Relevant & Engaging

Statistics & Data Handling

Teaching through Statistical Investigations

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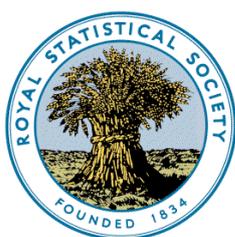
**Centre for
Statistical Education**

Chapter 5

This booklet is aimed at all secondary level teachers: there are hints and tips that we hope will be useful to support the teaching and learning of statistics and data handling. We hope that you find the material useful. Please email or write to us with suggestions for improvements. We will try to respond to all communications.
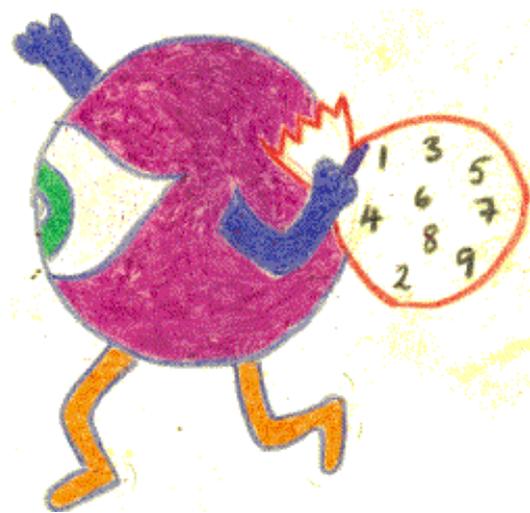
Doreen Connor
The Royal Statistical Society Centre for Statistical Education
The University of Plymouth
2009

email info@censusatschool.org.uk

www.censusatschool.org.uk

www.rsscse.org.uk

Chapter 5
Teaching through Statistical Investigations

The most important feature of any statistical investigation is that it is carried out for a valid reason and has real meaning. Data should always be collected for a purpose and the main goal is to get information from the data in order to illuminate or give some answers or conclusions to the original problem or question. An investigation should always follow through the problem solving cycle.

There is a good deal of research evidence, backed up by experience from educators in many countries, that teaching statistics through purposeful investigations that are used to solve real problems can motivate and help learners of statistics of all ages. The CensusAtSchool databases contain a rich source of real data and many very interesting problems can be posed which can be solved by carrying out investigations using the problem solving cycle.

The rest of this chapter is aimed mainly at the learners themselves. We will outline the main steps a learner should go through when doing an investigation, include an example of a possible planning sheet that your learners could use to help them and then give examples of possible investigations using the CensusAtSchool and ExperimentsAtSchool Databases. A few of these are discussed in greater depth with details of which variables you would need to select from the databases and possible forms of presentation that might be useful in each case.

Some ideas to help your learners plan their investigations

Part 1: PLAN   What is the question you want answers to? Is there a problem you want to find out some information about? How can statistics help you to find out the answer? Do you already have an idea of what it is you may discover? What do you expect the outcome and conclusions to be?

Part 2: COLLECT   Exactly what data do you need to help you answer your question? Where will you go to find it? What variables will you use – are there useful extras that might be interesting to investigate? eg gender, age, height. How much data will you need? Does it need to be a random sample?

Part 3: PROCESS   How are you going to organise your data? What kinds of tables and graphs will best present your data? How can you ensure you are concentrating on things that are important for your investigation?

Part 4: DISCUSS   What does your data tell you? Does it answer your question? Does it answer other questions? How are you going to present your conclusions? Does your data present other questions to you? Can you use your results to make predictions? Does it raise any concerns? Where should the investigation go next?

Part 5: EVALUATION   Were there weaknesses in your methods? Did these affect the quality of the results & conclusions? What would you do differently next time?

POSSIBLE PLANNING SHEET:

Student name……………………………………………………………………………….

Investigation Title……………………………………………………………………….

Starting Thoughts/Ideas

What question or Hypothesis am I going to investigate?

What do I expect the answers to be and why?

Data:
The population………………………………………………………………………………………..

The sample size………………………………………………………………………………………

What data and variables will I need?

How will I collect it?

Process:
What calculations will I do?

What information will these tell me?

What graphs/diagrams will I use?

What will these tell me?

Discuss:
What have I discovered?

How do my results help with my question/hypothesis?

Can I use my results to make any predictions?

Are there now any other questions that have arisen?

Evaluation:

Were there weaknesses in the methods used? Did these affect the quality of the results & conclusions? What would I do differently next time?

Ideas for statistical investigations

In the table below we present a number of other suggestions for investigation using data from both *CensusAtSchool* and *ExperimentsAtSchool*. More information and useful sample data graphs and results are available through the Results and data section of the website in the various phase 'Results' pages.

Questions/Investigations from
CensusAtSchool Phases and/or *ExperimentsAtSchool*

Useful Questions and Investigations	Phase
Lung Capacity – Are there any differences between boys and girls?	8
Lung Capacity – Does this relate to whether they think that 'maintaining a healthy lifestyle' is important?	8
Do left-handed people have faster reaction times and can they do the concentration exercise faster than right-handed people?	8
Do people who watch reality TV shows also want to appear on them?	8
Do reaction times correlate with time taken for the concentration exercise?	8
Which types of adverts should be restricted or banned?	8
Do right-handed people have longer arms than left-handed people?	8
Compare attitudes to climate change in recent years	8, 7, 6, 3

Investigation idea	Data needed	Ideas for presentation	Level
Do left-handed people have faster reaction times and can they do the concentration exercise faster than right-handed people?	Phase 8 variables: Hand Reaction Concentrate Random sample of 100 right-handed people and 100 left-handed people plus a single random sample of 100 to show proportions of left, right and either hands. (It could be a good idea to repeat the last sample several times to try to get a more accurate proportion.)	Histogram of reaction times from random sample of 100 Histograms of reaction times of left-handed, right-handed and either handed to compare Box plots of reaction and concentration times for right-handed and left-handed people. (Here a decision is taken to exclude any reaction times greater than 1 second) Scatter plot of reaction time against concentration time (having different symbols for left-handed and right-handed people would give a lot of information) Hard: Comparative Pie Charts to show proportions with fast average and slow reactions. (This would also need decisions taken as to what are fast, average and slow reaction times.)	KS4 Higher

Useful Questions and Investigations	Phase
Does the type of person you look up to change with age?	7, 3
Does people's attitude to public transport relate to how they actually travel to school?	7
Do people who play a lot of computer games eat more burgers than other people?	7
Does what you eat relate to how long you would like to live?	7
How are things likely to change over the next few years?	7
Who has the longest names – Boys or girls?	7
Do people who look up to celebrities tend to also have favourite activities that relate to this?	7
Do males and females agree about their favourite kind of fast food?	7
Can you predict somebody's height if you know how far it is from their Belly button to the floor?	7

Investigation idea	Data needed	Ideas for presentation	Level
How are things likely to change over the next few years?	Phase 7 variables: Age Gender prospects_crime prospects_nhs prospects_education prospects_police prospects_publictransport prospects_environment prospects_politicians This question mimics one used by MORI in their survey of adult views 2003	Simple bar charts and pie charts can be very effective here. The example below shows how the data for a sample of 100 could be arranged in a series of bars centred to show clearly which things respondents think will get batter or worse. Learners may choose to concentrate on a particular category the look at the differences between males and females or choose two different ages to compare – do 11 yr olds have different views to 15 yr olds? It can be a good idea for learners to conduct their own investigation in addition to looking at the CensusAtSchool data. They could then compare what their class or peers think about the same issues.	KS3/4

Useful Questions and Investigations   **Phase**

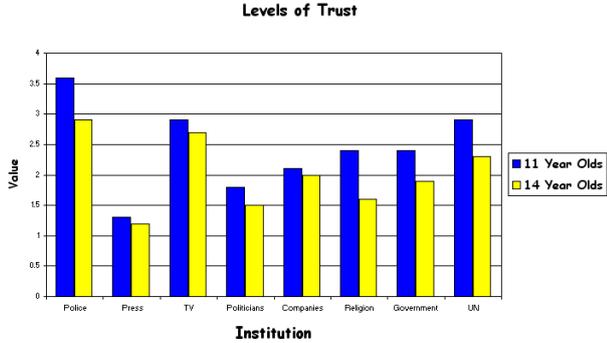Do girls use their phones for text more than boys?   6

What do people recycle?   6

Does the type of house you live in affect what you recycle?   6

Do people who think global warming is the most important environmental issue wear a hat on sunny Days?   6

Do people who prefer fruit & veg cycle to school more than others? Or do people who prefer carbohydrates go to school by car?   6

Compare the portions of fruit, vegetables, sweets and crisps eaten per day in 2003 with 2006   6, 3

Do 14 year olds estimate angles better than 12 year olds?   6 and Expts

Investigation idea	Data needed	Ideas for presentation	Level
Compare the portions of fruit, vegetables, sweets and crisps eaten per day in 2003 with 2006	Phase 6 variables: Age Gender portiosadayfruit portionsadayveg portionsadaysweets portionsadaycrisps Phase 3 variables; Age Gender Fruitportions Vegportions Sweetportions crispportions	An ideal method of presentation here is comparative bar charts like the one below. Because of the nature of the variables they are investigating they will need to make a number of decisions about how they sort the data. They can classify the number of portions into groups e.g. 0 –none, 1-3 moderate, 4-5 – loads etc if they wish. The graph below is taken from the Phase 6 data. It can be a good idea for learners to conduct their own investigation in addition to looking at the CensusAtSchool data. They could then compare how healthy their own class or peers are! There are also a number of other variables in the phase 6 database that could be investigated alongside this one. There is data on whether or not they have been on a diet in the last year (diet) and data on whether their favourite food type (foodtype) and how many days in the last week they have eaten meat (meat).	KS3/4

Useful Questions and Investigations   **Phase**

Do people who are worried about bullying also tend to be those who are absent from school?	5
Is there an association between favourite colour and which hand you write with?	5
Does the level of trust people have in institutions diminish with age? Do boys and girls trust different things?	4
Do those who like horror stories prefer rock/heavy metal music?	4
Alternatively, do those who like classical music prefer romance? What other further links do you find interesting?	4
Do Christians tend to trust big companies more than religious institutions?	4
Do piano players trust the government more than others?	4

Investigation idea	Data needed	Ideas for presentation	Level
Does the level of trust people have in institutions diminish with age? Do boys and girls trust different things?	Phase 4 variables: Age Gender trustPolice trustPress trustTv trustPoliticc trustCompanies trustReligion trustGovernment trustUN	An ideal method of presentation here is comparative bar charts like the one below. The values in the data reflect where the slider was placed on the questionnaire. At the DO NOT TRUST end the value recorded was 0 and at the TRUST end the value was 5. It would also be useful to calculate the Mean average value for each institution Box plots would also show the information well and the median and quartile values could be worked out from these. Levels of Trust It can be a good idea for learners to conduct their own investigation in addition to looking at the CensusAtSchool data so they can compare the views in the classroom with those of the database. In this case it is quite hard to work out how you could record an accurate value between 0 and 5 to show this.	KS3/4

Useful Questions and Investigations   **Phase**

Question	Phase
Is there a difference between male and female support for Manchester United in (a) England and (b) Wales?	1
On average, more learners living in rural areas of the UK walk to school than learners who live in urban areas	1
Are learners taller than they were 150 years ago?	1
Is there a difference between the heights of 12-year-old learners in the UK and South Africa	1
A larger percentage of learners in the South of England have access to the Internet than elsewhere in the country	1
Are females more likely than males to be born in the summer?	1
Shoe manufacturers have to produce larger shoes for sale in the north of England	1
Does travel to school take longer by bus?	1
Is there a connection between the size of the grid and how long it takes to complete the memory test?	Expts
Does the type of picture in the memory test make any difference?	Expts
Do girls estimate better than boys?	Expts

Phases 1, 2, … 8 of *CensusAtSchool* were run in academic years
2000/2001, 2001/2002, …, 2007/2008, respectively - all phases are still active.
ExperimentsAtSchool (Expts) was started in 2003.