

# Computers in the university exam hall: reflections from Scotland and Tasmania

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## Abstract

*Two higher education institutions on opposite sides of the world are pioneering the use of students' own computers in summative examinations. This study compares the affordances of the technologies they selected, the policy and procedural frameworks adopted, and implementation effectiveness. Student confidence in typing speed and accuracy were found to be important in their choice of keyboard over pen.*

## Introduction

Governments around the world have made significant investments designed to promote the use of and access to technology for learners. Examples include targeted teacher education and computer purchase schemes in schools, high speed network infrastructure for universities, provision of free internet access in community libraries and learning centres and increasingly fast home access to broadband internet services, regardless of local geography. Education is no longer something that happens mostly up to the age of 25 years. We live in an always on, always connected digital world with on demand access to just in time education. We are encouraged not just to aspire to being lifelong learners, but to live that dream.

Online education offers many opportunities. Studying takes place at a time, pace and location to suit the learner, and the use of video and interactive applications should accommodate a wider range of learning styles than traditional classes. However, a wealth of studies over many years have failed to demonstrate that all these opportunities impact significantly on learning outcomes (Means et al., 2010), although the complexity of evaluation studies is increasingly being recognised (Tamin et al., 2011; Oliver et al., 2007).

Nevertheless, online education offers personal advantages such as flexibility to students, and is at least no worse than face-to-face learning. It can also raise some difficulties when it comes to assessment. Formative assessment is not affected, but the role of the university as a self-credentialing institution faces challenges if awards were to be given to students who do not have the skills, attitudes and proficiency attested (Room, 2000, p. 105). Therefore summative assessment of online learning is a special case worthy of particular attention, given its potential role for affecting the reputations of higher education institutions.

Online learners are accustomed to using computers throughout their course, and find attending a designated exam hall to use a pen at odds with their study experience. Their ubiquitous use of technology may also have led to a real change in the way these students go about constructing an essay. The actual process of writing could well be different when using a computer compared to pen and paper. Therefore students familiar from an early age with this new mental approach could be disadvantaged by any examination where a reversion to the unfamiliar process of handwriting is imposed.

Serendipitously we became aware that both the University of Tasmania and the University of Edinburgh had already moved into this new assessment space, where students use computers to write essay-style examination answers. Our joint study sought to compare policy and procedural processes at the two institutions, to contrast the affordances of the selected technologies, and to collect and compare a snapshot of student reactions and responses.

## Policy and Procedures

Different techniques for conducting formal examinations have been piloted and approved in The University of Edinburgh and the University of Tasmania. Arguments in support of these changes included the growing dissonance between online learning and conventional pen-based assessment; the convenience of digital answerscript distribution for marking; ease of reading for assessors; faster text production for candidates; and the role of assessment in facilitating curriculum transformation.

### 1. The University of Edinburgh

In 2008 approval was granted in Edinburgh for a software-based system to be loaded onto students' computers for them to write their essays in response to questions provided on paper. The minutes of the approving meeting included the following notes:

In discussion about extension of the pilot to a wider group of students members noted that it would be important for students to retain the choice of whether to handwrite or type examination answers.... In the longer term it would be necessary to take into account the implications for capacity for large scale delivery, security and invigilation. Senatus Undergraduate Studies Committee (SUGSC) was content that security measures at present were robust.

SUGSC approved the use of computers for essay type examinations and encouraged course teams who wished to offer students this opportunity. (SUGSC minutes, 7 November 2008)

The procedure for Exam4 to be used in an examination requires the School to notify the central exams team, and specify if spellcheck and/or grammar check tools are to be allowed. Students are subsequently directed to a download site to obtain the client software, and strongly encouraged to try it. On the day of the exam, an exam receiver server is set up. On entry to the exam hall, students connect to the university wireless network and activate the pre-installed Exam4 client. Following the exam, the answerscripts are decrypted, printed and delivered to the school for marking.

## 2. The University of Tasmania

In 2011 similar approval was gained in Tasmania for a USB-based system to be used in similar fashion. At its meeting on 4<sup>th</sup> March, the Academic Senate passed these motions:

- a) Academic Senate approved the use of eExaminations.
- b) Academic Senate approved the recommendation that Heads of School and Unit Coordinators consider where eExaminations are deployed and how students are to be advised.

For the eExam System to be used, the central Exams Office is notified that laptops will be allowed and a USB stick provided to each candidate. A month before the exam, students are given the download site to obtain a USB stick image, and instructions on how to install this into their own stick for familiarization. The practice exam tests functions such as document hyperlinking and audio playback. Under normal secure conditions the actual exam paper and supplementary materials are placed onto a master USB stick and replicated. On the day of the exam, students set up their laptops and boot from the USB stick as far as the security image until the exam begins. Following the exam, the sticks are collected; answerscripts downloaded using the duplicator in reverse, and burned to CD-ROM which is handed over for marking.

## Affordances

The two technologies employed at our universities are Exam4 used at The University of Edinburgh (UoE); and the eExam System used at the University of Tasmania (UTAS). Table 1 shows the main features of the two systems.

**Table 1.** Affordances of systems for computer-based examinations

Feature	Exam4 <sup>1</sup>	eExam System <sup>2</sup>
Availability	Commercial product: licenced to institutions or individuals.	Basic version – free and open source With automated greeter – minimal institutional licence fee until 2016.
Platforms	Windows PC and Mac OS X 10.5+	Intel processor Windows PC or Mac (sometimes the latter requires a startup DVD).

<sup>1</sup> Extegrity Exam4 [www.exam4.com/](http://www.exam4.com/)

<sup>2</sup> eExam System [www.eExam.org](http://www.eExam.org)

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Feature	Exam4 <sup>1</sup>	eExam System <sup>2</sup>
Installation	Student client software is downloaded and installed onto personal laptop computer and used for familiarisation before exam day. Receiver server configured and run by institution.	Practice eExam USB image downloaded by students onto personal USB stick for familiarisation before exam day. Separate exam USB sticks are duplicated by the institution and provided to candidates at the exam.
Functionality	"the armoured word processor"; spell and grammar check can be disabled, as can cut/copy/paste.	Each student boots into the identical operating system and can only run provided software.
Security	During the launch process a security check ensures the machine is locked down to this programme only. For example cannot copy-and-paste from any other files on the computer, and computer cannot be used as a virtual machine.	No access to internal hard drives, USB mounted memory devices or any communications port. Assessor provides a unique desktop image for non-technical staff to verify correct USB stick and operation. Virtual machine detection.
Answerscript reticulation	Auto-saves to server every 10 seconds. Collection from server or one of the backup storage devices.	Answers autosaved to USB stick every 2 minutes. Collection through reversal of USB duplicator.
Resilience	Answers are regularly encrypted and saved through the wireless network to the server. Local hard drive and USB used as a backup (of encrypted versions). Proctor restart possible.	USB stick can be used to re-start after any failure with minimal loss on the same or a different computer. No single-point failures such as wireless access points or a server.
Marking	Answers are in encrypted digital format. After decryption, can be marked on or off-screen.	Answerscript files are in digital format and can be marked on or off-screen; or inspected using compatible applications (for non-text responses).

There are many similar features of the two systems. At both institutions, examiners are encouraged to initially consider a paper-replacement strategy, where candidates are given a choice between pen and keyboard. Therefore in the initial stages, candidates can be taking the same exam using both techniques. Both institutions have established protocols for the creation, administration and marking of computer-based examinations.

In the case of Tasmania, the same technology is also in use for pre-tertiary examinations (the equivalent of A levels in Britain, or Highers in Scotland).

### Student reactions and responses

Conducting research in high stakes examination settings is fraught with difficulties. Capturing research data from a real examination setting, without adding to the stress of the students, is challenging and mock examinations are often the closest ethically achievable context.

Research in Tasmania with computer education students has concluded that students find computer-based examinations very acceptable (Fluck, Pullen & Harper, 2009). Further, faculty staff recognise that digital exams offer advantages because not only can they allow digital media to be used in the questions, but data files (e.g. student generated computer files) can easily be collected as part of the examination submission. Legibility of submitted scripts is, of course, not a problem. In Edinburgh, where the choice to type essay exams has been available for Divinity students, the take up rate has been lower than anticipated, so research here has sought to uncover why this is so. The evidence collected suggests that students strongly support the option being available, but generally it is the older students, perhaps those returning to study who are most likely to opt to type in their examinations.

### **Student reactions: Method**

Agreement was reached between the authors to investigate exams held at the end of 2012 using a common survey form for participating students (Fluck & Moge, 2013). These students were invited to complete the survey questionnaire after completing a computer-based essay style exam. The survey included questions about self-reported typing proficiency, 11 attitudinal questions comparing reactions to the on-computer test with an on paper test; free text items and standard demographic data. Divinity was the subject assessed in Edinburgh, Constitutional Law in Tasmania. Candidates had the option to use paper or a computer for their responses in both cases.

We were interested in the nature of this choice process, and the underlying differences in approach to essay writing as a consequence. Responses were coded using a common scheme and analysed using SPSS. Free text comments were analysed thematically.

### **Student reactions: Results**

Seventy two candidates responded to the survey, 40 in Edinburgh and 32 in Tasmania. The Scottish students spanned a wider age range (median 19 years) but the Tasmanian cohort had a greater median age (22 years). Both were representative of their cohorts in age and gender distributions. Few had done a computer-based exam before, but over half were prepared to consider it.

In terms of this preparedness, more Tasmanian students reported typing faster than they could write (UTAS 81%, UoE 45%) and more Tasmanian students reported typing accurately compared to their northern hemisphere comparators (UTAS 44%, UoE 17.5%). The Tasmanian students were significantly more likely to feel that the overall structure and argument were better on computer compared with the Edinburgh students (UTAS 84%, UoE 52.5%; Fishers exact test,  $p=0.018$ ).

A classification and regression tree was constructed to explore the survey data. Classification trees can be used to perform univariate splits, examining the effects of predictors one at a time (Breiman et al., 1984). This identified individual typing accuracy, anxiety and whether students felt they had used their time effectively as the items that had the highest impact on students' deliberations about using the computer version of the exam. But it seemed likely that these sorts of factors interact, hence a categorical principal components analysis was undertaken. This suggested that there are probably two main factors influencing student choice. One of these, which combined typing speed and accuracy, had a very strong link to whether students would consider using a computer in an essay exam ( $p<0.01$ ).

In the final survey question, students were asked: "for you, what are the main differences between handwriting and typing an exam essay?" All the responses were classified into broad themes (see Table 2).

**Table 2.** Thematic analysis of free text comments (what are the main differences between handwriting and typing an exam essay?)

Theme	Number of responses
1. Ability to edit and manipulate text	20
2. Typing speed, accuracy and confidence	19
3. Whether the process felt normal or stressful	15
4. Legibility of script	10
5. How well thoughts could flow into writing	8
6. Lack of confidence in reliability of IT systems	7

To illustrate the breadth of student opinion, some specific comments were selected and included:

- On a computer, I'd be more prone to erase what I'd written because I'd associate it more with how I write my internal assessments, and trying to get the phrasing/wording right, rather than getting down the relevant information. [Theme 1]
- Tendency to excessively review what I have typed rather than following on my arguments itself and its development. [Theme 2]
- My biggest issue in exams is not being able to write fast enough. [Theme 2]
- Handwriting, you can plan, edit, not get a headache from the computer, not stress that it will break down half way through exam. [Themes 3 & 6]
- The main difference was that I spent longer on structure and argument and writing style on the computer. [Theme 5]
- Pen and paper means you can think about the next step as you are writing. Typing I only think as far as the sentence I am writing and I am concerned with spelling mistakes. [Theme 5]

This analysis triangulates and confirms the quantitative data, showing the importance of student typing speed and accuracy, and the perceived advantages of composing text in a word processor.

## Discussion

Higher education institutions are only venturing into computer-based summative assessment with great caution. This is natural, given the high stakes nature of the process for candidates and institutional reputation. The new systems compete initially with paper-based methods refined over many years to optimise reliability. We anticipate a rapid growth to maturity for computer-based examination systems, with a likelihood there will be convergence between the various technological functions in current products.

However this study suggests that neither technology nor adaptation of institutional processes appears to be the critical challenge. Both our universities have identified a

technology which has proved in trials to be satisfactory, and our established quality control systems have been flexible enough to allow new processes to be introduced.

Surprisingly, for us, our digitally fluent students may be our biggest challenge. Exams should not be about getting as much down on paper as possible, they should be about thinking and constructing a good argument. So we would expect students to pause while composing their answers, and hence raw typing speed should not be the most critical factor for success. But the reality as captured from student responses is that basic typing fluency influences student's choice about whether to type or to handwrite much more than any capacity to edit, revise and hopefully improve their text.

Looking to the future, as online learning expands, with class sizes mostly increasing, while teaching resource is constrained, assessing large numbers of student assignments poses a particular challenge. Trying to integrate an online assessment within the model of traditional examinations is probably not the most sustainable direction. We suggest there are three core approaches which are practical in such a context:

- Student submissions are processed by the computer according to pre-set algorithms to provide automated results and feedback. This type of test includes multiple choice tests, but also expands well beyond these, and can include programming assignments, manipulation or analysis of datasets, and the use of semantic analysis techniques to analyse short free text responses.
- Peer assessment, appropriately managed, is used to promote a learning community where students learn from and with each other. Providing guidance and practice in undertaking peer assessment is essential, and it may be necessary to overcome a feeling that students are being asked to do "the teacher's work"; but this approach can be used in almost all disciplines. Students can see how other students have tackled an assignment, giving different perspectives and providing an opportunity to discuss and challenge assumptions; excellent skills we should foster in all our graduates.
- A sampling approach is used so only a subset of student assignments are marked by the teacher, but all assignments could potentially be selected to be in the sample. This method is familiar in assessing student portfolios, and can be effectively combined with either or both of group and self-assessment.

In this study the broad themes in table 2 illustrate student responses to the question "for you, what are the main differences between handwriting and typing an exam essay?" The six broad themes identified in the student comments are still likely to be relevant for each of the three scenarios suggested above. None of these are about the technology or institutional processes; they are all about the students.

Students should be able to feel confident that the assessment technology is robust (theme 6). The task posed should be constructed in such a way that it has some feel of authenticity and they should have had sufficient practice with the system so that it has a degree of familiarity (themes 2 & 3). They need to feel that they can convey to the assessor what they intended (theme 4) – so they have to be able to articulate and arrange their thoughts in a way that is accessible to the marker (themes 1 & 5).

## Conclusion

Although it is easy to reticulate summative assessment challenges using web-based technologies, this can be very restrictive. Just because web-browsers can gather and return answer scripts easily, we need to be really sure students will be able to demonstrate professional proficiency in this context. If engineers, scientist, health-

workers and so on use particular software in their careers, then this will need to be made available to examination candidates demonstrating proficiency.

Future research could build upon these results by looking more carefully at the use of computers in courses prior to the examination. Bringing students to the point where they feel using a computer is 'normal' has been shown to be a factor in their decision to select the keyboard text production option. Additional investigations into the relationship between curriculum transformation and examination modality would also be interesting to universities worldwide.

As noted in the policy decision for The University of Edinburgh, scaling to larger numbers is a formidable problem when candidates are taking examinations using computers. Requiring or allowing them to bring their own is one solution to this issue, but it makes the others of security and fairness become more prominent.

This study has shown the importance of cultivating student skills and self-perceptions of typing speed and accuracy as they make the decision to take their laptop into the exam hall. This may be a very necessary step before computer-based exams can transition to post-paper formats; those which cannot realistically be represented on a paper alternate.

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