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Using computer based assessments in a large statistics service course

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Introduction

This article follows on from that published last year in *MSOR Connections* on using computer based assessment in first year mathematics and statistics degree courses at Newcastle University, [1].

Here we describe the successful application of computer based practice and in-course assessment to a large service course in statistics for students in the Business School at Newcastle University in 2007/2008. A major objective was to increase student engagement by providing more practice and continuous in-course assessment.

1. The course: Quantitative Methods for Business Management

Overview

The course is a core stage 1 statistics module primarily aimed at undergraduates enrolled on degree programmes in Newcastle's Business School. The module is an introductory course for students with limited prior exposure to the subject, the main objective being to equip students with the knowledge and skills to undertake simple data analyses independently later on in their degree and generally to develop their numeracy and transferable skills.

The course has grown in size from 240 in 2004/05 to 454 in 2007/2008. In 2008/09, we anticipate student numbers of around 550.

Students are taught together in a weekly, one hour lecture; the class are then split into smaller tutorial groups for small-group teaching sessions later on in the week. The course runs for a full academic year over both semesters.

Content

There are six topics, each of which takes about four weeks to cover. These topics are:

1. Sampling methods and summaries of data;
2. Probability and decision-making;
3. Probability models for data;
4. Statistical inference for the population mean;
5. More hypothesis tests; and,
6. Business modelling

Topics 1–3 are covered in semester 1, topics 4–6 in semester 2. Within each topic, a new sub-topic is started each week.

Assessment

In the past (up to and including the academic year 2006/07), the course has been assessed by both in-course assessment (ICA, 40%) and formal university examination (60%). The ICA component consisted of two large hand-written assignments, one at the end of semester 1 and the other at the end of the spring term in semester 2.

2. Motivation for the use of CBA

2.1 A more continuous assessment – an improved tool for learning

We found that the ICA used before 2007/2008 inhibited student learning and needed revising. The first assignment was not set until teaching week 10 of semester 1 and there was no incentive for students to learn during the Semester or to attend lectures regularly. Many students missed lectures and so chose not to submit work as they did not have the necessary taught skills. This was also true for students with A-level mathematics, as in the first few weeks the material is elementary and some perceived the work to be too easy and so missed lectures. However, the work quickly becomes more involved and by the time the assignment had been set some of these students had missed some of the material required to perform well.

The revision of the ICA format in 2007/2008 was focussed on increasing engagement by introducing more effective continuous assessment every 4 weeks matching the introduction of topics so that students can no longer 'coast'. Clearly, more text based assignments would be prohibitively resource expensive with such a large class (see 2.3) and CBA techniques were introduced given the 2006/2007 experience in the School of Maths & Stats. The two more substantial written assignments were retained as they are vital for demonstrating application of the taught skills tested by the CBAs.

2.2 Student diversity

Student diversity was another issue to consider: some students had already completed a stage 1 mathematics course in 2006/07 others have not studied mathematics/statistics since GCSE. In 2007/08, only 17% of students registered for the course had studied mathematics at A Level, some without statistics. Also, overseas students were just over 14% of the class. There is every likelihood that such diversity will become more acute. The way the course is assessed should recognise and be sympathetic to such diversities; for example, Entwistle *et al*. [2], discuss the importance of appropriate assessment strategies for weaker students, including positive reinforcement of core material – this is exactly what the CBAs would provide. Mastering the basics of each topic through the CBAs will provide a more solid base for tackling the written assignments. Carroll and Ryan [3] also discuss methods for improving teaching and learning practices with implications for assessment strategies when teaching international students (see 2.3 below).

2.3 Marking and feedback

Marking the ICA for such a large class is time consuming and resource expensive. A major criticism of this course in 2006/07 was a delay in feedback. The students felt this inhibited their learning of new material. The following is a direct quote from a mid-semester questionnaire given out to the students in March 2007:

> ***"I didn't get my mark for assignment 1 back until the end of January. How am I supposed to know if I'm following the work correctly? We covered loads of new stuff in between submitting the assignment and getting our marks back which relied on material covered in the assignment."***

Carroll and Ryan [3] argue that prompt feedback, and encouragement, is particularly important for international students. More generally, prompt feedback to students whose first subject is not mathematics and statistics is important to avoid student disengagement; Entwistle's investigation of first year students in Scottish higher education, taking a compulsory mathematics 'service' course [2], showed that a contributory cause of student failure was an almost complete absence of feedback on progress during the first term of their studies. The 2005 National Student Survey, identified inadequate feedback as one of the least satisfactory aspects of students' courses (National Student Survey, 2005). CBA feedback, from 2008/09, will be immediate. CBA feedback is also descriptive, and it is very easy for the lecturer to collate information on all students generally, identifying areas of weakness and hold a "feedback" session soon after the CBA to work through the more difficult points.

3. Using CBAs

Given the experience of CBA use in 2006/2007, it appeared that they could help tackle the problems of sparse assessment, student engagement, student diversity, and poor feedback as reported above. We decided to set up six CBAs over the course of the academic year; three in each semester, and assessing the material covered in each of the six topics outlined in section 1. Each CBA "went live" in practice mode in teaching weeks 3, 7 and 11 and in exam mode the week after. Thus, the students were assessed on material relating to each just as that topic was coming to a close so that the students could clearly see how each CBA fitted in with the course material. The questions used were largely data response type questions with each student being presented with a randomly generated unique dataset to analyse for each question. The more descriptive parts of the course were assessed via multiple choice questions taken from a large bank of questions.

The following (see Fig 1) is an example taken from CBA 5 on hypothesis testing and the χ^2 test. Each time the question is attempted a different set of data is presented.

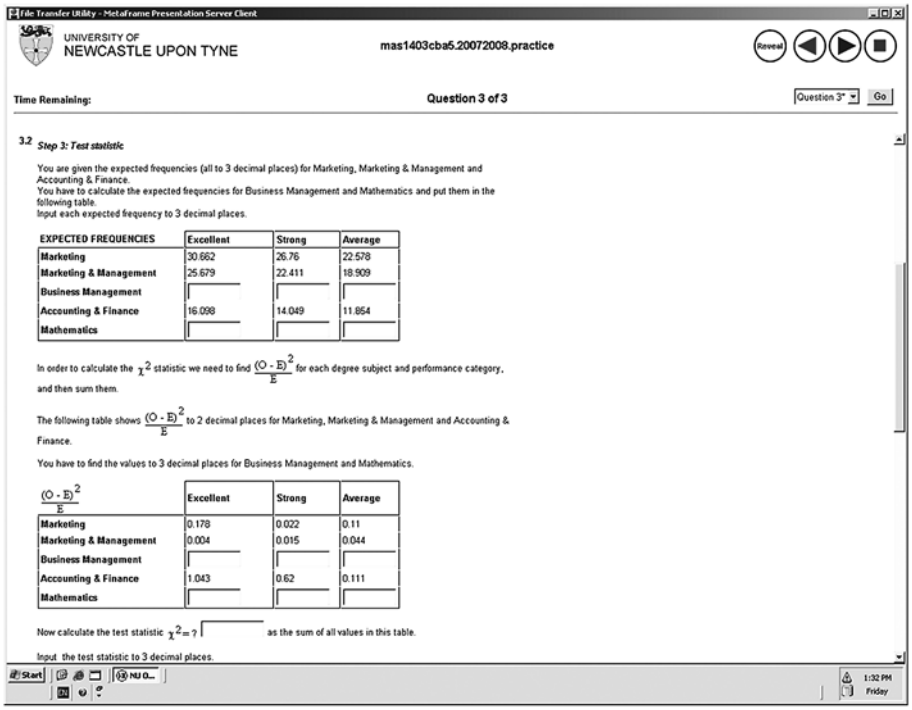

Fig 1 – Example question on hypothesis testing and the χ^2 test

The CBA system, in its current state, provides the full solution in exam mode after sitting the exam, but not the mark, and it usually took about a week to return the CBA marks to each student via email. This, however, will not be the case in 2008/09 – a new version of the CBA examiner will provide the student with marks for each exam.

4. What happened?

Generally the CBAs worked well and the student feedback regarding the use of CBAs is promising (see 5). However, a few problems did arise.

4.1 Extensions to CBA deadlines

The large class size, and the increased number of CBA submission deadlines meant that requests for extensions became more frequent and a considerable amount of administrative time and effort was spent on this issue leading to delays in the feedback of CBA marks to the rest of the class. One solution to this, as discussed at our recent teaching away day, might be to forbid any extensions to CBA work at all; if a student fails to submit an exam by the given deadline, they will have to submit a "Personal Circumstances Affecting Performance" form and if this is upheld, this CBA could be disregarded.

4.2 Access problems

A small number of students joined the course late or their sponsors did not release tuition fees and so the students were not registered for the CBAs. Most were largely rectified within the first four weeks and practically all were sorted out in time for the second CBA.

4.3 Using remote access

A large number of students decided to access the CBAs off-campus using the "Remote Application Server" (RAS). This server did, once or twice throughout the year, experience difficulties which resulted in a small number of students not being able to complete their CBA exam as they had started close to the deadline. Students were told on several occasions not to use RAS to submit work in exam mode close to the deadline. The student does not lose any work on a crash as it is automatically backed up and they can come back to the exam.

5. Student engagement and student feedback and reaction

The following (see Fig 2) gives the completion rates for all six CBAs and all are over 80%.

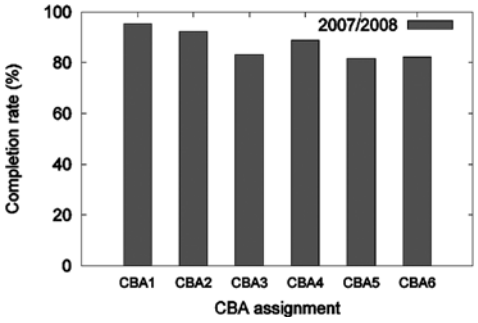

Fig 2 – Completion rates for all six CBAs

This coupled with the feedback below demonstrates that the class remained engaged throughout the course.

A questionnaire relating to the use of the CBAs in this course was distributed to the students in week 8 of semester 2; the students, by this time, had completed five of the six CBAs. Generally, the results were very pleasing, and the use of CBAs appears to have been a success. There were ten questions on this CBA. One question asked students to rate the usefulness of the CBAs as a tool to learning (1: Not useful at all up to 5: Very useful). Another asked students to rate how easy-to-use the system was (1: Very easy up to 5: Very hard). The graphs in Fig 3 overleaf summarise the students' response to these questions:

The students were asked to give feedback on any problems they encountered when using the system. The most common problem (9 responses out of 191 respondents) related to the RAS "crashes".

The students were also asked if they'd like to see CBAs in other courses. 69% said they'd like to see them introduced in *some* other courses, whilst 18% said they'd like to see them in *all* other courses!

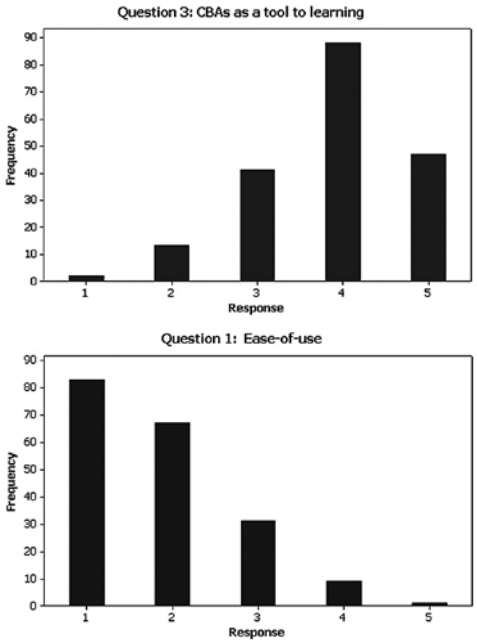

Fig 3 – Student feedback on

a) usefulness of CBAs as a tool for learning and

b) ease of use of system

More variable were the results on feedback. When asked how efficient they found feedback for the CBAs (1: Not efficient at all up to 5: Very efficient), the average response was 3.69. This is reflected in the end-of-questionnaire comments: many students said the only thing they were unhappy about was that the system didn't return their marks immediately, although they were given a full solution to compare with their answers.

The students were also given the opportunity to discuss the use of CBAs in their online module evaluation form for this course. Some of these comments are shown below:

"CBAs are great, I like the way you can do them in your own time and submit the exam when you're ready"

"CBAs have really helped me learn stuff in the course"

"The CBAs took me ages, and each one's only worth about three percent"

"Had a few access problems with the CBAs ☹ but overall they're quite good"

6. CBA and final exam marks and comparison with 2006/2007

We decided to compare final grades for students in:

- 2006/07 (no CBA component; 40% written assignments, 60% exam); and,
- 2007/08 (20% CBA, 20% written assignments, 60% exam).

Other than introducing CBA, there was very little change in the way the course was taught in 2007/08, though online videos have been introduced on important topics and use of calculators. Table 1 summarises the end-of-year grades:

Cohort	Mean	Median	St. dev.	Lower Quartile	Upper Quartile
2006/07	64.5	67.0	17.6	56.0	81.0
2007/08	67.2	68.5	15.6	56.0	87.0

Table 1 – Summary of end-of-year grades

The distribution of marks, is fairly symmetric around the mean, and a two-sample *t*-test to test for a difference in average marks between the two cohorts reveals a significant result ($t = -2.17, p = 0.030$). Factors other than the introduction of CBAs (for example a cohort effect) could have contributed to this difference; however, other than the introduction of CBAs the course has changed very little and so this comparison is informative. One student, having failed the course in 2006/07, re-sat the entire course in 2007/08 and said:

"They [the CBAs] have been great. There was no incentive for me to learn last year. The CBAs made me learn the course as I went along this year. I actually enjoyed doing them, and enjoyed getting stuff right! If we had them last year I might not be here now."

In 2006/07 his final mark for this course was 26; in 2007/08, it was 58.

7. Changes for next year

Given the experience of 2007/2008, the following are planned for 2008/2009:

1. Deadlines to be strictly observed with a formal policy in place.
2. Review all CBA questions given the data provided by the system on student performance.
3. New version of the examiner giving immediate feedback of assessment marks.
4. Create more videos to be linked from the CBAs.

8. Conclusions

The major objective of increasing student engagement throughout the course has been largely achieved. The six CBAs have contributed to this by creating a framework for this engagement. The setting up and consequent initial administration of the CBA has taken significant resource but this is far less than that required for the same level of in-course assessment by other means. Also, apart from some minor revision and upgrades and adopting policies on extensions the CBA work will dramatically decrease in subsequent years.

References

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2. Entwistle, N.J., Hounsell, D., Macaulay, C., Situnayake, G and Tait, H. (1989) The Performance of Electrical Engineers in Scottish Higher Education. Edinburgh: Centre for Research on Learning and Instruction, Department of Education, University of Edinburgh.

3. Carroll J. and Ryan J. (Eds.) (2005) *Teaching International Students: Improving Learning for all*. Routledge, London.