COMPARING THE INTRODUCTION OF CAA INTO A MATHS COURSE WITH RECOMMENDED AND SUGGESTED FRAMWORKS

Dr Margaret J Pollock[1]

Abstract *¾ Within the relatively small world of computer assisted assessment (CAA) there is consensus on the prospective importance of mass testing. Futurists like Bennett make this explicit. The logic behind the presumption is clear enough; that CAA, like computer assisted learning, is expensive to set up but inexpensive to run - a costly solution made affordable only when it is used with large numbers of learners at (consequently) low per capita cost. This presumption is at odds with the values of those who want to see online learning as a flexible and useful resource to learners and tutors, even when working on a small scale. This paper discusses the introduction of CAA into a relatively small mathematics course run for technology students and compares it with the suggested framework and processes that are outlined in the Blueprint for Computer-assisted Assessment, which also looks predominantly at large scale testing. The paper suggests that the gains from introducing CAA can far outweigh any extra effort required in initially establishing it.*

Index Terms ¾ Computer-assisted Assessment, improving retention rate, increasing access, mathematics for technology students.

INTRODUCTION

This paper chronicles the introduction of Computer Assisted Assessment (CAA) into an established Mathematics course already being delivered using Computer Aided Learning (CAL). The introduction of CAA produced a number of benefits and some drawbacks. This method of assessment produces cost gains in time by reducing the hours spent by staff setting and marking examination papers and provides financial cost gains to the institution by allowing students to join a course without having gained the usual prerequisite qualifications thus increasing access and also improving retention rate. It also allows students from diverse backgrounds to complete a course at their own pace. By setting more short assessments that are topic related, the students can no longer miss out difficult topics and have to gain a pass in them all thus increasing curriculum coverage. A survey of the students found that the majority of them preferred this method of assessment to traditional exams. Difficulties arose, however, as the deadline for completion of assessments drew near, and some students still had to complete them.

When the introduction of CAA was compared with a framework for its introduction such as the Blueprint for Computer-assisted Assessment [1] many of the areas it covered had no relevance to this Case Study. The Blueprint deals predominantly with large scale introduction of CAA to students who sit assessments all at one time whereas this Case Study deals with small scale introduction where students sit tests when they are ready.

Bennett [2] identifies globalisation, the commercial exploitation of new technologies and growing cultural diversity as the three principle factors impacting the developed economies in general and the development of CAA in particular. Driven by these changes, he offers a speculative future for CAA in three ‘generations’.

In ‘first generation’ computer based testing, item formats and test design are an automated version of existing paper tests. The system would, however, be adaptive. Items would be selected automatically in a way which takes into account previous responses.

What he calls ‘second generation’ electronic tests exploits multimedia technologies and our current understanding of psychology and measurement to create qualitatively different testing, particularly testing the ability to use all the new media to convey information. At one time it was important to be able to read a piece of work and to criticise its content in written form. Now much information comes in the form of pictures and movies (particularly TV) and it may become important to be able to establish how much a student has learned from a piece of film, how observant they are and whether or not they can critically analyse information presented in this form.

The ‘third generation’ testing revisits the purpose of assessment and suggests embedding it seamlessly into the curriculum where students may or may not know they are actually being assessed at any particular time. With the explosion of the World Wide Web such learning and testing will be accessible by all, thus a common set of educational content standards will need to be agreed, which are already well under way in the USA, but are much more diverse in the rest of the world as content is often culturally dependent. Bennett cites the example of pilot training using flight simulators as an exemplar for future methods of training and assessment where students can be introduced into the virtual laboratory and carry out simulated experiments. The use of audio as well as visual stimulation would be used and students reaction and adaptability to situations assessed.

[1] Dr Margaret J Pollock, Robert Clark Centre for Technological Education, University of Glasgow, Phone 0141 330 3352, m.pollock@mech.gla.ac.uk

The Blueprint for Computer-assisted Assessment [1] really only deals with the first generation of Bennett's testing scenarios, but mention is made of future possible developments. It offers a framework and checklists to any team considering the introduction of CAA.

A post-hoc comparison of these checklists and frameworks with our actual findings and decision-making procedures was carried out. Our experience, which we think is fairly typical of real-world adoption, found that savings of time and money were relatively easy to quantify, that complex pedagogical issues did not arise and that planning and implementation were easier than anticipated. The main problems we encountered were not anticipated.

A relatively simple analysis of costs and benefits of this single innovation will be presented in the context of a more general discussion of the evaluation of the costs of introducing and using computers [4], issues that are specific to Higher Education [5,6] and the Costing Guidelines for Higher Education Institutions [7].

Our experience of the introduction of CAA, analysis of costs and benefits and the experience of learners are the substance of the paper.

THE BLUEPRINT

In June 2000 a draft version of a book was published by the UKs CAA Centre (http://caacentre.ac.uk/) called Blueprint for Computer-assisted Assessment by Joanna Bull and Colleen McKenna et al [1] and a final version was released in Decemeber 2001. This publication offers checklists and frameworks to practitioners introducing CAA into university courses. These include reasons for using CAA (1.2 to 1.10) its advantages and disadvantages (1.11) and risks (12.1), a checklist for the analysis of assessment schemes (Appendix A) and a model covering key processes for the planning implementation and evaluation of CAA (Appendix H). The Blueprint aims to introduce the main issues associated with CAA and support its use in Higher Education.

It covers a whole range of areas likely to be encountered when introducing CAA, including reasons for its introduction (Chapter 1), types of assessment and question design (Chapters 2 - 6), range of technologies available (Chapter 7), use of multimedia (Chapter 8), innovations for the future (Chapter 9), issues surrounding its introduction into the institution (Chapters 10-15).

Copies of the Blueprint are available from the CAA Centre based at the University of Luton. A draft version has been available for comment from June 2000, with the final copy available from December 2001.

The Blueprint gives useful valid reasons for adopting CAA, but the bulk of the book provides information on question design and the introduction and organisation of large scale testing, neither of which are relevant to this paper. It stresses that CAA should only be one of a range of assessment methods which is at odds with Bennett [2,3] and disagreed with by the author, as the ease of introduction of CAA is likely to be subject specific.

The actual cost of its introduction is not directly mentioned except in FigH3 in Appendix H where the implication is for the reader to think about where the funding will be obtained. Access to hardware and software are assumed and an indirect reference to costs is made in the form of the requirement for technical support and staff training and support.

Benefits of CAA introduction are suggested on pedagogical grounds and cost savings in the form of reduction in time spent marking.

A FRAMEWORK FOR THE ANALYSIS OF COSTS AND BENEFITS

Most aspects of evaluating the costs of introducing and using computers are not particular to Higher Education [4] although there are some specific features [5,6] and guidelines [7].

The Blueprint offers no real guidelines to the cost of introducing CAA. It suggests that its introduction can be costly and some of these costs are hinted at by mention of staff time spent producing questions and the training requirements of technical and support staff. It also assumes the availability of computer suites. Reduction in marking time is suggested as a reason for introduction of CAA, and thus a benefit.

Costs of introducing CAA come under four main headings:- fixed, variable, marginal and opportunity costs.

'Fixed' costs include the cost of capital equipment, general software site licences and copyright. The Blueprint assumes the availability of computer suites but with the introduction of large scale testing more reliability and flexibility may need to be built in, thus increasing costs. It also advocates careful choice of software for robustness and reliability (Chapter 11).

'Variable' costs are made up of teaching assistant salaries, extra learning software and consumables. Institutional policy may apportion any extra costs of staff training, administration, IT support and maintenance, to courses.

A department may need to consider 'marginal' costs, eg the costs of adding more students to an existing course. In many institutions the time of staff with no fixed hours of work is regarded as always available for marginal extra work, in others every hour is jealously costed.

'Opportunity' costs are more difficult to quantify as they represent the cost of time spent on setting up CAA, such as writing questions, when the time could otherwise have been spent more productively on other moneymaking ventures, such as writing research bids.

Who is going to shoulder these costs? The Blueprint offers no advice on these issues.

Other methods of costing may be considered. Institutions often calculate costs in terms of the 'cost per student'. This varies with volume of activity (eg between little CAA use to all CAA use), the number of students involved and the phase in the life cycle of a course and of the technology. Estimates are sensitive to time horizons and the rate of change of technology. Computers, networks, buildings and books all have different useful lifetimes. Because of rapid technological change there is little time to accumulate reliable predictive data. It is worth considering who pays for changes in teaching and assessment resources - students (always pay for books, often photocopying, but seldom computers), teaching staff (pay in terms of time, stress, promotion prospects), budget holding units, and central administration's top slicing and pump priming (contribute towards or pay for fixed costs such as computer suites and software). In this course, for example, students are timetabled to use a computer suite which is already in existence and the software is loaded on to the server. Many of the students have bought a copy of the CAL package for their PC at home to work on in their own time, but they still have to do the assessments under supervision in the timetabled hours.

The first chapter of the Blueprint offers a number of valid reasons for choosing CAA, expanding on each one in turn.

The benefits, however, may be distributed between different stakeholders such as students, staff and administration. Most of the benefits suggested are for students such as increasing frequency of testing and thus raising student motivation to learn, and practise skills; increasing student feedback; increase range of assessments; broaden range of knowledge assessed. For staff there will be a reduction in the marking load, and for the University administration the results can be accessed directly and quickly.

There may also be unplanned or unexpected benefits of introducing CAA - change towards more flexible, open learning, ability to provide distance learning, or change to learning objectives.

THE DEGREE COURSE

The Bachelor of Technological Education (BTechEd) Degree is a four year BEd degree to educate future teachers of Craft and Design, Graphic Communication and Technological Studies in Scottish schools. This is a concurrent teaching degree where the students learn the subject matter and develop teaching skills simultaneously. The subject matter contains Technology subjects, including Electronics, Mechanics and Structures - for which students need a sound grounding in Mathematics. Within this course, there is no intrinsic requirement for mathematical knowledge; mathematics is included in the syllabus with the particular aims of facilitating the learning of technology subjects and making sure the students can apply it correctly.

We accept a variety of applicants, from students straight from school to mature students who have completed Access into Higher Education courses. We also take students with HNCs and HNDs in subjects such as Design, Electronics and Mechanics. A diversity of skills are required for the course itself and all these students have something to offer the teaching profession.

DEVELOPMENT OF THE BTECHED MATHEMATICS COURSE

In 1995 the Mathematics course had been running for 8 years. It began as a three year course and was gradually reduced to one year. During this process, all content was stripped out which was not necessary for further study of the Technology subjects. This was in line with reducing course content in other subjects to reduce the general overload of the degree.

Computer Aided Learning (CAL) was introduced into the course in 1995 - but conventional examinations were retained until 1999. The programme CALMAT was used (Computer Aided Learning in MAThematics produced by Glasgow Caledonian University) [8]-[10] with supplemental use of textbooks and worksheets [11,12].

Course Delivery (CAL)

Before the introduction of CAA in session 1999/2000, CAL was embedded into the course, but the assessment remained as traditional examinations. There was one class exam before Christmas, one class exam after Easter, a degree exam in June and an opportunity to resit in August. Students whose aggregate score for the two class exams was 60% or above were exempt the degree exam. Students who failed the degree exam were offered a further resit.

The Mathematics class was run in one block of three hours per week over 25 weeks. It was easiest to book computer suites and employ tutors in these time denominations, students were encouraged to take frequent breaks. During its first year of use, session 1995/96, there was no lecture or tutorial input and students were helped on an individual basis. This resulted in a pass rate of 81%. In the following sessions lecture/tutorials were run alongside the students work time and the pass rate increased to an average of over 95% (taken over the next four years). This, however, meant slipping back to using lectures as well as CAL. Students were encouraged to buy a copy of CALMAT and use it to study at home if they had access to a PC. This option was taken up by many students, particularly those who were struggling with their maths. When questioned these students said that they used it to work at home in their own time.

Introduction of Regular Testing

Before adoption of CAA was even considered a problem with coverage of material in the assessment had already been identified and a need to revise the coverage of the assessment regimen had been highlighted. In 1998, when paper tests and examinations were still in use it was already recognised that some sampling of course content was inevitable and estimated coverage varied with student grade. Considering a pass mark of 40% the maximum understanding of what was being tested was presumed to be 40% and may well be considerably less. It was felt that this form of assessment did not suit the purpose of the course since students could avoid topics they found difficult or were unsure of. It was obvious that understanding of a small fraction of the Mathematics curriculum was inadequate as preparation to use it for teaching some of the subject material eg Electronics or Mechanics.

As assessment requirements had to be tighter, the conclusion was drawn that students should have to pass all of a series of short tests, each related to a different topic. This requirement is context specific. In other contexts, it would be quite acceptable for students to be asked to only demonstrate understanding of some of the topics covered. In this context, however, good understanding of all chosen topics is essential.

The year before the introduction of CAA the students were given tutorial sheets on a different topic each week (as well as using CALMAT) and when they felt they understood the topic, they completed a multiple choice test on that topic. This produced an improvement of more than 20% (52% to 74%) of the students gaining a score of 60% or more either by exemption or in the degree exam. The continuous testing appeared to have a positive effect on the overall exam score and thus hopefully understanding, but was very time consuming for the lecturer.

It was decided, therefore, to change the course delivery so that the students would sit 10 short tests instead of the traditional exams, and the proposal passed the institution's QA procedures. The students were required to complete ten short assessments, and had to reach a level of at least 40% on each assessment with an aggregate score of at least 50% before being regarded as having completed the course. At this stage it was recognised that this decision was likely to significantly increase staff time spent on assessment. This perception, coupled with the discovery that the CALMAT software, to which we were already committed, had associated CAA software, led to a consideration of CAA as a solution. In the end, ten short tests were administered. Nine of which used CAA and one was a conventional paper test on statistics as CALMAT did not cover the subject as required. The end-of-year examination was abandoned.

Estimates of Staff Time Spent on Assessment

Estimates of the relative cost in staff time of CAA and paper-based approaches indicate costs for a CAA approach in the first year which are comparable with or lower than paper-based approaches, with costs falling very sharply in subsequent years. The payback time was less than one year.

The decision to adopt CAA was based primarily on staff estimates of the time involved. A short paper test takes about 1 to 2 hours to write and prepare and marking time is estimated as between 4 and 8 hours per test for a class of around 30 students. Since there were ten tests, this implies a yearly commitment of staff time of 50 to 100 hours.

Using TASMAT, one academic had to become familiar with the TASMAT system, check how items related to required topics in CALMAT, set up 9 tests and try the questions herself. In the first year, this took approximately 10 hours and in the next year (2000/2001) the process took about 5 hours - which is expected to be typical for subsequent years. In addition, there was one paper test - again taking between 5 and 10 hours to set and mark. Unexpected difficulties in the first year took an additional 10 hours of staff time. These included sorting out computer crashes during tests and checking students work so that they were not disadvantaged. Robustness of the software used is one of the operational pointers noted by the Blueprint (Chapter 11)

In comparison the time taken to assess the traditional way for 30 students was estimated to be about 60 hours and remains static each year or increases with increasing student numbers. The first class exam was always a mixture of multiple choice and short standard questions which took considerable time to prepare but was reasonably quick to mark (typically 10 and 5 hours). The second class exam was a standard examination with 10 long questions and no choice (preparation - 5 hours, marking - 10 hours). The two degree exams followed the same format as the second class exam with the preparation time about 5 hours each but marking time dropped to approximately 5 and 1 hours respectively, assuming all students sit both class exams, 50% get exemptions and 10% need resits.

Note that the examination preparation time includes word processing and development of a marking schedule, and takes longer than the time estimated to prepare short tests.

The most important benefit of introducing CAA has been the ability to set a number of short assessments which are topic related thus making the students tackle every topic and not miss what they find difficult. They are required to pass each topic. This is more difficult to do with traditional exams unless a test is set in each topic, thus increasing setting and marking time quite dramatically as already stated. An unexpected benefit of assessing this way has been to allow the students to sit the tests when they feel ready and thereby allowing them to work at their own pace.

The CAA Software - TASMAT

The Computer Assisted Assessment programme used for this course is called TASMAT (Tutorial and ASsessment in MAThematics) and was produced by the developers of the CAL Programme CALMAT which we have been using for the past seven years. TASMAT is directly linked to the CAL package and any number of tests can be produced using TASMAT's bank of questions and the tests can be linked back to the modules in the teaching programme CALMAT (http:/www.maths.gcal.ac.uk/calmat) [13].

Each test can have a maximum of 10 questions and for each question a maximum of 8 different questions may also be entered. The numbers within the questions themselves are also randomly chosen. All the choice and randomisation reduces the possibility of cheating as no two students will sit the same test. Students may try the tests first as tutorials as many times as they wish and the final result is not recorded. When they feel confident to tackle the test as an assessment, they are only allowed one attempt and the final result is recorded.

For the purpose of this course a set of nine tests were designed each one testing a particular topic. The course also has a tenth paper test on a topic for which there are no suitable CAL modules or CAA questions at present. No special time is set aside for the students to sit an assessment, as they are to be completed during the time-tabled hours, at the students own pace.

This is a small-scale introduction of CAA using an off-the shelf system, so much of the Blueprint is irrelevant.

With the introduction of CAA in 1999, the class delivery changed back again to three hour sessions on the computer with students getting individual help and no lecture/tutorial input. They can take breaks as often as they like during this time, but they are required to complete their assessments in the timetabled hours before the end of the academic year.

COSTS AND BENEFITS OF USING CAA

There are four main benefits to introducing CAA into the course. Firstly there is the financial benefit to the institution by improving access and increasing retention rate. Secondly there is the reduction in time spent by the lecturer on assessment allowing their time to be used more productively. Thirdly there is the benefit to the course itself where the students are now assessed on each topic and they must pass the assessment so all gaps in their knowledge are plugged. Finally students can tackle the assessments at their own pace thus allowing the course to be delivered to a diverse group of students. Also students can get immediate feedback on their progress.

Each student brings in a fee income of about £6000 to the institiution. Between 2 and 4 students used to fail the course each year and as a result often dropped out of the degree programme, resulting in a loss of income of £18000 per student. If improving the assessment technique leads to a greater retention rate as expected, then the change is also worth about £54000 to the university in student fees over a three year period.

Results from student feedback are so positive especially from students who used to struggle with their maths that the real cost benefit is already coming from improvements in recruitment and the ablity to offer greater flexibility to those students who could make a positive contribution to technology teaching with their background, but have not really been able to obtain sufficient maths qualifications to enter the course. They have often gained good qualifications in other areas which will allow them to be given credit for prior learning and time saved could be used to catch up with their maths. Until recently we have had to turn students away because of their lack of maths qualifications and this has now enabled us to take students in this category. Assuming three extra students a year this would provide a cost benefit to the university of £24000 per student or £72000 over a four year period.

We could also increase our intake without having to increase time spent on assessment.

DRAWBACKS AND DANGERS OF USING CAA

It is difficult for the students to cheat as the questions are presented in a different order to each of them and the numbers within individual questions are also randomly generated. Other students in the class are too busy with their own work to help a student sitting an assessment, and there is always a tutor present to check on progress. This also means that students within the class are tackling different topics at different times and again this reduces the scope for cheating.

Students pointed out what they felt to be other drawbacks, such as by working at their own pace and being at different stages, it was more difficult for the teaching assistant/lecturer to switch rapidly from one topic to the next when help was required. This was a student perception and not necessarily agreed with by the lecturer.

Also, at present, TASMAT only marks the final answer, not the working as a lecturer would in a traditional exam. This has been addressed by requiring students to use workbooks during the assessments to keep a record of their working. If a student feels that their work is worth some marks for effort, eg they made a silly mistake, the lecturer can check the working and give marks for that. This was done frequently but requires much less effort than marking an exam script and takes place during class time.

Test completion rate continues to be a problem, even after running the course for three years This was an unexpected problem for which we have yet to find a solution. It is not mentioned as a drawback by the Blueprint because the way we are using CAA as part of the course was not considered as an option.

Towards the end of the academic year when CAA was first introduced a serious computer system crash left the server out of action for a week which made it impossible for those students who had not already completed their assessments by then to complete them before the end of the year. These students had to be given extra time. This type of problem is highlighted in the Blueprint (chapter 12).

STUDENT FEEDBACK

When any innovation is introduced into a course, it makes sense to evaluate it with more care than usual. The Robert Clark Centre, where the staff and students mentioned in this paper are based, has an enviable reputation for the evaluation of learning [14] and though evaluation of these new assessment arrangements was more extensive than usual, an exhaustive independent evaluation was not used. This is probably typical of innovations of this scale.

In addition to the usual combination of reports from lecturers, student evaluation forms and a staff-student committee, students were issued with a questionnaire and interviewed to allow them to express their thoughts about this method of assessment, especially as a comparison with classical examinations which they have all experienced at some time. A detailed discussion of the student responses may be found in Pollock et al [15].

In the last three years the numbers of the students on the course were 26, 28 and 34, and questionnaire returns were 20, 23 and 27 respectively. The numbers of students preferring CAA to traditional exams were 16, 17 and 22, representing an average of over 60% of the cohort.

Students generally appreciated this method of assessment and particulalry liked working at their own pace and being able to tackle the tests as tutorials first. At the last staff/student committee meeting the first year students asked for other courses to be taught and assessed using this method.

CONCLUSION

Having compared the introduction of CAA into this course with suggestions presented in the Blueprint, the author offers the following conclusions:-

- Frameworks, such as the Blueprint, are very useful for Institutions who are considering the use of Computer Assisted Assessment on a large scale.
- Discussion within the framework mostly considers students sitting assessments together at a specified time and highlights the advantages, problems and risks associated with that scenario.
- Some of the reasons, advantages, problems and risks of choosing CAA for this Case Study are obviously highlighted by the framework but others are not.
- By also using an assessment system as a tutorial system other advantages are gained. For example, broadening access to the course for students with more diverse qualifications and also improving the retention rate
- Problems with question type etc. are very much subject dependent. Assessing maths at this level lends itself well to CAA.
- Problems associated with students working at their own pace, such as completion rate, are not flagged as it is not a suggested scenario.
- Changing to CAA for this course was easy, and also the obvious next step, as CAL was already being used as the predominant learning mode.

Staff in Higher Education, particularly in numerate subjects, could consider the possibility of using CAA even for part of their assessment, because of the increased breadth of assessment introduced and potential reduction in staff time required for marking.

The author's suggestion is that the help offered by guides such as the Blueprint for Computer-assisted Assessment is designed to fit a wide range of contexts. When it comes to innovation in a specific context, this useful and complex set of checklists and frameworks can be quickly reduced to a relatively small manageable list.

REFERENCES

[1] Bull, J, McKenna, C, et al *Blueprint for Computer-assisted Assessment,*, 2001, ISBN 1-904020-00-3, Published by the CAA Centre, University of Luton.

[2] Bennett, R, E, "Reinventing Assessment: Speculations on the future of large-scale educational testing", *Princeton NJ: Policy Information Centre,* Educational Testing Service, 1998, http://www.ets.org/research/pic/bennett.html (August 2000)

[3] Bennett, R, E, "How the Internet Will Help Large-Scale Assessment Reinvent Itself", *Education Policy Analysis Archives,* Educational Testing Service, USA, Vol 9, No 5., 2000, http://epaa.asu.edu/epaa/v9n5.html (December 2001)

[4] Farby, B, Land, F, Target, D, *How to assess your IT investment,* Oxford: Butterworth Heinemann, 1993.

[5] Carnoy, M, *International Encyclopaedia of Economics of Education,* Pergamon, 1995.

[6] Doughty, G, F, Pollock, M, Evaluating investments in learning technology for Electronics and Mathematics. *Proceedings 2nd UICEE Annual Conference on Engineering Education,* 1998, Auckland, New Zealand.

[7] HEFCE, *Management Information for Decision Making: Costing Guidelines for Higher Education Institutions*, Published by the UK Joint Funding Councils ref M 13/97, 1997.

[8] Cook, J "Bridge the Gap with CALMAT", *Proceedings of the 7th International Conference on Technology in Collegiate Mathematics,* 1994, IBSN-0-201-87020-7, Addison Wesley, 93-96.

[9] Cook, J, Hornby, J, "CALMAT Mathematics Courseware for Access to Higher Education", *Proceedings of the SMC Conference,* 1995, Stirling.

[10] Tabor, J, H, "Using CALMAT in "Levelling Up" Teaching", *CTI Quarterly Newsletter 4*, 1993.

[11] Pollock, M, J, McAteer, E, Doughty, G, F, Turner, I, "Rapid conversion of a mathematics course to CAL: a case study of a large-scale rapid change of resources and organisation", *ALT-J 4,* 1996, 28-34.

[12] Doughty, G, F, Pollock, M, J, McAteer, E., Turner, I, "Conversion of a mathematics course to tutor-supported computer-assisted flexible learning", *Open & Distance Learning in Industry and education,* ed S Brown, (Kogan Page), chapter 8, 1997, 99-110,

[13] Booth, D, J, "Managing Mathematics with CALMAT", *Maths&Stats* Vol 9, No3., 1998.

[14] URL: http://www.gla.ac.uk/rcc/projects/elict.htm, June 2002

[15] Pollock, M, J, Whittington,C, D, Doughty, G, F, "Evaluating the costs and benefits of changing to CAA" *Proceedings of the Fourth International Computer Assisted Assessment Conference*, 2000.