LARGE SCALE AUTOMATED ASSESSMENT

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Abstract *¾ Marking assignments is a time consuming activity which is further exacerbated by the need for regular submission and quick turn around time. At the University of Ulster, online assessment methods have been adopted in order to address the pressing problem of coping with large student numbers. The 'TopClass' system is used to provide a vehicle for the regular assessment of more than 400 students studying 'Networks and data communications'. This paper outlines the experience gained through large scale use of automated assessment.*

Index Terms ¾ Computer assisted assessment, TopClass, Networks and data communications

INTRODUCTION

The increasing student numbers in higher education and in particular the demand for skills to meet the needs of the new knowledge based economy are moving at a speed which the supporting infrastructure finds difficulty in keeping pace with. Conventional support for academic lecturers in computing and information sciences is declining, due to decreasing per capita student funding and a difficulty in attracting computing science research students, whose skills are generously rewarded in the commercial world of Information and Communication Technology. In particular, whilst the conventional classroom lecture can accommodate numbers limited only by physical space provision, the need for timely assessment and rapid feedback to large student groups presents a significant workload. The attractiveness of automated methods for testing and assessment increases accordingly.

To help meet the demand for skilled computing professionals many UK Universities now offer non-computing graduates a postgraduate conversion course. The University of Ulster offers one such course – the MSc in Computing and Information Systems. This course has grown rapidly in popularity from 15 students at its inception in 1982, to a total registration of 572 in 2000/01, making it one of the largest courses of its kind in the UK.

The MSc in Computing and Information Systems aims to provide postgraduate education and training, for non-computing graduates, in the concepts and methods of computing and information systems, relevant to the needs of the commercial, industrial and public sectors. The course is made up of 8 taught modules (6 compulsory and 2 optional) together with a dissertation, which requires a critical approach and provides the student with an opportunity to manage a software development project. The course is offered in both full-time and part-time mode and taught on two campuses – Jordanstown campus, North of Belfast and Magee campus in Londonderry – with lecturers on both sites teaching to a common syllabus with identical assignments and examinations.

NETWORKS AND DATA COMMUNICATIONS MODULE

The module in 'Networks and Data Communications' provides an appreciation of the architecture, topology and protocols of local and wide area networks. In addition, it provides an understanding of computer communication principles and an overview of the world wide web and applications such as e-commerce. Basic theory is augmented by information on the current technology that students may encounter in their workplace.

Currently students are taught in a conventional lecture environment, with assessment by both coursework and formal examination. Lectures were delivered over a 3-hour period each week, with 50% of the time being devoted to basic data communications and 50% to computer networks (delivered by 2 different lecturers). The nature of the material allowed concurrent teaching of these topics without the need for pre-requisite knowledge from either. Thus, although one module the students perspective is often of two different subject areas.

In common with other modules on the MSc in Computing and Information Systems, registrations have risen sharply in recent years with a total of 413 students registered to take the networks and data communications module in 2000/01. In 1998/99, driven by the increase in student numbers, the module co-ordinators decided to incorporate an element of computer assisted assessment (CAA) into the coursework component of this module in order to limit the manual effort. The CAA tests were administered on-line using the 'Topclass' system [1], providing immediate feedback of results to both students and lecturers, thus facilitating the identification of problems at an early stage.

The following sections outline the techniques employed, providing commentary on how integration of the CAA

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component has evolved during the past three academic years.

Coursework

Authoring high-quality questions for objective testing is a time-consuming task and so in it's inaugural year (1998/99), only one CAA test was introduced. This test, covering approximately half of the syllabus, accounted for 15% of the total module mark. A further 10% was available via an individual written assignment, the remaining 75% being attributed to the examination. Despite the fact that only one test had been introduced, the time saved marking was considerable.

Based on the success of this system, it was decided to increase the CAA component and redistribute the allocation of marks for the module such that coursework contributes 50% of the final mark for the module, the remaining 50% being scored in a 2 hour written examination.

Based on this model, in 1999/2000 the coursework was delivered as 5 class tests, each comprised of a number of questions based upon preceding lecture material. A final groupwork assignment, with students working in groups of 4, completed the coursework. The final coursework mark for the module was calculated as follows:

- The 4 best sets of marks from the TopClass tests contributed 80% of the coursework mark;
- The groupwork assignment contributed 20% of the final coursework mark (all members of the group receiving equal marks).

By discarding one set of marks from the tests, this ensured that any student who had not completed a test or had performed poorly (perhaps due to ill health) was not treated unfairly.

In the current academic year, it was decided that the groupwork component should be dropped as part-time students found difficulty in co-operating in this type of activity. The on-line assessments continued to be delivered as 5 class tests, each comprised of a number of questions from preceding lecture material as demonstrated in Table 1.

Examination

In 2000/01, the formal examination had 2 sections.

Section A took the form of multiple choice questions of a similar nature to the TopClass tests, but was administered under strongly supervised examination arrangements. The students completed their answers using a 'survey form' which was then marked using Formic [2]. Section B was comprised of 4 descriptive examination questions, of which students were asked to complete 2 of their choice.

Students are required to submit hand written evidence of their selection for any mathematically based question. This work is cross-checked with the completed survey form to ensure that no marks are allocated for randomly selected answers, thus ensuring that opportunist students do not benefit from inflated marks. Comparisons between marks in Sections A of the examination and the TopClass tests are reported later in this paper in the 'Results' section.

TECHNOLOGIES

TopClass

WBTSystem's TopClass [3] is a web-based solution for the delivery and management of online teaching and training materials. It operates as a client/server application over campus intranets or the internet, providing administrative functions for managing learners together with facilities for

- Course delivery
- Discussion and
- Testing.

Registered students can access the system using any web browser in order to take courses and tests and engage in discussions with their peers and tutors.

The testing facility in TopClass, creates tests from one or more question pools, where a pool acts as a repository for a set of questions. Each question must be associated with a question pool and pools can be used in multiple tests. Question pools may have just one single questions or many hundreds of questions.

TABLE I
COURSEWORK SCHEDULE

Coursework Number	Week Assessed	Material	Covered	Weeks Taught
		Networks	Data Communications	
1	3	Standards Encoding Systems	Asynchronous and Synchronous Communication Error Detection and Correction, Flow Control	1,2
2	5	Medium Access Control	Packet Switching, Datagrams and Virtual Circuits Series and Parallel communications	3,4
3	7	LAN Systems Ethernet, Token passing Wireless	Connections and Signalling Multiplexing	5,6
4	9	Network Interconnection	Networks Systems, Mediums and Topologies	7,8
5	11	Network Interoperability	Wiring Systems and Structures	9,10

Local Implementation

The 406 students who enrolled to undertake the 'Networks and Data Communications' module were allocated to 'classes' within the TopClass system. A maximum of 100 students were able to access the system at any one time and students were assigned to sub-groups depending on their campus location and mode of study. Up to three laboratories, each containing 30 workstations, were scheduled for sessions lasting 45 minutes each, in which the students accessed and completed the tests. A number of demonstrators familiar with the system helped in the supervision of the laboratories.

In week one of the module each student was provided with a username and a password with which they could access their own individual workspace throughout the term. A user-guide was also made available to the students to help them in navigating the system for the first time. Students accessed the system through a standard browser and entered their individual workspaces using the username and password provided.

The tests included a number of multiple choice questions ranging from the typical true/false boolean question to list matching where students had to carry out calculations and match their answer to one offered by the system. In an attempt to minimise students attempts at plagiarism, pools of 4 questions, similar in style and level of difficulty, were created. One question from each pool would be displayed at random to each student.

After logging on students were allowed 35 minutes to complete and submit a test. If a student had failed to submit the coursework within the time period set the student was timed out of the system and no result was recorded.

Time restrictions were also placed on when students could access and submit tests. Typically tests were available for a 2 hour period. This was particularly beneficial for part time students who may not have been able to attend lab classes due to work commitments. Such students could request permission to sit the test external to the university. However it was explained in advance to the students that the examiners hold the right to review the tests performed in unsupervised conditions with some scepticism.

Once the test window was closed results for the autocorrected test were made available to the students the following day. Students were then able to access their results via the options in the menu presented following logon. After all the tests were carried out they were made available to the students once again for revision purposes.

At any time students could use the discussion facility to communicate with each other and the lecturer (although this facility was rarely used).

TopClass Limitations

The system implemented at Ulster has been utilising TopClass version 3.1. It is recognised that many of the problems reported in this section have been addressed in more recent software releases.

One of the major limitations with TopClass 3.1 is that it does not give students any advance warning as to when they will be timed out from a test. This is a major source of complaint from students as it results in a zero mark being recorded. In some circumstances, students were allowed to re-sit the test.

Since the TopClass system was located on a server which did not have 24/7 maintenance it was inevitable that server problems would arise. On one occasion, this meant that the test had to be re-scheduled to the following week.

From an academic perspective, the greatest limitation of Topclass 3.1 is the type of results it returns. Whilst it is possible to obtain overall scores for the students it is not possible to see how the students score in individual questions. This presents a problem in so far as it is impossible to determine if there is a question that is presenting a problem to the class as a whole either because

- the incorrect answer has been flagged as the correct answer or
- the class have had difficulties in interpreting the lecture materials and require remedial assistance from the lecturer.

The most recent release of TopClass (version 5) addresses many of these issues, providing comprehensive tracking facilities and reports on class and individual learner progress. Teachers can easily monitor the progress of their assigned learners individually or by class. TopClass also integrates with Oracle Reports for powerful reporting capabilities.

Formic

Formic is an automated data entry and validation forms processing system. It automatically reads and processes any combination of tick boxes and hand writing offering a complete data collection solution. An integrated statistics module provides facilities for statistical analysis and enables the user to view the survey results database in various graphical formats. The system also provides for export of comma delimited files to other software packages.

PORTRAIT OF THE MSC STUDENT COHORT

In order to acquaint students with the features of the TopClass system and the different types of questions available to them, their first exposure to the system was an on-line survey to determine their previous experience and expectations from the course. The following tables provide a picture of students enrolled on the Networks and Data Communication module in 2000/01.

The Faculty of Informatics at the University of Ulster is rightly proud of its record in attracting female students. Female entrants to courses are typically around 40% (more than twice the national average) and the MSc in Computing and Information Systems is no exception (Table 2).

TABLE 2
STUDENT PROFILE: GENDER

Gender	Full-time (%)	Part-time (%)	All students (%)
Male	62	60	61
Female	38	40	39

Unsurprisingly, the age and qualification profiles (Tables 3 and 4 respectively) of entrants, indicate that the majority are recent graduates who recognise that a computing qualification increases potential for job opportunities and increased earning potential.

TABLE 3
STUDENT PROFILE: AGE

Age	Full-time (%)	Part-time (%)	All students (%)
20-25	69	18	49
25-30	16	40	26
30-40	13	36	22
40+	2	6	3

TABLE 4
STUDENT PROFILE: HIGHEST QUALIFICATION OBTAINED

Qualification	Full-time (%)	Part-time (%)	All students (%)
HND	4	1	3
Ordinary Degree	8	11	9
Honours Degree	82	68	76
Masters	6	20	12
Doctorate	0	0	0

In terms of students previous disciplines,

- arts and humanities;
- business and management and
- science and agriculture

are all well represented. It is not surprising to see lower figures in engineering and medical and health sciences due to graduate employment opportunities in these disciplines (Table 5).

TABLE 5
STUDENT PROFILE: FACULTY FROM WHICH QUALIFICATION OBTAINED

Faculty	Full-time (%)	Part-time (%)	All students (%)
Arts & Humanities	23	22	23
Business & Management	26	30	28
Legal, Social & Educational Sciences	13	8	10
Science & Agriculture	23	18	21
Medicine & Health	4	3	4
Engineering	11	19	14

Approximately 30% of all students have access to the WWW at home, with almost half of part-time students gaining access from work. Few students make use of internet cafés and only 1% access the WWW from the library! (Table 6).

TABLE 6
STUDENT PROFILE: MOST FREQUENT ACCESS TO WWW

Access	Full-time (%)	Part-time (%)	All students (%)
At the university	54	20	40
From home	30	34	32
From work	9	43	23
At a local library	1	1	1
At an internet cafe	6	2	4

Only 10% of all entrants have little or no computer experience at registration with approximately half describing themselves as amateur users. More than 40% consider themselves to be frequent or regular users. (Table 7).

TABLE 7
STUDENT PROFILE: COMPUTER EXPERIENCE

Computer experience	Full-time (%)	Part-time (%)	All students (%)
Non-existant	11	8	10
Amatuer-user	52	40	47
Frequent-user	17	20	19
Regular-user	20	32	24

The ethnic population of students reflects that of Northern Ireland as a region (Table 8).

TABLE 8
STUDENT PROFILE: ETHNIC ORIGIN

Ethnic Origin	Full-time (%)	Part-time (%)	All students (%)
White	93	91	93
Indian	0	1	0.5
Chinese	6	7	6
Pakistani	1	0	0.5
Black-african	0	1	0
Black-caribbean	0	0	0
Black-other	0	0	0
Other	0	0	0

The percentage of disabled students is comparable with figures on other courses within the Faculty, although it is not unusual to record under reporting in this category (Table 9).

TABLE 9
STUDENT PROFILE: DISABILITY

Disability	Full-time (%)	Part-time (%)	All students (%)
Yes	2	0	1
No	98	100	99

RESULTS

Evidence of Student Learning

On comparison of Section A of the examination with the TopClass assessment scores achieved by students on this module the following observations can be made.

Students on average scored 14 fewer marks in the examination compared to their TopClass assessments. The standard deviation of the differences between examination and assessment scores is 17 marks. The distribution of examination versus assessment scores is shown in Figure 1.

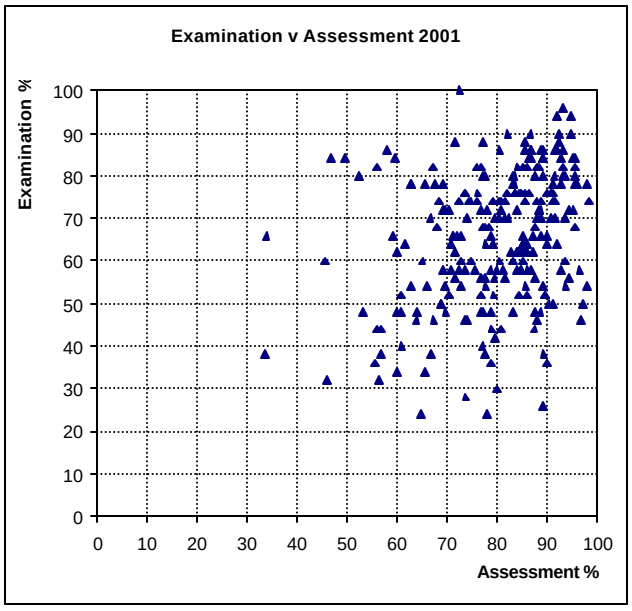

FIGURE 1

Some 5% of students achieved an examination mark that was greater than 48% less than that which they had achieved in the coursework. There is obviously concern about the commitment, to the learning experience, of these students.

However, there were a similar proportion of students for whom the situation was reversed, they scored more than 20% higher in the examination than the coursework. It would appear that these students progressed considerably after perhaps not being wholly committed to the continuous learning that was encouraged throughout the delivery of the module.

The difference of 14% between the average score in assessment and examination is similar to that on other modules of the course and is therefore not a cause for overdue concern. The following factors contribute to this effect:

- the equal weighting of each test, earlier tests are easier, for encouragement;
- students have less information to retain for a shorter time in the test scenario;
- assessment is continuous and drives students to score well and
- by its nature the assessment process is not as secure as the examination process.

At the time of writing, no marks are currently available for section B of the 2000/01 examination. However in 1999/2000, comparisons were made between sections A and B of the examination, in order to deduce if students gain any advantage from either method. Results indicate that on average students recorded higher marks in section A (Table 10). However, the average difference between sections A and B was 8%, which gives the examiners confidence in the use of multiple choice questions (MCQ) as part of the examination process.

TABLE 10
RESULTS FROM 1999/2000 EXAMINATION

Results	Section A	Section B
Average mark (out of 50)	30.3	26.6
Standard Deviation	8.69	8.70

Student Perceptions

Despite the fact that few students had previous exposure to CAA (Table 11), most found that this approach provided a useful learning experience.

TABLE 11
PREVIOUS EXPOSURE TO CAA

	CAA (%)	TopClass(%)
Yes	16	3
No	84	97

The majority found the system both easy to use despite some initial problems encountered in the access and submission processes (Table 12).

TABLE 12
USE OF TOPCLASS

	Navigation (%)	Access & Completion (%)
Difficult	3	5
Satisfactory	37	54
Easy	33	33
Very Easy	27	8

35% of students felt that 5 tests was too many, the remaining 65% felt that the frequency was about right. Unsurprisingly, no-one felt the need for more frequent testing! Almost everyone (95%) were in favour of using the 4 best sets of marks. 27% of students found the TopClass tests difficult, the remainder felt they were pitched at the right level. No-one felt that it was an easy option.

In terms of the student experience the majority felt that it had both improved the learning experience and assisted in their time management, with most students requesting for this approach to be adopted in other modules (Table 13).

TABLE 13
STUDENT LEARNING

	Improved learning experience (%)	Improved time management (%)
Yes	78	81
No	8	5
No difference	14	14

The overall feeling was that this type of assessment was at least satisfactory in producing a realistic and reliable grade and in assisting the understanding of the syllabus content (Table 14).

TABLE 14
STUDENT EXPERIENCE

	Realistic and Reliable Grading	Aid to Understanding
Poor	11	8
Satisfactory	38	32
Good	40	41
Very good	11	19

Individual responses from students indicate that this method of assessment has other attractions. One student indicated that it was more 'time efficient than assignments' whilst another expressed the opinion that it helped to 'focus study throughout the module'. Most criticisms related to the "element of luck" involved in MCQs which could give students a "false sense of confidence". The problems relating to tests being timed out and the resulting zero mark were also a cause for concern.

CONCLUSIONS

From an academic point of view this approach would appear to be reasonably successful, with the majority of students achieving good scores in both coursework and examination. However there are some improvements that could be made for the next time e.g. coursework could be more demanding and weighting considered (the latter is a fraught problem).

Evidence based on these results validate this as an acceptable means of assessment when compared to the usual manual process.

The way forward

The University of Ulster has recently purchased a site licence for WebCT[3]. This new system will be adopted for the delivery of on-line assessment in this module from 2001/02. WebCT facilitates the provision of calculated questions which enables the generation of mathematical questions based on a random set of variables. Once the question and the formula are entered, a series of questions (up to a maximum of 100) are automatically generated using the chosen parameters. Students will therefore receive a wide variety of different questions based on the single application of a formula thus increasing the security of the exercise.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of the Educational Development Unit of the University of Ulster for the use of their server and in particular Dr Alan Masson for his expert advice on the use of the TopClass system.
Thanks are also due to the Staff Development Unit for the training in and use of Formic.

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