Interacting with mathematics in Key Stage 3

Year 8 handling data: mini-pack

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Year 8 handling data: sample unit

Introduction

This Year 8 unit has been developed through a flexible use of the *Sample medium-term plans for mathematics*.

In the planning of the unit several decisions were made that affected the medium-term plans for mathematics.

- The objectives for the unit are from Handling data 2.

- It is taught during the autumn term of Year 8.

- Handling data 1 is then covered in the spring term.

- Number 2 is taught before Handling data 2 and is extended to 8 hours in order to incorporate calculator methods from Number 3.

- The skills of calculating an average from a frequency table have been developed through calculator methods in Number 2.

Handling data is sometimes approached by working through the four stages of the handling data cycle ('HD cycle' for short; see page 18 of the Guide to the Framework), perhaps through an extended project. While this is a valuable experience, early stages of the HD cycle are often time-consuming and the result can be less emphasis on interpreting and discussing data. Few teachers would dispute the importance of this element of the cycle and the need for engaging pupils in deeper discussion about data and the inferences that can be drawn from them. This unit emphasises discussion and interpretation of data alongside a high level of pupil interaction and engagement. It also gives pupils an opportunity to improve their speaking and listening skills.

The unit overview on page 7 shows how the elements of the HD cycle are developed through two weeks of lessons.

- The HD cycle permeates all the work in the unit. Pupils are made aware of the stage of the cycle under scrutiny in each lesson by reference to a poster. Bullet points are added to stages of the cycle as a result of reflections during the plenary. This activity is cued in the unit plan as 'You are here on the HD cycle'.

- Objectives taught and developed in the main part of the lesson are revisited in subsequent lessons as oral and mental starters.

- Issues involved in collecting data are addressed throughout as factors that influence planning, processing and interpreting the data.

- Most teaching (three of the six lessons) centres on the interpretation of data.

- It is helpful to revisit data themes in order to draw the HD cycle together and give coherence to the unit.

- A variety of stimulating activities is included together with appropriate references to data drawn from the Framework's supplement of examples and a data library CD-ROM ('data CD' for short). The same activities could be used with other data sources.

- The data are chosen to be relevant and interesting to Year 8 pupils. (The charts and tables provided can be re-labelled to reflect the latest craze.)

Objectives

A Discuss a problem that can be addressed by statistical methods and identify related questions to explore.

B Decide which data to collect to answer a question, and the degree of accuracy needed; identify possible sources.

C Plan how to collect the data, including sample size; design and use two-way tables for discrete data.

D Collect data using a suitable method, such as observation, controlled experiment using ICT, or questionnaire.

E Calculate statistics, including with a calculator; recognise when it is appropriate to use the range, mean, median and mode; construct and use stem-and-leaf diagrams.

[E Year 7] Calculate statistics for small sets of discrete data:

- find the mode, median and range;
- calculate the mean, including from a simple frequency table, using a calculator for a large number of items.

F **Construct, on paper and using ICT:**
- **pie charts for categorical data;**
- **bar charts and frequency diagrams for discrete data;**
- **simple scatter graphs;**

    identify which are most useful in the context of the problem.

G Interpret tables, graphs and diagrams for discrete data, and draw inferences that relate to the problem being discussed; relate summarised data to the questions being explored.

H Communicate orally and on paper the results of a statistical enquiry and the methods used, using ICT as appropriate; justify the choice of what is presented.

I Solve more complex problems by breaking them into smaller steps or tasks, choosing and using resources, including ICT.

Differentiation

The unit begins with an oral and mental starter that revisits a Year 7 objective. Other than this, all objectives are drawn from the Year 8 teaching programme.

A key principle underpinning this unit is that the objectives are accessible to all pupils. In the main, this is realised through the emphasis on conjecture, discussion, explanation and reasoning. By focusing on speaking and listening skills, some pupils will gain from hearing a peer explain an idea that is slightly beyond their own understanding of the mathematics. Others will gain from the challenge of articulating newly formed thoughts and justifying their understanding.

In addition, some activities in the unit are tailored to pupils' needs through the following teaching strategies:

- using a single task but choosing examples to consider within that task according to the level of challenge required;

- explaining and demonstrating briefly to the whole group in order to facilitate independent work, then providing extended explanation and demonstration to support some pupils;

- directing some groups to prepare generalised points to feed into the plenary while other groups continue to explore the targeted objectives.

Resources

- Poster 'Handling data cycle' prominently and accessibly displayed throughout (included in the school pack)

- Blank thought clouds / speech bubbles to add points to poster (from the data CD, P1 Thought clouds)

- Graph paper

- Compasses, protractors, pencils, rulers

- Documents to be printed from the data CD:
  - OHTs or poster displays (OHTs for M3.1, M3.2, M3.3 and P2 are included in the school pack)
  - handouts
  - handouts cut up for pupil sorting

- A set of 'show me' pie charts, sufficient for one between two or three pupils (these can be purchased or made from three interlocking coloured paper plates; see the data CD, OM3 Show me)

- A single set of sliding bars for teacher use (see the data CD, OM3 Show me)

- Write-on/wipe-off whiteboard and pens for 'show me' activities, sufficient for one between two or three pupils (these can be purchased or made from laminated card or white paper in plastic sleeves; for some activities, whiteboards are used with pre-drawn axes)

Key mathematical terms and notation

mode, mean, median, range

bar chart, pie chart, line graph, stem-and-leaf diagram, frequency table, distribution

primary source, secondary source, raw data, sample, hypothesis

Unit overview

Oral and mental starter	Main teaching	Collect		Notes	Plenary
	Specify and plan		Deciding how to collect	1 lesson	Key points and prompts to use when making decisions at the planning stage of the HD cycle
Specify and plan	Process and represent		Issues to consider when doing the collection	2 lessons	Key points and prompts to use when making decisions at the processing stage of the HD cycle
Process and represent	Interpret and discuss		Reflecting on the collection of data	3 lessons	Key points and prompts to use when making decisions at the collecting stage of the HD cycle
					Key points and prompts to use when making decisions at the interpreting stage of the HD cycle
					Revisit issues of the planning stage of the HD cycle

Unit plan

Oral and mental starter	Main teaching	Notes	Plenary
Objective E (Year 7) Recall Y7 vocabulary; involve whole group by use of whiteboards. Show me: • 3 numbers with a mean of … • 5 numbers with a range of … • 5 pupils whose median name length is 4 letters If Kath joins the group will the median change? If Jo and Sally join will the median change?	**Phase 1: Specify and plan (one lesson)** Objectives A, B, I (C, D) Using a context (e.g. Framework p. 249 football), discuss together 'What do we need to find out?' Form groups of 4 pupils, specify groups to consider A and groups to consider B: A Who might be interested in the answer to this question? Why? B What data do you need to collect? How would you do this? Take mini-plenary feedback from groups A and B. Data CD, M1 Five hypotheses and data: Ask same groups of 4 pupils to consider for each of 4 examples: • Are the collected data sufficient to test the stated hypothesis? If not what other data should be collected?	Extension (both activities and in preparation for plenary): Some pupils begin to make general checklist of points that influence choice ('decide' part of the collect data stage). First mini-plenary: Begin to draw out that *what* and *why* influence *how* (degree of accuracy). Support: Data CD, M1, examples 1–4 Extension: Data CD, M1, examples 2–5	Begin with specific feedback from hypothesis testing and use this to draw out importance of how decisions were made: • How comprehensive is the source? • How accurate is the source? • Was the design of the data collection sheet suitable? • How often will it be updated? • How do I access it? 'YOU ARE HERE ON HD CYCLE' Data CD, P1 Thought clouds: Add bullet points to SPECIFY AND PLAN section of poster (see introduction p. 4).
Specify and plan Objectives A, B Data CD, OM2 Seven hypotheses and questions (adapted from Framework p. 249) Write hypotheses on board and ask questions: • What data are needed? • How do you collect them? • How do you represent them? • What other hypotheses could you suggest?	**Phase 2: Process and represent (two lessons)** Objectives E, F (C, D) Data CD, M2.1 Travel (adapted from Framework p. 263) • For each example, which collection sheet could have generated the table, chart or graph? Data CD, M2.2 Goals (adapted from Framework p. 249 football): Show 2 bar charts (premiership and 2nd division). Ask pupils to sketch pie charts; compare and discuss. Split class into two halves – each half, in pairs, estimate values of the median and mode for one of the charts. Compare results: • What does each average tell you about the charts? • For each bar chart construct an accurate pie chart. Further practice: Data CD, M2.2 Goals, 1st and 3rd division Data CD, M2.3 Sunshine and heights (adapted from Framework p. 259): Use example showing list of data, frequency table of same data, and prepared bar chart. Pupils construct stem-and-leaf diagram. Compare raw data, stem-and-leaf diagram, frequency table and bar chart (note balance of gain in visual simplicity against loss of detail). Further practice: Data CD, M2.3 Sunshine and heights, another example	The 'do' part of the collect data stage focuses on usefulness in context. Skills of calculating the mean from a frequency table have been developed in Y8 Number 2. Pupils have interpreted pie charts and drawn them using ICT in Y7 (summer term). Explain and demonstrate accurate construction of pie chart using initial sketch as a check. Support a focus group during work on construction of pie charts. Explain stem-and-leaf diagram and demonstrate start of construction.	Data CD, M1, example 2 • Is this tabular representation helpful in addressing the hypothesis? If not what would you change? • What graphical representation would be useful? • What values would it be useful to calculate (e.g. a measure of the average and/or range)? Data CD, M1, example 3 • Is this graphical representation helpful in addressing the hypothesis? If not what would you change? • What values would it be useful to calculate (e.g. a measure of the average and/or range)? 'YOU ARE HERE ON HD CYCLE' Add bullet points to PROCESS AND REPRESENT section of poster. Draw out power of pie charts in comparing distributions of different sizes.

Oral and mental starter	Main teaching	Notes	Plenary
Process and represent Objectives E, F Data CD, OM3 Show me (note: interlocking plates need to be prepared, also axes on laminated card, whiteboards or plastic sleeves) Pairs of pupils use 3 interlocking plates and teacher uses 3 sliding bars. Pupils match pie chart to bar chart (language of proportion, percentage, fractions and angles). Using prepared axes on laminates, show me: • 3 bars showing shoe sizes for total of 50 pupils • as before but with modal shoe size 5 • 4 bars, total 50 pupils, no discernable mode	**Phase 3: Interpret and discuss (three lessons)** Objectives G, H, I (C, D) Data CD, M3.1 Weather: Show bar chart on OHT (title, axis labels and key hidden). Say chart is concerned with weather. • What could the vertical axis be? Reveal the label 'temperature'. • What about the horizontal axis? Reveal the label 'month' and title. • Why are there 2 bars for each month? Say that one key states 'London' and the other states 'Wellington'. • Which is for which? Data CD, M3.2 Greece and Ireland (adapted from Framework p. 268): Show 2 pie charts on OHT (title, labels and statements hidden). • Why are there 2 pie charts? • What could the title of the charts be? Reveal title and tell pupils that charts are concerned with age. • Which is which and why? • What are you saying you can see from the chart? Reveal labels 'Greece' and 'Ireland' and the 3 statements. • Which statement is true? Further practice: Framework p. 269, crime Independent group work: Data CD, M3.3 Mixed charts Data CD, M3.4 Photos: Select from 6 photos of groups of people. Estimate measures (mean, median and range) of chosen variables, e.g. height, weight, age, income, time to run 200 m. Compare groups using key vocabulary. Consider effect of moving individuals between groups or combining entire groups. Compare mean weight of 'children' and 'Sumo wrestlers'. • What would happen to the mean weight if the groups were combined? Estimate mean income of 'children'. Consider adding Liverpool footballer to group. • How will the mean change? Sketch possible distribution for heights of a group. Sketch on board unlabelled joint distribution of 2 groups. Ask pupils to identify the 2 groups. Data CD, M3.5 Reports, cut up into sections: Form groups of 4 pupils to sort and sequence the reports. Mini-plenary to report on reasons for the grouping and sequencing. Pupils split into pairs and work on one of the reports each: Add any elements missing (titles, labels, units etc.); discuss whether the conclusion of the report is convincing; suggest possibilities for further investigation.	Support and extension: Ideas for activities are suitable for all pupils. Level of challenge will emerge from pupils' conjectures, their level of explanation and reasoning and from teacher's response. For both 'hide and reveal' activities allow time for pupil discussion and conjecture. Gradually provide more information, ask further questions and refine interpretation of charts. During discussion of pie charts encourage use of terms such as proportion, percentage, fraction. Independent group work: Data CD, M3.3 Pupils in groups of 4; first pupil records group answer and reasons for question 1, etc. Photos on OHT or poster on wall. Ask similar questions for median and range. Distributions could be considered for other variables.	Reflect on how interpretation of data is influenced by the way data were collected. Data CD, M3.2: Show pie charts and ask: • Which country has a greater proportion of under 5s? • Which country has a greater proportion of females in the 15–39 age range? Follow this by asking: • What do we need to consider when designing/doing the data collection? 'YOU ARE HERE ON HD CYCLE' Add bullet points to COLLECTING section of poster. Data CD, M3.3: Choose a chart and ask: • What hypothesis might this chart help us to support? • How does this particular type of chart help us to do this? • Is there a calculation that would give additional information (average or range)? Follow this by asking: • What do we need to consider when we are using tables, diagrams and calculations to help us interpret data? 'YOU ARE HERE ON HD CYCLE' Add bullet points to INTERPRETING section of poster. Complete HD cycle by returning attention to SPECIFY AND PLAN. Use suggestions for further investigation from data CD, M3.5 activity to outline a follow-up project.
	Make stem-and-leaf chart of time taken, in minutes, to travel to school (as values are called out).		

Guide to the data library CD-ROM

Introduction

The CD-ROM provides a data library divided into two sections: a unit library and a source library.

Unit library

The unit on handling data in Year 8 draws on a variety of carefully selected and prepared data sources. These materials need to be printed, copied and organised into a collection that can enrich and enliven the teaching of handling data. They can be used with many different classes. The chart on page 12 shows the structure of the unit library, cross-referenced to the handling data unit plan.

The unit library follows the structure of the unit plan; the files are in separate folders for phases 1, 2 and 3 of the unit. Each file is coded according to whether it relates to the oral and mental starter (OM), the main activity (M) or the plenary (P). In some cases, a file may be used in different parts of a lesson or in more than one lesson.

Source library

In the source library, files are grouped into folders classified by subject matter or source. The source library can be used in several ways.

- Some files in the unit library link to folders in the source library. For example, the file M2.2 Goals links to the source folder 'Goals and Football'. Here you will find the spreadsheet of raw data from which the chart was constructed. This spreadsheet also contains data about goals scored in the week subsequent to that illustrated. Other files are also related to football, such as pupils' favourite teams.

- Other files in the source library are not cited in the Year 8 unit plan, but could supplement the suggested selection or be used in other Key Stage 3 units. Many of the activities suggested in the Year 8 unit are well worth using at other times, say in Year 7 or Year 9.

Files in the source library have been left for you to explore – a list is given on page 13. Your department could extend and develop this file structure as a relevant and up-to-date resource for other handling data units.

Printing and using the files

The charts and diagrams provided are a mixture of colour and black/white. Colour is advantageous for OHTs or wall charts. Black/white is more practical for pupil handouts. When converting between colour and black/white, you may need to adjust the colours before printing to ensure that they can be clearly distinguished.

OHTs or posters

These files are most effectively used with an overhead projector or data projector if you have one. This approach helps to focus class discussion. A compromise is to enlarge the charts to poster size. Handouts are less effective, as pointing to or hiding and revealing particular features is more difficult.

Handouts

Handouts are mostly tables of data and charts to be copied, one set between two to four pupils for paired or group work. Two reports need to be cut up for reassembly. Most handouts should be reuseable.

Prompts for the teacher

One or two of the files are prompts for the teacher – for example, hypotheses from which to choose for discussion, or ideas for using 'show me' pie charts.

Sources of data

When you are researching data on a particular subject, the internet is a vast and tempting source. For classroom work with data, however, keep in mind the preparation that will be needed as it can be extensive. For example, data are often presented in tabular form and you may need to construct a graphical representation for yourself.

A particularly useful and developing site is www. censusatschool.ntu.ac.uk, an international children's census. It provides ideas for the classroom and data of relevance and interest to school pupils. Several items from this site were used in preparing the files for this library. Other sites are suggested in the *Numeracy across the curriculum* materials. Remember that the *Framework for teaching mathematics: Years 7, 8 and 9* is also a rich source of examples. Many of the ideas used in this unit have been selected from the Framework's supplement of examples.

Contents of the unit library

Unit plan	Oral and mental starter	Main teaching	Plenary
Phase 1 (one lesson)		**Unit M1** Five hypotheses and data (set of sheets for each group of 4 pupils (examples 1–4 and 2–5))	**Unit P1** Thought clouds (four cut-out clouds to fix on poster of HD cycle during plenary sessions)
Phase 2 (two lessons)	**Unit OM2** Seven hypotheses and questions (write on board)	**Unit M2.1** Travel (set of sheets for each group of 3–4 pupils) **Unit M2.2** Goals (OHT or handout) **Unit M2.3** Sunshine and heights (set of sheets for each pair of pupils)	**Unit M1** Five hypotheses and data (example 2, cycling; OHT or handout) **Unit M1** Five hypotheses and data (example 3, drinks; OHT or handout)
Phase 3 (three lessons)	**Unit OM3** Show me (prepared sliding bars for the teacher and interlocking plates for each pair of pupils; prepared axes on laminates for each pupil or pair of pupils)	**Unit M3.1** Weather (OHT or poster) **Unit M3.2** Greece and Ireland (OHT or poster) **Unit M3.3** Mixed charts (two sheets, a set for each pair of pupils) **Unit M3.4** Photos (OHTs or poster) **Unit M3.5** Reports (cut up into sections; both reports to groups of four pupils)	**Unit M3.2** Greece and Ireland (OHT or poster) **Unit M3.3** Mixed charts (two sheets, a set for each pair of pupils)

Contents of the source library

Name	Size	Kind
Cans	—	folder
Bottles & cans.xls	19 K	Microsoft Excel 97/98 workbook
Cans (males & females).doc	148 K	Microsoft Word 97-98 document
Cans all.doc	72 K	Microsoft Word 97-98 document
Charts for cans.xls	40 K	Microsoft Excel 97/98 workbook
Census at school	—	folder
AskEveryone.doc	49 K	Microsoft Word 97-98 document
Census form.doc	252 K	Microsoft Word 97-98 document
Code used in census.doc	42 K	Microsoft Word 97-98 document
Data sex no name.doc	43 K	Microsoft Word 97-98 document
Data with no name.doc	47 K	Microsoft Word 97-98 document
Inductive statements.doc	35 K	Microsoft Word 97-98 document
Rural raw data.xls	198 K	Microsoft Excel 97/98 workbook
Urban raw data.xls	462 K	Microsoft Excel 97/98 workbook
Favourite things	—	folder
Charts favourite subject.doc	111 K	Microsoft Word 97-98 document
Favourite movies.xls	38 K	Microsoft Excel 97/98 workbook
Favourite subject.xls	30 K	Microsoft Excel 97/98 workbook
Top ten teams.xls	28 K	Microsoft Excel 97/98 workbook
Goals and football	—	folder
Goals bar charts 2.doc	120 K	Microsoft Word 97-98 document
Goals bar charts.doc	113 K	Microsoft Word 97-98 document
Goals raw data.xls	33 K	Microsoft Excel 97/98 workbook
Top ten teams.xls	28 K	Microsoft Excel 97/98 workbook
Heights of pupils	—	folder
Differentgroups.doc	63 K	Microsoft Word 97-98 document
Differentgroups.xls	25 K	Microsoft Excel 97/98 workbook
Height and footsize.xls	17 K	Microsoft Excel 97/98 workbook
Height by age (male&female).xls	23 K	Microsoft Excel 97/98 workbook
Heights (sample of Y8).doc	32 K	Microsoft Word 97-98 document
Mobile phones	—	folder
Mobile Phone Insurance claims.d	89 K	Microsoft Word 97-98 document
Mobile phones and internet acce	17 K	Microsoft Excel 97/98 workbook
Sunshine	—	folder
Hours of sunshine for UK.doc	41 K	Microsoft Word 97-98 document
Sunshine regional.xls	21 K	Microsoft Excel 97/98 workbook
Sunshine UK.xls	19 K	Microsoft Excel 97/98 workbook
Travel	—	folder
Air, Sea or Channel Tunnel.doc	60 K	Microsoft Word 97-98 document
Cars and travel to school.xls	25 K	Microsoft Excel 97/98 workbook
Distance to school.xls	18 K	Microsoft Excel 97/98 workbook
Travel to school.doc	71 K	Microsoft Word 97-98 document

Note: The files in the folder 'Census at school' are reproduced with the kind permission of the CensusAtSchool project (www.censusatschool.ntu.ac.uk), which is based at Nottingham Trent University.