The end of handwriting? Using computers in traditional essay examinations

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Abstract
Most of our students complete most of their written assignments using a word processor, but they are still asked to handwrite responses in an examination. It could be argued that they have not practised this task and the validity of the assessment could thus be questioned. This paper explores the possibility of bringing computers into the traditional essay-examination context, describes an appropriate hardware and software configuration, and provides feedback from initial evaluations with students and their reactions to the idea. Some of the implications and equity concerns that need to be considered before a decision can be made to use computers in essay exams are also discussed.

Keywords
essay, examination, graphics tablet, laptop.

Introduction
The last 30 years or so have seen major changes in technology as computers have developed from mainframes through microprocessors and PCs and now on to wireless and mobile devices. University campuses have physically reflected these changes by creating computer labs, and social computing spaces such as cybercafes. Our teaching practices have also adapted to exploit some of the potential of technology – making extensive use of the Internet and multimedia, communicating by email and encouraging – or quite possibly insisting upon – word processed assignments.

Yet we often examine our ‘NetGeneration’ students (Oblinger 2005) – who have learned to write and spell using a word processor and interactive online exercises – by giving them traditional closed-book, long-essay examinations and paper and pens to handwrite their answers. Examiners are then asked to assess the poorly handwritten (and often almost illegible) patchwork of arrows, insertions and crossings out (Heppell 2002). This cannot be an effective and appropriate way to measure the achievement of our students.

The Quality Assurance Agency code of practice stipulates that assessments must be valid, reliable, fair and consistent with an effective and appropriate measurement of the achievement by students of the intended learning outcomes (QAA 2000). These principles must surely fall into question if there has been no formal practice in handwriting prose. Equally, when the stress in the course work has been on word-processed output, then handwriting extended prose under exam conditions could be regarded as a poor alignment of assessment practices with intended learning outcomes (Biggs 1999) and further, it may not be an accurate reflection of the quality of work the student is capable of producing.

Arguments can be made for substantial computerization of assessment, to provide a richer, more relevant and more varied assessment toolkit (see for example Raikes & Harding 2003), but for many institutions change in practice is best achieved in relatively small
steps, so the essay-based examination is likely to be retained, at least in some disciplines, for the foreseeable future. This paper will not consider the merits or otherwise of the essay examination as an assessment method, it simply assumes that these types of examinations will continue to be used to a greater or lesser degree. Rather, it explores the possibility of using computers in the essay exam, with the dual intention of increasing the validity of the assessment, putting the student more at ease by examining them in a more familiar context, and making life easier for the examiner.

Initial considerations about fairness and equity

The purpose of any examination is to generate some sort of measurement, generally a measure of student performance at a particular moment. The outcome, the measurement generated, can be affected by any number of factors such as tiredness, sickness, gender, social class, parental attitude (Mathews 1985), any of which can call into question the validity of the assessment process.

Essays themselves raise a variety of equity issues, even when considered outside the added pressures of an examination hall. How an essay is written, not just its content is important. Briggs (1980) showed that the legibility and neatness of handwriting had a significant impact on the mark awarded to secondary school children taking national English examinations. Houndell (1984) describes different types of essay and how different approaches are used by students when constructing essays. Quite apart from the student’s skill in constructing an essay, it is clearly critical that the student aims to provide the type of essay that the tutor is seeking, otherwise a potentially excellent piece of writing risks attracting a poor mark (Norton 1990). Special techniques such as criterion referencing and the use of double marking can help to reduce inter-rater reliability issues in the marking process, but it should be noted that differences between subjects in their typical mark distribution (Mathews 1985), any of which can call into question the validity of the assessment process.

Typically, coursework marks are higher than marks achieved in an examination setting (Bridges et al. 2002) whether typed or handwritten. However, there is substantial evidence (for example Goldberg et al. 2003) that the use of computers during the composition process assists students in producing work which is of higher quality. Nonetheless, writing for coursework is surely different to writing for examinations so whether this quality improvement carries forward into the examination setting is still to be proven. The reason(s) for this observed improvement in quality may be any of a number of factors. When using a word processor it is easy to review your work and make small but significant changes, and there is much less incentive to write in a highly linear fashion (Ferris 2002). Oliver and Kerr (1993) demonstrated a positive correlation between score and number of revisions of a text. For students who are proficient typists there is clearly the opportunity to write more, as well as the opportunity to revise and reshape what is initially written. Hartley and Tynjala (2001) argue further that the very facility presented by the computer to encourage writing more and revising and re-ordering it, leads itself to deeper understanding and a greater engagement between the author and their text. This evidence for computers facilitating an increase in the quality of writing is further enhanced when combined with evidence that when marking essays a type-written essay will be marked more harshly than an identical handwritten text (Powers et al. 1994; MacCann et al. 2002; Russell & Tao 2004), leaving little doubt that a high mark awarded for a type written piece of work does reflect a higher level of achievement in the work.

Moving into an assessment context, Russell and Haney (1997) demonstrated that in a group of American school children, significantly higher scores on a piece of extended writing were achieved when a computer was used to complete the assignment when compared with students undertaking the test using pen and paper. Augustine-Adams et al. (2001) demonstrated that the volume of text typed correlated positively with higher exam grades for law students. They concluded that on average a student typing an examination could expect to perform slightly better than a student handwriting the exam.

Overall, it is recognized that the proposal to introduce computers into traditional examinations introduces some new variables, and it will be important to understand how these may impact on student performance. Clearly, students do not have identical keyboard skills or feel equally comfortable using a computer, and it will be necessary to ensure that no systematic bias is introduced as a consequence of any move towards using computers in the examination process. Equally it is recognized that students do not have identical handwriting.

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skills (Summers & Catarro 2003). Wolfe et al. (1996) concluded that confidence and experience using a word processor was a significant factor in the differences between the scores awarded for two essays (one handwritten and one typed) and importantly that the difference was greatest for those students with the least confidence and prior experience. In practice, we can feel reasonably confident about student IT skills (Haywood et al. 2004) and, although differences between students will always remain and should never be neglected, it seems reasonable that in 2006 we should match our assessment methodologies as far as possible to the most common study habits of our students.

The proposal – hardware plus software

The idea of using computers to allow students to type responses to essay style questions is not new. US law schools particularly have extensive experience of exactly this, and have established procedures (e.g. Duke Law School http://www.law.duke.edu/curriculum/examOnComputer.html, accessed 31 August 2006).

Exams in law rarely demand students to provide anything other than textual responses. There are other subjects where this would not be the case, where a student may wish to add a quick sketch map, a diagram, chart or equation. Such tasks are not generally quickly and neatly accomplished with keyboard and mouse alone. Hence, in 2006 an investigation was conducted in which a software application, developed for use in US law school examinations, was piloted in Edinburgh but using a tablet computer, so that the student could both enter text using keyboard, and also easily sketch a diagram if they wished.

Several makes of tablet computer were considered, and the Toshiba Tecra M4 was selected as the most suitable, although at the time we had no real evidence for what criteria should be used to make the selection. The decision was essentially to look for a machine with a good general performance specification including integral wireless capability and with a reasonably sized screen.

There were also choices in the software with a small number of broadly similar commercial products being readily identified. A key choice was whether to opt for a familiar software environment for the exams, such as Microsoft Word, or a very simple but less familiar word processing tool. It was felt that the use of a very simple tool would be more appropriate in that it was less likely to confound the mark for the academic content of the exam with a measure of the student’s skill in using a particular word processor. Thus Exam4 software marketed by Extegrity Inc. was selected and evaluation access was agreed with the vendor.

Exam4 was attractive for a number of reasons. It has a long record of being used in high stakes exams across the USA, where it has proved to be stable and reliable (R. O’Hara, personal email). The software includes excellent in-built security that blocks access to all other materials on the hard drive and network, makes regular backups of work in progress so that, in the unlikely event of a problem, all is not lost, and encrypts stored files as a means to control access to completed exams. Exam4 needs to be pre-loaded onto the computers to be used via a familiar download-and-double-click operation that can be done easily and quickly by students themselves onto their own machines, or as in the pilot described here, by IT staff onto University-owned machines.

In the initial evaluation, the software was easily loaded and installed, but it immediately became obvious that its security mechanisms were so efficient they entirely locked down the computer, rendering the tablet’s pen functionality inaccessible. This resulted in Extegrity agreeing to modify the software to provide drawing capability. Exam4 now includes a complete simple figure drawing and editing interface. Sketches, diagrams and the like can be drawn with the tablet stylus, mouse, or external graphics device. These drawings become associated with the text portion of the exam file, and are printed automatically along with the essay.

When launching the software the user follows a channelled, stepwise exam startup procedure, selecting from a series of simple menus or entering basic personal identification details which together configure all the pertinent administrative settings (e.g. saving) without the need for issuing any complicated instructions. Student-selectable options include the choice of a large or a small screen font, and whether to have a clock and/or a warning notice when time is running out.

Once the exam startup sequence has been completed, the student clicks a button to begin the exam itself. The software ‘locks the computer down’ so the student is unable to access the Internet, the hard disk or read information from an accessory device such as a USB stick or CD-ROM. It provides them with a simple word processor with basic formatting abilities: bold, italic,
underline and left, centre or right justification. Certain features and options are set in advance at the direction of the examiner and are part of the download. These may dictate whether features such as a spell-checker or cut, copy and paste are globally available, as well as the specific location where exams are submitted via the network. The interface is straightforward and intuitive, so users require only the most cursory orientation; no formal training is necessary.

An exam can be administered in different ways using Exam4. It was our intention to minimize the changes from existing practice, so a physical (paper) question paper was still created, secured in staff offices until needed and distributed by hand in the examination venue. Students only use the computer to type their answers, and at the end of the exam these are retained in encrypted format on their hard drives as well as transmitted to a specific nominated computer which can be located essentially anywhere. Transmitting functionality is built into the Exam4 student software, and exams are received by a small server application, ExamReceiver, which is installed on a computer under the control of the exam administrator. A separate administrative tool, ExamOpener, is then used to print all the exam files in a single batch. Printed scripts are distributed to staff for marking in the traditional manner.

The only part of the examination process to change significantly is that students no longer handwrite their answers.

Evaluation

Having established a working tool apparently suitable for our needs the initial stage was extended to a more detailed evaluation phase.

Fifteen student volunteers participated in the evaluation which was structured as follows:

1. Short introduction and background to project.
2. Demonstration of some features of the tablet computers and scheduled time for hands-on familiarity of use.
3. Demonstration of the examination software, and hands-on unstructured practice using it.
4. (Break)
5. 1 h simulated examination.
6. Completion of paper feedback forms.
7. 2× focus group discussions (recorded on audio magnetic tape) 45 min.

Students were rewarded for their participation by the provision of book tokens.

The simulated exam was organized along the lines of a traditional paper-based exam. Candidates were arranged in two long rows along the edges of the room, where the computers could all be connected to mains power. A printed question paper was provided for each candidate. Candidates were instructed to launch the software and complete the startup screens but to wait at the screen which indicates they should go no further unless instructed to do so. The ‘invigilator’ checked verbally that all students had successfully got to that screen, and then invited them to turn over the exam paper and proceed. At the end of the exam the ‘invigilator’ instructed the candidates to stop and to use the End Exam option in the software which saved student answers to a USB flash drive. Students were then asked to complete a paper-based feedback form, designed to elicit information about their reaction to the tablet computers and the usability of the software. The focus groups were used to explore their reactions to the idea of using a computer to write essay exams.

The group, who self-selected by responding to an invitation issued by the Student’s Association, included six boys and nine girls (of whom two were mature students) and they represented 11 different schools from the University. Although this session was not advertised as being about the use of computers in examinations the group were highly computer literate: all of the participants had regular access to a computer outside the University campus, and all of them said that they used a computer every day, some of them stressing ‘every day, a lot’ or ‘always on’. Ten described themselves as very confident computer users, five as more or less OK. Three of the very confident users had used a tablet PC before, and one further very confident user had used a Palm pilot with a stylus input. Three of the very confident users had taken exams using a computer, one for an MCQ exam, one for an essay and one as a special needs student.

When asked ‘Do you think it is a good idea to use computers for exams?’, the overwhelming response was ‘yes, but . . .’ (see Table 1).

Generally the students had few problems using the tablet PCs. They stressed the need to allow sufficient practice time to familiarize themselves before they
The most significant recurring comment was that rotating the screen was time-consuming, physically it was rather awkward (and has implications for desk sizes) and it is distracting both to others and to one’s own train of thought. The students also had few problems in using the software, although they made a variety of comments about how it might be enhanced and some additional functions beyond the in-built copy and paste functions were requested. Interestingly, students were not concerned that their work may not have been saved or may not have saved correctly.

While students were broadly supportive of exploring this idea, and perhaps even mildly enthusiastic, there were also some strongly expressed reservations. Many students were concerned about the impact of differences in typing abilities, and all stressed that sufficient practice time would be critical. Discipline differences were clear, with mild confusion being expressed by some students as to why anyone would ever want to include a drawing in an exam. A positive and easy to implement suggestion/request was to also provide scrap paper (which would be left in the exam hall) for those students who wished to use it.

Students from both focus groups stressed that they had concerns about possible unfairness owing to differences in typing skills (although students also handwrite at different speeds), and this was closely associated with concerns about how a word-processed exam might be marked differently to a hand-written exam, and that students would feel that in a typed exam they had to go back and correct errors which they would just leave in a

Table 1. Responses to ‘Do you think it is a good idea to use computers for exams? (tick as many as apply)’ (Numbers refer to the number of individual students selecting this response).

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1Numbers refer to the number of individual students selecting this response.

2Comment made by one of the students who had described themselves as ‘more or less OK’ using a computer, rather than ‘very confident’. There was one further general comment provided at this point ‘It would seem to give an unfair advantage to those who type faster than others, but the same could be said for handwriting.'
handwritten submission. Students did not view this unfairness as being equal or equivalent to similar unfairnesses inherent in the current examination system. There was no clear and consistent feeling about whether students would do better or worse in such an examination, some students welcomed the idea and others had significant concerns.

Discussion

When introducing technology into a traditional exam there are three possible outcomes of particular interest (Hartley & Tynjala 2001).

• There is no difference in the intellectual process when word processing exams vs. handwriting.
• There is a difference in the process, but it does not change the mark achieved.
• There is a difference in the process and it does change the mark achieved.

Considering the first of these points: It was clear from the evaluation that the process of rotating the screen as in this model of tablet computer was seen by the students as being a hindrance and interfering with their process of thought, one student commented:

I think the typing was fine. The only thing is when you’re drawing the picture; you have to keep turning it [the screen] round to change from typing to drawing. If you’re used to doing pictures all the time within your text it’s quite distracting not being able to keep looking back on them.

This can be addressed relatively easily by using a different type of tablet device – an A4 or an A5 graphic tablet connected by USB to a standard laptop would offer the desired functionality without physically intruding so much into the student’s train of thought. However, this would not meet another of the students’ concerns – that they would actually write in a different way using the computer.

It changes what you do – you spend longer choosing different words and getting the layout looking good. Yeah, you felt that you could go back and change things a lot more if it’s on a computer but if you’re writing it by hand and you change your mind half way through there is no real way of re-writing the bit you wrote before without crossing it out and putting stars and everything in so that was a lot easier on the computer because you can write it but there is also the temptation to keep changing it as you go along and not getting anything done because you keep going back and changing what you did before.

Hence the likelihood is that this innovation would lead to a change of some sort in the process of creating an answer to an examination question – would that in turn impact on the mark achieved by the student, and if so, how? Here the issues raised earlier about differences in marking are relevant. There is evidence that two assessment items one handwritten and one type written but otherwise identical will result in a higher mark for the handwritten text (for example Russell & Tao 2004). The students seemed to be critically aware of effects associated with how examiners will mark their scripts, suggesting that examiners would expect a higher standard for a typed exam because they would expect something closer to a coursework submission.

They would mark it more like the way they would mark an essay as opposed to an exam because at the moment essays and exams are marked by different people and you consider them differently in your head. You don’t think of going in to an exam as being the same – you don’t think of being expected to write as well as you do with an essay situation where you have got time to review it.

It’s a hurricane shift from marking a paper to marking an on-line exam.

Staff may not agree, but students were clear that what they believe to be the standard of work currently expected from them in an exam situation is significantly different from that which is expected from coursework.

I would do a poorer essay handwritten in the exam but it would be marked differently so it would be OK. They would end up being marked differently. They would have to consider the order you put your paragraphs into.

The suggestion was that normally in an examination all that is required is to get as much information down as fast as possible and that construction of a logical argument is not important.

you’ve got a fixed amount of time to write as much as you can on that subject.

These comments may be interesting, but they do not help address the remaining key question which is
whether an innovation of this nature will result in a change in the score achieved by students, and if so whether that new score is a more appropriate measure of the students’ performance or ability. The small group of students involved in this initial evaluation supported the idea that this pilot study should be developed further.

It’s definitely worth looking into it further. I think it’s a really interesting idea and one that most students would really embrace but personally I would feel very comfortable about going and sitting an exam where I wrote an essay on MS Word tomorrow.

It is our intention to extend the scale and the scope of our experiment to try to explore some of the psychological and pedagogical issues identified.

How and where it might be appropriate to hold such computer-based essay examinations is still the subject of discussion. There is a reluctance to use open-access computer labs as examination venues as this would reduce the number of IT-supported study places at the very time when demand is highest, although it is recognized that usage patterns for such spaces are already changing with increased use of wireless connectivity and student-owned mobile computers.

Given the level of laptop ownership among the student body it is thought both practical and appropriate to consider inviting students to use their own machines for future examinations of this type. This has two important advantages over using University-owned machines – the students will be familiar and comfortable with their keyboard layout, and from an institutional point of view it is clearly a less expensive solution. It will almost certainly be necessary to ensure that electrical power is available for these machines, hence there will be cost implications in making these facilities available in the exam rooms if the study is continued. Converting a standard examination facility might require raising the floor level to accommodate electrical power, but this would not restrict the use of that space to only computer-based examinations – indeed it may give a large room added flexibility which could allow it to be used in variety of new and interesting ways.

Those students who do not have their own laptop would be able to borrow one from the University’s loan pool. Institutionally provided USB graphic tablets could be made available for those examinations where drawings or sketches are likely to be created, or if this were not possible, drawings could be made on paper and collated with the typed paper manually (this should clearly be discouraged because it would add extra administrative complications and thus detract from the simplicity of this innovation).

Experience in the law schools in the US demonstrates that the process of students downloading and installing the software on their own machines is problem free. The software is compact, and conflicts with existing machine configurations are extremely rare. Students can download and practice using the software quite independently of the examination process.

Conclusion

Essay-type exams are certain to remain as part of the assessment portfolio, but it is feasible that some students will become increasingly uncomfortable with the requirement to handwrite their answers. Combined with the substantial evidence that writing processes differ when using a keyboard or a pen, institutions must now consider solutions which allow students to make use of the technologies, which are ubiquitous in other aspects of their studies, in a traditional examination context.

The combination of student-owned laptops, and some loan equipment, plus simple reliable software offers a practical solution, meeting the needs of a modern student while being affordable to institutions both in terms of explicit financial resources and implicit administrative and organizational costs. A number of challenges remain, both technical and pedagogical, and there are many questions still to be answered, but this work demonstrates an approach to the use of computers in a traditional essay exam which is achievable with minimal disruption to existing administrative processes and which appears to attract a large majority of students.

Acknowledgements

Change Academy and Edinburgh University Students’ Association.

References


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