e-Exams with student owned devices: Student voices

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This paper reports on what students think of using their own mobile devices, such as laptops, for examinations. e-Exams are an attempt to bring the pedagogical power of mobile laptop devices into the world of pen-on-paper high stakes exams. Trials of an open source, bring-your-own-device (BYOD) based e-Exam system were undertaken in six undergraduate courses during 2014 at The University of Queensland, Australia. Student voices were sought via surveys conducted prior, during and following a series of mid-semester e-exam trials. Opinions ranged from the enthusiastically positive 'I want it yesterday' to the negative 'not in my life time'. Impressions and concerns highlighted by this important stakeholder group included; typing proficiency, comfort with familiar keyboards, hand cramps from long writing durations, editing ability, reliability of technology, security, equity, cheating, familiar habits and apathy. Insights will prove useful to institutions looking to implement computerised exams using BYOD.

Keywords: e-exams, computer-assisted assessment, high-stakes testing, bring-your-own-device (BYOD), student voice.

Introduction

The idea of using computers for testing is not new with early computerised tests appearing in the 1960's for formative uses in medical, mathematical and language teaching (Swets & Feurzeig, 1965). Computer based tests are now available in many fields. Activity tends to be focused in the professional certification and training markets and remains relatively rare in institutions of higher learning where pen-on-paper exams still dominate. Computerised exams are used for the Australian Medical Council

Examination (AMC MCQ) and the United States Medical Licencing Examination (USMLE MCQ) components, and for information technology certification such as the Microsoft Certified Systems Engineer (MCSE) and Cisco Certifications. The International English Language Testing System (IELTS) and most US state Bar Law exams also offer a typing option. However, the majority of computerised tests available today tend use 'selected' response questions rather then an open ended or constructed response format, although some proprietary exam tools in the IT industry do include simulated software and networking problems. The majority reliance on selected response question types serves to limit the 'pedagogical landscape' in the exam room with a tendency to replicate paper-based modes of questioning. An open or constructed response focused computer enhanced exam could include a wider range of activities, such as working though simulations, scenarios, manipulation of three dimensional images, building multimedia, computer aided design tasks and carrying out virtual experiments. The lifting of pedagogical limitations in the exam room also has the potential to encourage transformation in the broader curriculum (Fluck & Hillier, 2014). The potential for improved efficiency when using computer marked items and closer alignment with the increasingly common use of ICT in the formative stages of courses are further trends indicating that much greater use of computerised testing is set occur in the near future. However as we push for a greater numbers of students to be able to undertake such exams, the scalability of existing approaches to computerised testing that use equipment supplied by the examining authority are coming under pressure. The budgets of most educational institutions across the developed world are being constrained and so a large-scale investment in specialist computer equipped testing centres is becoming unlikely.

Mobile Devices for Exams

A possible solution is to co-opt the mobile equipment that a great many students already own. In particular there is high ownership rate of laptops by students at around 90% in the US (Dahlstrom & Bichsel, 2014) and little higher at the author's own University at 94%. This provides a potential source of hardware with which to run an e-exam. This is not without its problems because the exam authority must be able to secure these machines and any technical solution must be able to operate across a range of hardware and operating system types. Products are available in the marketplace such as ExamSoft (2015) and Safe Exam Browser (SEB 2015) that are installed into student owned laptops. Further developments are underway in a number of countries to make greater use of bring-your-own devices (BYOD) for exams, including in Australia (Hillier & Fluck, 2013), Austria (Frankl, Schartner & Zebedin, 2011), Canada (Peregoodoff, 2014), Denmark (Nielsen, 2014), Finland (Lattu, 2014), Germany (Schulz & Apostolopoulos, 2014), Iceland (Alfreosson 2014), Norway (Melve 2014) and Singapore (Keong & Tay 2014).

In addition to the technical hurdles for an e-exam programme, there is the problem of user and stakeholder acceptance. As we transition from pen-on-paper to keyboard the decisions we make about the approach to e-exams will impact students the most. The differences between a computer supplied by an institution and their own, familiar equipment could have an impact of student acceptance and performance in an exam. Authors such as Dermo (2009), Frankl, Schartner and Zebedin (2012), Terzis and Economides (2011), Mogey and Fluck (2014) have written on the use of computers for exams and have raised issues such as integrity (minimising 'cheating'), reliability (stability of the equipment and software to perform error free), familiarity (as to minimise the distraction the computerised environment itself so that candidates can get

on with responding to the exam questions to the best of their ability), efficiency (particularly when compared to hand-written exams) and psychology (the impact of stress and anxiety).

Bring-your-own-device (BYOD)

The use of ICT at higher education institutions has traditionally been based around institution supplied computers in laboratories and libraries. Over the last decade, students have been increasingly bringing their own equipment onto campus and connecting to campus networks. This has occurred due to the increasing ownership of suitable devices by students (from 1.3 devices per person in 2010 to a projected 3.6 in 2014 – Dahlstrom & diFilipo 2013) as well as the stagnation of available equipment on-campus while student numbers have been increasing. From the point-of-view of students the use of personal equipment for study purposes has a number of advantages. It provides convenience for students in that their own devices allows for greater availability of a computer at a time and place that best suits the student, allows for a consistent software environment between tasks, allows for a high availability of all working data files and further it allows the use of a more familiar keyboard and touchpad or mouse allowing for greater efficiency and comfort in equipment use. When it comes to using this same equipment for high stakes exams there are potential benefits stemming from the familiarity of students with their own keyboard and mouse/touch pad such as a faster rate of text production in a time limited exam. Cost savings in hardware provision for institutions is also relevant due to the relatively infrequent occurrence of exams that would require a large number of computers – for example, at the author's institution this would mean that the 2500 seats available at any given time for exams would need to be furnished with a computer. Potential drawbacks of using student owned devices include variation in capability ('power' and capacity),

reliability (against crashing, battery life), security of the exam environment and integrity (cheating) concerns.

Measures such as hardware certification, controlling the software environment, providing back-up power, and careful invigilation has the potential to over come many of the difficulties associated with using student owned equipment in the exam room; however we ultimately need to convince students that such a move is a good idea. It is at this point we examine the role of the student voice in technology acceptance for exams.

Giving Students a Voice

Exams, perhaps more then most other forms of assessment are the most stressful with high stakes outcomes for students. Further, students as one of the most significant stakeholders do not usually have the most powerful voice when it comes to the running of exams or when implementing changes. Any changes to the way exams are to be performed behoves planners to include the student voice into the change process. Much of the educational literature on the use of ICT for assessment is frequently written from the point of view of educators, administrators and educational technology experts (Andrews & Tynan, 2010). However, in many parts of the education system students do have input (Alkema, McDonald, & Ryan, 2013) normally via student unions, societies, representation on committees and via increasingly common course evaluation surveys (Blair & Valdez Noel, 2014). This style of representation is often removed from the immediacy of the assessment event and so lacks the richness of a direct consultation with students as part of a planning and implementation process. Research such as that by Andrews, du Toit, Harreveld, Backstrom, & Tynan (2014) is an example of a closer engagement with students at the coal-face of their learning. By consulting students on a range of issues related to the conduct of exams, as close as possible to the point of

action or change, we can better appreciate their perspectives and include their concerns within the design of the change process.

The study

This study was undertaken at the University of Queensland, a multi-disciplinary university in Brisbane, Australia serving 50,000 students. The institutional ethics committee approved all data collection processes and instruments used in the study.

The study comprised two main phases as outlined in figure 1.

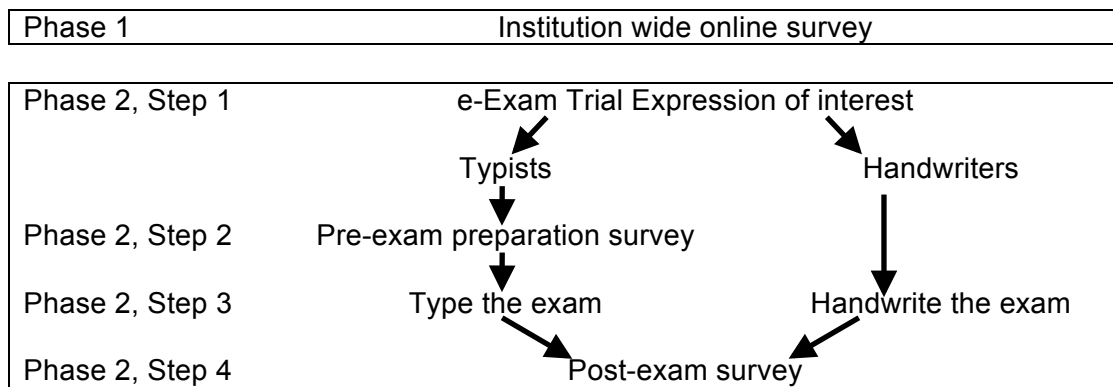| Phase 1	Institution wide online survey

Figure 1: Study design

The first phase was an online survey conducted prior to the e-Exam trials. The survey was made available to all students within the university via the institutional learning management system (LMS).

The second phase was a series of six e-Exam trials that were broken down into four steps each. Students in six courses undertaking mid-semester examinations worth between 15% to 25% of the course grade were provided the option to type the exam using their own laptop, with the fall-back being regular pen-on-paper. Those that elected to type were required to boot their laptop using an e-Exam 'Linux Live' USB storage device (Transforming Exams 2014) that contained a modified version of Ubuntu to prevent internet or local drive access along with Libra Office and an additional custom 'exam starter' wizard that guided the students to start their exam.

Within each of the trial courses students were asked to complete an online 'expression of interest' (and consent) indicating their preferred choice of exam mode. Those who expressed interest in typing were then asked attend a set-up / practice session to provide an opportunity to become familiar with the e-Exam system and to ensure that the e-Exam system was compatible with their laptop. Those that attended the session were asked to fill in a survey to collect data about their laptop and their first impressions of the exam system. Finally all students (both typists and hand-writers) undertook the exam and were asked to complete a post-exam survey.

Data collection and analysis

Across the series of surveys several open text questions provided an opportunity for students to voice their opinions on their ideas and experience e-exams. This data was collected as part of a wider study into e-learning, e-submission and computerised examinations. The focus in this paper is specifically on exploring the student voice with regard to use of student owned devices for typing examinations.

Pre-trial institution wide survey

In the first phase institution wide survey an open response question sought student opinions on the idea of computerised examinations. The vast majority of respondents have little or no prior exposure to e-exams and so opinions collected were 'preconceptions'. The question "What are your main concerns regarding computer based examinations at this time?" followed a series of Likert response items. An analysis of the Likert items was reported elsewhere (see Hillier 2014). Demographic questions such as age, gender, program level and program field (discipline area) were also included.

e-Exam Trials

At the beginning of each e-Exam trial the expression of interest form provided an indication of expected numbers electing to type within that course. Students were then asked to attend the set-up/practice session before being permitted to type the exam. We anticipated some attrition in numbers so we kept records of the students participating at each stage. The number of students who stated they would type (or did) at each stage of the trial process is displayed in Table 1.

Table 1 Number of typists at each stage of the trial

Steps of trial	Yes will type	Maybe type	Total typists	Attrition	No (hand-write)*
1 EOI	201		201		361
2.1 Pre - before try	94	16	110	91	10
2.2 Pre - after try	86	15	101	9	23
4 Exam (after)	71		71	30	450

Note: not all respondents completed every question. A number of students electing to hand-write did not fill in the EOI and the post-exam survey so are slightly under represented. Similarly not all attendees at the pre-exam set-up session returned a survey.

There were just over 200 students (36%) out of approximately 560 students in the six courses who expressed interest in typing. Then 124 turned up to a set-up/practice session with 115 surveys returned. During the set-up/practice session, 94 said they intended on typing the exam before they had tried the e-Exam System. After trying the e-Exam System with their laptop, 86 said they still intended on typing their exam. Finally, 71 students typed their exam and 450 elected to hand-write.

During the set-up/practice session we collected technical data related to their laptop, compatibility with the e-Exam system, their initial impressions and intentions. The questions relating to student's impressions and intentions were comprised of the Likert items listed in Table 2.

Table 2. Selected pre-exam session survey questions (typists only).

Question	Type	N	Mean	SD
The written instructions were easy to follow	L	108	3.9	1.0
It was easy to learn the necessary technical steps	L	105	4.0	1.1
It was easy to start my computer using the e-Exam USB	L	108	4.1	1.2
I feel confident I will be able to do these steps in a real exam	L	106	4.0	1.1
The software within the e-Exam System was easy to use	L	105	4.1	1.1
I now feel relaxed about the idea of using the e-Exam system for my upcoming exam	L	106	3.8	1.0

Students were provided an opportunity to voice their opinions based on their initial impressions of the e-exam system via two open comment questions: "What are you main concerns regarding e-exams at this time?" and "Other comments - praise or suggestions for improving how the system works".

The last step in the data collection process was a feedback survey handed out at the time exam responses were collected. Again seeking student voices, three open ended questions were provided: "If you hand-wrote this exam: what were the reasons for handwriting (i.e. reasons for NOT typing) this exam?" or "If you typed this exam: what were the reasons for typing this exam?", along with "For you, what are the main differences between handwriting and typing an exam response?" and "What are your main concerns at this time regarding the use for computers for exams?"

By asking students to voice their concerns at each stage we were able to gain insight into the evolution of their thinking as they gained experience of this new way of conducting exams.

Results

Demographics of the 928 respondents to the pre-trial survey were 63% female and 37% male. This diverged from the intuitional norms of 55% female and 45% male enrolments meaning males were under represented in the survey. The vast majority of survey respondents, 83% were between the ages of 17 and 25, while 88% of respondents enrolled in an undergraduate program and 12% postgraduate. Institutional statistics show that 81% of course work students are undergraduates making for a small over-representation of this group in the survey.

Mobile device ownership (excluding desktop computers) was an average of 2.3 devices each (standard deviation of 0.8). Overall, 94% of students owned a laptop, 84% owned a smart phone, 41% owned a tablet, while 34% owned a desktop computer.

Student's Voices – Preconceptions of e-Exams

During the pre-trial institution wide survey we found little prior experience of computerised exams with 60% of respondents having never taken a computerised exam and a further 30% haven taken just a 'few'. The students spoke up with 541 comments or 'preconceptions' via the online survey. The students raised a number of issues; risk aversion relating to technology, cheating and current practices featured significantly.

> "Technical issues e.g. data loss, program crash, accidental deletion, slow loading, unrecognisable formats etc. – *Physiotherapy student*.
> "Internet connections, issues of copy-pasting, issues of access to other programs (including web browsers) while doing an examination, potential for easier reading

of other people's answers when doing a computer-based examination" – *Arts student*.

"The technology being unreliable stresses me out more than the thought of doing the exam." – *Law student*

"My main concern regarding computer based exams is the level of preparation the supervisors have to fix a technical problem that may occur during the examination." - *Agricultural Production student*

"Hiding the screen from other student's prying eyes." - *Environmental student*

"I also am not convinced of the administrator's ability to prevent cheating by students. I want to compete on a level playing field whereby knowledge is tested against others in the field of study not on who has worked out how to violate the system." – *Business student*.

Computer literacy also featured in student's rationale:

"As a mature aged student, I would feel at a disadvantage doing a computerised exam as I am not as computer literate as many of the younger students." - *Chemistry student*.

"It's true that 'computerised exams favour some students more than others' - i.e., the ones that are proficient typists over the ones that aren't - but the same is true of paper-based examinations, which favour those with the ability to work through strong pain in their writing hand. Any set-up will be to the advantage of someone!" – *Arts student*.

Students were also attune to the suitability of keyboard entry with respect to the typical assessment questions set in their discipline:

"A real programmer would be looking up the APIs for their language every time they wanted to do something, but they can't because they're forced to only use paper-based notes they have on hand. It's infuriating." - *Computer science student*.

"For a maths or science courses it's very tedious to type up equations and symbols." - *Chemical Engineering Student*.

[It] "would be difficult to create an exam based on typing musically (creating scores/sheet music)…[It] is different for each program and most of the time taken during the exam would be trying to work out how to use the program." – *Arts/Music student*.

"I need to be able to draw sketches and write formulae conveniently." – *Civil Engineering student.*

"It is hard to write Chinese characters on a keyboard and the keyboard becomes a dictionary using current software so it is a bit unfair." - *International Studies and Languages student.*

Students also trained themselves for paper based exams and this had lead to sense of investment in the approach.

"In engineering assignments it is still important to be able to practice 'pen and paper' type questions for assignments because this helps in studying for exams and remembering important facts." - *Electrical Engineering student.*

"I have a history of performing exceptionally well with written exams, not getting less than a 7 [the highest grade] on my final exam papers. I don't want to risk this historic performance by introducing a new method of exam delivery." – *Business student.*

Others were positive about the idea of computerised exams.

"I would strongly support a shift to computer-based exams, regardless of format (e.g. multiple choice, short answer, essay). A computer-based examination would be considerably more convenient for both the student (write more quickly, easier to modify answers) and the examiner (MCQ marked faster, examiners wouldn't struggle with illegible handwriting, less missing exam papers)." - *Medicine, Surgery student.*

While there was those that avoided typing due poor keyboarding skills, there were others that avoided hand-writing due to poor penmanship or physical discomfort when writing for an extended period of time.

"I feel that I am always at a disadvantage because I write ever so slowly. ... Hand cramps, pen clicking and ink smudges are inconvenient too. I would love the chance to be able to type all my answers out on a computer." – *Psychological Science student.*

"I'm left handed and writing continuously for an hour and a half in my law exams leads to a huge amount of mess on my hand from pens/pencils smudging. I feel that computer based exams would allow me to actually achieve better." – *Law student*.
"I hate paper based exams. Hand cramps are the worst, especially for me. I've had years of wrist injuries." - *Health Sciences student*.

While there were those that complained of hand cramps from writing there opposing views expressed:

"I feel the question about hand cramps definitely speaks volumes about how soft students can be." - *Civil Engineering student*.

Students also identified that the majority of their work during semester was computerised, along with claims that they are being disadvantaged by being forced to use pen-on-paper for exams.

"Students are at a disadvantage these days with written exams: we do not use paper based methods as much and many students have illegible handwriting." – *Social Science student*.
"Given that computer use is assumed knowledge in higher education settings, it would be a weak argument to suggest a student would be disadvantaged any more than a student is disadvantaged by using pen and paper." - *Law student*.

Some students raised the impact of using familiar or unfamiliar keyboards on their writing efficiency:

"A large concern is the type of keyboard used. To have someone who has used an Apple keyboard all their life use a different type of keyboard for an examination (especially since it's timed and the quantity of work plays a part) it would be a disadvantage to the person." – *Arts student*.
"As a Dvorak typist, being forced to use the QWERTY keyboard if electronic exams were taken on university computers would be a significant disadvantage." – *Software engineering student*.

Students perceived a trade-off between the familiarity of BYOD and the risk of cheating:

> "I'd rather use a familiar keyboard in an exam, but it's easier for students to cheat using their own computer." – *Chemistry student*.

Some argued that university supplied equipment should be used but this would not be without issues too;

> "In a university as large as UQ computer based exams would be extremely hard to organize, particularly in large courses like psychology, but if students could use their laptops they will have a higher chance of being able to cheat." – *Communications student*.

Some students expressed concern over potential damage being done to their equipment by the e-exam system:

> "How is my computer shut off so that I can't access my documents while completing an exam. What kind of lasting effects will it have on my computer?" – *Business student*.

The need for students to be familiar with the environment is highlighted:

> "Simple interface problems (short-cut keys not working, mouse buttons not working as expected) could cause BIG problems and frustration under time pressure." – *Electrical Engineering student*.

The overall distribution of comments provided via the pre-trial phase survey across a set of emergent categories is shown in figure 2.
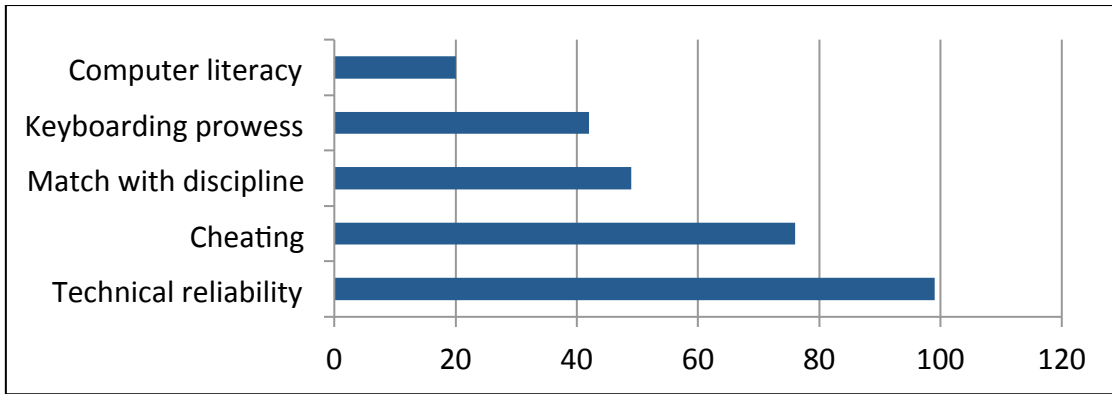
Figure 2 Emergent themes from pre-trial survey comments.

Further exploration of the preconceptions of students towards computerised exams is available in Hillier (2014).

Student's first look at an e-Exam approach using BYOD

During the set-up/practice session 115 surveys were returned by students who had just tried the e-Exam System with their laptop for the first time. Students were asked to rate the e-exam system using Likert items including the ease of following set-up instructions, the ease of undertaking the start-up steps, the ease of starting their computer with the USB stick and the ease of using the exam system software. They were also asked about their confidence in their ability to perform the necessary steps in a real exam and if they were 'relaxed' about the idea of using the e-exam system in their upcoming exam. The ratings assigned by students are displayed in figure 3 and tended to be rated as 4 on a 5 point scale (5 being strongly agree/positive).
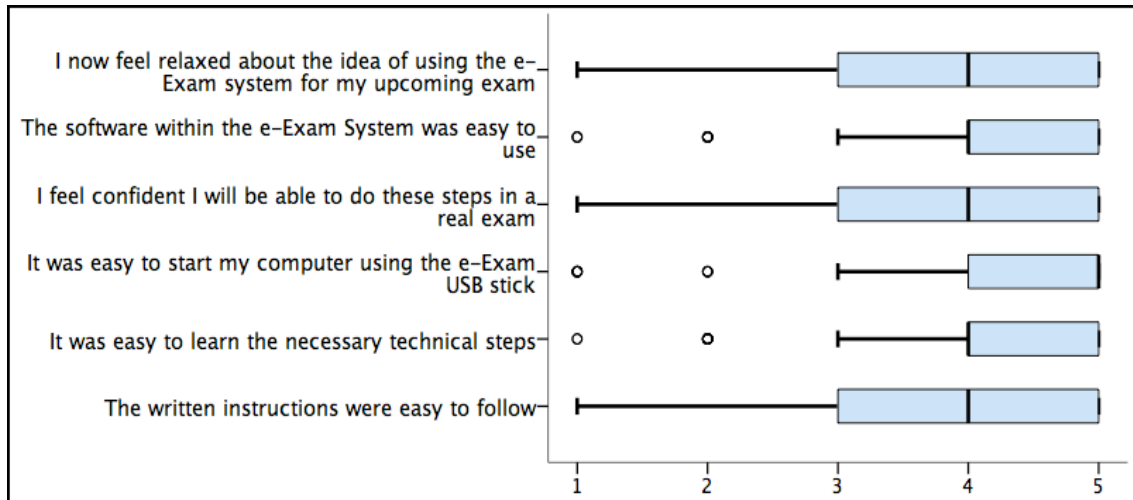
Figure 3 Ratings of the BYOD based e-exam system (5 = strongly agree)

There were 69 respondents who provided comments, with the main themes presented in figure 4. The technical test focus of the session was reflected in the larger proportion of related comments. A general fear of a technical mishap during the exam was of concern to 24 students. Concern about forgetting how to use the e-exam system was expressed by 10 students. Eight students identified difficulty or differences in the behaviour of touchpad and scrolling behaviour as a concern. The loss of power was a worry for 7 students as was the loss of data. General praise was received from 13 students and 9 students commented on the ease of use of the system.
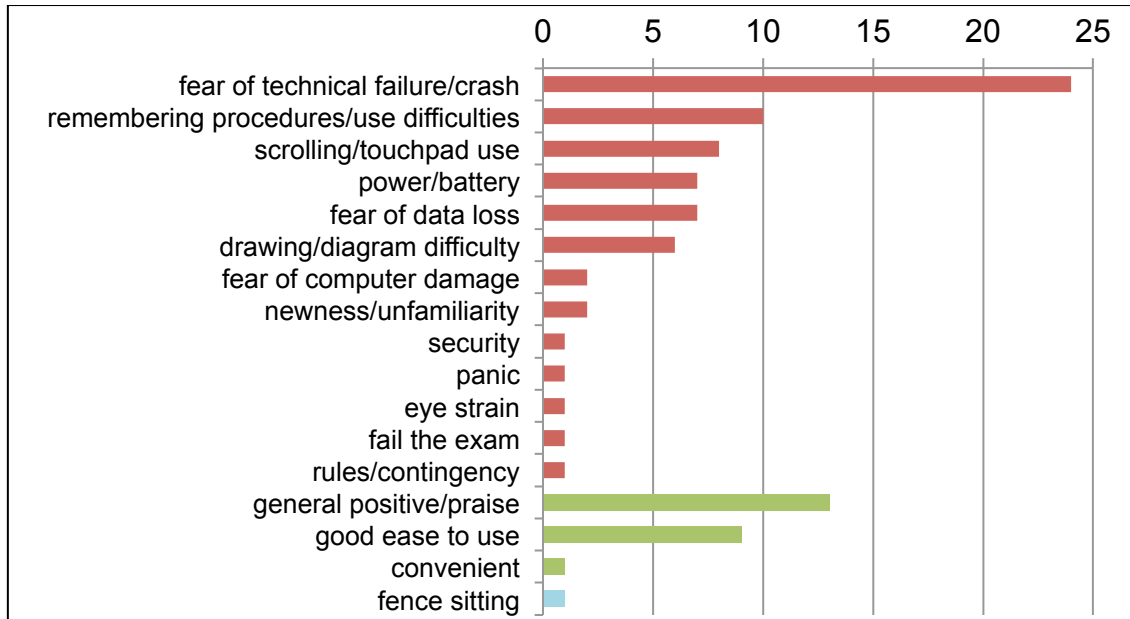
Figure 4 Emergent themes from student comments on the pre-exam survey.

Students were also asked to report any technical difficulties or issues. Some issues prevented them from using their laptop for the exam while others were minor inconveniences that could be overcome by providing a power socket, adjusting the software or further practice. Nineteen laptops were found to be incompatible with the e-exam system due to either a graphics hardware incompatibility (8 machines) or some other unknown reason (11 machines); the latter was likely due to BIOS/EFI firmware limitations. The range of technical issues identified is shown in figure 5.
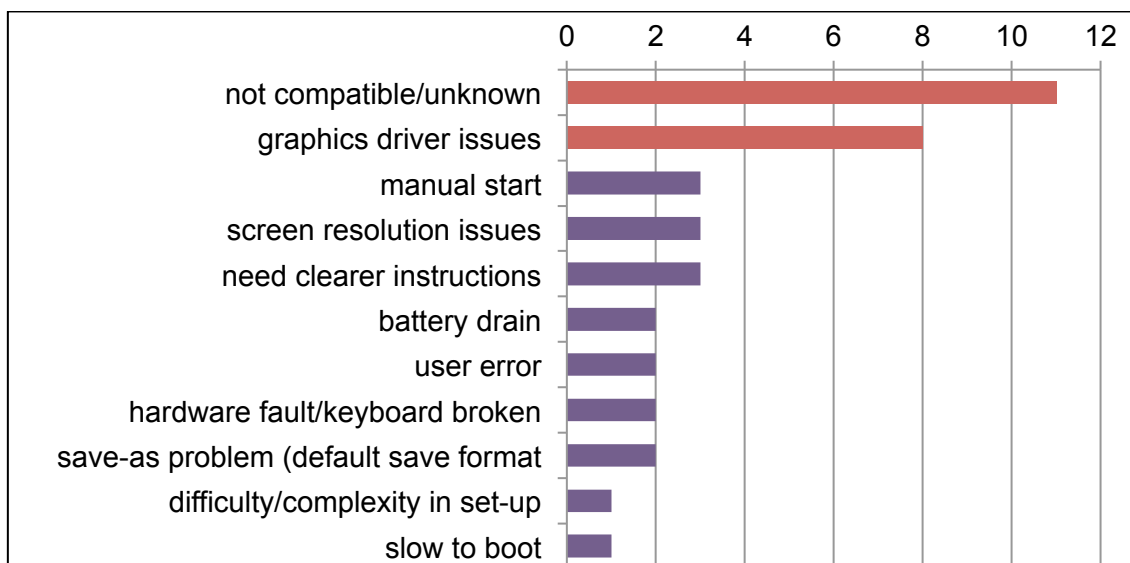

Figure 5 Count of technical issues encountered during set-up sessions

Following the exam

Immediately following the exam students were asked to comment on the exam they had just experienced via three open-ended questions. Those that chose to type gave reasons including their good typing skills affording more time in the exam while allowing easier editing and making up for messy handwriting:

> "Quicker typing and the ability to edit or completely delete my answer without compromising on space." "I knew I would be able to go back and change my answers easily. I type faster than I write - I would have more time to answer questions." "I could get info down faster and examiner could read it." "It is cleaner, I make lots of mistakes when I'm writing and it usually ends in lots of scribbles everywhere." "I have ridiculously messy handwriting."

The avoidance of sore hands was also mentioned by several students:

> "You can write as much as you otherwise would but don't get a sore hand when typing."

Some students felt that typing was more 'natural' and it helped them think:

> "Much easier to construct arguments and to think clearly when typing." "Typing is more natural for me. I think best when I am typing and I feel I am able to work faster as well."

It was noticeable that those who chose to type were not particularly concerned about technical issues or the merits of using their own laptop. This may be due to the relatively few technical issues experienced during the trials. Those that chose to hand-write gave a broader range of reasons for their choice. Their fear of technology failure and a lack of confidence in the capabilities of their own laptop were expressed. Comments from students on their fear of technology failure include:

"I was initially planning to type this exam but decided against it due to the unpredictability of machines." "Expecting initial issues with new system." "I prefer to handwrite my exam as there is less opportunity for potential technical difficulties and computer glitches." "Don't want to risk losing data & programs on my computer." "I felt more comfortable handwriting as nothing can go wrong & I wasn't relying on the computer system to complete my exam."

Then there were those that were torn between their fear of technology failure and the avoidance of sore hands or messy writing.

"I think more about what I'm writing when I handwrite but my hand gets sore and it isn't fast." "More stressful on computer, sore handwriting."

Students stated that they were accustomed to handwriting and its dynamics, particularly for exams:

"I have done three years of prior exams writing so stick with what you know." "I've done all previous exams by handwriting. Don't want added stress in exam." "As an English as a second language speaker, I use drawings a lot to represent some words that I can't spell perfectly". "When doing a rough copy I find the ability to cross out mistakes or write all over the page useful for organising arguments."

Students also use handwriting for taking notes in lectures and in their study:

"I study and revise by writing notes, flash card and drawing pictures. Because of the method I practiced with it is easier to remember content when handwriting." "It is also what I'm used to as I handwrite most of my notes and I prefer it that way."

Some students also stated that they 'think better with a pen':

"I feel if I write something out by hand I think clearer … it feels more solid than something on a screen." "I feel I think more carefully when writing and find it easier to read over my answer." " I connect better with my answers when writing."

Some students also chose to hand write despite acknowledging their messy handwriting.

"It's easier to handwrite. Though probably not easier for you to read my writing."

Others acknowledged trade-offs such as:

"If I were to type, my responses may be written better in terms of language. However I feel that under exam pressure, I do not have time to think as much and I would not be able focus when looking at a computer screen."

Apathy regarding the e-exam trial was also a contributing factor.

"Lazy to bring laptop." "Bringing a laptop to today's class was inconvenient." "Less hassle, didn't have to lug my computer around."

A lack of access to suitable equipment was raised (although 'loan' laptops were made available).

"I do not own a laptop so did not think it was possible." "My laptop battery is not good enough to sustain for half an hour of the exam. If desktop is provided I may consider using typing exam." "My computer didn't support the software."

Uncertainty about the practicalities of typing was also expressed.

"I was unsure I would like typing under pressure." "I didn't know if the computer would work and I didn't how I would react."

A couple of students highlighted the different behaviour of the e-exam system that follows Windows conventions compared to their regular operating system OSX (having tried at a set-up session). This caused issues for these students:

"The e-exam resets the shortcuts, too confusing to figure out in 15 minutes."

Overall the majority of students who typed stated that they felt their good typing skills would afford them a time advantage. Student comments included "Typing is an easier quicker way to write paragraph long answers" and "Thought it would be more

time efficient." This was mirrored, although to a lesser extent, by around one fifth of those that hand-wrote who felt they had poor typing skills.

Around 40% of those who typed also said they felt that their handwriting was not up to par. One typist remarked: "I have terrible handwriting. Felt bad about it". The potential to edit work after initial writing was also nominated by 40% of typists. Of those that chose to handwrite their exam, the top two reasons stated were a fear of technology failure (30% of hand writers) and a preference for the familiar mode of hand-writing exams (25%). A count of the reasons given for their choice of exam mode is displayed in Figure 6.
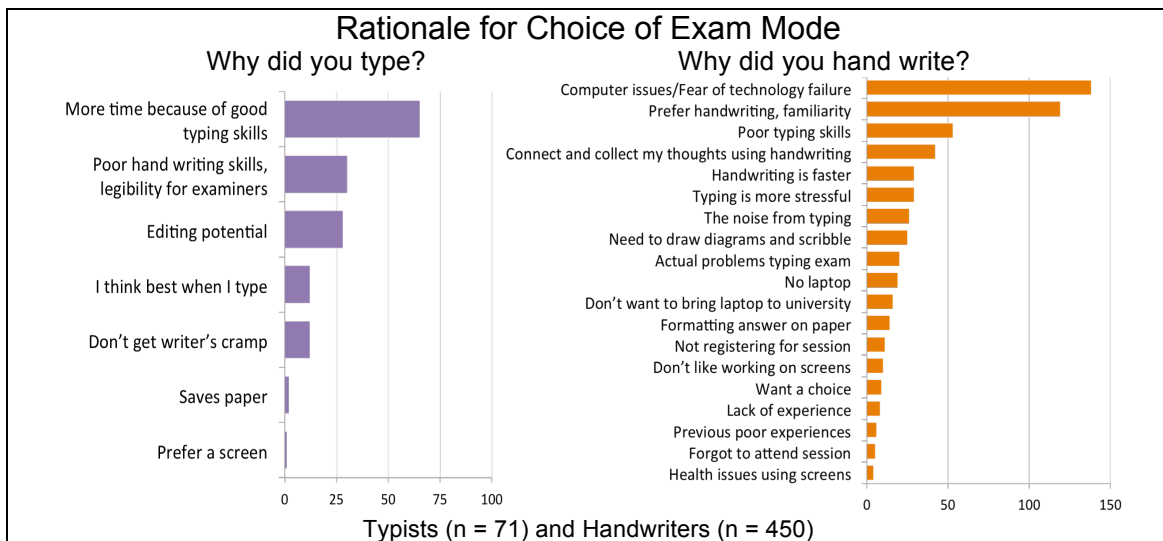

Figure 6. Rationale for choice of exam mode.

Trends across the phases of the study emerged. There were many similarities between the comments of those that chose hand-writing and the comments obtained in the pre-trial institution wide survey from students who were sceptical about computerised exams. This is not surprising given that the vast majority of both groups were commenting from positions of inexperience of computerised exams.

A general trend was noted in the comments of students who elected to type in that they were still cautious having just tried the e-exam system at the pre-exam set-up session but were then much more positive in their comments following the exam.

We also noted the preponderance of shorter comments on the hand-written surveys conducted during the trial phase versus the online survey conducted in the pre-trial phase, this somewhat supports the notion that typing engenders more verbose responses than does handwriting (Mogey & Peterson 2013).

Conclusion

Despite the commonality of using computers for assignments and reports during semester, a large majority of students in these trials choose to hand-write their exam. They provided a range of reasons why this was so, from a fear of technical failure and poor typing ability, to their comfort with the status quo. We could speculate to a degree, that the preponderance of hand written exams has become a self-reinforcing phenomena. It to be expected that students will take steps to enhance their chance of success in exams by training themselves to work with a pen using techniques such as hand-writing notes in lectures, re-writing notes for revision and using outlines to structure their work. A study by Mueller and Oppenheimer (2014) examined the impact of using a laptop to take notes in lectures on student success in exams and found that handwriting led to better test results in their experiments. The rationale given by Mueller and Oppenheimer (ibid) was the performance differences were due to the different way in it becomes necessary to reprocess messages being recorded by slower handwriting versus the ability to type verbatim with very little processing by the brain. However, their study only tested students using pen-on-paper quizzes and did not utilise any computer based testing. We can speculate that in a world where the keyboard is a dominant means of examining, students may take deliberate steps to train themselves in

this mode of production, adjusting their exam preparation strategies accordingly. A study by Barrett, Swan, Mamikonian, Ghajoyan, Kramarova and Youmans (2014) showed that this could prove fruitful. They found that when note taking and assessment formats were congruent, students scored significantly higher compared to students using incongruent methods.

We are still in the very early days of using computers for high stakes testing, yet the common use of keyboards in other areas of study may already be leading to some changes in the way students work best. Students who chose to type their exam clamed a higher proficiency with a keyboard, felt better able to compose their responses and felt that they thought better with a keyboard. It was noted earlier in this paper that the introduction of computerised exams has the potential to lead to downstream changes to the overall curriculum (Fluck & Hillier 2014), it may yet lead to changes in the way students study for exams too.

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