Using Data – Teacher Notes

Science uses data to accurately answer questions about the world. Good data must be measured accurately, assessed precisely, and be reported in useful units.

Measurements and Units

A measurement is a number used to help describe something. A unit is a standard quantity of measurement, defined and agreed upon by scientists. For example, from 1889 until the mid-20th century, a metre was defined by a physical rod of platinum kept in Paris. Today, a metre is defined by how far light travels in a certain fraction of a second. Using the right unit of measurement for the task is very helpful – you wouldn't enjoy trying to measure the distance of your cross-country road trip in millimetres!

What instruments would we use to measure the following:

Temperature? A thermometer

What would be the units of measurement? Celsius or Kelvin or Fahrenheit

The length of an arm? A tape measure or ruler

What would be the units of measurement? Metres or centimetres or millimetres

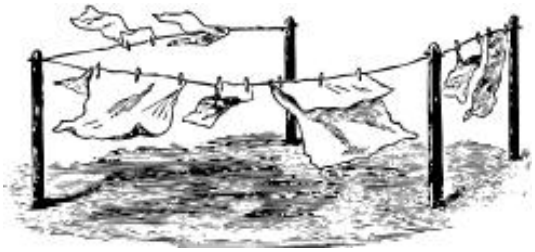
The volume of water in a bucket? Beakers or measuring cylinders or pipettes

What would be the units of measurement? Litres or millilitres

Why do we avoid describing our observations with words such as 'big', 'small', 'hot' or 'cold' in our laboratory reports? These descriptions are relative i.e. they can change from person to person. What a three-year-old observer might record as big (something bigger than themselves) might be recorded as small by an adult because it would be smaller than them. Hot weather in the Arctic might refer to a balmy 6^{o}C whereas in WA 6^{o}C would be regarded as cold.

Designing Good Experiments

A good experiment measures one thing at a time. We set up two situations which are exactly the same except for one thing (often called the independent variable), and measure the effect that single difference has on our experimental set up. A good experiment also needs to measure accurately (i.e., close to a known standard); measuring length using the distance from your nose to your ear is not an accurate measurement. Lastly, good experiments usually take multiple measurements so they can determine their precision (i.e., the closeness of two measurements to one another). This is because sometimes there are random errors in measurements, but if we take multiple measurements, we'll know if our results agree. Designing your experiment before you start measuring is very important to be sure you are getting good data that will answer your question.



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Woodside Australian Science Project
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Example: Students wanted to find out whether a wet towel would dry more quickly outside or inside. Each group chose two dishtowels of the same size and the same material and then wet both. With a thermometer, they measured the temperature outside in full sun (32°C) and inside the classroom (18°C). They hung one towel up outside in the full sun and the blowing wind, and the other inside the classroom. Then they measured the time it took for each towel to dry. Their results are in the table below.

Group	**Towel outside** (Time to dry)	**Towel inside** (Time to dry)
1	23 minutes	36 minutes
2	23.5 minutes	35 minutes
3	23 minutes	34.5 minutes
4	23 minutes	35 minutes

Was this a good experimental design? Why or why not? A good experiment requires that we change one thing, measure one thing and everything else stays the same. This was not a fair test because there was not only a change of temperature, there was also wind blowing outside.

Can we consider the information in the table above to represent good scientific data? No. The experiment was flawed (see answer above) and the readings provided in the table were neither ***precise*** nor ***accurate***.
In science, engineering, and technology, we require measurements that are ***accurate (close to a known standard)***. They should have used a more accurate instrument, such as a stopwatch which would give more accurate readings of minutes, seconds and tenths of seconds. We usually try to give measurements to two decimal places. This would improve the accuracy of the readings. ***Precise*** readings require repetition of the experiment and averaging of the measurements.

The students then corrected the mistakes in the design of the experiment and obtained the following accurate and precise data.

Group	**Towel outside** (Time to dry)	**Towel inside** (Time to dry)
1	21.53minutes	35.62 minutes
2	23.50 minutes	35.78 minutes
3	23.34 minutes	34.50 minutes
4	23.00 minutes	35.15 minutes

How much longer does it take for a towel to dry inside? On average, it takes 35.26 minutes to dry inside and 22.84 minutes outside. On average it takes 12.42 minutes longer to dry a towel inside.