Computer-based assessment in numeracy and data analysis for Business

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Background

The subject Mathematics and Statistics forms a division within the School of Computing and IT and provides two types of modules. The first type are modules for students wishing to study majors or joints in Mathematical Sciences or Statistical Sciences. The second type are modules for students who require a module of Numeracy, usually Data Analysis, as support for their major or joint studies in Science, Computing, Business or Engineering. One of the modules of the second type, MM1007 Introductory Data Analysis for Business, was selected for use in this innovation.

Module MM1007 is studied by approximately 450 students across three campuses, two franchise colleges and via the Wolverhampton Online Learning Framework (WOLF). It is taught by some twelve staff situated at three campuses, and by a further two staff at the franchise colleges. All students, irrespective of their campus or college, are taught using a common set of notes and sit the same assignments and examination.

Students enter Wolverhampton Business School (WBS) to study on a variety of degrees such as the BA (Business Studies) or on a variety of diplomas such as HND (Business Studies). Students who are intending to Major in Business Studies or some similar subject in WBS enrol on the Combined Awards scheme. All these students have MM1007 as core on their programme.

The pre-requisites for the module are a minimum of a grade C in Mathematics at GCSE for students entering from school or college and its equivalent if students enter with BTEC or Advanced GNVQ. Mature students are interviewed and must provide evidence of some mathematical competence. These are minimum qualifications and a minority frequently possess GCE A level mathematics.

The group of 450 students contains three types of students. The first type consists of intelligent, highly motivated students for whom any teaching approach is probably suitable. This group is approximately 40% of the total in size and students within it work hard to succeed, extending the help they receive to self-help. The second type consists of those students for whom mathematics is rather more difficult than their other topics and who, initially, require considerable guidance. This group is about 30% of the total in size. Those students who persevere and partake of the resources available (i.e. attendance at tutorials and workshops) generally succeed and indeed many succeed as well as the first group. The third type consists of those students whom staff consider to be a challenge. These students have considerable difficulty with elementary mathematics (percentages, fractions, graphs) and find even using a calculating machine difficult. This group is about 30% of the total in size and potentially are failures within the module. It was hoped that the innovation would be of especial benefit to these students.

The 450 students consist of about 100 at the franchise colleges and 350 within the University. The 350 are split into five groups and each group is given the opportunity to attend a three hour session, choosing whether to attend at the Compton, Telford or City campuses and morning, afternoon or evening sessions. WOLF is also used for delivery for those students wishing to study using an electronic medium. The three hours consist of a lecture, a computer workshop when students learn to solve problems using Excel, and a problem-based workshop when students solve mathematical problems. The lecture size is about 80 students and the students are split into groups of 20 for tutorials and workshops. One member of staff assumes responsibility for a group of about twenty students. They are the contact point for the group and mark the assignments and the exam scripts.

Students receive a set of notes at each class. If they fail to attend, the notes, and associated workshop materials, are available to them on the Mathematics and Statistics Web site and can be saved and printed within the University. In fact, because the material is kept permanently stored on the Web site, students can run the whole lot off at the beginning of the module. Solutions to all the problems are also provided on the Web along with copies of the last three years' exam papers and solutions to the questions. The module guide is also available.

Rationale

With such a module as this, it is obvious that students must spend a large proportion of their time outside the formal class time solving and practicing problems. Some students are motivated do this using the provided tutorial sheets and text book references. Staff have observed that the majority of students do not do this for various reasons, one of which is that often feedback is not available. It is also known to staff that practicing previous exam questions and assignment questions is an excellent way for students to learn to apply their knowledge.

The problems of assessment for such a large module are well known to staff. No single member of staff can mark all 450 assignments and the load is spread across all those who teach on the module. This leads to problems of consistency of marking, collecting in all the results from across the different sites and colleges and ensuring feedback within three working weeks.

In summary, a method is required which allows students to gain confidence from practice, to obtain practice at sitting assignments, and to obtain instantaneous feedback. To be practical, the method must use staff time more efficiently, use an electronic means of setting and marking, and be capable of eventual incorporation in WOLF.

The innovation

It was decided to solve the above problem by concentrating on the two assignments. These allow the grading of the various learning outcomes associated with the module. Assessment criteria are provided for the students in the appropriate assignment.

For each assignment, a bank of questions corresponding to each topic was constructed and stored electronically in the form of a computer program. Each program is made available as a single standalone file which can be run from a networked PC. It is designed to be available to students for work at home by being small enough to fit on a single floppy disk. It is also available to be placed on the WOLF server and can then be downloaded from there and run on a local PC.

When a student wishes to practice, he or she loads the program using any one of these methods and is provided on screen with a set of questions randomly assigned from the stored internal bank. The student answers the questions, puts the answers on screen and then receives feedback at the end of the session. The feedback is in the form of a mark and the correct answer for each question. The student can choose to practice as many times as he or she wishes. When, eventually, he or she has had sufficient practice, they can present themselves at the appropriate time and the timed test begins.

The rationale behind allowing the student to practise the test as often as they like is simple. It motivates them; it helps students, particularly the weaker students, to overcome the common problem of a fear of maths by enabling them to target their revision at the questions that they think that they can learn how to do in order to achieve the grade that they desire. The clear association that they will see between revision and higher marks on particular questions will hopefully give them the confidence and self-belief to engage more deeply with the subject material.

The tests follow the approach pioneered by a statistics test, studies upon which produced evidence of improved student deeper learning from the approach [1–5].

The outcomes

Staff were asked to vet the questions for suitability and appropriateness. Two groups of students were then asked to test the running of the programs and the bank of questions contained in the two tests. In the majority of cases, each student was asked to run through the test, check the feedback, reflect using the feedback for about 20 minutes and then run the test again with another bank of questions. The results are shown in the two tables below.

Test 1 included surveys and questionnaires, sampling, elementary financial arithmetic, summaries and charts.

Test 1: 12 students (% results)

Test 1	Run 1	74	32	85	21	26	48	55	43	72	58	40	15
	Run 2	68	46	74	-	41	50	58	-	83	67	49	42

For the majority of students, there was some evidence that the test performance increased after only one practice (Wilcoxon's test P= 0.066; reference 6,7). Examining the differences for each student suggests that performance for students scoring highly (70% or more) in their first run has not on average increased. For students scoring in the middle range (from 40% to 55%), performance increased. The biggest change was for the group failing to achieve in the first run who scored much better in the second.

Test 2 included mainly regression and correlation plus tests of significance.

Test 2: 8 students (% results)

Test 2	Run 1	63	71	31	28	40	25	15	27
	Run 2	85	86	48	39	61	49	-	43

For this test, which covered different topics, there is good evidence (Wilcoxon's test P=0.018; reference 6,7) that performance has increased for all students who took two runs. In this instance it can be seen that there are increases across all types of student.

In general, although the sample size is small, it appears that the practice gained from sitting the same test twice leads to improved performance, particularly for the 'failing' students.

Benefits

The benefits from the point of view of the mathematics is that students have the opportunity to gain confidence, practice tests and gain a pass. This leads to a higher retention rate. After the initial resource investment—production of a bank of questions and suitable programming to produce the tests—staff time can be used more effectively since they have no need to set the questions, have no need to mark them and have no need to provide written feedback.

Evaluation

The major feedback has been from student comments. Those students who sat the tests provided good comments. Some quotes are given below, divided into positive points and negative points.

Positive points
'learned from practicing, could have done with another session', 'not as scared of maths as I was', 'quite good fun', 'felt more confident about the assignment', 'being able to practice meant I knew what was expected of me', 'instantaneous feedback is very good', and a final one 'the cheats will not find it easy to copy'.

Negative points
'the technical side of running the tests worried me', 'I felt under pressure', 'couldn't get the software to work on my machine', ' put off by having a member of staff supervise the actual test'.

Interviews with staff suggested that they were, without exception, in favour of the method. Their only reservation was the amount of effort that would be required if they had to produce their own data banks. They felt that this method was very suitable for Level One students.

On the whole, the evidence is that the method does improve confidence and interest in the subject. It also has the potential to increase the retention rate

Future developments

Currently, one module in statistics already uses something similar and works well. The students must, of course, be supervised when they take the test (to ensure they don't collaborate or substitute a more knowledgeable friend). The work carried out during the innovation has led to the production of tests for this module and there is no reason, resources permitting, why other modules should not be provided.

Another potential source of usefulness is to employ WOLF as the medium for the delivery of the tests. Storage of the grades could be done at the same time. This would have the advantage that the medium will be familiar to students and technical difficulties can become the responsibility of the IT Services.

The University is aiming to provide the key skill of 'Application of Number'. This method is a way of increasing confidence in such numeracy and providing assessment without staff time being spent marking. Of course, considerable effort would have to be expended in producing the appropriate data bank and programming for a University wide scheme. The questions produced would have to be relevant to the subject or School concerned.

References

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