The potential impact of computer-aided assessment technology in higher education

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Abstract

Distance learning generally separates students from educators, and demands that interventions be put in place to counter the constraints that this distance poses to learners and educators.

Furthermore ‘Increased number of students in Higher Education and the corresponding increase in time spent by staff on assessment has encouraged interest into how technology can assist in this area’ (Mogey and Watt 1999, 1). As student assessment is an important challenge faced by Higher Education institutions, this paper investigates the role that Computer Aided Assessment (CAA) can play for both face-to-face and distance learning institutions. The discussions include the definition of CAA, its rationale, potential benefits, limitations, impacts on student learning and strategies for developing effective computer-based or online assessment. Research has indicated that when students are actively engaged by giving them more tests, assignments or examinations, the pass rate increases. CAA is one of the methods that can be used to engage students actively in their learning. It allows marking; immediate feedback, the recording of student scores and the analysis of student performance to be processed by computer and thus alleviate the burden on educators. Computer Aided Assessment is described as any instance in which some aspect of computer technology is deployed as part of the assessment process (Atkinson and Davies 2000). These may include:

- Interactive exercises and tests completed on a computer
- Onscreen marking of students' word-processed writing
- Use of revision software
- Using of spreadsheet or database to keep a record of student marks
- Use of e-mail to send coursework and to receive marks and feedback etc.

There are many benefits linked to CAA, some of which are objectivity and consistency of standards; automatic, immediate, and detailed feedback to all students; time saved when marking and allocating marks (Billings, 2004; McKenna and Bull 2000; Musham
2004). Limitations linked to CAA include the possibility that CAA may not be suitable for assessing skills such as constructive argument, writing, presentation and interpersonal skills. Computers and software sometimes crash and boot students offline during testing, and cheating sometimes occurs [Musham 2004; Greenburg 1998]. The above-mentioned issues are discussed with the aim of encouraging higher education institutions to consider the potential benefits of introducing CAA.

INTRODUCTION

Distance learning physically separates students from educators, and demands interventions to counter the constraints that distance imposes upon learners and educators. Furthermore, an ‘increased number of students in Higher Education and the corresponding increase in time spent by staff on assessment has encouraged interest into how technology can assist in this area’ (Mogey and Watt 1999, 1).

As student assessment is an important challenge for higher education institutions, this paper investigates the role that Computer-Aided Assessment (CAA) can play in distance learning institutions. This discussion will include the definition of CAA, its rationale, potential benefits, and limitations, and its impact on student learning and strategies to develop effective computer-based or online assessment. This paper is founded upon a literature base and presents the arguments surrounding CAA technology and its application in higher education.

Research has indicated that to engage students via more tests, assignments or examinations leads to an increase in the pass rate. CAA is one method that helps students to engage actively with their subject. It allows marking, immediate feedback, the recording of student scores, and the analysis of student performance to be processed by computer and thus alleviate the burden on educators (Billings 2004, 26; Clariana and Wallace 2002, 598; Lingard 2004, 7; McKenna and Bull 2000, 1; Musham 2004, 11).

WHAT IS COMPUTER-AIDED ASSESSMENT (CAA) TECHNOLOGY?

Atkinson and Davies (2000, 2) define Computer-Aided Assessment as ‘any instance in which some aspect of computer technology is deployed as part of the assessment process’. Computer-aided assessment would employ the following use of computer technology:

- the online completion of interactive exercises and tests
- online marking of assignments and exercises
- the use of revision software
- electronically mailed coursework
- marks and feedback
- web pages to set tasks for students and to provide tutor support
- the use of spreadsheets or databases to keep records of students' marks
- software to detect plagiarism.
THE RATIONALE FOR USING CAA IN THE OPEN DISTANCE LEARNING (ODL) ENVIRONMENT

There are many reasons why academics assess learning and it is important that assessors consider these reasons when they design assessment strategies. For instance, it is important for assessors to consider the knowledge, skills, values and attitudes that they want to assess. It is important to design an assessment that will fulfil your needs appropriately. It is useful, therefore, to consider the decisions that are going to be made, the information needed to make the decision, and what methods are the most effective for gathering that information (McAlpine 2002, 4). Paper-based and computer-based assessment methods should both be considered since they each have their own benefits and limitations.

Paper-based versus computer-based assessment

According to Mason (1998, 4), a re-evaluation of traditional assessment procedures in higher education are long overdue, as they are ill-suited to the digital age in which using information is more important that remembering it. Traditional assessment procedures may include paper-based assessment. There are certain skills that resist paper-based assessment. On the other hand, computer-based assessment technology diversifies assessment tasks, broadens the range of skills that can be assessed, and provides students with more timely and informative feedback on their progress. Considering online and computer-based assessment is a natural outcome of the increasing use of information and communication technology to enhance learning in higher education all over the world. Open and distance learning institutions should provide flexible assessment as well, which is possible through CAA (Devlin 2002, 1).

Increasing academic workload in higher education

At the University of South Africa, for example, over 10 000 students enrolled for Economics I, and in this climate of an ever-increasing academic workload, it is impossible to assess such large classes with the usual traditional methods that were used when the same course enrolled only 100 students. The adoption of computer-based assessment technology would certainly help to manage large volumes of marking and assessment-related administration. The automation of online tasks, for instance, may have the long-term potential to provide time/cost-efficient student assessment (Devlin 2002, 1).

Computer-based assessment and students with learning disabilities

Computer technology can be invaluable for assessing students with learning disabilities since it offers opportunities for developing innovative assessment tools in higher education. The nature of computers as information processing tools, their role in creating
user-friendly and interactive online learning environments, and the possibility of creating instructional tools to meet individual student needs, make computers a potentially powerful technology for assessment (Kumar 1994, 4).

**POTENTIAL BENEFITS AND LIMITATIONS OF COMPUTER-BASED ASSESSMENT TECHNOLOGY**

It is generally accepted that assessment plays a central role in student learning irrespective of the mode. Online learning challenges students to learn new skills and ways of learning. Devlin (2002, 2) argues that online assessment teaches skills that it is not possible to gain from doing a normal essay.

Some potential benefits of computer-based assessment technology

Researchers in this field have outlined a number of benefits of computer-based assessment in comparison with the traditional methods of assessment. The most commonly cited benefits now follow:

- **Use of multimedia.** Computer technology has the potential to include images as part of the question and/or answer. Photographs, diagrams, maps, music scores, equations, audio, video and animation can be used to excellent effect. Some computer tests include interactive simulations that seek to replicate real life workplace situations (Greenberg 1998, 4). Students with learning disabilities can benefit greatly from the use of multimedia.

- **Automatic, immediate, and detailed feedback to all students.** This is not possible with a hand-marked assessment. For formative assessment, feedback can be immediate, detailed and the same for all students (McKenna and Bull 2001, 5).

- **Objective and consistent standards.** Computer technology will always obey the scoring rules fed into the programs. However, in traditional hand-marked scripts, subjectivity may be a problem.

- **Information is more accessible to disabled students.** Irrespective of disability, computer software makes it possible for students to reflect on their learning. For example, the Digital Audio Integration System (DAISY) assists students to listen to the text, and Optical Character Recognition (OCR) software can scan text for students with visual disabilities (Moodley, 2006).

Some limitations of computer-based assessment technology

African countries are generally characterised by technologically less-advantaged students, especially in rural areas. Some people are therefore concerned that computer-based assessment technology may be elitist and unfair to students who are unfamiliar with computer operations and do have easy access to computers (Greenberg, 1998). Musham (2004, 8) argues that computer-based assessment is not suitable for assessing skills such as constructive argument, writing skills, presentation skills and inter-
personal skills. Student authentication and cheating are other limitations generally cited. It is therefore important to build into any online assessment a secure method of student authentication. Some academics feel that computer-based assessment cannot test high order skills such as synthesis and analysis (MacKenna 2001; Musham 2004, 8). Applying Bloom’s revised taxonomy can help to map different types of questions, and thus give an indication of the coverage and diversity of knowledge and cognitive skills used during an assessment. For example, if the questions that make up an online assessment can be designed as indicated in Table 1, and low to high cognitive skills can be assessed (Musham 2004, 9).

Table 1: Revised Taxonomy Table by Anderson and Krathwohl (2001) in Musham (2004)

<table>
<thead>
<tr>
<th>Knowledge dimension</th>
<th>Cognitive Dimension</th>
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<tbody>
<tr>
<td></td>
<td>1 Remember</td>
</tr>
<tr>
<td>A. Factual Knowledge</td>
<td>Question 1</td>
</tr>
<tr>
<td></td>
<td>Define</td>
</tr>
<tr>
<td>B. Conceptual Knowledge</td>
<td>Question 2</td>
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<tr>
<td></td>
<td>Explain</td>
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<td>C. Procedural</td>
<td>Question 3</td>
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<td></td>
<td>Relate</td>
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<td>Question 4</td>
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<td></td>
<td>Compare</td>
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<td>D. Meta</td>
<td>Question 5</td>
</tr>
<tr>
<td></td>
<td>Suggest</td>
</tr>
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**COMPUTER-AIDED ASSESSMENT AND STUDENT LEARNING**

Computer-based assessment can be very useful for formative assessment in distance education. Formative assessment is designed mainly to assist the learning process by providing feedback to the learner; it highlights areas of further study and improves further performance. Feedback motivates students and informs them how well they are performing (Kumar 1994, 1; Devlin 2002, 1; McKenna and Bull 2000, 5).

According to McKenzie (2004, 1–8), the use of the Online Marking and Results system (OMAR) at the University of Melbourne resulted in improved student learning and student satisfaction with their courses which could translate into increased enrolment and revenue for the University. OMAR is web-based software that permits academics to customise online templates for performing their marking of student assignments and offer feedback to students. For open and distance learning institutions with large enrolments, such as at Unisa, both academics and students can benefit from using OMAR.

Baggott and Rayne (2001, 7) used frequent computer-based assessments (CBA) at Birkbeck College, University of London, to test strategies for improving learning support in their first year Biology curriculum. Mature and part-time students participated
in this research. They administered frequent CBAs, incorporating extensive feedback, both to pace the students’ study efforts and to indicate areas in which additional help from a lecturer might be required. A combination of summative and formative CBA was employed. The results were as follows: The mean examination score for students who accessed the formative CBA was 63 per cent; those who did not avail themselves of these tests achieved a mean score of 50 per cent. Conclusions made from this research include the following:

- The CBA provided support, as evidenced by the fact that the majority of students made use of, and benefited from, the formative tests.
- The CBA promoted learning, as evidenced by the fact that the median score was maintained between the open book summative and the closed book summative assessments. Those who used formative CBA performed much better on the closed book exam. Extensive feedback made an important contribution to student success.

These approaches may be widely and successfully applied in the open and distance learning environment of Africa if the appropriate planning is carried out.

Research studies conducted in Norway, Stord/Haugesund College by Svein Ove Lysne and Jostein Tvedte (2000), used the WebOrama computer tool to involve open and distance learning students in their learning. 'WebOrama is a system where video clips, sounds and texts are integrated and played or showed as sequences' (by Svein Ove Lysne and Jostein Tvedte (2000, 131). The main reason for introducing WebOrama was to cater for the three most important factors in their courses, which were engagement, work and guidance. The students' new role in the research project was to take responsibility for their own learning and education. The results and scores of the final examinations and the compulsory course work proved that the increased emphasis on active students and problem-based working methods made for better scores. When internal students were compared to external or distance learning students, it was revealed that external students scored equally or even better than internal students on final exams and on compulsory work. This may mean that computer-based technology has the potential to actively engage students in their learning and improve their scores.

STRATEGIES FOR DEVELOPING EFFECTIVE COMPUTER-AIDED ASSESSMENT TECHNOLOGY IN HIGHER EDUCATION

Lingard (2004, 5) argues that computer-based assessment should not be considered in isolation from other assessment methods within a course. It is important to consider fundamental issues of assessment and their role in teaching and learning.

Devlin (2002, 3) introduced strategies that can be used for developing effective computer-based assessment. Some of these strategies can be useful in guiding distance education institutions in developing countries such as Africa. The strategies were summarised into the following checklist:
• An access and usage checklist
• A quality of teaching and learning checklist
• A technical and administrative checklist.

A brief discussion of this checklist follows below.

Access and usage checklist

Make sure that all the students have access to computers and that computer skills are
developed to such an extent that they can manipulate them with confidence. According
to Lingard (2004, 8), care must be taken that some students are not disadvantaged by
the use of technology. Bull and McKenna (2000, 4) further emphasised the point that
technology should not get in the way of the student achieving a score that accurately
reflects his/her ability. It is important to note that mature distance learners and students
from technologically less advanced countries such as Africa, might lack the necessary
computer skills. In that case, it is important that appropriate support is available. The
lack of access to the main university campus and regional campuses at Unisa, for ex-
ample, should be addressed. Appropriate educative resources must be made available
to address the issue of ICT skills.

Quality of teaching and learning checklist

For effective teaching and learning, Bull and Danson (2004) suggest that new practition-
ers in computer-assisted assessment should first consider how assessment is currently
undertaken within their courses, and identify where computer-assisted assessment might
be beneficial. The assessment methods chosen should relate to the learning outcomes of
the course. It must be clear what is being assessed and why (Lingard 2004, 5). Students
should have plenty of opportunity to practice their knowledge and skills before they
embark on computer-based assessment. These opportunities may include diagnostic,
continuous and formative assessment of student learning. The possibility of plagiarism
should be eliminated or minimised. Where automated responses are incorporated, high
order cognitive skills should be considered. Mechanisms to enable rapid feedback from
both students and academics should be in place. Where online exams are incorporated,
students should be given enough time to practice in order to prepare adequately. Dynamic,
computer-based tasks and activities should integrate interactive images, sound and text.
Appropriate technology should be provided for students with learning disabilities.

Technical and administrative checklist

Make sure that the computers used by both academics and students are compatible.
The computer system used should be able to deal with student difficulties related to
password, access, and usage. Adequate technical support staff during the development
and use of formative and summative assessment should be ensured. Computers and
software sometimes crash and boot students off-line during testing (Greenberg 1998), and emergency backup facilities should be put in place.

Start-up guidelines

Devlin (2002, 6) suggests three useful guiding principles when starting to use computer-based assessment. These are:

- Start with clear educational objectives
- Start small
- Start where success is most likely.

Brief discussions of the three principles follow:

**Start with clear educational objectives or learning outcomes**

Doing so will meet one of the principles of effective assessment, which is, to align assessment with learning objectives and learning activities (Naidu 2003, 211). Then, consider which assessment technologies are appropriate to influence student learning. Moreover, consider how computer-based assessment will add to the learning experience of students. Another issue to take into account at this stage is the needs, characteristics and situations of the learners. Where students from technologically less advanced countries, which is the characteristic of most African countries, form part of the student cohort, it is necessary to equip these students with the skills necessary to undertake assessment tasks that require the use of this medium.

**Start small**

Devlin (2002, 1) recommended that the aim for assessment should be quality rather than quantity. He also indicated that many academic staff had successfully started with a computer-based assessment task that is a minor proportion of the assessment for a course or module. The approach is essential because any technical, educational or other difficulties that might arise can be resolved without being disadvantageous to students. It is advisable to start with formative assessment rather than with summative assessment. Students’ experience with formative assessment can prepare them for a summative form of assessment. According to Lingard (2004, 8–9) the introduction of computer-based assessment for formative purposes is less complex than for summative assessment for there are fewer stakeholders to consult for effective implementation.

**Start where success is most likely.**

As already indicated above, successful computer-based assessment is most likely to occur if the assessment is aligned with teaching and learning objectives. The computer-based assessment technology should allow students to communicate their understanding and receive prompt and constructive feedback on how well they are performing. Devlin put forward the following guidelines (2002, 8):
• Provide students with more flexibility in time, place, and the selection of assessment option. This will favour open and distance learners from diverse backgrounds. The University of South Africa is using a blended approach to teaching and learning for some of its postgraduate courses. Blended learning is used to describe learning that mixes various event-based activities, including face-to-face classroom learning, live e-learning and self-paced learning (Valiathan 2002, 1).
• Provide equitable opportunities for all students to demonstrate their knowledge.
• Identify new possibilities or opportunities not seen at present.

It is clear from the above guidelines that computer-based assessment suits formative objectives very well.

CONCLUSION

There are many issues related to computer-based assessment that need to be explored before embarking on its use. This paper touches on a very small percentage of what seems to be a complex and exciting area of teaching and learning. Within the scope of this paper, a number of issues have been outlined in order to assist anyone who wants to explore and apply computer-based assessment technology in teaching and learning. These include the definition of computer-aided assessment, the rationale for its use, an explanation of its benefits and limitations, a discussion of its impact on student learning in some institutions of higher learning, and it closes with strategies and guidelines for developing effective computer-aided assessment in higher education. In conclusion, let it be understood that computer-aided assessment cannot be an answer to all the challenges related to teaching and learning. It can, however, be considered where it best benefits teaching and learning, and where pencil and paper assessment cannot perform as well. Therefore, where the computer technology is available, academics and students are encouraged to optimise its use for the benefit of all.

References

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