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Computer-Aided Assessment as a Holistic Learning Tool in Geoscience

Dr Dawn T. Nicholson

Faculty Project Officer, School of Earth Sciences,
University of Leeds, LEEDS LS2 9JT, United Kingdom
E-mail: dawn@earth.leeds.ac.uk; Tel: 0113 233 5234; Fax: 0113 233 5259

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ABSTRACT

A common perception exists that computer-assisted assessment (CAA) is synonymous with summative multiple choice testing. This perception may be partly responsible for a lack of enthusiasm encountered among some academic staff to incorporate CAA into teaching programmes. This has been the experience in attempts to promote the use of communications and information technology in the curriculum in the Earth and Environment Faculty at the University of Leeds. Nevertheless a wide range of CAA applications is in use in the faculty. In this paper, examples of the imaginative employment of CAA in geosciences are used to illustrate that CAA can, in fact, be a major player in a holistic, high order learning environment.

In the Earth and Environment Faculty, objective, multiple choice question (MCQ) tests are used for summative assessment, self assessment and as a revision tool. There are also examples of the use of MCQ's primarily as a teaching, rather than an assessment tool, and for the management of student learning. Interactive computer-based learning (CBL) and web-based resources incorporate smart assessment systems with revision loops, where poor scores on a test prevent further progression until a revision area with alternate questions has successfully been visited. A growing number and variety of Virtual Field Resources (VFR's) are being developed by geoscience staff, containing elements of formalised CAA and self assessment. Further developments in CAA are being encouraged at LU using the in-house managed learning environment (MLE) 'Bodington Common'. This facility enables on-line tutor marking of short answer questions and electronic submission of coursework. The latter is of particular interest because it presents opportunities for introducing management tools such as plagiarism detection.

Currently, there is no faculty-wide strategy for the implementation of CAA. The challenges for the future are (i) to raise the profile and encourage the use of CAA; (ii) to demonstrate the potential of CAA for learning and teaching at higher cognitive levels;

and (iii) to co-ordinate the implementation of different CAA methods within a programme in order that students experience a balanced learning environment.

Keywords: computer assisted assessment; geoscience; learning; teaching

INTRODUCTION

There is a perception that computer assisted assessment (CAA) is synonymous with objective, multiple choice question (MCQ) testing which is applicable only for summative assessment of lower order cognition. Referring to Bloom's taxonomy of learning or cognition levels (Bloom and Krathwohl 1956) this equates to the competencies of knowledge, comprehension and application. Others (eg McBeath 1992) have argued that higher order competencies such as analysis, synthesis and evaluation, can also be addressed with objective tests and examples of these are amply illustrated in the CAA Centre 'Blueprint' (Bull and McKenna 2001). However, evidence from exemplars developed in the Earth and Environment Faculty at Leeds University (LU), are that: (i) MCQ's are also being used for self assessment, as a teaching tool and for the management of student learning. (ii) CAA is not synonymous with objective tests such as MCQ's but can also include short answer questions, electronic submission of coursework, on-line tutor marking, revision loops and the assessment of student skills and thinking processes.

BACKGROUND

The Communications and Information Technology in the Curriculum (CANDIT) Project is a two year project funded by the Teaching Quality Enhancement Fund (TQEF) of the Higher Education Funding Council for England (HEFCE). The CANDIT Project has enabled the employment of one project officer in each of seven faculties at LU. The aim of the Project is to co-ordinate, stimulate, encourage and promote the use of C and IT in learning and teaching, in line with the broad recommendations of the Dearing report (Dearing 1997). At the outset of the Project, which commenced in June 2000, an audit was undertaken to determine (i) the current usage of C and IT in learning and teaching at LU; (ii) opportunities for enhancement of learning and teaching by the application of C and IT; and (iii) the needs of teaching staff which could be met by the Project, particularly with respect to specific module support and staff development. One of the many issues raised during follow-up discussions with individual tutors was the use of C and IT for assessment of student work.

Teaching staff have access to an in-house developed managed learning environment (MLE) known as Bodington Common. This MLE contains utilities to develop a wide range of student resources including reading rooms, web documents, external links, pigeonholes for electronic submission of work and communications rooms. There are also facilities for creating MCQ papers, and for on-line tutor marking of electronically submitted coursework and short answer questions. Because of the ease with which such resources can be developed, even by tutors who do not possess a high degree of computer literacy, creation of MCQ papers in Bodington Common is a common starting point for tutors wishing to enhance their teaching materials and methods with the use of C and IT.

Conversely, there is also a reluctance among some tutors to utilise MCQ papers because they perceive that objective tests are only appropriate for testing lower order skills of knowledge and comprehension. However, examples drawn from teaching materials developed in the Earth and Environment Faculty at LU illustrate not only that MCQ's can be used to test higher learning levels but also that they have much wider application than simply summative testing.

MULTIPLE CHOICE QUESTION TESTS

MCQ's for summative testing

The commonest way that MCQ tests are used in the Earth and Environment Faculty at LU is for summative assessment. The timing of assessment varies, some tutors setting a short test to accompany each lecture or major topic, others preferring a more intensive end-of-semester test. A typical assessment scheme allocates 10% of marks for a module to summative MCQ tests. That 10% is evenly divided between the number of tests involved, which are completed on-line during private study time. The tutor has access to records of the number and timing of attempts taken by each student. Bodington Common includes the facility to set a cut-off date after which students can still access and complete the paper but cannot record a score. Several tutors award 50% of the marks available for simply attempting the test, with the remaining 50% being awarded for actual achievement. The other 90% of marks for the module are assessed in a variety of other ways including by written examination and coursework submission. Several advancements in the construction and operation of MCQ's have been made. These include a facility in the School of Environment to draw upon a very large bank of questions in random fashion, and the University-wide facility to generate automatically fully formatted MCQ papers in Bodington Common from a simple text entry xml file (H. Dee, pers. com).

MCQ's for self assessment

Very few tutors set MCQ tests purely for self assessment revision tools. There are two main reasons for this. First, the process of creating electronic teaching resources can be time-consuming for tutors who are unfamiliar with the technical demands involved. There is a tendency, therefore, to argue that since the resource has taken considerable time and effort to develop, it should 'count' for something tangible, such as a mark which contributes to the overall assessment scheme. Second, a similar attitude pervades student thinking, in that if an assignment does not contribute to the formal assessment for a module, it is given much lower priority than other demands on their time. Notwithstanding the above, some tutors do set objective tests for revision purposes even though it is often only the stronger students who take advantage of them. Experience at LU has shown that several key factors increase the likelihood of students making use of formatively assessed computer assisted resources such as these. The first of these is that there must exist a culture, within the faculty, the school, the programme, or even within a single module, of utilising learning technology. This is best attained by introducing its use very early on in the career of a student. The second is that students must be absolutely clear on the relationship between teaching sessions, and assignments which are formatively or summatively assessed. A third factor is that peer pressure often provides additional motivation for students to learn independently. Finally, students appear much more likely to attempt an MCQ test which enables them to practice skills rather than to test knowledge. For example, several tutors in the School of Earth Sciences have set objective tests for revision purposes in which students are asked questions requiring analysis of a geological map or detailed inspection of photomicrographs of rocks in thin section. In order to attempt the questions, students must practice geological skills taught earlier in the course.

MCQ's as a teaching tool

One tutor found that due to timetabling, postgraduate students of engineering geology were starting work on a five week laboratory project before they had had time to fully assimilate relevant fundamental principles covered in teaching sessions given previously. The students were being asked in their laboratory work to conduct shear tests on rock joints which required an understanding of the mechanics of shear and stress as well as a familiarity with standard units of measure. A series of MCQ tests was developed which takes students via a series of linked, progressive steps through the use of standard mechanical units, some fundamental principles of shear strength, and the application and analysis of these principles to shear tests on rock joints. By the end of the final MCQ test students will have applied their knowledge to a simulated rock joint shear test and have undertaken some preliminary analysis of results, in much the same way as they are subsequently expected to do in the laboratory. These tests have now been in use for three years and their positive impact is notable: Having completed each

of the MCQ tests prior to attempting the laboratory project students have demonstrated a clearer understanding of material covered in earlier teaching sessions and are able to apply that comprehension directly to the practical work. The synthesis and analysis of their data as presented in laboratory project reports has also improved as a result. The scoring of the MCQ tests is almost incidental and serves only to indicate to the students their own level of achievement. Some students are known to attempt the tests more than once until their score improves to a level comparable with their peers.

MCQ's as a tool to manage student learning

A common problem experienced by tutors is managing the private study time of their students. Students are notoriously bad at deciding *what* they need to know and *which* aspects of a piece of information are of greatest relevance to them and the course they are studying. This is particularly evident when it comes to asking students to read and summarise scientific papers. One tutor has reduced this problem by setting a series of MCQ tests based on journal articles which students have been forewarned to read. Questions are set which first attempt to test the students basic comprehension of the paper and then require them to evaluate and make judgements on the significance and application of its content. Students are also asked to relate key principles contained in the papers with material which they have encountered in other teaching sessions, including practical classes and fieldwork.

Evidence suggests that the majority of students do complete these tests, and by inference, have read the papers to which they relate. This is encouraged by awarding 10% of module marks to the MCQ's and 'supplementary reading', and also by giving a clear warning to students that this work may form the basis of part of the end-of-semester written examination which counts for 60-70% of total assessment for the module. A further factor is that in requiring certain reading and completion of the appropriate MCQ before the next teaching session, students are made aware that the MCQ is not merely a 'test', but forms an integral part of the teaching material for the course.

OTHER APPLICATIONS OF CAA AT LU

Self assessment with feedback

Incorporating CAA into computer-based learning

An interactive computer based learning package is under development using Macromedia Authorware to teach first year undergraduates the principles of structure contours. The completed and updated package will incorporate a number of self

assessment questions with immediate and detailed feedback. There will be no means for tutors to record student achievement in such 'tests' since they are designed only to indicate to the user the degree of understanding achieved. An earlier version of the package is currently in use by students. They do not receive any formal assessment for completing the work, but material contained within it is clearly identified as forming an integral part of the teaching materials for the course. Other forms of assessment such as paper-based essay assignments and written examinations may draw on principles explained in the CBL package. Students may later be asked to demonstrate, under examination conditions, skills which are covered in the CBL package. For these reasons, invariably all students who take the module attempt the CBL package at some stage in the course of their study. The CBL package is a particularly effective learning tool for this material because using animations and complex 3D graphics with interactions, it allows students to simulate work normally undertaken during practical classes, involving drawing and step-by-step construction of 3D geological models from 2D mapped information. The use of computer graphics is probably the most effective medium in which the description and explanation of these 3D geological and topographic features can be achieved.

Revision loops and virtual field resources

A similar, interactive virtual field resource (VFR) is also under development using Macromedia Dreamweaver with Coursebuilder. This innovative resource will make use of a wide variety of teaching tools including graphics, photographs, text and animations. Assessment styles will be equally varied, including multiple choice, drag and drop, text entry and classification. Each will provide immediate feedback at varying levels of detail. As a result, it will provide an attractive, self-paced learning environment for students, increasing motivation, and with it, the likelihood of completion. The resource will, to a degree, simulate some experiences gained during conventional fieldwork and will enable some assessment of skills and processes. A further development will manipulate some assessed sections of work such that students who answer incorrectly will be automatically re-directed back to a revision page. This VFR is being developed in support of an actual field trip but will be available to students prior to the fieldwork to enable preparation. After the field trip the resource will be available for students to use as the basis for a paper-based, summatively assessed post-trip project report.

On-line tutor assessment in a MLE

Electronic submission

The LU MLE Bodington Common allows for electronic submission of coursework. This electronic 'pigeonhole' system also allows for tutors to mark the work on-line,

automatically calculating an overall mark according to a weighting scheme pre-set by the tutor. The marks can either be made available to students from the same on-line location or be downloaded to a spreadsheet file. CANDIT project officers are particularly keen to encourage the uptake of electronic submission among faculty because of the opportunities which it will afford for the use of on-line plagiarism detection systems. One of the challenges for the future will be to increase awareness among faculty of the increase in plagiarism of materials available on-line. Thus far, few tutors have required students to submit work electronically. The only significant exception applies to several tutors in the School of Geography who require students to prepare a simple web site on a set topic. The completed web pages are submitted electronically via Bodington Common or FTP and are available for view by other students registered on the module. At this point, the work can be formally assessed by the tutor or peer assessed by the student group.

Short answer questions

Bodington Common also has a facility for electronic submission and on-line tutor marking of short answer questions. This is a relatively new provision, with poor take-up by staff so far. This may in part be attributed to the fact that short answer questions are not a common method of assessment in many of the disciplines covered in the faculty.

CHALLENGES FOR THE FUTURE

One of the key challenges for the future is to continue to raise the profile and encourage the use of CAA. The key to achieving this goal is in demonstrating how CAA can provide solutions to some of the practical and pedagogical problems faced by tutors. For example, providing clear evidence of how CAA can be used to reduce marking time, increase the amount of feedback given to students, manage student private study time, and monitor student learning achievement. Progress is being made in the Earth and Environment Faculty at LU by the provision of staff training and seminars. Tutors are also encouraged to take part in a variety of discussion forums and to contribute to special interest groups. Close contacts are also being made between the CANDIT project and key personnel including faculty learning and teaching committee members, special interest groups and heads of resource centres. Nevertheless, the two most effective sources of persuasion appear to be (i) peer 'pressure' in the form of demonstrable success in innovation, and (ii) the provision of short and sweet, custom-designed staff training sessions, hand-in-hand with provision of support staff.

A key pedagogical challenge is to demonstrate the potential of CAA, particularly objective testing, for learning at higher cognitive levels. Prejudice against objective testing is slowly being broken down by providing good exemplars and giving instruction

on the design of questions, an important skill which takes time and experience to develop fully. A further pedagogical challenge is to co-ordinate the implementation of CAA across the faculty to ensure a balanced learning environment. In the absence of any faculty-wide strategy for the implementation of CAA it is important to ensure that student populations and study programmes receive a balanced learning and assessment environment in which a wide range of assessment methods are employed. Another challenge is to reap knock-on benefits from CAA such as the increased use and awareness of plagiarism detection which could result from an increase in electronic submission.

There are also several *practical* considerations which present challenges for the future. These include the aspiration for increased computer literacy among teaching and support staff. Due consideration and provision also needs to be made for the investment of staff time required for developing new skills and teaching materials and for additional and improved equipment and hardware to support such developments. Learning and teaching resources which have been developed elsewhere in higher education and commercially also need to be made more easily available. This requires that central forums such as the Learning and Teaching Support Networks continue to publicise new resources, and that developers set reasonable costs for users in higher education.

CONCLUSIONS

Evidence from the Earth and Environment Faculty at LU supports arguments that objective testing can be used to assess higher learning levels. MCQ tests are also being used innovatively as a teaching tool and for the management of student learning. Other forms of CAA developed or under development include the use of self assessment and feedback loops in virtual field resources, the assessment of skills and thinking processes in CBL packages, electronic submission of coursework and on-line tutor marking. These are evidence of the use of CAA as a holistic tool in learning and teaching which need not be confined to summative, objective testing. While progress is being made in increasing the appropriate take-up of CAA and particularly its innovative deployment, there are a number of issues which constrain progress. Practical issues include the provision of resources and staff support, the availability of software and utilities, and computer literacy among staff and students. However, perhaps the primary stumbling block is the general lack of awareness of practical and pedagogical benefits of CAA. It is to be hoped that continued efforts to demonstrate good practice to academic staff will sufficiently change the culture in higher education ultimately that the take-up of appropriately targeted CAA will increase.

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