GENERAL RESOURCES

Validity, reliability, accuracy and precision

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An outline of their meanings and a summary of definitions from Science *Years 7–10 Syllabus* and other sources

Validity of first-hand data

To what extent did the processes and the resulting data measure what was intended to be measured? Were the measurements taken caused by the phenomena you are investigating?

For example, a student wishes to determine which is the best fertiliser to grow pot plants using three pots, but with different plants in each pot. She uses the same amount of the same fertiliser in each pot.

What is wrong with this investigation? Are her results valid? What would you change?

Reliability of first-hand data

This is the degree to which the same results are obtained when the investigation is repeated under identical circumstances. You could ask yourself 'how repeatable are these results?'

For example, the time taken to boil a 250 mL beaker of water using a Bunsen burner is investigated. Using two different methods and repeating the experiment five times yielded these results:

Experiment number	Time taken to boil water (s) Method 1	Time taken to boil water (s) Method 2
1	112	105
2	110	96
3	109	118
4	113	100
5	110	121

Clearly, Method 1 produces more reliable results than Method 2. What factors may have been included in Method 1 that were not addressed in Method 2? Could you confidently predict the result of the sixth experiment using Method 2 to within a few seconds?

Of course, results of an investigation may be reliable without being valid. If there is a flaw in the method being used, but the method repeatedly produces the same results, the results may still not be valid, or accurate, as the next section discusses.

	First-hand information and data	Secondary information and data
Reliability	Have I tested with repetition?	How consistent is the information with information from other reputable sources? Are the data presented based on repeatable processes?
Validity	Does my experimental procedure/ design actually test the hypothesis that I want it to? Have all variables been identified and controlled?	Do the findings relate to the hypothesis or problem?

Accuracy

Do the results of the investigation agree with the accepted value? For example, in an experiment to measure the value of 'g' on Earth, the result was 8.9 ms^{-2}. The accepted value is 9.8 ms^{-2}. Even when the experiment is repeated, the same result is obtained. The value obtained is not accurate; it is 10% less than the accepted value.

Precision

The previous experiment is refined and repeated using better measuring apparatus. The result is now 8.921 ms^{-2}, still not accurate but taken with much greater *precision*.

Precision versus accuracy If the actual value is 4.321 and you say that it is 4.30, then you are precise to the first decimal place but inaccurate by 0.021. If a value is represented as a bulls-eye on a target, a group of guesses or measurements represented by closely grouped points have a high degree of precision. If that group is near the centre, it is highly accurate as well. On a bulls-eye, think of accuracy as how close to the centre your arrow hits, and your measurement of precision as how closely you can group your shots.