Biostatistics: e-learning strategies for improving student understanding – an e-learning practice case study

Author's name Glenn Baggott

Institution name Birkbeck, University of London (School of Biological and Chemical Sciences)

Background

Birkbeck specialises in part-time evening study for mature students, who are in employment during the day. The median age of learners is 29 in the School of Biological and Chemical Sciences; and there is an even gender balance. Teaching sessions run from 18:00-21:00 and a taught half-module consists of 11 weekly sessions. The undergraduate degree programmes last 4 years and are awarded on performance in 9.0 modules (of 10.5 completed) of which 5 must be Honours (H) level. The Biostatistics course is a compulsory H level, year 3, half-module for B.Sc. Biological Sciences.

The challenge

All teaching and learning at Birkbeck suffers from severe time constraints. There are few opportunities for tutorials and time for self-study is very limited. This is due to students being in employment and from mature students' having more extensive family and work responsibilities. Effective learning of statistics is also hampered by the poor numeracy of undergraduate bioscience students[1], from a negative attitude to the topic[2], and the perception that biology is not conceptual or mathematical[3]. Unsurprisingly, performance in this module was worse than for other H level modules. In 2003 and 2004, 40% and 50% of the class achieved a mark of 50% or less and about one-third attained a mark of 51-70%.

The challenge was to provide appropriate, timely, support designed to help students improve their understanding of biostatistics in this adverse learning environment. A desirable option, a module based on 'real-life' research-focussed biological questions[4] was felt too time-consuming for part-time study. Consequently, the aim was to modify the existing conceptually-based module utilising teaching, learning and assessment strategies designed to reduce negativity, build confidence, and provide feedback that encouraged thinking and practising of the subject.

Intended outcome(s)

An audit in 2004 identified the necessity for more tutorial support linked to: 1) progressive assessment; 2) provision of rapid, specific feedback (for practice problems) and generic feedback (for summative tests). Given the adverse learning environment it was decided that the increased tutorial support could only be achieved by e-learning tools. The primary objective, then, was to use computer-based learning materials to supplement in-class tutoring. E-assessment would be used to provide tutorial support in the guise of formative assessments with instantaneous diagnostic feedback, showing how students could improve their performance. E-assessments would be integrated within an assessment regime designed to build learners' confidence and facilitate the demonstration of understanding in an unseen, written, 'theory' examination. The latter was used to assess the application of students' knowledge to novel problems.

Established practice

In 2002 and 2003 the module consisted of 10 weekly sessions each comprising a 40-minute lecture, 2-3 practice problems and then up to 3 assessed problems, all with tutor support. Summative assessments consisted of: 1) week 16 submission of assessed problems; 2) an unseen, open-book written test in week 11 replicating the structure of the unseen 'theory' paper; 3) an unseen 'theory' paper in week ~20. As the 'theory' paper required only simple arithmetic, it was intended that this assessment would test a candidate's understanding of biostatistics rather than computational virtuosity. Whilst Minitab statistical software was used for statistical computations in class, there was no specific use of e-learning tools to enhance student learning.

The plan

E-assessments were a planned part of a revised assessment strategy. So changes would be made to the assessment regime but not the content. The learning outcomes and marks for each practice or assessed problem would be clearly published. Before the unseen 'theory' paper, both the practice problem solutions and grades, with individual written feedback, would be released. The first summative assessment was scheduled for week 5 as an unseen, open-book, not time-limited, computer-based assessment (CBA); individual detailed diagnostic feedback to be provided within days. The questions posed would be fairly easy, so building confidence in the student's ability to master this topic. In the following week a formative assessment on CD with questions similar to those of the week 5 assessment would be released for self-study. Authoring would be in-house using Authorware/TRIADS software[5] incorporating random datasets to generate alternative questions. The TRIADS system based on Macromedia Authorware was chosen for its ability to produce and deliver highly interactive computer-based tests capable of testing higher order learning.

The formative assessment would be delivered in two forms: one with diagnostic feedback and the other a 'self-test' returning only a score. The delivery of this tutorial material at this specific time was intended to facilitate engagement with the topics. The second summative, unseen, open-book, assessment would be in week 12 and consist of a CBA (1.75h) and a written section (1.25h) covering topics from weeks 6-11. The written section replicated the structure of the 'theory' exam. Detailed, individual, feedback would be provided for the CBA and written test within days. Generic feedback would be also provided for the written section. In week 12 a second CD of formative assessments would be released with questions/assessments structured as the first CD. For the unseen, written, 'theory' paper (week ~20) the time would be increased (to 2.25h) to include reading time. There would be one compulsory question (definitions) and two others chosen from five.

Division of work

Tutorial CDs were prepared in advance using dedicated staff. This was helpful as expertise was not dissipated and solutions to authoring difficulties could be found rapidly. However, the content is now fixed as the dedicated staff are no longer employed; but this is not a particular problem for this topic. Summative tests were analysed for effectiveness in discriminating student performance and teaching staff made any adjustments necessary.

The e-learning advantage

The use of CBAs incorporating diagnostic feedback for self-study provided a significant enhancement of tutorial opportunities for these part-time students. The release of these CDs at the time of the corresponding summative assessment helped to engage the learners with the topics and ensured practice at an appropriate time. Students could use their feedback from summative tests in combination with CD diagnostic assessments as an aid to self-improvement; an outcome not achievable by conventional means in the Birkbeck learning environment.

Key points for effective practice

1. The e-learning element should be used to address a specific need readily identifiable as such by the learners. In this case, to increase opportunity for improvement.
2. CBA feedback must be detailed and diagnostic to facilitate student improvement.
3. Combine formative practice with recent summative assessments to provide the best opportunity for improvement.
4. Ensure the first CBA is relatively easy (yet low stakes) to build student confidence.
5. CBAs can entail a risk of 'coaching' for assessments. Wean learners by combining CBA and written tests (as in week 12 test). They are then better prepared for the unseen written 'theory' paper.

Evaluation

After full implementation of the CD-supported structure the proportion of students achieving marks of 51-70% increased to 57 and 53% in 2005 and 2006, respectively. As in previous years about 20% performed well (mark>70%). For students that achieved a mark >50% median scores for the 'theory' exam increased from 50% in 2003-2004 to mid-60% in 2004-2006.

In 2002-2003 the median marks for the week 12 test and the 'theory' exam were the same; in 2004-2006, 'theory' marks were 6-13% higher than for the week 12 test. As intended, scores for the week 5 CBA were higher (71-82%) than for other assessments. Scores for other assessment elements did not change over this period.

In 2004-2005 students were surveyed using a modified Assessment Experience Questionnaire (AEQ) based upon the '11 conditions of assessment that support student learning' [6]. The AEQ included only those questions that explained the majority of the variance[7]. The AEQ was administered at the week 12 test and the 'theory' paper. Questions were posed about the current assessment, past assessments (week 5 or week 12 test) and learning resources. Most students agreed that the feedback helped prepare them for the assessment (73%); that they read the feedback carefully and that it prompted them to further study (94%); that the feedback helped them understand (88%); and that it showed them how to improve (69%). Three quarters of students said they found the CD content useful; all used them.

Pitfalls

In 2004 the formative tests were initially web-delivered. Usage was very low and so they were issued on CD late, just before the 'theory' exam. In 2005 both methods were used and hardly anyone used web-delivered tests. In 2006 only CD's were supplied. The mode of delivery of e-learning materials can be critical for success.

Conclusions and recommendations

The introduction of e-assessments for tutorial self-study into this module improved the performance of students the unseen 'theory' examination, an assessment designed to demonstrate a learner's ability to apply their understanding to novel problems. The improvement in student performance was achieved by the use of e-learning tools to address the module's main weakness, insufficient tutorial support, plus a restructuring of the module assessment regime by: a) a confidence building strategy; b) subsequent detailed, timely, feedback within a progressive assessment regime; c) provision of CD formative tests with summative assessments so promoting engagement with topics at appropriate times.

Additional information

For further details please contact Glenn Baggott, Email: g.baggott@bbk.ac.uk

References

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4. Panizzon, D. L. and Boulton, A.J. (2004) Strategies for enhancing the learning of ecological research methods and statistics by tertiary environmental science students. *Bioscience Education E-journal*, volume 4 available at http://www.bioscience.heacademy.ac.uk/journal/vol4/beej-4-1.htm (accessed December 2006).

5. A demonstration of TRIADS is available under the Assessment section of the website of the Centre for Interactive Assessment Design, University of Derby: http://www.derby.ac.uk/ciad/

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