IMPLEMENTING CAA IN CHEMISTRY: A CASE STUDY

Emilia Bertolo, Glenis Lambert

Implementing CAA in Chemistry: A Case Study

Emilia Bertolo,[a] Glenis Lambert[b]

[a] Department of Geographical and Life Sciences, Canterbury Christ Church University, Canterbury, Kent, CT1 1QU (UK)
meb27@canterbury.ac.uk

[b] Learning and Teaching Enhancement Unit, Canterbury Christ Church University, Canterbury, Kent, CT1 1QU (UK)

Abstract

Computer aided assessment (CAA) was implemented in the level 1 module Skills for Forensics Investigators; the assignment was focused on several chemistry concepts. The aim was to provide students with rapid feedback, while trying to enhance their engagement with the subject; reducing the lecturer's marking load was perceived as an added bonus. The CAA system used was Perception from Question Mark Computing; the assessment comprised two components, one formative and one summative. The formative test could be accessed at any time, and provided feedback that sought to guide further learning; the summative component had no feedback and could only be taken once. From the lecturer's perspective, the experience was very positive. The initial time invested preparing the assessment was considerable; however, that time was used in a creative way (designing the assignment) as opposed to a conventional paper based assessment, in which the time would be spent in routine marking. A total of 83 students, 94% of the students for that module, participated in the assessment process, suggesting that the use of technology did not prevent students from taking the assignment. Student evaluation was gathered via anonymous on-line questionnaires; 38.5 % of all the students involved in the assessment (32 students) answered the evaluation survey. Results indicate that the CAA system has made a positive impact upon the students' learning experience. This assessment raised some issues regarding students' "last minute" working practices. Students who left the test until the last minute and who experienced difficulties were dealt with individually, but this is an aspect which needs to be resolved through clear regulations rather than on an ad-hoc basis. Overall, the experience has proven very positive for both staff and students. The success of this assignment has led to improved communication with the students on the nature of their online assessment.

Introduction

Computer assisted or computer aided assessment (CAA) refers to the use of computers in assessment (Gladwin, 2005). Jenkins (2004) has compiled a range of case studies illustrating the potential benefits and limitations of CAA. Among the benefits, Jenkins identifies repeatability, close connection between the activity and the feedback, flexibility of access and increased student motivation. As pitfalls, the author mentions development time, potential risks associated with hardware, software and administration, and the necessity for students to possess appropriate computing skills and experience. Wisely used, CAA can be far richer than paper-based assessment and have a very positive influence in the assessment process, offering quick, often instant, marking and feedback (Bull and Danson, 2004). Flexibility is an added bonus for the case of open access web-based assessments, since the tests can be taken at a location and time to suit the student (Bull and Danson, 2004).

Considerable efforts have been made to introduce CAA in chemistry at HE level, with the HE Academy playing a pivotal role in many cases. Adams et al (2002) have developed a series of online question banks using the QuestionMark Perception assessment management system. Price (2006) conducted a project aimed to enhance students' early experience at university, using CAA to provide formative feedback to students in their first year of undergraduate Chemistry courses. Over 80% of the cohort used the quizzes, and students reported that they found the ready access useful and helpful. Lowry (2005) used a CAA system for formative self-assessment, to provide chemistry support to Environmental Science students. Most students traditionally consider chemistry as "hard" science, and have difficulties engaging with the subject; the premise was that any mechanism that increased students' interaction with chemistry would be beneficial. His study concludes that the CAA system made a positive impact upon the learning experience of the students involved.

Rationale behind this case study

This paper describes the results of a computer assessment set up for level 1 students of the module Skills for Forensics Investigators (2005-2006 cohort). The assessment covered materials taught for a total of eight contact hours. The aim of the project was to use CAA to design an assessment procedure that could:

- provide a closer connection between the assignment and the subsequent feedback, and
- facilitate students' engagement with the subject.

The previous cohort had completed a paper-based assignment, consisting of short questions. Due to the large number of students involved (ca. 100), it was difficult to provide students with quick feedback. It was thus felt that the formative component, which should be part of any assignment, had not been sufficiently fulfilled. Moreover, informal feedback from the students had highlighted the difficulties for some students to engage with the subject, which can appear difficult and unattractive in some cases; this is a key problem

identified by other authors when teaching science subjects in an HE context (Overton, 2003; Lowry, 2005).

One of the advantages of CAA is that it can efficiently shorten the time gap between assignment and feedback. Moreover, Jenkins (2004) and Lowry (2005) both mention increased student motivation as a benefit of CAA. It was thus hoped that replacing the paper based assessment with a computer marked one would be positive for the students, with the added benefit of considerably reducing the lecturer's marking load.

From the lecturer's point of view, the key concerns were the initial time investment necessary to design the assessment, and the difficulty of designing pedagogically sound questions (see Clarke, 2001, and King et al, 2001). Since the learning outcomes that the assessment had to test were reasonably low level according to Bloom's taxonomy (identify, recall, calculate, etc.), it was not thought that the potential limitations of CAA in testing higher level learning outcomes to be a serious concern in this case. With the emphasis on facilitating students' engagement with the subject, and in view of the fact that the existing paper-based assessment was open, it was decided to go ahead, but maintain a careful watch on what was happening within the system to try to isolate any obvious malpractice.

Method

The assessment procedure
The CAA software used was Perception from Question Mark Computing. A total of 83 students (94% of the students registered on the course) participated in the assessment exercise, which ran over a two-week period. Access was not restricted to just the computers on campus and thus students could do the tests from home. The assessment consisted of two tests, one formative and one summative. The formative test could be taken several times; once started, it had to be completed within 30 minutes. The formative test was aimed to:

- avoid/minimise "computer anxiety": the format of the questions was similar to those of the summative test, so students could familiarise themselves with the various styles of questions;
- spot any unforeseen technical problems at the earliest opportunity;
- allow students to practice the concepts learned in the lessons, and enhance their knowledge of the subject: besides the mark achieved, students could access feedback relating to their answers; the feedback was constructed so that it tried to explain why an answer was incorrect, but not so that it gave the correct answer. The aim was to get the students to consider their understanding and not just to memorise the right answers.

The summative test could be only be accessed once, and did not provide feedback or the mark; once started, students had one hour to complete it. The question types used were multiple choice, fill in the blanks, true/false and

numerical, and some of the questions included images. The marks were released to the students just after the two-week assessment period had ended.

Student evaluation

After the assessment had concluded, student evaluation was gathered via an on-line questionnaire. The questionnaire, modelled on the one used by Bullock (2001), comprised 10 questions, 9 based on a 5-point Likert scale and a final one to gather any further comment. From the 83 students that took part in the test, 32 responses were received (38.5%). The graphs constructed with answers to the 5-point Likert scale questions are shown in Figures 1 to 6; the further comments can be found in the results and discussion section.

Results and discussion

Student evaluation

Some interesting observations can be made regarding students' perceptions about the experience, although the relatively low number of responses (38.5 % of all the students that took part in the assessment) is not enough to extrapolate conclusions to the whole group. The first two questions related to the usefulness of the formative test: Figure 1 shows that 93.7% of the students agreed or strongly agreed that the practice test was useful to prepare for the assessed test, and most students (87.5%) agreed that the practice test helped them understand the concepts explained in the lecture. Students also seemed to identify the link between the assessment and the taught sessions (see Figure 2).

Figure 1. Student responses regarding the practice test, given as % (n = 32).
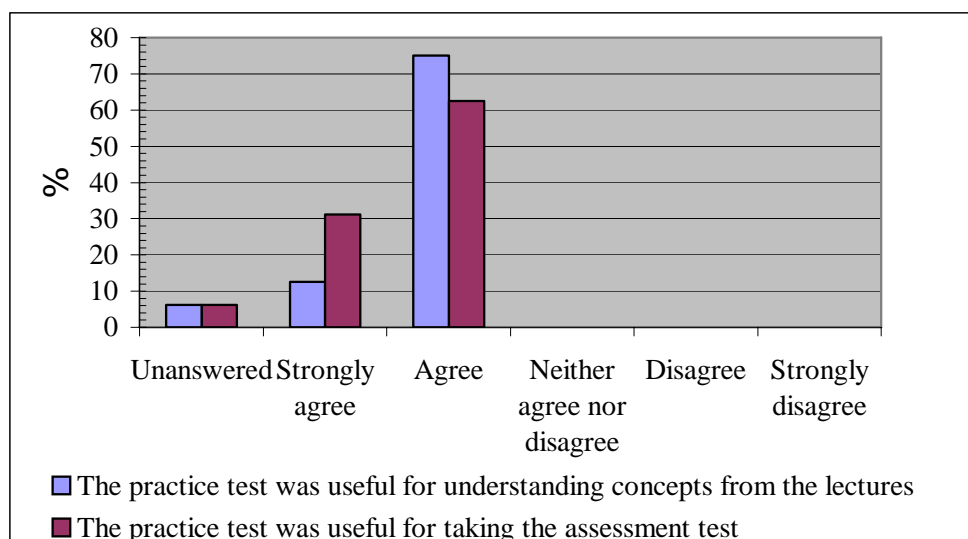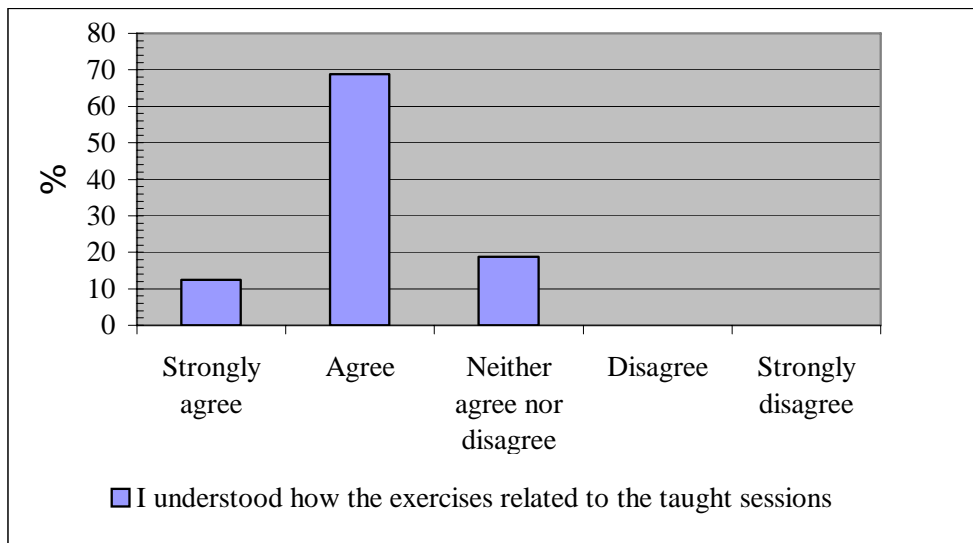

- The practice test was useful for understanding concepts from the lectures
- The practice test was useful for taking the assessment test

Figure 2. Student responses, as a %, regarding the link between the assessment and the taught sessions (n = 32).

I understood how the exercises related to the taught sessions

Figures 3 and 4 show students' responses regarding CAA vs conventional paper based assignments. In general, students' attitude towards the computer assessment was very positive. 93.7% of the students liked doing the CAA, and 78% of the students agreed/strongly agreed that using a computer tool made them feel more in control of their learning. Only one student would have preferred to do a paper-based assignment; 23 students (71.8%) disagree/strongly disagree with that statement, and the other 8 (25%) were neutral to that statement. Figure 5 shows students' views about the level of support received: only one student did not feel sufficiently supported, while the rest (46.8%) felt neutral about that point or agreed/strongly agreed (37.5%) they had been well supported.

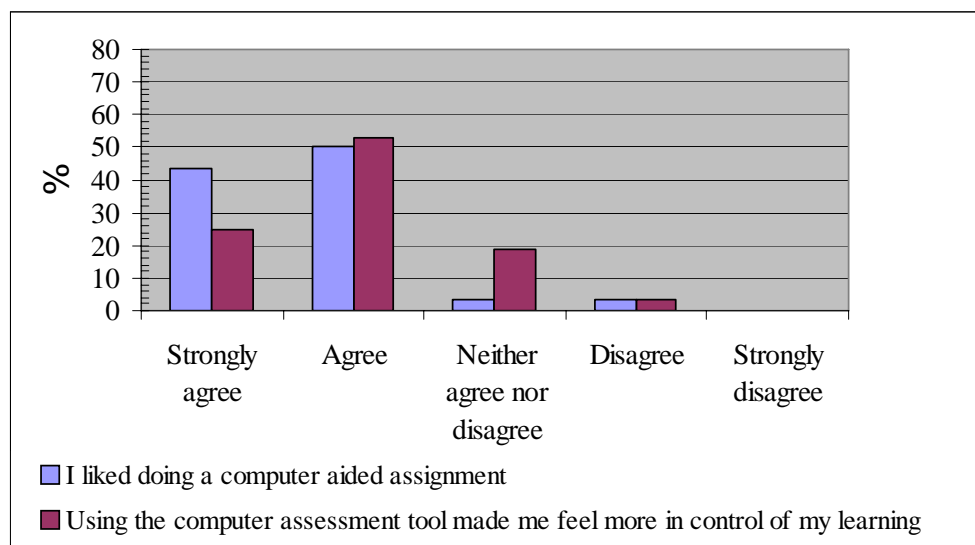**Figure 3. Student views on CAA, given as a % (n = 32).**

I liked doing a computer aided assignment

Using the computer assessment tool made me feel more in control of my learning

Figure 4. Student preferences, as a %, regarding paper-based assessments for this module (n = 32).

I would have preferred to do a paper-based assignment

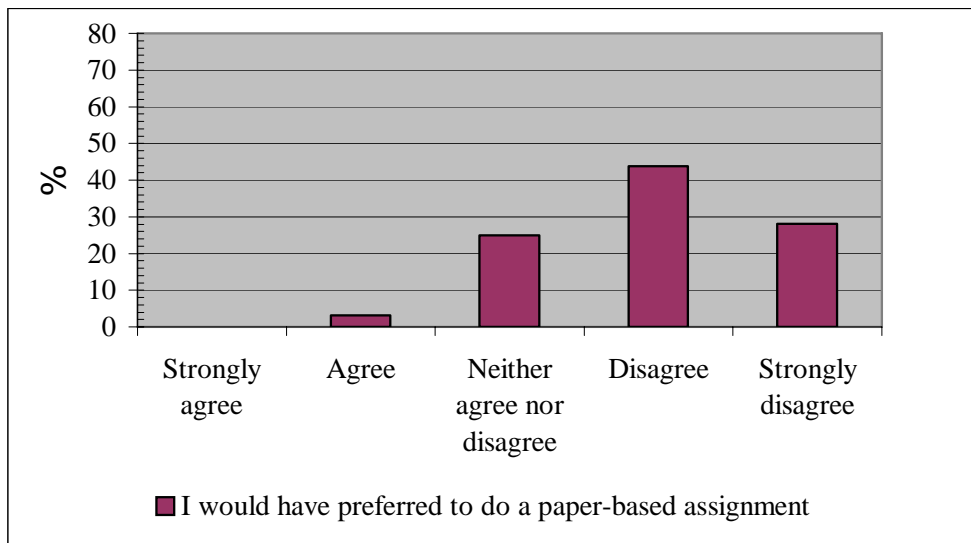**Figure 5. Student views on the adequacy of the staff support received, given as a % (n = 32).**
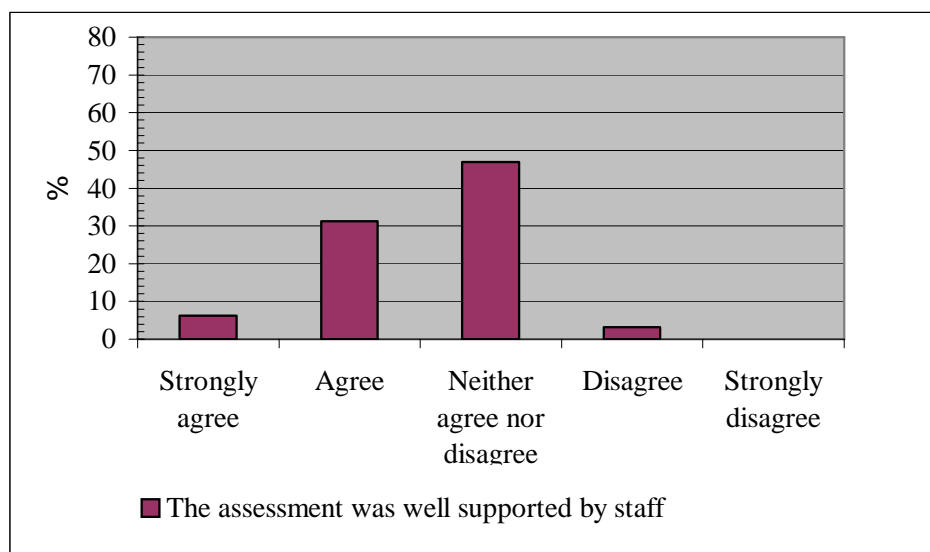


The assessment was well supported by staff

Figure 6 shows students' responses on the software used for the assessment and their previous computer experience. This group was mainly composed of experienced users, with 79% of them saying they had been using computers for more than 5 years. They did not seem to have problems with the software used in the assessment, with 78% saying it was easy/very easy to use. It is also noteworthy that 83 out of 88 students participated in the assessment process (94%), which suggests that the use of technology did not prevent students from taking the assignment.

Figure 6. Student responses on a) the software used for the assessment and b) their previous computer experience

a) How easy was the software to use?
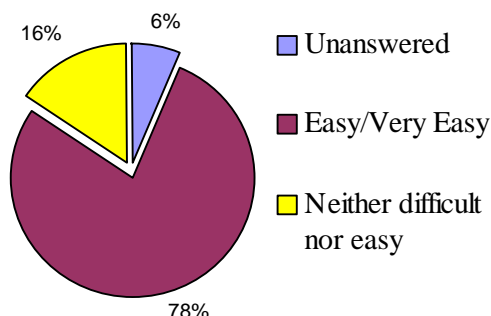
b) How long have you been using computers?
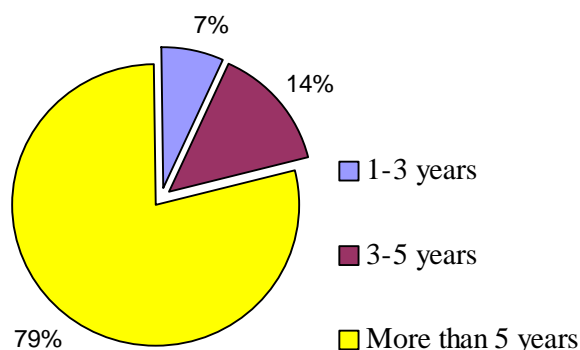
Of the 32 responses received, only five students added a further comment. One was related to the lectures content ("Slight confusion on one of the questions about chromatography, maybe some sort of tutorial or helpful guide within the practice assessment could be used? Apart from that I found the assessment useful"), and the other four were focused on the assessment itself. In all cases, they were very positive about the experience (see below).

"I think that the online test programme is a very good idea, you can be tested and not be as nervous as you would sitting in a hall full of people"

"I preferred doing the computer aided test as it allowed me to do it in my own time"

"the test was useful and the practice test was extremely useful to help understand what the real test was going to be like"

"I have no further comments. I thought the on-line chemistry test was extremely useful and it helped me understand chemistry more".

The lecturer's perspective

Translating the original paper assignment into a computer one was not too difficult, since the original test consisted on a series of short answer questions and mathematical problems, but it was time consuming. Once the assessment was deployed, the process ran surprisingly smoothly considering the number of students involved. Only a handful of students reported technical problems. One issue not anticipated was the totally unrealistic expectations about staff availability held by some students: they seemed to think that, since the tests were available 24hr per day, the same would be true of staff. This could be why student perception of staff support is not as positive as it could have been expected. A possible way of addressing the problem would be to include details about staff availability in the assessment instructions.

The learning technologist's perspective

In 2004, Canterbury Christ Church University began to use Questionmark/Perception for small scale implementation of medium-stakes summative assessments. Many programmes were using Blackboard for formative assessments, but difficulties in quality assuring Blackboard led to the decision to use Perception for all summative testing. Policy, based on QAA precepts for distributed learning (QAA, 2004), and the BS 7988: 2002 standards (BSI, 2002), and which dovetailed into the existing examinations policies, was formulated. Given the complicated nature of the Perception V3 programme, it was decided that the Learning and Teaching Enhancement Unit would make assessments for staff and a process was initiated to ensure that tests were accurate and fit for purpose. This added to the time taken to create the test. It is envisaged that future tests will be made using the Respondus tool, and delivered to the LTEU in QTI format which should shorten this time.

This assessment exercise produced a number of challenges to the existing risk assessment which formed the basis on the online summative assessment policy:

- Students were to be enabled to take the test off campus.
- Students could take the test at any time.
- There was no real way of knowing whether the student who took the test was in fact the correct student.

The practice test was accessed 291 times by 40 students, most students trying it an average of four times before moving to the summative test. Most support issues arose from users off campus. Approximately 33% of users accessed the test at home, and of these 3 were unable to access the test, even after extensive advice on browser settings etc. This indicates a potential problem for students who leave the test until the last minute. 43 students took the test on the last 2 days, 6 leaving it until after core support hours (see Figure 7).

Some students tried to access the summative test before they were ready to take it. This raised the issue of whether they had deliberately looked at the test before taking it. Server logs showed how long each student with a failed attempt had accessed the test, and none had spent more than a few seconds logged in, indicating that they had indeed made a mistake. A decision was made on an individual basis as to whether these students should be able to take the test again.

Figure 7. Number of tests taken over the period of availability.
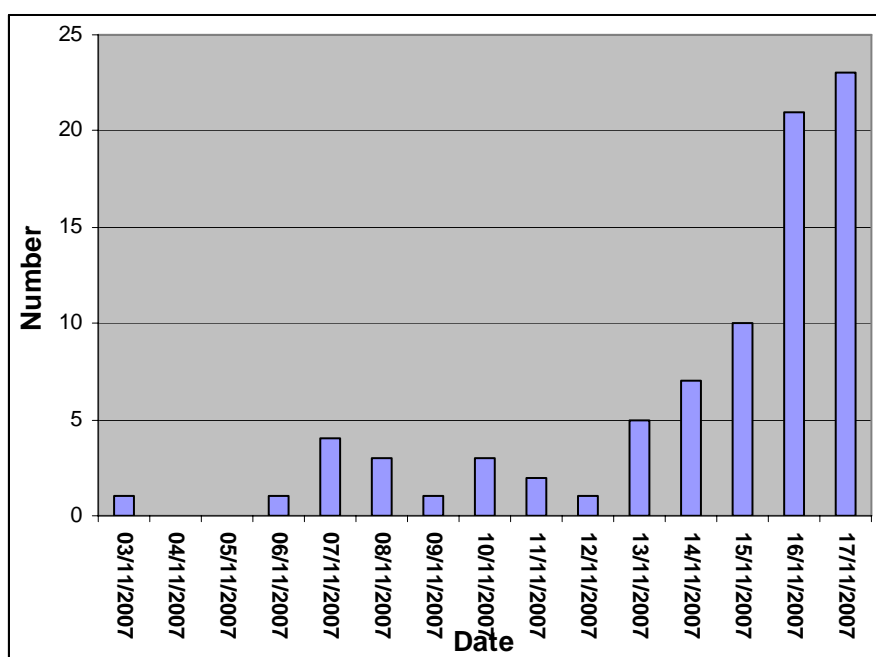
Whereas the risks identified by Zakrzewski and Steven (2000) in the implementation of CAA for summative assessments are mediated via procedures undertaken by academic and support staff, and which were well-understood institutionally and catered for in existing policies, this test raised new aspects of risk which were exacerbated by the students' "last minute" working practices. Students who left the test until the 11th hour and who experienced difficulties were dealt with individually, but this is an aspect of testing which takes place over time which needs to be resolved through clear regulations rather than on an ad-hoc basis. The success of this assignment has led to improved communication with the students on the nature of their online assessment.

Conclusions and recommendations

Establishing boundaries regarding staff availability seems key for the success of a CAA exercise. Instructions detailing staff's response time to queries would enhance students' experience, provide a more realistic framework of expectations, and ease the pressure on the staff involved. All the technical problems related to the assessment arose from students accessing the assessment from outside the university network: the problems were not always easy to diagnose, due to differences in Internet providers. It was decided that, in future assessments, students would be encouraged to access the formative test from home, but told to do the summative one from a university computer if they want to have technical support.

Student feedback regarding the computer assessment has been very positive. However, the results should be taken with caution, due to the low number of responses (38.5% of the total). Also, since the questionnaire was voluntary, the respondents are self-selected and not random: only students with some motivation filled it in. On the other hand, it could be said that no student felt so negatively about the process that they needed to fill in the questionnaire. This group was mainly composed of experienced computer users, which may have influenced their opinion of the experience: more data from future cohorts will have to be gathered in order to ascertain the influence of computer experience in students' attitude towards the assessment procedure.

From the lecturer's point of view, the experience was challenging but very positive. The initial time invested preparing the assessment was considerable; however, that time was used in a creative way (designing the tests) as opposed to spent in routine marking. Overall, results indicate the experience was positive for both staff and students. The experience and feedback from this cohort has been very valuable to improve next cohort's assessment; the results for cohort 2006-2007 will be soon available.

Acknowledgements

References

Adams K., Byers B., Cole R., Ruddick D., Adams D. (2003) Computer-aided Assessment in Chemistry, LTSN Physical Sciences Development Project, http://www.physsci.heacademy.ac.uk/Resources/DevelopmentProjectsReport.aspx?id=78 (10 January 2007).

BSI (2002) British Standard BS788, Code of Practice for the use of information technology (IT) in the delivery of assessments.

Bullock A. (2003) Using WebCT for computer aided assessment (CAA) - a case study, Teaching Forum, 5, 11-14, http://www.brookes.ac.uk/virtual/NewTF (25 May 2006).

Bull J., Danson M. (2004) Computer-assisted Assessment (CAA), LTSN Generic Centre – Assessment Series No 14.

Clarke A., (2001), Designing computer-based learning materials, chapter 4, Gower Publishers Ltd.

Gladwin R. (2005) Getting started with CAA, The HE Academy Physical Sciences Centre.

Jenkins M. (2004) Unfulfilled Promise: formative assessment using computer-aided assessment, Learning and Teaching in Higher Education, 1, 67-80.

King T., Duke-Williams E. (2001) Using Computer-Aided Assessment to Test Higher Level Learning Outcomes, Proceedings of 5th International Computer Assisted Assessment Conference, Univ. of Loughborough, 177-187 http://www.caaconference.com/pastConferences/2001/proceedings/p1.pdf (10 January 2006).

Lowry R. (2005) Computer aided self assessment – an effective tool, Chemistry Education Research and Practice, 6 (4), 198-203.

Overton T. (2003) Key aspects of teaching and learning in experimental sciences and engineering, in A handbook for teaching and learning in higher education, ed. H. Fry, S. Ketteridge, H. Marshall, 2nd Ed, Kogan Page, UK.

Price G. (2006) Computer aided assessment and formative feedback – can we enhance students' early experience at University? HE Academy Physical Sciences Centre Development Project,

http://www.physsci.heacademy.ac.uk/Resources/DevelopmentProjectsReport.aspx?id=213 (10 January 2006).

QAA (2004) Code of Practice Precept B7 and B8, Assessment of Sudents. (2004), http://www.qaa.ac.uk/academicinfrastructure/codeOfPractice/section2/default.asp#assessment (25 March 2005).

Zakrzewski, S and Steven, C (2000) A Model for Computer-based Assessment: the Catherine wheel principle, Assessment and Evaluation in Higher Education 25, 201-215.