUS • It has a unit of measurement with an arbitrary starting and terminating point
Ratio	Height: cm Income: $ Age: years/months Weight: kg Attitudinal score: Guttman scale (see Chapter 10)	This has all the properties of an interval scale PLUS • It has a fixed starting point at zero

The nominal or classificatory scale

A nominal scale enables the classification of individuals, objects or responses based on a common/shared property or characteristic. Such individuals, objects or responses are divided into a number of subgroups in such a way that each member of the subgroup shares a common characteristic or a property. A variable measured on a nominal scale may have one, two or more subcategories depending upon the extent of variation. For example, 'water' and 'taxi' have only one subgroup, whereas the variable 'gender' can be classified into two subcategories: male and female. Political parties in Australia can similarly be classified into four main subcategories: Labour, Liberal, Democrats and Greens. Those who identify themselves, either by membership or belief, as belonging to the Labour Party are classified as 'Labour', those identifying with the Liberals are classified as 'Liberal', and so on. The name chosen for a subcategory is notional, but for effective communication it is best to choose something that describes the characteristic of the subcategory.

> Classification by means of a nominal scale ensures that individuals, objects or responses within the same subgroup have a common characteristic or property as the basis of classification. The sequence in which subgroups are listed makes no difference as there is no order relationship among subgroups.

The ordinal or ranking scale

An ordinal scale has all the properties of a nominal scale – categorising individuals, objects, responses or a property into subgroups on the basis of a common characteristic – but also ranks the subgroups in a certain order. They are arranged in either ascending or descending order according to the extent to which a subcategory reflects the magnitude of variation in the variable. For example, income can be measured either quantitatively (in dollars and cents) or qualitatively, using subcategories: 'above average', 'average' and 'below average'. (These categories can also be developed on the basis of quantitative measures, for example below $10 000 is defined as below average, $10 000–$25 000 as average, and above $25 000 as above average.) The subcategory 'above average' indicates that people so grouped have more income than people in the 'average' category, and people in the 'average' category have more income than those in the 'below average' category. These subcategories of income are related to one another in terms of the magnitude of people's income, but the magnitude itself is not quantifiable, and hence the difference between 'above average' and 'average' or between 'average' and 'below average' subcategories cannot be ascertained. The same is true for other variables such as socioeconomic status and attitudes measured on an ordinal scale.

To summarise, an ordinal scale has all the properties/characteristics of a nominal scale, in addition to its own. Subcategories are arranged in order of the magnitude of the property/characteristic. Also, the 'distance' between the subcategories is not equal as there is no quantitative unit of measurement.

The interval scale

An interval scale has all the characteristics of an ordinal scale; that is, individuals or responses belonging to a subcategory have a common characteristic and the subcategories are arranged in an ascending or descending order. In addition, an interval scale uses a unit of measurement that enables the individuals or responses to be placed at equally spaced intervals in relation to the spread of the variable. This scale has a starting and a terminating point and is divided into equally spaced units/intervals. The starting and terminating points and the number of units/intervals between them are arbitrary and vary from scale to scale.

Celsius and Fahrenheit scales are examples of an interval scale. In the Celsius system the starting point (considered as the freezing point) is 0°C and the terminating point (considered as the boiling point) is 100°C. The gap between the freezing and boiling points is divided into 100 equally spaced intervals, known as degrees. In the Fahrenheit system the freezing point is 32°F and the boiling point is 212°F, and the gap between the two points is divided into 180 equally spaced intervals. Each degree or interval is a measurement of temperature – the higher the degree, the higher the temperature. As the starting and terminating points are arbitrary, they are not absolute; that is, you cannot say that 60°C is twice as hot as 30°C or 30°F is three times hotter than 10°F. This means that while no mathematical operation can be performed on the readings, it can be performed on the differences between readings. For example, if the difference in temperature between two objects, A and B, is 15°C and the difference in temperature between two other objects, C and D, is 45°C, you can say that the difference in temperature between C and D is three times as great as that between A and B. An attitude towards an issue measured on the Thurstone scale is similar. However, the Likert scale does not measure the absolute intensity of the attitude but simply measures it in relation to another person.

To summarise, the interval scale is relative; that is, it plots the position of individuals or responses in relation to one another with respect to the magnitude of the measurement variable. Hence, an interval scale has all the properties of an ordinal scale, and it has a unit of measurement with an arbitrary starting and terminating point.

The ratio scale

A ratio scale has all the properties of nominal, ordinal and interval scales and it also has a starting point fixed at zero. Therefore, it is an absolute scale – the difference between the intervals is always measured from a zero point. This means the ratio scale can be used for mathematical operations. The measurement of income, age, height and weight are examples of this scale. A person who is 40 years of age is twice as old as a 20-year-old. A person earning $60 000 per year earns three times the salary of a person earning $20 000.

Summary

The understanding and interpretation of a concept or a perception may vary from respondent to respondent, hence its measurement may not be consistent. A variable

has some basis of classification and hence there is far less inconsistency in its meaning and understanding. Concepts are mental perceptions, whereas variables are measurable either subjectively or objectively on one of the measurement scales. When you convert a concept into a variable you classify it on the basis of measurement into categories, thereby minimising the inherent variability in understanding. When you are unable to measure a concept directly, you need first to convert it into indicators and then into variables.

The way the required information is collected in quantitative and qualitative research is the most significant difference between them. Qualitative research mostly uses descriptive or narrative statements as the 'units of measurement', whereas quantitative research places greater emphasis of measuring responses on one of the four measurement scales. Though qualitative research places emphasis on descriptive statements in data collection, in some cases these statements are classified at the time of analysis into categories on the basis of the main themes they communicate. However, there are times when you will prefer to use verbatim descriptions and narrations to build your logic and arguments.

Knowledge of the different types of variables and the way they are measured plays a crucial role in quantitative research. Variables are important in bringing clarity and specificity to the conceptualisation of a research problem, to the formulation of hypotheses and to the development of a research instrument. They affect how the data can be analysed, what statistical tests can be applied to the data, what interpretations can be made, how the data can be presented and what conclusions can be drawn. The way you ask a question determines its categorisation on a measurement scale, which in turn affects how the data can be analysed, what statistical tests can be applied to the data, what interpretations can be made, how the data can be presented and what conclusions can be drawn. Also, the way variables are measured at the data collection stage to a great extent determines whether a study is considered to be predominantly 'qualitative' or 'quantitative' in nature.

It is important for a beginner to understand the different ways in which a variable can be measured and the implications of this for the study. A variable can be classified from three perspectives that are not mutually exclusive: causal relationship, design of the study and unit of measurement. From the perspective of causality a variable can be classified into one of four categories: independent, dependent, extraneous and intervening. From the viewpoint of study design, there are two categories of variable: active and attribute. If we examine a variable from the perspective of the unit of measurement, it can be classified into categorical and continuous or qualitative and quantitative.

There are four measurement scales used in the social sciences: nominal, ordinal, interval and ratio. Any concept that can be measured on these scales is called a variable. Measurement scales enable highly subjective responses, as well as responses that can be measured with extreme precision, to be categorised. The choice of measuring a variable on a measurement scale is dependent upon the purpose of your study and the way you want to communicate the findings to readers.

FOR YOU TO THINK ABOUT

- Refamiliarise yourself with the keywords listed at the beginning of this chapter, and if you are uncertain about the meaning or application of any of them revisit them in the chapter before moving on.
- Imagine that you have been asked to evaluate your lecturer. Determine which aspects of teaching you would consider important and develop a set of indicators that might reflect these.
- Self-esteem is a difficult concept to operationalise. Think about how you might go about developing a set of indicators to determine variation in the level of self-esteem in a group of individuals.
- Critically examine the typology of variables developed in this chapter. What changes would you like to propose?

Now, as you have gone through the chapter, try answering the following questions:

- Explain the differences between a concept and a variable.
- Develop the typology of variables from different perspectives.
- What is the difference between extraneous and intervening variables?
- What are the different types of measurement scale? What purpose do they serve in a research study?

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