Towards Transformation: eExaminations for ICT-enabled learning outcomes

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Abstract: ICT has not always proven effective at enhancing student learning achievement in conventional learning outcomes with pre-existing curricula. Therefore its effectiveness may have to be evaluated with respect to student acquisition of new knowledge, skills and attitudes which depend upon computer use for their evaluation. This project describes how a new method for conducting summative assessments was developed and used in a pre-service teacher education program. The materials have been made available for other researchers to use, and are expected to be trialed in the school sector in 2009.

Keywords: ICT, assessment, open-source, eExamination

1. Introduction

Without a suitable computer-based way of conducting examinations (as an example of rigorous assessment), curriculum transformation may be unlikely because assessment is a major determinant in teaching. This report is preliminary, describing the development of an eExamination method and its use in pre-service teacher education. Using open-source software developments, a set of tools has been created and trialed for candidates to use their own full function personal computer under examination conditions. These tools are available for download.

As flexible and online learning mediated by ICT become more pervasive, there is a growing need for educators to consider modes of assessment using similar tools. Major IT companies presented this view at the Learning and Technology world forum in London (Cisco, Intel & Microsoft, 2009). The cost of assessment in higher education is the most rapidly growing component of tuition fees (Ricketts, Filmore, Lowry & Wilks, 2003) whilst open content shrinks the cost of tuition and learning materials (Wales & Baraniuk, 2008). However, the increasing discrepancy between teaching through blended or online mode with a learning content management system and assessing using pen-and-paper is another reason
to consider ways in which candidates can verify their achievement whilst using computers.

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2. Previous studies

The role of ICT in supporting the curriculum has been extensively evaluated by some large government-sponsored projects. The ICT and attainment review in England (Cox et al., 2003) found positive effects in almost all subjects, but particularly with specific uses, such as word processing in English, modelling in mathematics, or using simulations in science. The authors noted:

Researchers have often measured the ‘wrong’ things, looking for improvements in traditional processes and knowledge instead of new reasoning and new knowledge which might emerge from the ICT use (p. 34).

Many such studies have noted the Hawthorne effect of novelty, either as an extra motivational force, or ICT as an extra skill to be mastered in addition to the content knowledge addressed. A large scale study in the USA (Dynarski et al., 2007) found even good software had little learning benefit. Cuban (2001) made a case for the ineffective use of computers in classrooms. Such studies make it at least contested that computer use in support of a pre-existing curriculum is effective, let alone efficient. For the latter to be the case, researchers might legitimately inquire as to whether learning outcomes are achieved more rapidly.

Online assessment is quite widespread in Australian Universities, but largely superficial for both formative and summative purposes (Byrnes & Ellis, 2006). It is mostly used for online quizzes, online forums and online assignment drop boxes. In many cases online assessment is conducted using an institutional Learning Content Management System (LCMS) such as BlackBoard, WebCT, or an in house product. Online assessments offer several advantages:

- Time analysis of responses to the question level (Gvozdenko & Chambers, 2007).
- Including video in questions, particularly for scenarios in authentic assessment.
- Adaptive testing, where the next question to be posed is determined by prior response(s).
- Question banks and randomisation of questions and response orders to reduce cheating.
- Automated analysis of results from entire candidate cohorts.
- Immediate feedback can be given.
These benefits and the difficulties associated with various online assessments have been described by Leask (1999). Plainly, online assessment is not good for evaluating creativity, problem-solving ability, critical thinking, reflection, or authentic learning, collectively the characteristics of deep and effective learning. The delivery technology itself creates problems of inter-candidate interaction and is prone to technical malfunctions which can affect many students simultaneously. Should the whole network fail, the examination needs to be rescheduled (Institute for Interactive Media and Learning, 2007). We have yet to see much use of ePortfolios, role plays and simulations, although these have been suggested as being powerful alternatives.

Developments in assessment are advocating alternative and diverse assessment methods, including peer assessment, portfolio, reflective journaling, self-assessment, and performance-based assessment, which are deemed to be constructive, authentic, contextualized assessment, and to promote deep learning and skills development. (BC consulting, 2006, p.3)

All assessment needs to be “valid, reliable, fair and flexible” (Booth, et al., 2003: 8). In some cases, the context for assessment equity and quality is the individual written examination.

Only six per cent of partially online assessable units had a final exam that could be taken online. Of the partially online assessable units without an online final exam, 83 per cent had a traditional pen and paper final exam, indicating that the use of final exams is quite widespread. Overall, 84 per cent of partially online assessable units had a final exam. (Byrnes & Ellis, 2006)

Outside Australia, there appears to be a greater uptake of eAssessment in schools, with 38% of Awarding Bodies surveyed in England using e-Assessment to deliver up to 60% of their assessment programme (Chapman, 2006).

LCMS-based online testing environments offer useful tools for conducting assessments of knowledge. Automated marking is feasible for multiple-choice questions, and for short answer questions where key words are sought in the response. Assessment feedback requiring an understanding of an essay etc. is not yet widespread and responses which include diagrams might be difficult to mark automatically. The challenges faced by online systems are those posed by Booth et al. (2003). Assessment of student knowledge and skills within a web-browser window or delivered by bespoke assessment software provides a restricted environment which prevents the demonstration of abilities associated with the use of specialist software or a combination of applications.

To be fair, online systems need to authenticate the individual undertaking the assessment – some systems have gone so far as to take photographs at random intervals to assure this (Rönnberg, 2001). However, the camera may not necessarily be pointing at the person undertaking the responses, so this is not
Foolproof. Another aspect of fairness is generally eliminating collaboration: since
the computer is online, this is hard to implement except by locking out critical
functionality during the assessment. E-Tests developed by Ko and Cheng (2008)
require an Iomega zip disc peripheral, all the data files are encrypted and the
program will only run on computers with a pre-registered network card. Such a system
handles large numbers of students very well, but is restricted to simple question types.
Such systems primarily facilitate automated marking, whilst we sought to provide a
comprehensive environment to move all assessment types into a digital modality.

Fairness can be improved by adopting a proctored or supervised testing
environment, where all students are watched by an examiner as they undertake the
assessment. But how can the examiner prevent collusion if all candidates are using
computers? Bluetooth, wireless networking, infra-red and mobile phone
connections are all feasible communication channels and these are not easily
blocked. Thus, if assessment, particularly of high stakes summative examinations,
is to move into an ICT environment, some other technological and pedagogical
approach is needed. One which can exploit student-owned equipment would be
particularly suitable, since few institutions can deploy many hundreds of
computers for the small fraction of the year devoted to formal assessment.

3. The course and content

The eExamination was conducted in a third year unit of a Bachelor of
Education program, which normally takes four years to complete. A first year unit
ensures they have at least a minimal level of personal operational ICT skills – they
can already operate word processors, compose web pages etc. A large number of
units in the program use an elearning content management system (WebCT-Vista)
in blended mode, so students are reasonably well versed in the use of ICT for their
personal learning. It needs to be stressed that the eExamination (50% of the final
award) assessed understandings gained in the third year unit, not of operational
computer skills. The learning aims for this unit were that students should:
1. Demonstrate awareness of the extent and difference between home and school
ICT access for pupils.
2. Facilitate and lead appropriate, equitable and responsible pupil use of
information and communication technologies integrated into all areas of
learning.
3. Demonstrate personal skills & knowledge of ICT in school education, and
understand this requires continuous updating.
4. Inform parents and the community on how information technologies are, or
would be, used in the school.
3.1 Course assessment

Several weeks prior to the open-book eExamination, students were offered a free practice CD-ROM which was used to boot their own or an institutional computer using a crafted Ubuntu-Linux operating system. A folder on the desktop contained the eExamination materials. Completed scripts were saved to the desktop, and subsequently to a USB drive. In the case of equipment failure, a paper version of the eExamination was available, or students could re-start using another computer. Access to the Internet or any other digital resources was not allowed. Digitally facilitated collusion was prevented in three ways:

- Networking drivers were omitted from the CD-ROM-based operating system compilation.
- Networking cables were withdrawn from the wall sockets in each computer laboratory. This was quick and easy to do, and visually monitored.
- The gateway for the sub-net containing the laboratories was disabled by our IT technicians for the duration of the eExamination.

3.2 Preparing the eExamination

Ubuntu\(^1\) is one of several Linux distributions which is available either for installation onto a computer or which can be run from a ‘live CD’. This latter option allows a computer user to try the operating system without over-writing any existing installation on their machine. Ubuntu continues to be developed by a community initiative, sponsored by Canonical Ltd. (Ubuntu, 2007). The licence for Ubuntu and most of its associated software allows copies to be distributed freely. An application called Reconstructor is available to create new live-CD distributions of Ubuntu, allowing software packages to be added or deleted from the standard CD image. We have modified this application to simplify the creation of an eExamination CD-ROM by automating the process and reducing the number of steps required. One critical step for examiners is to decide which customisation options to include (see Fig. 1).

The option to disable computer-based networking allows examiners to conduct the digital equivalent of open-book examinations. However, local communications such as Bluetooth (which can interface to mobile phones) or unwired networking can be disabled separately. To reduce distracting computer sounds in an examination hall, the loudspeaker drivers can be eliminated. If students are using their own laptops, or even loan-pool laptops, local hard disk drive access can be eliminated.

The eExamination creation process allows the examiner to include a folder of examination materials onto the CD-ROM. The folder can contain a word-processed document (as in our example), videos, application software etc. The

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\(^1\) http://www.ubuntu.com
examiner can also specify an image file which becomes a desktop background. This image is a useful security feature: any computer screen not showing this unique image must have been booted from another source. For non-technical eExamination invigilators, this provides a quick visual check to confirm each student is using the correct materials.

![Modified Reconstructor options screen](image.png)

**Fig. 1.** Modified Reconstructor options screen

### 4. Evaluation

At the end of the eExamination, students were offered a single page eAssessment survey. This was voluntary, and had ethics approval. 138 students sat the eExamination and 125 returned the survey. The results are summarised in Table 2.

<table>
<thead>
<tr>
<th><strong>Table 2:</strong> E-Assessment survey results (2007)</th>
<th>Yes</th>
<th>No</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you taken a computer-based examination before this one?</td>
<td>58%</td>
<td>42%</td>
<td></td>
</tr>
<tr>
<td>Did you have any technical difficulties in today’s eExamination?</td>
<td>22%</td>
<td>76%</td>
<td>2%</td>
</tr>
<tr>
<td>Did you use the practice CD prior to today’s eExamination?</td>
<td>82%</td>
<td>18%</td>
<td>2%</td>
</tr>
<tr>
<td>On balance, is it better to have formal tests conducted using computers or using handwriting on paper?</td>
<td>Better on computer</td>
<td>61%</td>
<td>Better on paper</td>
</tr>
</tbody>
</table>
Thirty-nine percent of students recalled an ICT competency test from their first year of the course. These, together with students who had completed online pre-employment tests, accounted for the large proportion (58%) that had previously taken a computer-based examination. Nearly one third of the students that reported technical difficulties (8% from 22%) included the comment ‘the system was slow to respond’. This is a regrettable effect of using a ‘live’ CD operating system since commands must be loaded from the optical media. Other specific reports of technical difficulties included:

- I could not remember how to create a diagram
- Spelling issues – I kept touching the wrong keys
- AutoCorrect changed my words

No computer failures were reported to the invigilators through the examination. In the previous year we had two computer ‘lockups’, but both candidates had been able to resume after a restart, losing none of their work. Most students had used the practice CD before the examination, so had become aware of the minor differences between Ubuntu and the Windows XP environment used in the Faculty computer laboratories. Twelve percent of students thought the practice CD was very useful, and a further 47% thought it was moderately useful. 17% said it was not at all useful.

A majority (61%) of students expressed a preference for formal tests to be conducted using computers instead of handwriting on paper. This compares with 94.5% preference found in a case which included online feedback (Jonsson, Loghman, & Nadjm-Tehrani, 2002). The additional comments from students in this study related to typing, timing and attitudes. Ten percent of students claimed to be slow typists (and may therefore have been at a disadvantage), and 14% commented on the distracting noise of multiple keyboards clattering. However, students also noted that typing is faster and easier to read, and slow hand-writers were also disadvantaged by pen-on-paper exams. It was not possible to identify the ten percent that were slow typists as mature-aged students, but 34% of the cohort entered the degree by routes other than secondary schooling. Sixteen percent of students thought there was not enough time to answer all the questions, which may be a pedagogical design issue rather than a technical difficulty, although distinguishing between the two is difficult when the mode of writing has been altered. One student expressed a great fear that the computer would crash. General comments included the following:

- This was great! I can type much faster than I can write and no hand cramps!! 😊
- I believe that this testing way was better than hand writing for the reasons such as I am able to type faster than handwrite and your hands didn’t cramp up.
- I think it is better on cXXXX paper as yXX you can writer faster.
5. Discussion and Conclusion

Are pre-service teachers ready to use ICT for their own assessment processes? The results of this exercise indicate that the majority are indeed ready for this kind of change, but there is a significant minority who find it threatening or uncomfortable. Good assessment practices will encompass a range of styles and types of assessment. This study has looked at a summative supervised examination conducted using computers, as an adjunct to a take-home assignment with a more formative focus. The latter assignment was generally submitted through an online drop-box via the institutional learning content management system, indicating student familiarity with personal computer use. Determining student readiness to use ICT in assessment therefore depends upon these two contexts.

Perhaps we can judge their attitudes by their reactions to being assessed themselves using ICT? This cohort was divided for the purposes of a timed summative examination between those that preferred to handwrite, and those that found using the computer much easier. In retrospect, we could have asked students to indicate their ages, to see if writing preference was related to this factor. If so, this would emerge as a real Gen Y consideration, leading to tension between them and digital immigrants. Mediating between such distinct groups could provide a significant challenge for awarding bodies. Some interesting work could be done on the equity issues associated with allowing free choice of writing modalities in examinations, or alternatively providing a single proscribed writing method as in our study.

There are an increasing number of computer-mediated assessment products on and hitting the market. Apart from propriatorial interests of the suppliers, each of these generally restricts the demonstration of ability to a closed environment. Example systems have the following restrictions:

- Suited for a restricted discipline/knowledge domain (eg Pearson Vue for UK Driving Tests\(^2\))
- Requires examiner expertise with a particular question-setting or authoring software application (Articulate Quizmaker 2.0\(^3\))
- Internet connectivity required throughout the examination, but candidate ability to run any other software is blocked (MaxExam\(^4\) or Securexam\(^5\))
- Question types restricted to offered choices only (BrainsBuilder\(^6\))

One reason for supporting a change to eExaminations is the linkage between tertiary and secondary assessment methods. These are only loosely linked systems, yet it is likely methods used in one sector will be noticed and appropriately

\(^2\) [www.pearsonvue.co.uk](http://www.pearsonvue.co.uk)
\(^4\) [http://www.maxexam.co.uk/info/whymaxexam_features.asp](http://www.maxexam.co.uk/info/whymaxexam_features.asp)
\(^5\) [http://www.softwaresecure.com/student.htm](http://www.softwaresecure.com/student.htm)
\(^6\) [http://www.brainsbuilder.com/site/features.do](http://www.brainsbuilder.com/site/features.do)
adopted in the other. Secondary sector assessments are impeded from adopting computer-mediated methods whilst tertiary systems rely heavily on high stakes written examinations (Fluck, 2007). Our informal scrutiny of pre-service teachers in schools substantiates this linkage, with few instances of computer-based assessments observed in classrooms. We speculate that the low rate of eAssessment in schools could also be due to governance issues (Robertson, Grady, Fluck & Webb, 2006), lack of opportunity for teachers to perceive significant advantage (Rogers, 2003) or greater demands in schools which are ‘busy places’ (DEST, 2006, p. 121).

The collective opinion of this student cohort was ambivalent about the introduction of computer-based examinations. Some recommendations for proceeding with change along these lines would include:

- Attempt to find quieter keyboards
- Try to make time pressures in E-exams less severe and therefore typing speeds less crucial.
- Find some quicker way to collect competed scripts. In the current event we should prefer a non-networking solution, such as write-to-CD or boot-from-USBdrive.

In conclusion, the system used in this study had a number of useful attributes. The open-source operating system on a live-CD provided a holistic examination environment which students could use to practice personal skills at home. The system allowed eExaminations to be supervised by invigilators without specialist information technology skills. eExaminations can be easily constructed for a range of software environments, from candidates working on isolated workstations to ‘open-book’ contexts with full internet connectivity. The use of the live-CD can potentially allow candidates to use their personal laptop for the E-exam. Future developments using USB-drives can overcome problems with operational speed, and also facilitate the collection of completed scripts. Instructions for this method and the open source ‘Reconstructor for Exams’ software are both available at www.eExaminations.org.

References


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