Practical Statistics Teaching Ideas

Educational research indicates that putting a context/purpose on data collection and interpretation is much more likely to lead to a better understanding of and feeling for the material. Here are some examples of ways of gathering data for students to then explore and so make meaningful use of the statistical tools they have to hand. Making use of graphical calculators, EXCEL, AUTOGRAPH, MINITAB is also a good way to explore the results more quickly. Each idea has been tried with AS/A2 students and in some cases with year 7/8 students as well.

It is often a good idea to introduce a topic through students collecting their own data first and then deciding/discussing how best to analyse the results – or indeed how best to gather the data and design suitable experiments in the first place. Teenagers are especially interested in food, mobile phones and money so the list is dominated by such topics, which appear to attract their interest! Number 1 on the list makes an excellent first lesson of the year/term for any group studying AS Maths involving Statistics, or indeed GCSE Maths or Statistics.

1. Chocolate

Equipment needed: mini mars bars (enough for one each), random number tables, AUTOGRAPH and data projector/interactive whiteboard to display results, optional: graphical calculators for display of data.

(a) Read 10 random numbers out at the start of the lesson, generated from the calculator, and then get students to write them down in the correct order. Read out the right answers and the students mark themselves out of 10.

(b) Give out the mars bars - one to each student who then consume them. Repeat (a) 10-20 minutes later.

(c) This can continue throughout the lesson. You now have an interesting discrete data set that can be explored and compared at the different times. You usually find that memory levels peak around 20-25 minutes after consumption.

(d) Suggested investigations – use AUTOGRAPH to compare medians, mean, IQR values and ranges at each of the time intervals. Students now use graphical calculators to draw comparative box plots and comment.

2. **Get students to bring in data** e.g. hand-spans of left and right hands, head-spans, heights and arm lengths (can measure in class with sufficient tape measures) Now compare e.g. left and right hands – often big differences – using mean, also sd. Split by gender and repeat. Repeat for other measurements above. Enter data into graphical calculators and use the two variable statistics mode to summarise data for e.g. left and right hands and draw a scatter plot. Find correlation using the calculator. Alternatively, use AUTOGRAPH, EXCEL or basic scientific calculator to find summary statistics.

3. **Mobile phones** – get students to text the word COLLEGE (but not send it) with left and right hands and a partner times them to do so (switch predictive

texting off first!). Record data for class and compare main and non-main hands – is there a difference or are they ambidextrous? The analysis that can be done with the graphical calculators, on AUTOGRAPH or by hand depends on the student context, e.g.:

(i) If A2 students could carry out a hypothesis test on the differences (paired t test)

(ii) If AS students, they could use the calculators/AUTOGRAPH to draw scatter plot for left and right hands and find a correlation. You could also get the students to use the one variable statistics mode to find the summary measures for the differences between each hand and comment.

Interestingly, data may suggest that this generation is becoming more ambidextrous, perhaps due to things like texting and computer gaming skills.

4. **Rulers** – drop a ruler through your main hand and record the distance dropped. Repeat and take result on third drop. Now repeat with other hand and then compare results for the whole class using mean, s.d., median etc., again using the calculators to provide rapid results.

5. **Newspapers/magazines** – there is a theory that the more expensive colour adverts for goods have a greater proportion of the colour black in them. Use a grid to approximate the proportion of a series of magazine adverts which is coloured black and record the price of the item. The data can be analysed graphically on calculators/EXCEL/AUTOGRAPH or by hand and correlation can be brought in as well. You can categorise the adverts by the kind of goods being sold – clothing, electrical, food etc etc. and use mean, sd to compare prices and proportions of black in different categories. You can also construct a price – black proportion ratio to create a univariate data set and then compare using mean, sd across the categories of advert.

6. **Taste Tests** – get students to rate on a scale of 1-10 the test of say Sainsbury's own choc chip cookies versus Maryland cookies (labelling them as brand A and B and randomizing which cookie is eaten first using the toss of a coin – students to drink some water between cookies and possibly blindfold them as well – done in pairs). You can then compare brand A and B to see if they can tell the difference, having first worked out the differences between ratings for each person to get a single set of data, which is then inputted into calculators or examined by hand and using an ordinary scientific calculator. Clearly if there is no difference you would expect the average of these differences to be close to zero, but there will be a degree of variation as measured by the sd of the data which is worth also discussing. All of this can be extended to e.g. non-parametric testing such as the sign test or Wilcoxon test using calculators to support the analysis.

7. **Cadbury's Dairy Milk** – distribute squares of chocolate (could use maltesars or any chocolate/fruit/sweets which are easy to distribute) around the room, but ensure that it is very uneven, with several getting none, some e.g. 8 squares, some 4, some 2, some 1 etc. The idea is to demonstrate the

difference between mean, mode and median, with a discussion as to which measure is best in this context. Can also lead in to discussion of things like aid to developing countries and mismatch between 'haves' and 'have-nots'. Students can then be asked to redistribute the squares in order to achieve a particular median, mode etc. Graphical calcs can be used to find quartiles and other measures if desired. This lesson goes down well with students (even tried it with a group of year 7 and 8 students – bottom sets in an 11-16 school – and got good responses). Can clearly be used for numeracy and GCSE students as well.

8. **Pulse Rates** – get students to do some simple piece of exercise e.g. running round the field, press-ups etc, taking pulse before and then immediately afterwards. Time to return to previous pulse can also be measured. For each student doing the exercise the increase in pulse rate can be measured from resting rate to post-exercise. The data can then be explored using mean, median, IQR etc. on the calculators. An extension is to group separately by smokers and non-smokers and compare – the sporty students who also smoke often get a shock. Some students I have done this with in the past, using Autograph to display the data, have subsequently given up smoking as a result of what the data showed!

   Instructions for using Autograph with an example of the data collected are given below:

   (i)   Open a new statistics page. Click on DATA-ENTER GROUPED DATA
       - Class intervals - equal intervals, integer data or manual
       - Frequencies - either manual or calculated from raw data
       - Edit raw data   – dialogue box-manual entry import or cut/paste from a spreadsheet create sample from a probability distribution.

   (ii) Click on OBJECT and select diagram type.

   Clicking on the name of the data set in the bottom left allows you to further edit the data.

9. **Jammy Dodgers** – bring in a few packets and measure the diameters of a sample. Use combination of linear variables to find mean and s.d. for a row of four (the width of a packet). Now get students to find the mean of a row of four biscuits plus or minus 3 sds using class data – gives a range typically one centimetre wide for 99.9% of data. You should find that there is always a half a centimetre slack in the packaging at either end to allow for variability in size of the biscuits, giving a practical use for linear combinations.

10. **Quality Street** – a variation on (9) above. Bring in boxes of quality street and get the students in groups of 3 or 4 to find the mean and sd for each sweet type in the box. Now pool data for the whole class – you'll almost certainly find that the mean and sd are the same for each box. Using whole class data, find the mean and sd for each sweet type and using these as approximations for

population mean and sd find mean and sd for net weight of whole box. Now use standard normal distribution techniques to find the probability that the net weight is below that printed on the box. This allows for discussion of the use of statistical techniques in quality control.

11. **Cookies Comparison** – students compare own brand (e.g. Sainsbury's own) and Maryland using variables of their choice – different for each small group of 3 or 4 students. The small groups then analyse the results depending on their level of knowledge and feed back at the end of the lesson using posters they create. This works well in a long lesson (say 80-90 minutes) and can be appropriate for e.g. Further Stats modules for F Maths students or Stats 1 students – just suggest a different level of analysis. Either way, the analysis can be done quickly in a single lesson, allowing the students to think carefully about what they are doing. There is ample opportunity to use effective differentiation within such a lesson.

12. **A Visit to the graveyard** – find a large local graveyard and divide the yard into sections, preferably by grave type (e.g. children, cremations, older graves etc). Assign a group of students to each section and ask them to sample a selection of graves – you could do so in proportion to the number in each section or just get them to sample the same from each section if the sections are similar in size. The process of choosing a sample needs to be discussed first, but could involve a coin toss for moving left or right, back or forward and then a die to indicate the number of paces moved forward or back. Students should record for each grave the information available on: gender, age, date of birth and death, profession (where available), number of words on tomb etc. The data is messy – some stones will be hard to read or difficult to get to – but then this is real statistics which rarely involves sanitised data. Clearly risk assessments first are important – take care of hidden holes etc!

Analysis is then possible as a project, exploring the data using descriptive statistics, graphs such as box-plots, pie charts etc. The initial lesson can be conducted in an 80-90 period and provides plenty of real data to use in developing understanding of uni and bivariate statistics.

The key in all of this is to get the students realizing that statistics can be useful and fun in analysing/exploring real-world situations. Try not to give all the answers as well, so for instance in taste tests leave problems with the experimental design or ask them to design the experiment, allowing discussion between and with the students.

Try to build a statistics practical or two into work-schemes for each topic covered. My experience is that students remember the topics covered using this practical approach much better than using data from a textbook or website. Not only that, grades in examinations are much higher as a result. Also, as many practicals can be done quite quickly, the theory can be taught without losing time in hectic schedules. Finally, I have also found that my enjoyment as a teacher of statistics has increased greatly since using this approach to teaching the subject and that the students are very tolerant of the occasional flop lesson – they value the opportunity to try something new.