HANDWRITING OR TYPING EXAMS – CAN WE GIVE STUDENTS THE CHOICE?

Nora Mogey, Mike Purcell, Jessie Paterson, John Burk

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Nora Mogey, Information Services, University of Edinburgh,
Nora.Mogey@ed.ac.uk

Mike Purcell, Jessie Paterson, John Burk, School of Divinity,
University of Edinburgh

Abstract

Previous work at the University of Edinburgh has explored the possibility of bringing computers into the traditional essay-examination context, and has presented initial reactions from students (Mogey & Sarab, 2006, Mogey et al 2007). This paper develops that work and describes a designed experiment intended to tease out critical differences between handwritten and typewritten student scripts and the students approaches to writing or typing exams. The study takes student scripts generated in a mock examination using the format of the student's choice (either typed or handwritten) and transcribes them into the other format. All scripts are then double blind marked, and other quantitative data such as number of words written can be easily gathered. Qualitative data has also been collected about the students' attitude to and confidence in computers. Analysis will enable us to take an informed decision about the equity of implementing computer based essay examinations on an institutional scale.

Background/Introduction

For some years, staff at the University of Edinburgh have felt concerned that students do almost all their work on computers, but at the end of the semester they are examined by handwritten essays (Mogey & Sarab, 2006).

This misalignment of assessment practice to the learning environment can be addressed by requiring students to sit their exams on a computer, and indeed this is already routine practice in many US law schools. After a small amount of exploratory work we identified Exam 4 from Extegrity Inc as the software used successfully in many US bar exams (1). Exam 4 has proved itself to be robust and reliable, and includes security features which were considered important, such as taking regular snapshots of the exam in progress, and the option to totally lock down the machine from accessing any applications other than the exam software.

It was then decided to undertake some early pilot studies with students. Initial concerns of the project team were that some students may wish to include a diagram or a table in their exam answer, and that this is difficult using a laptop keyboard. The solution which was proposed was to use tablet PCs thus giving the option to use the keyboard for text, or to use the tablet for inserting diagrams. The software authors were generous in their willingness to add functionality into their software to facilitate the inclusion of diagrams, charts and tables. Three different pilot studies have taken place since 2006, with subjects drawn from the student's association; 4th year biological sciences and a small MBA class who used Exam4 for a summative assessment – at the request of the students. These studies have established that although no students experienced difficulty in using the software there was a general uncertainty (in the minds of both staff and students) about whether this was really fair and equivalent to a handwritten exam, and there has been a great deal of caution on the part of examination boards and boards of studies when course teams have sought permission to use this tool.

The idea of using tablet PCs to facilitate drawing diagrams is now not considered to be critical: the students' lack of familiarity with tablet PCs and the mechanism to rotate the screen was felt to be problematic, and we are happy to provide paper if students do want to make a sketch. This can easily be attached to the typed script, and in many disciplines is not a relevant consideration. Not surprisingly all the MBA students (n=5) who requested to type their exams thought the idea of essay exams on computer was good, and said they would be happy to take an exam this way again. Of the 10 final year biology students, six were happy with the notion of essay exams on computer, two were not supportive and two were in two minds. The main concerns were about typing ability and whether the software would crash, while the biggest perceived advantage was the ability to edit text "it is easy to skip back and forward, rereading and changing areas as new ideas spring to mind. This is a vast improvement. In addition towards the end, handwriting does not deteriorate."

While we can offer reassurance to students about how robust the software is, and give plenty of practice, it is harder to address some of the subjective concerns that are frequently expressed "it is harder to type than write when nervous"; "the advantage to computer users would be unfair". Unsurprisingly there is indeed evidence that students with good IT skills perform better at online writing exercises. Horkay et al (2006), studying school pupils, found that hands on experience was significantly related to online writing assessment performance - computer familiarity added about 10% to the score achieved.

Very few relevant studies have been identified which provide empirical evidence relating to university students under examination conditions, however there is a substantial body of research focusing mostly on American school children in non-examination settings. In one of the few higher education examination studies Augustine-Adams et al (2001) concluded that on average a law student typing an exam could expect to perform slightly better than their colleague who handwrites. In other sectors there is

substantial evidence that students who have written their essays using a computer write to a better standard (MacCann, Eastment & Pickering 2002; Russell & Plati 2001; Goldberg 2003; Hartley & Tynjala 2001) and there is also evidence that students who write essays on a computer write more than students who handwrite (Russell & Haney, 1997; Russell & Plati 2001; Wolfe Bolton Feltovich & Niday, 1996). Further, while it might be attractive to offer students a choice of whether to handwrite or type their exam response, many authors (eg Russell & Tao 2004, MacCann et al 2002) demonstrate that a type-written essay will be marked more harshly than an identical handwritten text. With knowledge of this outcome we cannot fairly offer students a choice without further investigation

Hence this research seeks to answer some of the questions that are currently acting as barriers to offering students the opportunity to type their responses to essay examinations.

- Is the mark awarded to an examination script influenced by the format of the script (typed or handwritten) rather than its content?
- Is there generally a difference in the amount of text that can be written or typed in an examination?
- Are students who type slowly any more or any less disadvantaged than students who handwrite slowly?
- Do students perceive typing examinations to be as fair as handwriting responses to examinations?
- Do students report approaching the construction of an essay response differently when using a keyboard or handwriting?

Methodology

Christian Theology 1 is a class of about 70 first year students with an unusually high proportion of ‘mature’ students.

The students were invited to sit a ‘mock’ examination during timetabled class time, during week 11 of a 12 week semester. The Exam4 software was demonstrated during a class in week 8 and students had the opportunity to try it out and become familiar with the software on their own laptops. Technical support was available on request and laptops were available for loan. Students were allowed to sit the exam in the format of their choice: typing using a laptop (which could be their own or could be provided on loan) or handwriting onto paper, or they could decide not to sit the mock examination at all.

The mock examination was held in the regular class venue but under examination conditions. Students using laptops were mostly situated towards the front of the room, and all had access to power sockets. Students handwriting were seated at the back of the room.

At the end of the exam typed submissions were collected on a USB stick prior to decryption and printing. All originals were marked swiftly in order to provide formative feedback to the students well in advance of the real examination. Meanwhile a professional typist was employed to produce faithful typed scripts from the handwritten originals, replicating any spelling and grammatical errors and similarly the typed originals were distributed amongst 'volunteers' who each created a handwritten version. Thus a typed and a handwritten version of each script was generated, and these were both in turn duplicated and then blind marked. Four marks for each student script were generated, one from each of four markers, two for typed versions and two for handwritten versions. All the markers were experienced at marking first year divinity essays.

Questionnaires were given to all participating students pre and post the mock exam seeking information about students' confidence with and attitude to IT, and about their preferred strategy when constructing examination essays. A small focus group was also held to explore student concerns about essay examinations on computer in more depth.

Results: Initial Sample Exploration

Some students completed pre-questionnaires without sitting the mock exam, and some students who sat the mock exam failed to return the questionnaires resulting in some missing data. The pre-questionnaire data and the mock script are probably the most important items for the purposes of the study. Overall data of some sort was collected from 51 students as shown below:

Pre-questionnaire only from 14

Mock Mark only from 6

Pre Questionnaire plus mark only from 16

Post Questionnaire plus mark only from 3

Pre- questionnaire, mark and post Questionnaire from 12

(There are marks from 37 students and there is Pre questionnaire data from 42 students.)

69% (n=35) of the sample was female and 31% (n=16) male. 34 students were in the age range 18-21 years and 8 in the age range 28-54 years. 37 (88%) students reported using the computer either daily or as frequently as possible, only two responded "less than daily" (both female). The students reported themselves as confident users of technology – 15 responding they were "very confident" and 25 responding "more or less OK". No one responded with anything lower than this (perhaps there is a reluctance to admit a low level of confidence?). A very even spread of typing ability was reported 12 saying they type faster, 14 saying they handwrite faster, and 12 students saying there was no difference in typing and writing speeds. Proportionately more females reported being faster handwriters and the males faster typists. Typing speed was not associated with IT confidence level.

Do students report approaching the construction of an essay response differently when using a typewriter or handwriting?

Students were asked about the preferences and approaches to writing essays – both for assignments and in examinations. 86% (n=36) said they would prefer to type an assignment. Reasons cited for the preference included legibility, ability to edit and rearrange text, and speed. Only 6 students said they would prefer to handwrite an assignment (one of whom reports typing faster than writing). Almost all students will use an essay plan (only 4 did not – 1 female and 3 males) but males are more likely to use a typed plan and females a handwritten plan. (This matches with the preference shown by females for writing over typing.) There was no obvious link between IT confidence and tendency to plan but those who write fast are more likely to handwrite a plan.

Moving on to examinations, many students report approaching them differently from assignments:

	n
I would not have any difference in approach	11
I would write a briefer plan	9
I would write a more detailed plan	8
Some other difference reported	9

Other differences about exam-essays included comments such as

- *"I try to conceptualise the whole thing in my head before starting. I spend more time on constructing sentences in advance before writing"* (male student who prefers to type, equal typing and writing speeds)
- "*Spider diagram the essay"* (female who prefers to handwrite but no difference in typing and writing speeds)
- "*My writing tends to flow more because I know that I can not easily alter what I have written"* (female who prefers to type assignments but handwrites faster)

Do students perceive typing examinations to be as fair as handwriting responses to examinations?

From the outset students have expressed concern about variability in typing speed a typical comment is *"It's not a level playing field as some people can type a lot faster than others."*

11 students thought they would write more using a computer and 11 thought they would write less, 10 though it wouldn't make a difference and 5 didn't know. As expected, those who reported themselves as fast typists thought they would write more (Table 1)

	Type faster	Write faster	No difference	Total
Type more	8	2	1	11
Write more	0	9	2	11
No difference	4	0	6	10
Don't know	0	0	5	5
Total	12	11	14	37

Table 1: Students' expectations of whether they could type or handwrite more in an exam compared to reported writing speeds

When asked whether they would do better or worse as a result of typing an exam again the responses tended to reflect typing ability (Table 2)

	Type faster	Write faster	No difference	Total
Do better on PC	8	1	4	13
Worse on PC	1	9	2	12
No difference	2	0	1	3
Not sure	1	2	7	10

Table 2: Students' expectations of whether they would do better or worse using a computer compared to reported writing speeds

Overall students did tend to think that using a computer would make a change to the quality of the work they produced in the exam, making comments in two broad areas: one to do with WP functionality (the ability to change layout and structure of the text) and one to do with fluency of thinking processes. But they were split as to whether these differences would improve or reduce from their score:

Impact on Quality of Essay	Count
no change	12
positive change, structure & layout	7
negative change, structure & layout	1
Positive change, thinking processes	6
negative change, thinking processes	6

In response to the direct question "Are essay exams a good idea?" 10 students responded with broadly negative comments, 18 with broadly positive comments and 6 specifically mentioned the need to offer choice.

Positive Comments included

- *Yes, as the world is becoming more and more computerised, we must embrace this in all parts of academic life.*
- *Yes, because the nature of exams are changing and revision styles are changing because of computers.*

- *Yes. People are using computers more in the workplace, so it would be beneficial.*

Negative comments included

- *No, because it would put people on different starting points (e.g., touchtyping). Also exam conditions are different, we have always done exams on paper.*
- *No. Computers can crash & break down. This would not be good if we had a time limit. They are not efficient and safe compared to pen and paper.*
- *No. I would write less; it would interrupt my thought process.*

Pro Choice comments included

- *Good idea to have a choice to make it fair on both those who type faster and those who write faster*
- *It's hard to tell till we try it. I definitely think it should never be obligatory.*
- *Not for me personally but I think it's a good idea to be an option.*

As expected fast typists want to type, and fast writers want to write. But there was strong support among the 'no difference in speed' group for typing exams (Table 3).

	Type faster	Write faster	No difference	Total
Positive reaction	7	1	10	18
Negative reaction	2	7	1	10
Give choice	0	4	2	6

Table 3: Summary of open responses to "Do you think it is a good idea to use computers for essay exams? Why?" compared to reported writing speed

The two fast typists who would prefer to handwrite exams commented

- *"No. Too much stress"*
- *"Not really; I think it's a bit unnecessary & computers have a tendency to go wrong."*

And the fast handwriter who would like to type exams said

- *"Yes I do. The process of writing is different. Coming back to university after working I have had to relearn pen and paper. I think this is a backward step. "*

A number of students specifically suggested that it will be important to offer students choice, other comments included cautions that sufficient warning and allowing plenty of practice time would be important. It may be of interest that it was only students who were faster handwriters who suggested the need for choice.

Results: Data from the Mock Exam

37 students elected to take the mock examination, 28 female and 9 male. Proportionately more females opted to handwrite the mock, and the older students tended to be more likely than the younger students to opt to take the mock exam. Using scores from two previous pieces of coursework allows us to ask if it was the students who had been more successful so far who elected to sit the mock – but there was no evidence this was the case.

	Handwrite	Type	Total
Female	11	17	28
Male	2	7	9
Total	13	24	37

10 students borrowed computers including 5 who had not requested prior access (and it is assumed therefore did not practice with the software). One student requested in advance that they should have a standard keyboard and mouse not just the laptop keyboard, and this was arranged.

24 typed and 11 handwritten scripts were collected at the end of the mock examination, 2 additional handwritten scripts had been generated one day earlier by students who were unable to attend the scheduled class time. The total number of words written was recorded for all scripts.

Females tend to write slightly more than males but there was no association between words written and the student's age.

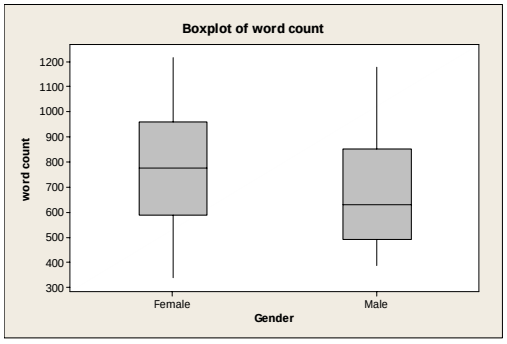

Figure 1: Boxplot of word count by gender

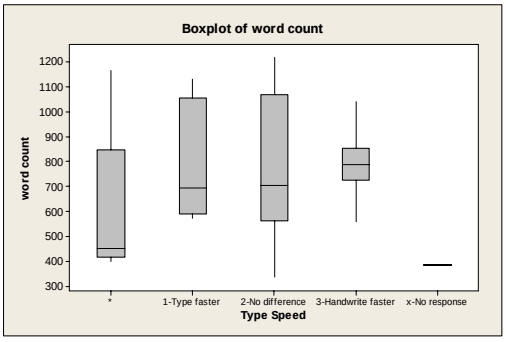

Figure 2: Boxplot of word count by reported writing speed

Did the students who said they were good typists actually write more in the mock? No - there was practically no difference in the number of words written by those who reported themselves as fast typists and those who reported themselves equally fast at typing or writing. Fast handwriters wrote more on average and there was much less variation in the volume written by fast handwriters than the other groups. Those who didn't express comment about their relative speed of writing vs typing wrote noticeably fewer words than those who had responded to the question.

Is there generally a difference in the amount of text that can be written or typed in an examination?

Students who typed in the mock exam wrote more words than students who opted to handwrite.

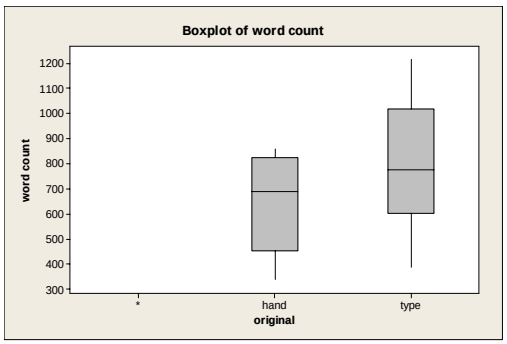

Figure 3: Boxplot of word count by format of original mock script

(* = missing observations)

Using a Two-Sample T-Test of the null hypothesis Ho: There is no difference in the mean number of words which will be handwritten or typed, results in T= -2.15, p= 0.041 (25 df) statistically significant at 5% level.

Hence there is evidence that in general students will type more than they will handwrite, however the amount written is not strongly associated with students reported typing speed. This may indicate that the amount written in an exam is only partially dependent on the speed of writing – it must also depend on the fluency of thought.

There is only data from 8 students to contrast how much they thought they would write with how much they actually managed to write. 4 out of 8 said they had done as they had expected, of those where reality differed from expectation: 2 thought they would type more,1 reported typing less and 1 said they couldn't judge; 1 said they would type less but thought it hadn't actually made a difference and 1 said it wouldn't make a difference but they reported actually typing less.

Are students who type slowly any more or any less disadvantaged than students who handwrite slowly?

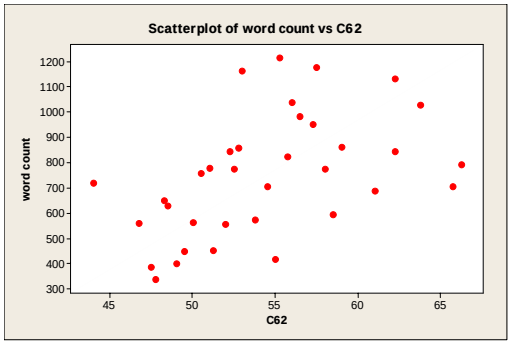

Figure 4: scatterplot word count vs mean mark

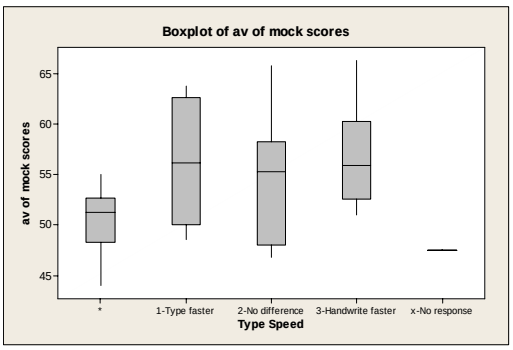

Figure 5: boxplot of mean mark by reported writing speed

Longer scripts tended to score more than short scripts (correlation = 0.484) (Figure 4). The boxplot (Figure 5) suggests that there is no systematic difference in the scores obtained by fast or slow typists. There is a large amount of variability in the data but the highest scores were achieved by students who did not report themselves as being fast typists.

Is the mark awarded to an examination script influenced by the format of the script (typed or handwritten) rather than its content?

Generally where originals were typed then scripts scored more highly than where originals were handwritten scripts.

Scripts marked in their original formats
Mean Score Awarded handwritten scripts = 52.79 St Dev = 7.13 (n=52)
Mean Score Awarded typed scripts = 54.90 St Dev = 9.0 (n=96)

However when looking at the marks awarded to the all scripts, (ignoring their original format) then the handwritten scripts generally score slightly more.

All Scripts (including transcriptions) (n=74)
Mean Score Awarded handwritten scripts = 55.12 St Dev = 8.25
Mean Score Awarded typed scripts = 53.19 St Dev = 8.53

This gives weak evidence in support of a format effect - typed scripts have generally been marked down and handwritten scripts marked up – however it is very small in comparison to the variation between markers.

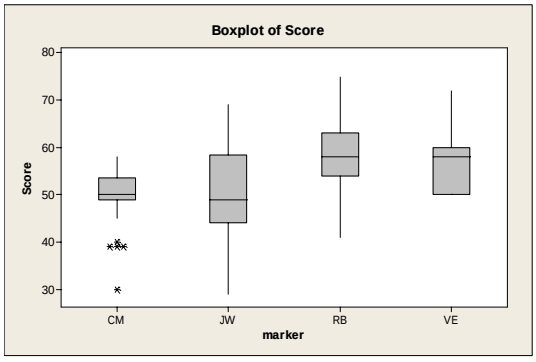

Figure 6: boxplot of mark awarded by marker

marker	N	mean	Std dev	Min	Max
CM	37	49.54	6.03	30.00	58.0
JW	37	50.46	9.32	29.00	69.0
RB	37	58.68	7.33	41.00	75.0
VE	37	57.95	6.39	50.00	72.0

Table 4: Basic summary statistics: Marks awarded by different markers

Using a general linear model to analyse the contribution to variability in scores confirms that the variability due to differences between the markers is the most important effect (F=15.72, p=0.00) and the contribution due to differences in the format of the script are not statistically significant (F=2.0, p=0.16).

Discussion

It is important to recognise that this study has only considered a single group of students from one discipline area, and that the students volunteered to take the mock exam thus forming a self selected sample. Comparison with our institutional freshers survey suggests the sample matches the undergraduate population as a whole very well for gender and is slightly biased in favour of more mature students. Considering the group who took the mock exam a slight bias towards females and mature students has been but they represent a reasonable spread of academic ability. This study has only attempted investigations within Divinity but recognised that approaches to essay writing may be different in other disciplines. However at first year level most courses will be looking for broadly similar skills, so this is not considered to be too problematic.

Existing research studying differences between handwriting and computer mediated writing, has tended to focus on school pupils and has explored writing outside examinations. Although this study attempted to simulate some of the stresses experienced in an exam hall, they can never really be replicated in a mock exam. *"I did it* (used the laptop) *for the mock because it didn't matter, and if I had done really really well on that mock I would have felt slightly different. Obviously I didn't revise very much for it so I would feel more confident in a real exam, but it's just too much of an alien idea because I've written all my exams."* Clearly revision, confidence and pressure must all have some impact on what and on how students write. However, exam boards are quite reasonably most reluctant to allow experiments in high stakes exam situations, hence it is probably necessary to use mock examinations as this study has done until staff and students feel properly informed about the implications of using laptops for essay-examinations.

Some may feel it is unreasonable to expect students to provide their own laptops. One argument is that the institution should provide the machines - thus gives a level of security that cannot be guaranteed with student owned machines, and another argument is that this makes it less likely that a machine will fail during an exam. Many of the issues raised can best be negated by demonstrating successful use cases. One student elected to borrow a machine because they were concerned the software would "trash" their machine – observing peers should help offer reassurance that this is not in practice a reported issue. Security and reliability issues have been raised generally by those with only limited knowledge or experience of the software or the procedures proposed, and can again be countered by pointing to successful examples of implementation. We have taken the view that because student laptop ownership is known to be above 90% (from Freshers survey data), and because some laptop keyboards feel quite different from others that most students will be most comfortable using their own machine. Power will be provided to all desks so battery life should not be a concern, beyond that students are expected to provide a machine in an exam-worthy state, or to request a loan machine.

Further interesting aspects revolve around the likelihood that students go about the process of constructing an essay using a word processor in quite a different way to how they construct an essay on paper. It is also recognised that constructing an essay in an examination is likely to be a different process to constructing an essay for an assignment. It is established that students have different understandings of what is expected in an essay in order to achieve a high score (Hounsell, 1997) and of course students also have their own individual approaches to studying. In an examination a further set of variables are introduced because students generally do not have access to the same tools and resources as they would for a cousework essay. In this study we have only attempted to gather the most basic data about approaches to essay writing, but responses indicate that some students also go about constructing an exam essay in a different way to a coursework essay.

Typing speed is frequently presented as a major concern and cited as a source of inequity. This study has demonstrated that students who typed in general wrote more than students who wrote by hand. This may not simply be because of a straightforward difference in the volume it is possible to write – typed text tends to take up less space on the paper so students may feel there is a need to keep writing "*I had no concept of how much I had written, with a hand written exam you aim to write about three sides of A4".* Connelly, Dockrell and Barnett (2005) demonstrated that first year undergraduates had a handwriting fluency only similar to that which would be expected in 11 year old children. They found most students have little requirement to handwrite and their handwriting fluency is therefore limited. They demonstrated that students who were able to write more quickly were more likely to do well in an essay-exam particularly because they were able to include longer conclusions to their essays – suggesting that there could be a real strategic advantage for students who plan their essays and especially their conclusion sections.

Whether or not there is actually a difference in how students go about writing an essay on paper or on a computer, or for an assignment rather than in an exam, there remains the possibility that the markers will be influenced by the format in which the essay is submitted. Are markers consciously or subconsciously influenced by the appearance of a script? Previous studies have shown a small but consistent effect when marking handwritten originals and their typed transcripts (Powers et al 1994, Russell & Tao 2004). Russell & Tao (2004 b) concluded that computer printed scripts would score on average 1.3 points less than the same words in a handwritten script. This study agrees that markers may indeed be influenced by format – and that difference might be worth almost 2 marks to the average student (55.12- 53.19 = 1.93) . Such variability could of course be controlled by ensuring all markers were only given scripts in one format, but the cost of transcribing large numbers of scripts almost certainly render this impractical. Russell & Tao (2004 b) however demonstrated that giving the markers typed scripts printed in cursive font, and alerting the markers to the format effect, both had the effect of reducing the difference in the score; both approaches may be practical to implement.

Conclusion

The problem of students routinely doing coursework on computer but being assessed by a written essay can be tackled in two main ways – change the type of assessment being used or make sure that the practice and the final assessment use the same medium. Discussions about the merits or demerits of the essay as an assessment tool and about a correct balance between coursework and examinations are not likely to be concluded quickly hence it has been considered essential to correct the mismatch between how students write coursework and how students write exams.

One choice would be to take a decision, at course level or higher, that all students will type their examinations. This is not substantially different from the current position where all students (with the exception of some with special requirements perhaps) are forced to handwrite their responses.

It is anticipated that the variation in typing speeds will be greater than the variation in handwriting speeds, but we believe this can be addressed relatively simply by ensuring students have enough pre-warning that their examination will be typed – and by providing opportunities to increase individual typing skills. Essentially it would be feasible to assume that typing proficiency is expected of a modern student, just as fluency in reading is currently assumed, even ‘though student reading speeds vary greatly.

Another possible route is to offer students the choice of handwriting or typing their exam responses. Boards of Studies have been reluctant to consider this suggestion because it means students are not all doing the same thing – and because of a risk that the choice to write or to type might unfairly or unknowingly influence the grade achieved. This study has sought to examine those concerns and where possible to offer some answers. One clear outcome is that we have demonstrated that students who type are likely to be able to write more words in the exam than students who handwrite. Ideally this needs to be translated into more thinking time to construct well argued responses rather than simply writing vast numbers words.

We have also demonstrated that any variation in the mark awarded due to difference in format is negligible compared to variation due to differences between markers. Although a single exam question would often be marked by a single marker the likelihood is that variation between markers of different questions will remain a very important effect. We therefore conclude that although there is evidence of a small format effect that this is not the main source of unreliability between exam scores and we can therefore justify giving students the choice of whether to type or to handwrite their essay-examinations. It is simply not fair to insist that students (who have perhaps not handwritten any essay since their last examination) should handwrite their next exam when there is a practical alternative. Whether students and exam boards will be convinced by the evidence available remains to be tested!

Next steps

This study could usefully be extended in many directions. Further data has been collected (but not yet analysed) with the intention of exploring essay quality, not just a single mark. The six factors recorded are: Engagement with the question; Knowledge of the subject; Critical skills; Evidence of wider reading; Structure/Presentation; and Referencing/Bibliography. Biggs' Solo taxonomy could be used to explore essay quality more deeply – and to facilitate comparison with other studies. As students academic skills are expected to develop with experience then their approaches to essay writing may vary, and in later years of university the diversity of expectations in different disciplines could be expected to grow. It will be necessary to explore any systematic differences in later years and different subjects before we can feel totally confident that to offer a choice is fair. We have made no attempt to explore or to try to mould tutors attitudes to different formats of essay, it may well be valuable to put effort into ensuring marking is as fair and equitable as possible.

Another logical extension of this work could be to move to marking the examination scripts digitally, rather than printing them and distributing to examiners on paper, however it is felt that at present restricting the change and innovation to just one part of the examination process is more likely to enable its adoption. Work on improving feedback and marking digitally is being undertaken, with a view to a future convergence.

However before we can move to hosting major exams on laptops routinely a further challenge is to provide a suitable location. Most computer labs are not configured in a way that facilitates their use as an exam venue – tending to have pillars and machines located in clusters or rows with machines back to back, both making invigilation difficult. The University of Edinburgh is therefore laying a raised floor in one of its major exam venues, with sunken floor boxes providing both power and network. This will not limit the use of the room to only being suitable for computer based examinations and indeed should allow a wide variety of different potential uses.

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