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LEARNING METHODS INVOLVING COMMUNICATION BY STUDENTS

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1. Introduction

Students learning statistics are really much happier when there is a story, or storyline which forms the background for their enquiries.

I wish to maintain also that they derive great benefit (and not only to their study of statistics) from explaining to their peers and teachers what they have done to solve a problem.

The component of our 1st semester, 1st year statistics course in Applied Science that I discuss here incorporates both of these features, but I have chosen to concentrate on the latter.

I have proposed elsewhere (Taffe, 1990) that the main beneficiary of any explanation is the person who gives the explanation. The process of reorganising ideas into a linear chain of description and explication, in real time, helps you to see new connections and new perspectives on the content as a whole. You increase your mastery of the content in leaps and bounds.

For the listener, however, explanations often mystify. Recall Bock's Law: If it can be misunderstood, it will be, and if it can't be misunderstood, it will be; and Taffe's Corollary: Hardly anyone will understand any explanation, no matter how clear.

We may conclude from these laws that the well known and highly esteemed 'gravity feed' method of teaching may not be optimal in terms of student learning, at least not if used at all times.

At Swinburne, first year Applied Science students have the opportunity to transfer the benefits of explanation to themselves.

2. Communication by students

The Presentation. For the first semester unit "Data Analysis and Probability" there are two assignments, which are really aspects of the same single assignment: the Presentation and the Written Report. They are

based on a small set of investigation-type problems, which provide the storyline (see appendix).

Students are given to understand that their task is not to solve the problem - they will be given any help they require if the problem proves difficult. Their task is rather to communicate to their teacher and some of their peers the results of their work on the problem, and to answer questions about it.

Two weeks after being given the problem they present their communication in 15 minutes (including 5 minutes for questions). This is assessed by their teacher for evidence that they understand (even a small part of the original problem), and for their success in communication.

One week later they hand in a written report based on their talk and preferably answering some of the questions raised in discussion at the time of the talk.

Guidelines. The students are given brief guidelines (see appendix) as to what is expected in both parts of the assignment.

Discussion. It is well known that what 'drives' students (as far as their academic work is concerned) is the assessment of the work - what is assessed and how it is assessed. By including in the course a component (30% combined weighting for the presentation and the written report) of work which is assessed for quality of communication we indicate that we think this an important part of their statistical education.

Generally the students enjoy the work, and the problems with which they become familiar can provide a basis for exemplifying later theory. I recommend assignments of this kind to you.

Bibliography

Taffe J. (1990), The Gravity Feed Model of Teaching, Laws and Strategies, in D. Vere Jones (ed.), *Proceedings of the Third International Conference on Teaching Statistics*, International Statistical Institute, Voorburg, Vol. 2, pp. 43-50.

APPENDIX

Swinburne University of Technology
Department of Mathematics

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Guidelines for presentations

Presenter

Your presentation should be along the following lines:

Introduce yourself formally.

State the central idea or question you are investigating in an easily understandable way. You should say how you expected the investigation would turn out before you started it.

Give an outline of your talk in the form of a few headings, to let your audience know what to expect.

Concentrate on illustrating 2 or 3 main ideas – don't pay too much attention to details.

State your conclusions and invite questions.

Things to keep in mind

Time – be strict with yourself. Allow 10 minutes for your talk and 5 minutes for questions and comments.

Illustrations – on OHP slides, on the blackboard. They should be simple – one main illustration on each. Writing should be large and clear.

Speak more slowly and louder than you usually do. Look around at everyone in the audience (not just at your lecturer).

Audience

Being in the audience is just as important as giving the presentation. Take seriously your responsibility to ask questions and to offer comments. Try to imagine working on this topic yourself and think how you would have handled it. This will help you to think of questions and comments.

Assessment

In assessing your presentation marks will be given for:

Thorough preparation
Clear sequence of ideas
Appropriate techniques and illustrations
Drawing appropriate conclusions
Handling of questions

A mark out of 15 will be given.

Guidelines for written reports

The written report should be constructed on the following lines:

Introduction

Say what the topic asks you to do, discuss the central idea and how it relates to the study of statistics. Say what kinds of results you expected before you started to investigate the question. 3 marks

Method

Set out clearly how you went about the task, what decisions you had to make, what difficulties you met and how you resolved them. 3 marks

Results

Present your main results in graphic or tabular form, and point out the main things which should be noticed. 3 marks

Conclusion

Set out what conclusions you have come to in the light of your results. If possible comment on how the topic relates to parts of your statistics course and to real-world problems. You may wish to make suggestions about improving the topic for future students. 4 marks

Appendix

You should include a listing of the data at the end.

The whole report should take no more than 3 o 4 pages. Two more marks will be awarded for overall presentation and quality of the report. These will be awarded as follows, according to your lecturer's judgment:

0 The report fulfils the basic requirements.
1 The report shows some evidence of original thought, or perhaps extends the topic in some way or makes a useful comment.

2 The report does more than one of the above-mentioned things and is excellently presented.

The report should be handed in one week after the presentation.

TOPIC 1 PSSST!

In a group of nine friends, one starts a rumour. She tells it to one of her friends, and the friend passes it on to the next member of the group that he or she meets. This continues until the rumour is told to someone in the group who has already heard it. This person does not pass it on, so the rumour stops spreading. What is the probability that everyone in the group hears the rumour? Use random numbers from a table or from your calculator or generated by Minitab to simulate this process and give an estimate of the probability.

TOPIC 2 BIRTHDAY SNAP!

Ask students coming out of the engineering building (or going in to the library or the café ...) what day of the month their birthday falls on (possible answers are 1, 2, 3, ..., 31). Write down the answers in the order they are given. When a number is repeated, say 'Snap!', rule off the list and start again. Do this until you have a large number of snaps (at least 25). Count how many people were required for each snap, and summarise the sample distribution of this number in a suitable way.
Now consider this problem: How big does a group of people need to be for at least an even chance (probability ≥ 0.5) of a 'birthday snap'? How can you use your sample to estimate this number? Can you suggest other ways of solving this problem?

TOPIC 3 BUFFON'S TOOTHPICK

Obtain a large sheet of paper (e.g. butcher's paper) and a toothpick. Measure the length of the toothpick and rule up the paper with parallel lines whose distance apart is the same as the length of the toothpick. (Alternatively, cut a stick so that its length is the same as the width of the boards in a wooden floor). Throw the toothpick onto the paper (or the stick onto the floor) and note whether it lands across one of the lines. After the fifth throw note down the relative

frequency of 'crossings'. Do this again after the tenth, fifteenth, twentieth, and so on till the hundredth throw. Plot these relative frequencies against the number of throws. Discuss the results. The probability of a crossing has been caculated as $2/\pi$. Is this consistent with your results? (This is usually referred to as Buffon's Needle Problem).

TOPIC 4 A DICE PROBLEM

Is it easier to throw (at least) one six with six dice or (at least) two with twelve? Borrow some dice from your lecturer and investigate this problem. Use 100 throws with six and 100 with twelve. In each case record the relative frequency of successful throws after the fifth, tenth, ..., hundredth throws and plot these relative frequencies against the number of throws. Discuss the results and predict what would be likely to happen if three or more sixes had to be thrown with eighteen dice.
How could Minitab be used to simulate the rolling of the dice?
Is there a way of calculating exact answers?

TOPIC 5 A SIMPLE CODE

Select a page from a novel and use it to construct a frequency distribution of the 26 letters of the alphabet. Compare this frequency distribution with the distribution of letters in the coded message below. Explain how comparing letter frequencies in this way can be useful in deciphering codes, and translate the message:

Wbw rhn zh mh max Vhfxwr Yxlmbote? B ptl mhllbgz ni uxmpxxg 'Max Mpbml" tgw 'Phz-t-ktft', unm ymgteer pxgm mh 'Max Zbke'l Zhmmt Xtm' tgw etnzaxw frlxey lbvd!

TOPIC 6 POKER: THE CHANCE OF A PAIR

Deal 5 cards from a well shuffled pack of 52 cards. Record whether this hand contains one 'pair' (and nothing else) or not. Repeat this experiment 20 times and estimate the probability of being dealt a hand containing one pair.
Using random numbers (and possibly Minitab) simulate 100 poker hands and use the results to estimate the probability of one pair.

Calculate the probability and comment on the accuracy of the two simulation methods.
Discuss the problem of estimating the probability of 'three of a kind'.

TOPIC 7 HIEU TAKES A PUNT

Hopeful Hieu is soon to do a multiple choice test. The test is to consist of 20 questions, each with 4 possible answers. Only one of these four answers is right.
Hieu is worried. His social life has cut into his study time quite a lot. If he knows the answers to 9 of the questions he is confident of passing, because he would need only one of 11 guesses at the other questions to be correct. But what if he knows only 8, or 7, or 6, or...? How many does he need to know to have at least a 50% chance of passing? Could his chance of passing drop below 5%?
Statistics is not his best subject. Help Hieu by using random numbers to simulate his guesses (a random number less than 25 means a correct guess). Suppose he knows 9 answers. Simulate an attempt at the test by making him guess until he gets another answer right or all 11 wrong. Do this 20 times and record his percentage of 'passed'. (This is your estimate of his chance of passing when he knows only 9 answers). Then suppose he knows 8, and so on.

TOPIC 8 HAT'S ALL FOLKS!

One evening at the theatre ten hats are handed in at the cloakroom. The attendant is so busy she forgets to put tickets on the hats. When the hats are called for after the performance she simply hands them out at random. The patrons are so engrossed in their discussion of the performance that they accept the hats without checking that they have the right ones. How many hats can we expect to be returned to their rightful owners?
Number the ten hats owners 0 to 9 and use a table of random numbers or a calculator to assign the hats randomly. Repeat this procedure until think you have a reliable estimate of the expected number of correct returns. After each simulation calculate the average number of correct returns per simulation and graph this against the number of simulations.

TOPIC 9 SITTING DUCK

Each day a hunter goes duck shooting. She fires repeatedly until she shoots a duck and then she takes the duck home to her hungry family. The shots she fires are independent and the probability of hitting a duck with each shot is .2. Her husband, concerned at the expense of his wife's wasted bullets, finds out that free range ducks can be bought from the local market for $4.50 each and suggests that since bullets cost $1 each it may be cheaper to buy the ducks. Use Minitab to simulate 100 days' shooting and decide whether the husband is correct. How could you have answered this question without using Minitab?

TOPIC 10 BLOOD GROUPS

Suppose that in a large population the blood types A, B, AB and O occur in the proportions 30%, 20%, 10% and 40% respectively. From this population, four blood donors are selected at random. By simulating 100 such samples of four people, estimate the proportion of the population that would, on average, not have their blood type supplied from the 4-persons sample. Compare this estimate with the exact value of the average proportion uncatered for by the four-person donor group.

TOPIC 11 TESTING, TESTING!!

Blood samples frome the 11 members of a cricket team are taken, and are mixed together. If this mixture contains any trace of the performance enhancing drug Spinoutaside, each of the 11 players will then be tested separately. This means that either one test or 12 tests will be required. Assume that the probability of each player using Spinoutaside is 0.1, and that the players' drug-taking (or non drug-taking) habits are independent of each other. Estimate the expected number of tests required, by carrying out 100 simulations. Compare this estimate with the exact expected number of tests required.

TOPIC 12 GOODY TWO SHOES

The lights have gone out. You have 10 pairs of shoes in the bottom

of your wardrobe, but they are in an untidy pile. You pull out six shoes. What is the probability that you have at least one pair? Use a simulation method to estimate this probability.

TOPIC 13 FLYING DUCKS

It is early morning on the first day of the duck season. A flight of 10 ducks takes off. Ten hunters shoot and each hits the duck he aims at. How many ducks escape?
Use random numbers to simulate this situation 10 times to get an estimate of the expected number of escaped ducks. Do this again 50 times and then 100 times and comment on how the reliability of your estimate improves. Estimate the probability that no more than 3 ducks escape.

TOPIC 14 TWO PEAKS

The town of Two Peaks has an unusual legal system. The procedure in any trial is as follows:

(i) The judge rolls a die and reports the number, k, to the 4 jurors.
(ii) Each juror uses his or her calculator to generate a random number between 0 and 1, and votes to convict the accused if, and only if, the first digit of the number is $\leq k$.
(iii) The accused is found guilty only if all four jurors vote to convict.

Leland De Palma is on trial in Two Peaks for the murder of his mother-in-law Lorna.
Using a die and your calculator, estimate the chance of him being convicted by simulating 100 court verdicts. Calculate the probability exactly and compare the answer with your estimate.