Lesson plan

Engineering Gold
Laboratory Data 1 and 2

Timetable

Teacher:	.....	**Lesson:**	.....
Group:	.....	**SEN students:**	.....
Date:	.....	**Support Staff:**	.....
Room:	.....		.....

Focus

In this activity students analyse and interpret data from the enquiries carried out by Professor Styring and students in the lab. We would suggest you watch the 'Engineering Gold' and 'Engineering Gold in the classroom' programmes in preparation for running the activities.

Objectives

Students will learn to:

- Process complex data.

Outcomes

All students will be able to:

- Identify outliers in given data.
- Draw a graph with range bars.

Most students will also be able to:

- Explain how to treat outliers when processing data.

Some students will also be able to:

- Explain how range of data can be used to show real difference between data sets.

Resources

- 'Engineering Gold' programme
- worksheets *Laboratory Data 1* and *Laboratory Data 2*
- graph paper

Starter (10-20 mins)

1. Show the students the 'Engineering Gold' programme or the section showing Professor Styring carrying out the lab enquiry with the ski and ramp and describing the other enquiries.
2. Ask the students how Professor Styring attempted to make his results reliable.

Main (45 mins)

1. Give the students worksheets and graph paper.
2. Introduce the activities, ensuring students understand each task.
3. Students work in pairs to complete the questions, then in fours to review their work. Check progress with each group (You may have to demonstrate how to plot and draw a range bar for some groups).

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Plenary (5 mins)

Emphasise the significance of using range bars instead of using average results to identify a significant difference between two data sets.

For homework students could use the results from an enquiry they have recently carried out to plot range bars and interpret and analyse the data further, if appropriate. The results could, for example, be from their own Ski Lubricants enquiry.

Answers to questions

Laboratory Data 1

1. Fluidity means how easily the liquid flows.

2. B

3. Q

4. If the formulation froze then it was pointless testing it further as it would not work on the snow slopes.

5. B, D, J, K, O, P, T
They gave a flow rate which would probably give sufficient flow of formulation to keep the ski waxed over the length of the course.

6. **a.** Obvious outliers are (D) 27 and (E) 19.
b. The slope may not have been wiped clean between tests, so there may have been formulation left which affected the next test.
c. Carry out more repeat tests for the formulations with outliers.

7. **a.** 24.2ml
b. 31.0ml
c. 18.6ml
d. 22.2ml (including all readings), 21.0ml (excluding outlier)
e. 33.2ml (including all readings), 34.0ml (excluding outlier)

Students need to know about the experimental process before they can make their decision. Provide them with the following excerpt from this student's lab notes:

"We weren't as careful at the end about cleaning the ramp, so the last test for D stuck a bit. For lubricant E we used too much lubricant for reading 5."

Laboratory Data 2

10. **a.** Graph of average results with range bars.
b/c. Accept any sensible answers with suitable reasons.
d. Carry out a larger number of repeat tests for each formulation and then test the best formulations in a system on skis on the slopes.
e. Increasing the oil content helps the ski to start moving at a lower height up to 5ml, and then increasing the oil content increases the height at which the ski moves. The best formulation is 5ml water and 5ml oil with 5ml detergent.
f. Accept any sensible answer.
g. He tested every formulation 50 times and controlled all the other variables.