

How to Identify and Change the Level of Measurement of Variables

What is the Problem?

All variables can be classified as having a particular level of measurement. Many statistical techniques require that variables are measured at a particular level, so knowing the level of measurement of a variable is crucial when working out how to analyse the variable. Failing to correctly match the statistical method to a variable's level of measurement leads either to nonsense results or to potentially misleading results.

There are three key questions to resolve in relation to the level of measurement of variables:

- How can we work out the level of measurement of any variable?
- Which level of measurement is best?
- How fixed are the rules regarding level of measurement?

What does 'Level of Measurement' Mean?

The level of measurement of a variable refers to how the categories or values of the variable are arranged in relation to each other. There are four main levels of measurement: ratio, interval, ordinal and nominal. However, for the purpose of the statistical methods discussed in this book we do not need to distinguish between the ratio and interval levels. Accordingly I will use the term 'interval' level to include ratio-level variables. The level of measurement of a variable depends on whether:

- there are different categories;
- the categories can be rank-ordered;
- the differences or intervals between each category can be specified in a meaningful numerical sense.

Interval Level

An interval-level variable has all three characteristics and is therefore regarded as being at the highest level of measurement. An interval variable consists of values that can be expressed in *numerically meaningful* terms. For example, age, weight, height, income, and number of children in a family are all interval variables for which the numbers that represent the values of the variable are numerically meaningful (compared with codes of 1 and 2 to represent gender, where the codes have no numeric meaning). The numerical values of an interval level variable are organized in *order* – from the lowest to the highest value or vice versa. Finally, since the values of interval variables are numerically meaningful we can specify the *amount of difference* (or the interval) between cases with different values. Thus we can say that the difference between a person with a value of 20 and a person with a value of 15 on the age variable is 5 years.

Ordinal Level

An ordinal variable is one where we can rank-order categories from low to high. However, we cannot specify numerically *how much* difference there is between the categories. For example, when age has the categories 'child', 'adolescent', 'young adult', 'middle-aged' and 'elderly' it is measured at the ordinal level. The categories can be ordered from youngest to oldest, but we cannot specify precisely the age gap between people in different categories.

Nominal Level

A nominal variable is one where the different categories have no set rank order. For example, religious affiliation is a nominal variable where we can distinguish between categories of affiliation (e.g. Jewish, Roman Catholic, Orthodox, Protestant, Islamic, no religion) but cannot rank these categories as having an obvious *order*.

How to Work out a Variable's Level of Measurement

Figure 6.1 provides a summary of the distinction between levels of measurement. To work out the level of measurement of a variable, ask yourself how many of the characteristics in the first column of the figure your variable has.

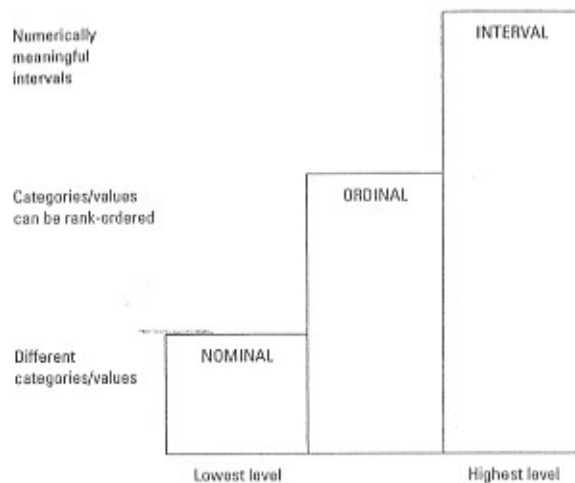


Figure 6.1 Differences between levels of measurement

Related Terms

There can be some confusion when reading texts and selecting statistics since some authors use terms other than nominal, ordinal and interval, while others use other sets of terms interchangeably with level-of-measurement terminology (see Table 6.1).

- *Qualitative and quantitative.* Qualitative variables are those where the codes have no inherent numerical meaning (as with nominal variables), while quantitative variables are those where the codes do have a numerical meaning (interval variables). This distinction does not recognize ordinal variables and thus makes it unclear how they are to be analysed.
- *Categorical and numeric.* This is equivalent to the qualitative–quantitative distinction.
- *Discrete and continuous.* A discrete variable is one with distinct categories, while a continuous variable will have a potentially unbroken set of values between the low and high values. Nominal and ordinal variables will normally have discrete categories and interval variables will frequently be continuous. Unfortunately this is not always the case, as some interval variables can be thought of as discrete variables. For example, the number of children a person has is an interval variable that is also discrete – the number of children a person has must be one of the discrete

Table 6.1 Synonyms for different levels of measurement

Level	Other terms
Nominal	Categorical; qualitative, discrete
Ordinal	Qualitative, discrete
Interval/ratio	Numerical, continuous, quantitative

values 0, 1, 2, 3, ... ; it cannot be, for example, 1.23543. Dichotomous variables can also be regarded as discrete interval-level variables (see below).

Low and High Levels of Measurement

Nominal-level variables are regarded as having the lowest level of measurement. The codes of the variable contain the least information – they only indicate the existence of difference. Interval variables are regarded as being at the highest level of measurement since the codes contain at least three types of information about cases – existence of difference, order and the amount of difference between cases.

What is the Best Level of Measurement?

From a statistical perspective interval-level variables are the most desirable.

- An interval-level variable conveys much more information about cases and their relation to one another than does a nominal or ordinal variable. The more we know about cases the more powerful a variable should be in explaining phenomena.
- The most powerful statistical methods assume that variables are measured at the interval level. Using nominal or ordinal variables restricts the available methods of analysis.

However, statistical requirements are not the only consideration. Many social science variables simply are not interval and cannot be measured at the interval level (e.g. ethnicity, religious group, gender, family type). Furthermore, while interval-level measurements result in more *precise* data, these measurements are not necessarily more *accurate*. For example, if we ask people how many times they attended religious services in the last 12 months they may provide a precise number of times but this will not necessarily be correct. Sometimes the more precision we seek the greater the chance of obtaining inaccurate answers.