

## Choosing Scientific Measurements <sup>[1]</sup>

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For many experimental research methods, the researcher is not even aware that they are choosing scientific measurements.

In physics, chemistry and engineering, for example, the type of measurement is well established, and the researcher instinctively knows the standard system.

For other disciplines, the measurement system used needs to be evaluated very carefully and methodically. The process is not about arbitrary units or scales, but the actual type of measurement <sup>[3]</sup>. It must take into account both the nature of the variables <sup>[4]</sup>, and the type of data <sup>[5]</sup> generated by the research method.

## **Nominal Scientific Measurements**

Nominal scientific measurements are numbers arbitrarily assigned to variables, allowing easier manipulation <sup>[6]</sup> of sets.

For example, a researcher with 6 sample groups might prefer to refer to them as numbers. This will make the discussion of the methods <sup>[7]</sup> and results <sup>[8]</sup> less difficult.

For example,

'In group 1 we found that...'

The numbering system merely provides a point of reference, and no underlying relationship or structure is inferred. 'Group One' is no better than 'Group Six,' for example, and the assigned numbers are only convenient labels.

Letters of the alphabet could be used, and it would make absolutely no difference to the experiment.

## **Ordinal Scientific Measurements**

The ordinal system of scientific measurements <sup>[9]</sup> uses a scale of numbering that has some meaning, and is statistically analyzable.

For example, a researcher designing a questionnaire <sup>[10]</sup> might use the Likert scale of

response to questions, from '1 - strongly disagree,' to '5 - strongly agree.' This does allow some numerical evaluation of the results [11], but it is not an accurate scale.

For example, you could not use 4?, or subdivide the scale. The Moh's scale of hardness, the logarithmic Richter scale and the Beaufort Wind Scale are examples of ordinal measurements.

The ordinal scale is merely an arbitrary assignation of numbers, allowing researchers to operationalize [12] the experiment.

The distance between 1 and 2 is not the same as between 2 and 3, so this system of scientific measurement is merely a convenient method of quantifying non-numerical data. Whilst a useful tool, experiments using ordinal scales will always undergo a vigorous process of scrutiny.

## Interval Scientific Measurements

Interval scientific measurements are probably the most familiar type of scientific measurements, using a scale assigned to a phenomenon, with an arbitrary zero point.

Celsius and Fahrenheit are examples of interval measurement, with an arbitrarily determined value for zero. The difference between 20 degrees and 50 degrees Centigrade, is the same as between 50 degrees and 80 degrees.

An interval scale is also divisible. You can use thousandths or millionths of a degree, with no problem, and statisticians [13] can manipulate the numbers, to find averages or medians.

The only limitation is of ratios, as for example, 100 degrees centigrade is not necessarily twice as hot as fifty degrees, because the scale allows negative measurement.

For example, what temperature is twice as hot as -10 degrees Centigrade? However, there may be an overlap between interval and ratio measurement; ratio measurements are always interval measurements.

## Ratio Scientific Measurements

Ratio scientific measurements do possess a relationship of scale. With weight, for example, 100 kilograms is twice as heavy as fifty kilograms. 60 seconds is three times longer than 20 seconds are.

The Kelvin scale of temperature is a ratio measurement, because absolute zero is not arbitrarily assigned, so that you can say that 40 degrees Kelvin is twice as hot as 20 degrees Kelvin.

Ratio scientific measurements do not have negative values; for example, you cannot have negative mass or length. It is not possible to have a length of less than zero, or fewer than zero seconds.

## Operationalization

Wherever possible, the operationalization [12] stage of an experiment should always try to use intervals or ratios, because they are less arbitrary and less open to criticism.

## Operationalization in Research

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They enable other researchers to easily test results and replicate the experiment [14], focusing upon the findings rather than questioning how, and why, certain units were used.

Obviously, this is not always possible, with many research methods requiring some arbitrary designation. This could be a subjective unit for measuring aggression, or the perceived activity level of an organism.

As long as the reasoning [15] behind the system is fully explained, during the operationalization, there should be no problem. The research design and scientific measurements will stand up to scrutiny.

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