The World of Chance

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Abstract

"The World of Chance" is an unconventional statistics course, modelled on the Chance courses devised at Dartmouth College and taught at the University of Canberra, Australia, from July to November 1998 and 1999. Statistical concepts are introduced to students via a mixture of lectures, class discussions of news stories, and activities. This article contains a description of the goals of "The World of Chance" and an annotated bibliography of the resources used to achieve these goals. This is followed by an evaluation of the extent to which these goals were met, and resulting ideas for improvements to the course.

Introduction

Moore (1997a) has encouraged all those involved with teaching introductory statistics to take a fresh approach to the task. One of the goals of this approach can be expressed broadly as including more data and concepts but fewer recipes and derivations in the material presented to students. This goal is to be achieved through a balance of lecturing, technology and active learning methods such as demonstrations, group discussion and projects.

One way to structure such an introductory statistics course is through Chance. On the Chance Database (http://www.dartmouth.edu/~chance), the following definition of Chance is given: a "Chance course is a case study quantitative literacy course .... The aim of Chance is to make students more informed, and critical, readers of current news that uses probability and statistics as reported in daily newspapers ... and current journals and magazines ...."

"Thw World of Chance", taught in 1998 and 1999 at the University of Canberra, Australia, was inspired by the courses described on the Chance Database. The stated goals of "The World of Chance" are to enable to students to be able to assess critically the statistical content of articles and other presentations in the media, and to understand and appreciate the judicious use of statistics in their own field of study. About 75% of the students who enrol in the course are Information Technology (IT) majors who do not have a statistics course as a compulsory part of their degree.

Resources

The course consists of 26 fifty-minute lectures and 12 two-hour tutorials: these are listed in Table 1 and Table 2 respectively. Two guest lecturers were used in 1999 and are shown in the timetable. Guest lecturers used in 1998 were Mr John Zarb of the Australian Bureau of Statistics on "Smarter Data Use" and Professor Brendan Mackay of the Australian National University on "The Bible Code: Fact or Fraud?".

*** Table 1 and Table 2 here ***

Moore (1997b) was chosen as the textbook as it covered the four topics chosen for the course, namely surveys, experiments, graphics and probability. Recom-

mended for reading were Griffiths et al. (1998) and Utts (1996): a number of the thought questions from Utts were used as introductions to lectures. Most students bought Moore's book and a number of tutorial discussion questions were set from it. Griffiths et al. (1998) has the advantage of containing data sets of particular interest in the Australian setting, and a number of these were used as examples in lectures, along with tutorial discussion questions. The tutorials are held in computer labs and for nine of the twelve tutorials students carried out activities adapted from Rossman (1996), Schaeffer et al. (1996) and Spurrier et al. (1995).

Most of the lecture material in the survey topic came from Moore (1997b). The video "Statistics for Quality" is a useful Australian resource, which concentrates on the statistical aspects of quality in five Australian industries. They include the market research company AGB McNair, which is relevant to this module. The television series "Yes Prime Minister" is also available on video, and the episode "The Ministerial Broadcast" contains a short relevant scene where by the judicious use of leading questions, a clever public servant is nonetheless shown to be both in favour of and against compulsory military training for young people.

Designed experiments lend themselves well to videos, and in the experiments topic I used the "Against All Odds" series as well as "Experimental Design", a short video on an agricultural experiment from the University of Adelaide.

The most useful resources for the graphics topic weree the three books by Tufte (1983, 1990, 1997). Wainer's (1984, 1997) publiations were also useful, providing a humorous approach to the principles of graphical presentation. Advice on graphical presentation is not new, however; see for instance the Joint Committee on Standards for Graphic Presentation (1915). Many other books that deal with graphical presentation emanate from the graphic design profession e.g. Pedersen (1988). Not all the principles espoused in graphic design texts would necessarily be supported by Tufte but they are a useful source of graphics to show in class.

Moore (1997b) and Schaeffer et al. (1996) provide good sources of lecture material and activities respectively on the probability topic. For those with a gambling frame of mind, Chance Team (1998) provides much useful material.

One of the harder decisions was which computer package to use. Students have occasionally withdrawn from introductory statistics courses because they were not happy using PCs and the statistical package SPSS. However these are probably isolated incidents and likely to reduce in frequency as more people are exposed to PCs either at school or work. It was decided to use SPSS because it would be

useful for students continuing to further study in statistics at the University of Canberra. The Chance Team (1997) have produced a guide to introducing the use of a statistical package, full of sound advice. The large number of IT majors in the course also led to a smooth introduction to SPSS as the students were familiar with Windows, menus, dialog boxes and so on.

Evaluation

A survey of attitudes towards statistics (SATS) was developed at the University of New Mexico and has been described in Gal et al. (1997). Results from its administration to a large number of statistics students has been described by Schau et al. (1995) and Dauphinee et al. (1997).

A smaller, ten-question survey of attitudes towards statistics is also given in Gal et al. (1997). Five more questions from the SATS were added and the survey administered to students in "The World of Chance" in the first and last lectures of semester. This fifteen-question version matches a survey administered to students in a first-year engineering course at the University of Technology, Sydney, Australia, and as more data becomes available it will be possible to undertake comparisons of the results of this survey in the two institutions. A copy of the questions asked appears in Table 3. The rating scale used was 1 = "strongly disagree" through to 5 = "strongly agree". Only small changes in grammar are required to administer this survey at the end of a course: for instance, Question 1 becomes "I have enjoyed taking a statistics course".

*** Table 3 goes here ***

Thirty-six students responded at the beginning of semester and 16 responded at the end of semester. The median response to each question, along with the "desired" response is shown in Table 4.

*** Table 4 goes here ***

In the post-semester ratings, most of the median scores are either neutral or towards the "desired" rating e.g. in question 1 the median rating post-semester was 4 and the "desired" response is 5. The only questions where the median response leant in an "undesirable" direction were questions 4, 11 and 14. This

suggests that even after a semester of studying Chance, students are generally satisfied with the level of exposure to statistical ideas they have undergone and are not convinced of a close connection between what they have learnt and their employment or their participation in society. This suggests that there is a need to emphasise the way statistical thinking can assist them both at work and in everyday discussion of current events reported in the media. It appears from discussion wuth students that not many of them read the newspaper regularly and further discussion of news items could take place at the expense of some lectures.

Consideration of changes in attitude from the start to the end of semester requires paired responses, and there are 14 of them. The median change in response to each question is shown in Table 5, and histograms of the change in response (post - pre) are shown in Figure 1. One-sided Wilcoxon signed-rank tests were preformed to assess whether there had been a significant change in response to the 15 questions during the semester. The p-values of the 15 tests are also shown in Table 5.

*** Table 5 and Figure 1 go about here ***

Care should be taken in interpreting these results because of the small sample sizes and the multiple comparisons (15 of them). On a broad level, however, it is possible to say that there appears to have been some shift in response in the "desired" direction to questions 1, 8, 9, 10 and 13. These questions suggest that on average the students enjoyed their experience studying statistics and that they learnt some specific skills regarding interpretation of lotteries, opinion polls and other statistical information that appears in the media. This encouraging result suggests that the goal of assessing critically the statistical content of articles and other presentations in the media was met. On the other hand, the goal of understanding and appreciating the judicious use of statistics in their own field of study does not appear to have been met, as there was no discernible shift in response to questions such as 2, 5, 12 and 14. Since most of the students are IT majors, this suggests that either a stronger emphasis on the relationship between statistics and IT, or more use of IT-based learning experiences could be helpful.

Students also rated the nine tutorials (listed in Table 2) that took place in a computer laboratory and involved data collection and analysis. All activities received a median rating (on a scale of 1 = poor to 5 = excellent) that was 4

(very good) or better, with the favourite activity being the ones involving food! The tutorials on walking styles and calibration involved timed walking along an outdoor footpath and students tended to stay away when they realised that someone might actually see them doing statistics. The tutorials on sampling cars and traffic flows were not an embarrassment to students because although the data collection took place outside, it simply involved recording numbers on paper and was on the edge of campus, far from other students. Attendance also dropped in the last week of semester due to Foundation Week activities, hence the low participation in the tutorial on simulation.

Improvements

The results of the Survey of Attitudes Towards Statistics point to the following suggestions for improvement in the course for 2000.

1. Be prepared to break the lecture schedule if an interesting statistical story breaks in the news.

2. Students were able to carry out and report on an experiment or observational study on any topic that interested them as the major assessment for the course. Suggest that if they are in employment, students relate their major project to their work.

3. Invite more guest lecturers from fields where statistics is being applied in interesting ways.

4. Make more use of the STEPS modules and other Web-based or CD Rom-based material.

I'm looking forward to implementing these improvements in 2000 and in conclusion, if anyone reading this is contemplating getting involved in the world of Chance, I would strongly recommend it!

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Table 2. Tutorial timetable.

1. Questionnaire design (a discussion of questions from Moore (1997b) about sample and questionnaire design)
2. Descriptive statistics in SPSS: pulse rates (Spurrier et al. (1995))
3. Random sampling: cars in a carpark (Spurrier et al. (1995))
4. Factorial experiments: paper planes (Spurrier et al. (1995))
5. Blocking: walking styles (Spurrier et al. (1995))
6. Correlation: price and quality of chocolate biscuits (devised by Tom Moore and explained on the Chance database)
7. Graphics (a discussion of graphics from local newspapers and hand-production of graphical representations of complex data sets)
8. Time series: measuring traffic flow at traffic lights (Spurrier et al. (1995))
9. Regression: measurement of body parts (Spurrier et al. (1995))
10. Calibration: guessing and measuring distances to nearby landmarks (Spurrier et al. (1995))
11. Probability (a discussion of probability calculations from news stories and an introduction to Simpson's paradox)
12. Probability: using simulations to estimate probabilities (Taffe (1994))

Table 3. Survey of Attitudes towards Statistics

1. I think I will enjoy taking a statistics course.
2. Statistical skills will make me more employable.
3. Because it is easy to lie with statistics, I don't trust them at all.
4. Understanding probability and statistics is becoming increasingly important in our society, and may become as essential as being able to add and subtract.
5. Statistics is not particularly useful to the typical professional.
6. You need to be good at mathematics to understand basic statistical concepts.
7. To be an intelligent consumer, it is necessary to know something about statistics.
8. Statements about probability (such as what are the odds of winning a lottery) seem very clear to me.
9. I can understand almost all of the statistical terms that I encounter in newspapers or on television.
10. I could easily explain how an opinion poll works.
11. Given the chance, I would like to learn more about probability and statistics.
12. I often use statistical information in forming my opinions or making decisions.
13. I feel insecure when I have to do statistics problems.
14. Statistics should be a required part of my professional training.
15. When buying a new car, asking a few friends about problems they have had with their car is better than consulting an owner satisfaction survey in *Choice*.

Table 4. Median responses to the survey of attitudes towards statistics.

question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
pre	4	3	3	4	2	2	4	4	3	3	4	3	3	3	3
post	4	3	3	3	2	2	4	4	4	4	3	3	2	2.5	3
desired	5	5	1	5	1	1	5	5	5	5	5	5	1	5	1

Table 5. Median change in response to the survey of attitudes towards statistics.

question	1	2	3	4	5	6	7	8
change	1	0	-0.5	0	0	0	0	0.5
p-value	0.0157	0.5	0.3976	0.3478	0.3966	0.4081	0.2137	0.0365

question	9	10	11	12	13	14	15
chance	1	1	0	0	-0.5	0	0
p-value	0.0013	0.0029	0.4719	0.3891	0.0047	0.4601	0.1104