

# eExams – high stakes summative assessment for the digital age

**Andrew Fluck**

University of Tasmania, Newnham, Australia

Andrew.Fluck@utas.edu.au

**Abstract:** *Students at the University of Tasmania (UTAS) are using their personal computers in examinations for the fourth consecutive year in 2010. Rationales for this practice include extending online and blended learning practices into high stakes assessment; providing interactive and multi-media scenarios on the exam desk; providing digital scripts for computer-supported marking and moderation; and improving legibility of students' scripts. To undertake an eExam, candidates start their computer from a USB stick or CD-ROM and work on-screen. The system interdicts all digital communications and local disk access. A strategic project funded by UTAS has allowed more Faculties to support eExams and trials have also been facilitated in the pre-tertiary sector.*

*The introduction of eExams illustrates institutional innovation adoption, both within the University and by other organisations. eExams provoke consideration of several important issues such as equity in text production, the comparative achievements of keyboard and pen users, envisioning new kinds of digitally-based assessments, contrasting costs and reliability of ICT and paper. All these issues are important but can also serve to obscure the leverage effect of digital assessment on new learning practices in a jurisdiction selected for initial rollout of the national broadband network which will require more advanced computing skills for commercial benefit to be realised.*

**Keywords:** eExams, laptop, innovation

## Introduction

Assessment is crucial to learning and teaching. Its nature can determine course content. As academics, we strive to link assessment with the sorts of learning activities in which students engage and to employ a variety of assessment methods. As online learning becomes used more extensively, and students increasingly use computers for formative assessment, there is a natural interest in using technology for high stakes summative methods of assessment as part of a balanced regime. Therefore, this project has allowed students to use personal laptops in examinations to include computer-based simulations, video and other ICT-based activities within a proctored environment which retains certainty of authorship.

The project builds on two years (2007-8) of successful piloting with an eExam system using institutional equipment. Further development has brought the security of the eExam system to a level considered similar to that pertaining in the standard examination hall and allows students to use their own personal computer. The current version runs very quickly from a

USB stick on each student's machine, denying access to local hard drives or communication systems. This prevents use of unauthorised material or collusion.

Having proven the concept in the UTAS Faculty of Education, the next step in 2010 has been to extend the range of use to other Faculties and to the pre-tertiary sector. This extension allows others to perceive the benefits of the system, an essential step to adoption of an innovation (Rogers, 2003).

Strategic innovation is the discovery of a fundamentally different strategy (or way of competing) in an existing industry (Anderson & Markides, 2006; Hamel, 1996, 2000; Kim & Mauborgne, 1997). Thus innovations break the rules and usher in a new paradigm. One of the challenges for this project will be to scale it up sufficiently rapidly to achieve this.

## **Background literature**

Society and learning are being transformed by computers (Gosper et al., 2008). The Australian Government is committed to a Digital Education Revolution with a focus on students in Years 9-12 who will shortly percolate into universities (Rudd, Smith & Conroy, 2007). Government is concerned about lethargic ICT-based transformation in education: "while ICT has fundamentally reshaped whole industries, revolutionised production processes and generated massive improvements in productivity in our workplaces, our education systems have been slower in adapting" (Gillard, 2008). This makes the adoption of ICT in education a problem of national significance, and therefore understanding the use of ICT in assessment is vital. This has been recognised overseas with an annual conference on eAssessment in the UK over the past 13 years (Ross, 2006) which involves many accreditation agencies. Research into school student acceptance of eAssessment is being conducted by the National Foundation for Educational Research (Burge, Foster & Lewis, 2006). In addition, there are emerging regulatory principles for eAssessment in school education (e.g. Qualifications and Curriculum Authority, UK, 2007). To remain competitive, Australia cannot be complacent as certification frameworks of other nations evolve to use 21st Century assessments for 21st Century learning.

Australian institutions aspire to systemic transformative uses of educational computers (Downes et al., 2002; Fluck, 2003). Therefore they need assurance high-stakes assessments will not remain dependent on old technology (i.e. on the use of pen and paper). Very little technology is allowed into the conventional examination hall. Mobile phones are banned, calculators are required to be identified on the exam paper, but a few dictionaries may be permitted. Assessment is a key driver of student learning (Biggs, 2002). Thus, student learning is unlikely to change in response to ICT without a transformation of assessment practices. Major computer companies have recently asserted the need for assessment to adopt computers in assessment because this is a pre-condition for curriculum transformation (Cisco, Intel and Microsoft, 2009). Their interest may be commercial, but they are also acutely aware of innovation adoption processes. Other factors may influence transformation such as infrastructure and training, but this project focuses on the role of formal summative assessment and its relationship with ICT-based curriculum transformation.

Previous Australian Learning and Teaching Council (ALTC) projects have looked at computers as a way of automating assessment (Crisp, 2008; Freney & Wood, 2008). These techniques require a high level of specific skill (designing java applets, QuickTime VR and

interactive spreadsheets) on the part of assessors and the process is vulnerable to one-point failure at the server (Meyer et al., 2007). Other emphases have been upon diagnostic or adaptive testing, restricted to a specific discipline area (Newby, 2008; Solomon, 2006). A related project looks at digital formats for external assessment, particularly performance recording (Newhouse & Williams, 2008). In pre-tertiary assessment, discussions have begun in England about moving in the direction of eExams with a substantial market for successful systems (Shepherd, 2010), particularly ones that can overcome the logistical problems.

These projects in Australia and abroad provide the background for the UTAS strategic project described in this paper.

## **Methodology**

The project has used a robust theoretical framework, based on Rogers' dissemination of innovations (2003), and aligned with the Australian Learning and Teaching Council (ALTC) commitments to promote and support strategic change in higher education institutions for the enhancement of learning and teaching, including curriculum development and assessment. Based on the Rogers' framework, the project is providing opportunities for potential adopters to perceive the relative advantage of the innovation. This affords UTAS an opportunity to facilitate a national approach to address how technology affects learning and teaching. Simultaneously, teachers of pre-tertiary subjects in Tasmania have used the eExam System to conduct trials with mid-year examinations.

In the pilot stage of this project, cohorts of approximately 180 students were assessed through a supervised computer-based examination system. Institutional computers were started up from a specially prepared 'live' CD-ROM. The preparation of this CD-ROM was analogous to the printing of an examination paper. The examination was pre-burnt onto the 'live' CD-ROM, automatically appearing as a desktop folder once the computer had completed the boot-up procedure. The exam system on the CD interdicted network functionality, and prevented them inspecting the local hard disk drive. The inclusion of a unique artistic feature on the desktop background allowed non-technical supervisors to ensure the correct operating environment was present on each candidate's computer. Students were able to complete short answer questions and provide sketch drawings. The system was extremely reliable, and resilient to operator error or equipment failure. The completed scripts were collected from each workstation using a USB data-stick, copied on a computer and then e-mailed to the external marker. The results of this piloting have been extensively reported elsewhere together with analysis of surveys and student comments (Fluck, Pullen & Harper, 2009).

In the development stage reported in this paper, the eExam System has been further developed and an additional cohort of students has used this new version in 2009. This second version has also been used in five Tasmanian schools for mid-year examinations in 2010. Preparation of large numbers of complex USB sticks has been simplified by the acquisition of a NexCopy duplicator which can be considered the digital age equivalent of a photocopier.

The underlying live operating system for the eExam System is Ubuntu. Ubuntu is a free and open source operating system, in contrast to other commercial products such as Microsoft Windows or Apple OS-X. Like other operating systems, it provides the capacity for a modern computer to undertake basic functions such as respond to keyboard and mouse, and place results onto the screen or printer. As Ubuntu is progressively improved, the eExam System

has to be re-constructed on the latest release. The project has now converted the computer start-up procedure to work from USB data sticks (flash drives) which also contain separate partitions for the examination questions and the answer scripts. This makes it much easier for candidates, because they only need to insert the USB stick into their laptop to begin the exam. A technical difference means Apple Macintosh computers still need the optical medium, but this works in conjunction with the same USB stick as for all other candidates.

Evaluation of the 2010 cohort was restricted because some students felt they were forced to adopt a novel examination environment purely because the researcher wanted to collect data. Therefore ethical clearance was not sought nor was data formally collected from this cohort.



**Figure 1: A set of USB sticks each containing the eExamination system, question paper and answer partition**

A risk analysis was carried out which considered innovation engineering problems and technological issues. These were divided into high and low probability scenarios which were matched with possible responses. This is an example of a low probability, low impact innovation engineering risk:

A student or lecturer refuses to participate in a mandated eExamination on grounds of principle.

*The project presumes pen-on-paper alternatives will be made available as backup or for conscientious objectors through the piloting phase to reduce the incidence of such stances.*

## Results

Two uses of the eExam System are reported here. The first was with university students undertaking a compulsory unit in computer education. The second was with Year eleven and twelve students across Tasmania taking the university entrance subject *Information Technology and Systems*.

At the end of 2009 one hundred and twenty three students took an eExam at the Newnham and Cradle Coast UTAS campuses using mostly their own laptop computers and some

institutional laptops (for about 10% of the cohort) or desktop computers. In preparation for this event, a copy of the eExam System was made available to the students beforehand (with an old question paper) and a one hour tutorial was devoted to demonstrating and practising with the system. When the students entered the examination hall, they had access to filtered mains power and a printed copy of the question paper to read during the booting up phase. In this assessment, every candidate used a computer except for a few exceptions. The exceptions included two students for whom the USB stick would not insert sufficiently deeply into their computer to make electronic connection: extension cables have been added to the equipment list to cater for this eventuality. The written paper was used by a couple of students who appeared to be resisting the change of format on principle.

As previously mentioned, because of the stressful nature of the examination experience, students had requested no formal data collection take place on this unique occasion. Since extensive data had been collected during previous iterations, and reported in the literature as noted above, this request was complied with. According to anecdotal comments by the students, the vast majority were exceptionally pleased with the exercise. Questioned by the UTAS exams office staff, all approached were very happy with the smoothness of the examination. Noise was not a problem – the quiet working environment mirrored that of conventional examinations. As a consequence of this success, an article was published in a national newspaper (Lane, 2009).

In the pre-tertiary sector in mid-2010, fifty-six students in five schools used the eExam System to take their mid-year assessments. They were all shown or given a practice copy beforehand to become familiar with the system. It was noted that institutional-owned equipment was used throughout.

Feedback from the pre-tertiary teachers was generally positive and noted the resilience of the system. A similar technical incident with a networked or communication-dependent system may have affected every student instead of just one.

- *Had one incident where a student's computer locked up and they had to reboot, but document was saved and no other problems ensued. Was a capable student so coped, but a lesser student may have been thrown.*
- *Went very smoothly*
- *All went very well, easy to use system for this type of exam.*
- *I liked the ability to mark work without having to be able to read handwriting. However, eExams are not exploiting the possibilities e.g. videos describing the case study etc.*
- *It was good*

Feedback from students was also generally positive, but one potential security flaw was identified:

- *Happy with process*
- *No problems at all. It was just like using Microsoft Word.*
- *Yes, enjoyed it very much.*
- *Power failure could be a potential problem. Scrolling up and down was required.*
- *I don't see there being any advantages to the end-of-year exam being a written exam. I would much rather another computer based exam.*
- *No advice needed for the eExam system designer. I believe that the eExam was good. All exams should be done on computers.*
- *Students like it - technology was not a handicap - all could type fast.*

- *Students weren't fazed. They all refused the choice of doing the exam on paper.*
- *My 2 best students weren't impressed with the security. Felt that it was too easy to save the answer document into the Answers folder, go back into normal [operating system - Windows] log on and re-open it where you could access other documents/internet.*

Cheating in examinations is a constant threat to validity, and the eExam development team are working on encrypted log files for startups/shutdowns to address risks such as the one illustrated in the final comment. Vigilant supervisors with technical assistants will be important in any transition phase.

The overall assessment from participants was very positive and indicates further trials should be conducted. The trial revealed the resilience of the system (coping with a major equipment failure) and also a security concern (which further development is addressing). This small scale exercise required supervising teachers to mark scripts from the USB sticks themselves. In a larger scale trial these should be batched and data collected automatically, then copied to CD-ROM. This provides a permanent medium for the student scripts (which can then be further reticulated in digital format) but also rapidly releases the USB sticks for use in another examination.

## Discussion

The introduction of eExams as an alternative to handwritten examinations is just a first step. This first step can be accomplished with little or no change in practice for examiners who submit their question papers digitally for printing. However, in the future it will become possible for examiners to write questions such as the following (note the use of hyperlinks to particular resources):

Watch the video [Complex DNA](#) [95 seconds] and use the [enzyme replication simulation software](#) to construct a molecular junction to inhibit the binding process. Submit your enzyme design template together with an explanation of how it will perform the required task.

Thus, not only can question papers be set in digital format, but responses can be data files for the specialist software used for the answers. This kind of change will reflect potential changes in teaching practice and should not involve great skill acquisition on the part of examiners. Conversations with pre-tertiary teachers of information technology and systems reveal their interest in short video case studies of business situations. This will ameliorate the time taken to read detailed descriptions of the same situation, and reduce the complex literacy burden from candidates.

These outputs offer many advantages over other systems since candidates can take the test on screen without requiring an internet connection; there is no restriction as to question types (standard examination formats can be used to require essays, diagrams or even video responses, as well as the multiple choice types). Test preparation only requires the same skills as if preparing for the paper to be printed. Being open-source, the system is low-cost and can be improved/adapted by adopting institutions. This open-source licence also makes it legal to give students practice examinations based on the system. The successful piloting indicates these outcomes are realistically attainable.

The eExam system has raised numerous questions which are all worthy of consideration. Here are some of which the author has become aware:

1. Should every student use a computer or should this be a choice of writing tool as is currently the case (some use biros, some use fountain pens, others use pencils etc.)?
2. Does the kind of computer give any specific advantage to candidates?
3. At what point in the innovation process should we move on from replication of pen-on-paper exams to incorporate features only possible in a digital environment such as video-based scenarios, questions requiring complex analysis with software tools (e.g. calculus and computer algebra systems or spreadsheet-based mathematical models) etc.?
4. How are the pre-tertiary and university sectors linked in respect to this assessment innovation?
5. Will the advent of digitally-based high stakes assessment tools automatically engender the adoption of ICT tools in teaching?

## Conclusion

The national benefit from this project has been new knowledge about the relationship between ICT-based assessment practices and ICT adoption for curriculum transformation. In addition, there is a potentially commercialisable tool for economically replacing printed examination papers with a digital equivalent. The benefits for students include bridging the gulf between IT-based learning and paper-based assessment; the capacity to perform changes and re-organise written replies at any time up until the end of the examination without messy crossing out; and fewer students with disabilities permitting keyboard use will need separate rooms, leading to inclusivity of practice. For university staff, the system offers a simple way to transfer examinations into a computer environment; invigilation is made easy through the use of a unique desktop image for each paper; and marking is simplified through digital duplication of all candidate scripts.

The project outcomes are significant for higher education in Australia because the collection together of several hundred computers solely for examination purposes is unlikely to happen on cost and logistical grounds. The project makes it possible for students to bring their own laptop into the examination hall, because the assessor can choose to forbid access to the local disc drive and/or networking. The adoption of a computer-mediated supervised examination framework is strategic in terms of change management and cultural adoption. This contributes to the enhancement of learning and teaching in higher education by allowing high stakes assessment to be conducted with minimal assessor development, by students using personal computers or laptops. Once this become accepted as a genuine alternative, curriculum transformation becomes possible, since eExaminations can be based upon new software and new digitally mediated ways of understanding the world. There are significant environmental savings to be made by eliminating or reducing the use of paper.

This eExam project has built upon two years of successful piloting at UTAS (Fluck, 2009) and exemplifies the key principles for such digital assessment:

- Portability – it should be possible to set it up using almost any available equipment, including a student's own personal computer.

- Equity – it should be accessible to a wide range to students, including those with disabilities.
- Familiarity – students should have every opportunity to practice essential skills in this environment.
- Technical capacity – it should not limit students’ creativity or expression.
- Archivability – the environment should produce material which will be accessible in future years.
- Inviolable – students should not be able to alter the environment to gain an unfair advantage. (Fluck, 2004)

As we come to the end of 2010, two other Faculties are introducing eExaminations (Law and Arts) as an optional text production method by allowing the use of computer keyboards instead of pens. The trial in the mid-year pre-tertiary assessments for the Tasmanian Qualifications Authority (TQA) has been provided to the TQA Board as it makes strategic decisions about adoption of eAssessment at that level and considers a state-wide rollout. The eExam System has provoked a useful set of institutional responses. It remains to be seen how rapidly the paradigm for high stakes assessment will change, and whether this will have flow-on effects in curriculum.

## References

- Anderson, J., & Markides, C. (2006). Creativity is not enough: ICT enabled strategic innovation. *European Journal of Innovation Management* 9(2), 129-148.
- Biggs, J. B., (2002). Aligning teaching and assessment to curriculum objectives. *LTSN Imaginative Curriculum Guide IC022*. Retrieved 4 September 2010, from <http://www.palatine.ac.uk/files/1030.pdf>.
- Burge, Bethan, Foster, Helen Lewis, Kate (2006). *What children think of e-assessment*. Upton Park, Slough, England: NFER Department of Assessment and Measurement.
- Cisco, Intel and Microsoft (2009). *Assessment call to Action - Transforming education: Assessing and teaching 21<sup>st</sup> century skills*. Retrieved 14 March 2009, from <http://download.microsoft.com/download/6/E/9/6E9A7CA7-0DC4-4823-993E-A54D18C19F2E/Transformative%20Assessment.pdf>.
- Crisp, G. (2008). *Raising the profile of diagnostic, formative and summative e-assessments. Providing e-assessment design principles and disciplinary examples for higher education academic staff*. ALTC. Retrieved 14 March 2009, from [http://www.altc.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/fellowships\\_geoff\\_crisp\\_report\\_jan09.pdf](http://www.altc.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/fellowships_geoff_crisp_report_jan09.pdf).
- Downes, T., Fluck, A., Gibbons, P., Leonard, R., Matthews, C., Oliver, R., Vickers, M., & Williams, M. (2002). *Making better connections*. Canberra, Australia: Commonwealth Department of Education, Science and Training.
- Fluck, A. (2003). *Integration or Transformation? A cross-national study of ICT in school education*. University of Tasmania: PhD Thesis. Retrieved 9 February 2007, from <http://eprints.utas.edu.au/232/02/02whole.pdf>.
- Fluck, A. (2004). ‘Can students use computers for formal examinations?’ *Proceedings of Teaching Matters conference* (p. 14). 25 November, University of Tasmania, Hobart.
- Fluck, A. (2009). Towards Transformation: eExaminations for ICT-enabled learning outcomes. *World Conference on Computers in Education*, Bento Gonçalves, Brazil, 27-31 July, 2009.
- Fluck, A., Pullen, D., & Harper, C. (2009). Case study of a computer-based examination system. *Australasian Journal of Educational Technology* 25(4), 509-523.
- Frenay, Martin & Wood, Denise (2008). The Delivery and Management of Feedback and Assessment in an e-Learning Environment. *The International Journal of Learning*, 15(2), 169-178.

- Gillard, J. (2008). *Address to The Australian Computers In Education Conference*, Canberra, 1 October 2008. Retrieved 17 March 2009, from [http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/ACECMinistersSpeech\\_011008.pdf](http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/ACECMinistersSpeech_011008.pdf).
- Gosper, M., Green, D., McNeill, M., Phillips, R., Preston, G., & Woo, K. (2008). *The impact of web-based lecture technologies on current and future practices in learning and teaching*. ALTC. Retrieved 16 March 2009, from <http://www.cpd.mq.edu.au/teaching/wblt/overview.htm>.
- Hamel, G. (1996). Strategy as revolution. *Harvard Business Review*, July-August pp. 69-82.
- Hamel, G. (2000). *Leading the revolution*. Boston, MA: HBS Press.
- Kim, C. and Mauborgne, R. (1997). Value innovation: The strategic logic of high growth. *Harvard Business Review*, January-February, pp. 103-112.
- Lane, B. (2009) Laptops pass the big exam. *The Australian* Sydney, 18 November, p. 24.
- Meyer, J., Fyfe, G., Fyfe, S., & Ziman, M. (2007). *Online assessment feedback as an instrument of reflective learning practice in human biology: Final report*. ALTC. Retrieved 17 March 2009, from [http://admin.carrickinstitute.edu.au/dspace/bitstream/10096/5010/1/grants\\_report\\_onlineassessmentfeedback\\_april08%5B1%5D.pdf](http://admin.carrickinstitute.edu.au/dspace/bitstream/10096/5010/1/grants_report_onlineassessmentfeedback_april08%5B1%5D.pdf).
- Newby, David (2008). Development of a computer-generated digital patient for teaching and assessment in pharmacy in *What's happening in assessment?* - ALTC. Retrieved 17 March 2009, from [http://www.altc.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/grants\\_assessment\\_whats\\_happening\\_dec08.pdf](http://www.altc.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/grants_assessment_whats_happening_dec08.pdf).
- Newhouse, P., & Williams, J. (2008). *Digitally based formats for alternative external assessment for senior secondary school courses in W.A: Final Report*. School of Education, Edith Cowan University, Western Australia. Retrieved 5th April 2009, from [http://csalt.education.ecu.edu.au/downloads/DigiAssess07\\_CSaLT.pdf](http://csalt.education.ecu.edu.au/downloads/DigiAssess07_CSaLT.pdf).
- Qualifications and Curriculum Authority, UK (2007). *Regulatory principles for e-assessment*. London: Author.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Simon and Schuster.
- Ross, Jeff (2006). *The e-Assessment question 2007: 'Using ICT to measure skills, understanding and knowledge'*. London, England. Retrieved 10th January 2007, from <http://www.eassessmentquestion.co.uk/> on.
- Rudd, Kevin, Smith, Stephen & Conroy, Stephen (2007). *A Digital education revolution*. Retrieved 31 December 2007, from [http://www.alp.org.au/download/now/labors\\_digital\\_education\\_revolution\\_campaign\\_launch.pdf](http://www.alp.org.au/download/now/labors_digital_education_revolution_campaign_launch.pdf).
- Shepherd, J. (2010). Exams: Changing habits may spell end for pen-and-paper tests. *The Guardian* Retrieved 4 September 2010, from <http://www.guardian.co.uk/education/2010/aug/18/exams-keyboard-answers-ofqual>
- Solomon, A. (2006). *LinuxGym: A sustainable and easy-to-use automated developmental assessment tool for computer scripting skills*. ALTC. Retrieved 17 March 2009, from <http://admin.carrickinstitute.edu.au/dspace/bitstream/10096/178/1/LinuxGym%20-%20UTS%202006.pdf>.

### **Acknowledgements**

The author would like to acknowledge the excellent work of Joshua Hesketh who has led the programming effort on the eExam System for Open Technology Solutions.

© Fluck 2010. The works included in these conference papers are the property of their authors and are used by permission. Readers should apply the same principles of fair use to the works in this electronic journal that they would to a published, printed journal. These works may be read online, downloaded for personal use, or the URL of a document (from this server) included in another electronic document. The text itself may not be published commercially (in print or electronic form), edited, or otherwise altered without the permission of the author. As with printed materials, care should be taken when excerpting or referencing text to ensure that the views, opinions and arguments of the author accurately reflect those contained in the original work.