

Minibooster 7: Progressing to level 6 and beyond

Evaluation

Background

This Minibooster complements Miniboosters 1, 2 and 3: *Accuracy and reliability*, *Evaluating a practical technique* and *What do we mean by evidence?*

Minibooster 1 Accuracy and reliability helps pupils to:

- consider the accuracy of measurements using different pieces of equipment;
- make judgements about accuracy;
- understand that a limited range of data can yield unreliable evidence;
- understand the value of repeat readings.

Minibooster 2 Evaluating a practical technique helps pupils to:

- identify odd-looking results (anomalies);
- consider possible practical reasons for this;
- suggest how to improve the practical procedure.

Minibooster 3 What do we mean by evidence? helps pupils to:

- make sensible decisions about what evidence to collect;
- decide if they have a suitable range of data;
- decide what is relevant evidence;
- distinguish between fact and opinion.

Miniboosters 5 and 6, *Describing patterns* and *Understanding variables* should be covered before this Minibooster.

Minibooster 5 Describing patterns helps pupils to:

- identify variables and describe patterns between them;
- identify and interpret patterns in data;
- construct tables of results to show patterns;
- describe patterns in graphs;

- understand that reordering data can show patterns more easily;
- link patterns to their predictions.

Minibooster 6 Understanding variables helps pupils to:

- understand about the different types of variables;
- make links between the enquiry question and the independent/dependent variable;
- understand the importance of sensible quantities for the fixed and independent variables;
- select meaningful ranges and values for the independent variable;
- understand that not everything is a fair test.

A pupil working at:

Level 4

- describes and suggests how planning and implementation could be improved;
- suggests improvements in their work, giving reasons.

Level 5

- evaluates their working methods to make practical suggestions for improvements;
- can identify anomalous results and begin to explain them;
- can think of possible reasons why the enquiry might not be valid;
- describes and suggests with reasons how planning and implementation could be improved.

Level 6

- identifies and explains anomalous results;
- can make practical suggestions about how to improve the accuracy and reliability after considering the data or conclusions;
- begins to consider whether the data is sufficient for the conclusions drawn;
- evaluates evidence, making reasoned suggestions about how their working methods could be improved;
- explains how the evidence from the results links to the conclusions drawn and whether it is sufficient;

- explains how improvements to the planning and implementation would have led to the collection of more valid and reliable evidence and a more secure conclusion;
- explains why the secondary evidence is in/sufficient to support the conclusion or interpretation made and any implications arising;
- explains how secondary numerical data has been manipulated to support a conclusion or particular viewpoint.

Level 7

- can recognise limits to the validity of the method if experimental parameters are altered;
- decides if the data is sufficient and appropriate for the conclusions drawn;
- identifies the need for repeat readings to obtain reliable data;
- can make practical suggestions about how to improve the working methods and predicts the resultant improvement on the accuracy and reliability;
- begins to consider whether the data they have collected is sufficient for the conclusions they have drawn;
- explains how the numerical data has been manipulated to make valid comparisons and conclusions linked to the original scientific question;
- evaluates the planning and implementation, and explains how this could account for errors and anomalies and how inadequacies could be remedied.

To move pupils from level 4 to level 5

1. Explain the purpose of evaluation in science.
2. Explain the different aspects of evaluation.
3. Scaffold their evaluations initially.

To move pupils from level 5 to level 6+

1. Explain the aspects of the Miniboosters above so that pupils have the skills to consider all the aspects that contribute to a good conclusion.
2. Model for pupils what you would look for in order to evaluate the data, graph and conclusion.
3. Work with pupils to devise criteria or a checklist that they can use as an initial scaffold to help them carry out successful evaluations.
4. Demonstrate the impact is of altering the range and number of observations on the patterns seen and conclusions that can be drawn.

Activities

1. Provide a selection of tables of results, graphs and conclusions for some enquiries, for example:
 - tables with three repeat readings for each reading and some anomalous results;
 - tables with three repeat readings for each reading and some anomalous results where all readings have been used to calculate the average;
 - tables with a narrow range of data (too few readings or too narrow a spread of variables);
 - tables with only two sets of results where there are few readings that are consistent;
 - wrong type of graph for the variables (e.g. a bar chart when it should be a line graph);
 - a graph with the line of best fit missing
 - a graph with an inappropriate line of best fit or an inappropriate scale;
 - a brief conclusion that does not describe or explain any pattern;
 - a conclusion that is not fully supported by the data; a conclusion that does not refer to the data.

Ask pupils to decide whether the evidence supports the conclusion and explain why. They can then explain what needs to be done to improve the collection of data, the graph or the conclusion.

2. Use examples of results tables, graphs and conclusions from pupils' work from within the department to model what you are doing when you evaluate the conclusions drawn. Use this to draw together some guidelines or criteria or to extend the checklist on Worksheet 7(i) '*Evaluation checklists*'.
3. Use these guidelines with Worksheet 7(ii) '*Types of enquiry*' to decide which criteria relate to which types of investigation. Apply these to examples of pupils' work showing the different types of enquiry, deciding whether the conclusion/evaluation is accurate and reliable, or ask pupils to produce a better evaluation.
4. Use the PowerPoint® '*Evaluation at level 6+*' from the '*Aspects of How Science Works*' folder. This is a resource to use with pupils; teacher guidance is given in the notes view.
5. Use the AKSIS *Investigations: developing understanding in scientific enquiry* materials, pp. 107–118. Available from the ASE ISBN 086-357-310X.
6. Quickly demonstrate a familiar practical to pupils. Make up a 'complete' table of results to share with pupils. Using this as a basis, ask them to construct their own tables of results with different ranges and numbers of variables. Compare the conclusions drawn from their tables to the ones that could be drawn from the 'complete' table.

Worksheet 7(i)

Evaluation checklist

Have I got enough results for a pattern?	Were there any problems with the equipment?
Can I trust the evidence?	Did I have a good range for my independent variable?
Was my sample size big enough?	Did I change the independent variable by equal values to help show a pattern?
Did I identify all the variables?	Where could I have made errors?
Did I change one variable and keep the rest the same?	Did I pick the right independent and dependent variables to answer the enquiry question?
Did I measure accurately?	Have I displayed my results in the best way to show a pattern?
Did I repeat my measurements and find the average?	Has all the evidence been used to decide if my prediction was correct?
Did I use sensible quantities for my variables?	Has the evidence I collected raised more questions? What are they?
Were there any variables I could not control?	Can I improve my investigation or enquiry?
Were there any 'odd' results? Did I include these or leave them out? Why?	Can I say how any improvements might provide better evidence?

Worksheet 7(ii)

Types of enquiry

Surveys and correlations (looking for patterns)	Using secondary sources (looking up information in a book or using CD-ROMs, the Internet etc.)
Controlling variables (fair test)	Identification and classification (grouping things or deciding which group something goes in)
Using and evaluating a technique (checking why a particular thing is done, e.g. putting lime on the soil)	Exploration (observing or measuring something over a long time)