Evaluating a practical technique

Background

A pupil working at:

Level 4

- can suggest improvements to their work, giving reasons

Level 5

- makes practical suggestions about how their working methods can be improved

To move pupils from level 4 to level 5

1. Revisit work done on accuracy, reliability and anomalous results.
2. Ensure that pupils can successfully identify odd-looking results (anomalies).
3. Look for practical and/or procedural reasons for anomalies.
4. Look for practical suggestions to improve procedure.
5. Decide whether the anomaly is an under- or over-estimate of what was expected.
6. Decide which suggested reasons for anomalies or suggestions for improvements best explain the results obtained.

Suggested teaching sequence

The following activities could all be done in one lesson or split into separate activities and spread over more than one lesson.

1. **To teach pupils how to judge reliability of results and identify any anomalies**
   Ask pupils to discuss the reliability of the model results on 'Dissolving salt' (sheet 4) in pairs, and to pick out any odd-looking results (anomalies). It is important that pupils articulate why the result is anomalous. Pairs could join as a foursome to refine their answer before they feed back to the group.

2. **To teach pupils how to explain anomalies and suggest improvements to remedy them**
   After pupils have identified the anomaly they need to start looking for practical reasons for its occurrence. To support this, use a series of cards (such as on sheet 5, 'Explanation cards'). Pupils can work in pairs to sort the cards into 'does explain unreliability', 'doesn't explain unreliability' and 'not sure'. Pairs can then share their answers in a foursome before feeding back to the group. Blank cards are for pupils to add their own ideas.

© Crown copyright 2004

Pupils will then need to make practical suggestions about how their procedure can be improved. This is best done through group discussion – it will probably be easier for pupils to remain in their fours. Some groups may need support.

For example, teachers may provide suggested improvements on 'clue' cards and ask pupils to match these with the appropriate explanation cards. Sheet 5 contains some examples as a start. A list of sensible improvements should be recorded.

In their fours, pupils make judgements on whether the accepted explanations would lead to an under- or over-estimate.

In their fours pupils look at the results of the first activity and choose at least one explanation for the anomaly and a suggested improvement to remedy it.

3. **To teach pupils to select the most appropriate measuring instruments for common practical work**
   Pupils discuss in groups the most appropriate instrument to use to take particular measurements. This links back to mini booster 1, 'Accuracy and reliability'.

   It also gives an opportunity to revisit common practicals. Possible suggestions are:

Common practical	*Choice of apparatus*
Burning Mg (gain in mass)	A balance that measures to the nearest 1 g, 0.1 g, 0.001 g
Measuring the distance when calculating the speed of sound	A 30 cm ruler, a metre ruler, a trundle wheel
Measuring the amount of food when doing food tests	Balance to the nearest 1 g, balance to the nearest 0.1 g, spatula
Measuring the effect of light on photosynthesis	Light meter (data logging) Light room compared to dark room
Measuring oxygen released during photosynthesis	Gas jar or test-tube
Measuring the amount of iodine solution when testing for starch	Beaker, 10 ml measuring cylinder, teat pipette
Measuring the amount of sodium hydroxide required to neutralise 20 ml of hydrochloric acid	Beaker, 100 ml measuring cylinder, 10 ml measuring cylinder
Time for an athlete to run 100 m	To the nearest second, nearest 1/10th of a second, nearest 1/100th of a second

© Crown copyright 2004

4. **To teach pupils to evaluate a set of results**
   Using dissolving salt data (sheet 4), ask pupils in pairs to answer the following questions:
   - What do you think the pupils used to measure the salt?
   - How accurate is it?
   - How much water should they use? (Give pupils an opportunity to measure out an actual amount of salt to support them with choosing an appropriate amount of water.)
   - What should they use to measure the water?

Relevant Key Stage 3 national test question

- **2003 paper 2, tier 3–6 question 15; tier 5–7 question 6**
  Identification and explanation of anomalous results

© Crown copyright 2004

Dissolving salt

Two groups of pupils were trying to find out how much salt dissolved at different temperatures.

This is what they found out.

Temperature in °C	*Group 1*	*Group 2*	*Average grams of salt dissolved*
30	1.7 g salt	1.7 g salt	1.7
40	1.9 g salt	2.1 g salt	2.0
50	2.2 g salt	4.0 g salt	3.1
60	3.3 g salt	3.3 g salt	3.3
70	4.7 g salt	4.5 g salt	4.6
80	6.0 g salt	5.8 g salt	5.9

- Can you spot the odd (anomalous) result?
- What do you think would be a more accurate result?
- If you use this, more accurate, result, what happens to the average?

© Crown copyright 2004

Explanation cards

We spilt some salt on the bench	I would have preferred to work with someone else
We spilt some water on the bench	It was sunny outside
We didn't make sure all the salt had dissolved before we added some more	My teacher was in a bad mood
The water started to cool down before we could add the salt	We shook up the test-tube instead of stirring it

Possible statements to match with explanation cards

Use a funnel

Use a dry funnel

Make sure the solution looks clear

Use a measuring cylinder

Use a water bath

© Crown copyright 2004