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## Transforming exams across Australia: Processes and platform for e-exams in high stakes, supervised environments

**Final report** 2019

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# List of acronyms

ADFA	Australian Defence Force Academy
ANU	The Australian National University
AR	Augmented Reality
ASCILITE	Australasian Society for Computers in Learning in Tertiary Education
BYOD	Bring Your Own Device (also as in BYO laptop)
CQU	Central Queensland University
DET	Department of Education and Training, Australian Government
ECU	Edith Cowan University
LMS	Learning management system
MCQ	Multiple-choice question
Moodle	Modular Object Oriented Dynamic Learning Environment (a LMS)
Monash	Monash University
MQU	Macquarie University
NAATI	National Accreditation Authority for Translators and Interpreters
NAPLAN	National Assessment Program - Literacy and Numeracy
OLT	Office for Learning and Teaching
RMIT	RMIT University
SES	Social Economic Status (as in low SES)
TEQSA	Tertiary Education Quality and Standards Agency
UniSA	University of South Australia
UNSW	University of New South Wales
UQ	The University of Queensland
UTas	University of Tasmania

# Executive summary

## Project context

A paradigm shift in higher education is underway. We are moving from analogue, disconnected, paper-centric assessment practices towards the inclusion of digitally connected, relevant and authentic approaches to learning and teaching. This enables us to accredit graduates as ready for the work and social world of the 21st century.

This move is necessary because current invigilated examination practices are stuck in the 20th century. Modern e-tools of the trade, in the form of sophisticated software applications and information resources, are disallowed in favour of analogue isolation in the exam room. Students accustomed to connected, digital ways of working are struggling to demonstrate their skills under conditions rarely faced in the professional and vocational sphere. Academics are also held back from developing richer, more-authentic ways of assessing learning in light of the current trade-offs between pedagogical efficacy, integrity and feasibility. Although increasing numbers of digital assessment tools are being offered, many neglect authenticity in favour of scalability or security, or focus on a narrow context of classroom quizzes or testing centres. These systems are often reliant on having perfect network connectivity. There is currently no robust, viable method to do authentic e-assessment that will work to align both in-class progressive assessment for learning and higher stakes summative assessment undertaken in large scale exam halls.

This project transforms examinations by identifying the necessary underlying conditions and contextual factors for successful authentic e-assessment practice. There were two critical developments in this project. Firstly, the recognition that web-browser-based assessment alone does not permit candidates to demonstrate skills based on sophisticated computer software applications fit for professional work. Secondly, the use of a common USB booting system provides total institutional control of student-owned computers without interfering with their personal data or software. These critical ideas led the project team to design a robust e-Exam platform, which is also resilient to network breakdowns. The project team then went on to implement and verify, across a range of institutional contexts, a viable technological and procedural approach to scale authentic e-assessment.

## Aims

This project aimed to enable the development and delivery of authentic e-assessment in the supervised exam room context, in a manner that was scalable and sustainable. To facilitate the move from paper to digital exams, the project set out to deliver a practical solution in the form of an e-Exam technology platform supported by guides for students, teachers and administrators. Evidence as to the viability of the approach to authentic e-Exams was to be provided by 35 research-led trials across a range of institutional contexts that included student, teacher and administrator experiences. These findings will guide teachers, assessment developers, technology support, examinations managers and institutional leadership in matters of policy, practical implementation and pedagogic design.

## Approach

The project involved iterative phases of development along a roadmap. A series of e-exam trials were conducted in different institutional contexts with the findings of each round feeding forward into the next iteration. Each institution progressed at their own pace.

Start >	> > >	> > >	> > >	> > >	> Future >
Get Ready	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Institutional approvals, research ethics, hardware and infrastructure	Paper-equivalent small scale Basic doc exams to begin!	Post-paper small to medium Expanding the app and media landscape	Medium to large scale Adding the power of an LMS	Whitelisted and logged Internet Networked BYOD exam	Open but fully logged Internet Network mixed mode BYOD exam
	Crawling	Walking	Running	Jumping	Flying!

Across the four years of the project, 10 partner institutions had input, 35 e-exams were conducted with over 3000 students, teachers, and administrators participating in exam sessions, in surveys, focus group interviews, workshops and an international symposium.

### Project deliverables

The project team not only met all defined deliverables of the project but also provided additional outputs that centred on dissemination and adoption. The project team focused upon activity likely to have the greatest impact on the higher education sector, this being developing knowledge about authentic e-assessment practice and in providing the practical infrastructure to implement e-exams in supervised settings. Significant outputs included:

- the Transforming Exams project website houses the majority of project outputs listed below and served as a portal for updates, see <http://transformingexams.com>
- the e-Exams technology platform consisting of a client, server and administration components. This software was updated as the project progressed and distributed to project partners. Demonstration versions are available on the project website
- learning resources and guides for students, teachers, technical administrators and examinations managers were developed and made available on the project website
- a national roadshow and symposium encompassed five capital cities in which over 300 higher education personnel participated
- dissemination outputs included over 60 presentations at conferences and institutional meetings, with session recordings or the slides made available via the project website. These sessions advised the higher education community of the rationale and a roadmap towards authentic e-assessment as well as the research findings from 35 diverse research-led e-Exam trials
- a total of 15 refereed publications were produced (with more to come) covering results from 35 e-Exam trials in which 1700 students typed their exam. Findings covered e-Exam system design and use, students' perspectives on e-Exams and on their writing strategies, possible digital assessment futures and potential impacts of authentic e-assessment on curriculum transformation.

### Key Findings

The project encompassed multiple realms from theory, perception and policy to practical measures such as technology development, implementation and use. Key findings included:

- creation of a viable, robust technology platform for e-Exams. It is flexible, supporting a transition from paper-equivalent exams to rich, authentic digital assessment. A technology platform for e-Exams must support pedagogical alignment at all stages of learning from the classroom into the exam room. Therefore, it integrates and leverages existing systems such as common word processors, learning management

systems and software commonly used in the discipline. A viable e-Exam system must work in the rough spaces of classrooms and education settings. The e-Exam system was found to be secure and reliable, highly resistant to network outages and can function offline. This allows students to focus on completing their exam and minimises disruption to exam timetables

- students accept e-Exams and find them suited to their largely preferred ways of working. Students report that typing is preferable to handwriting in exams. However, some students need support in the transition with a significant minority facing challenges in adjustment of writing habits and in supplying equipment that is up to standard. The transition roadmap, along with a mix of institution and student technology, will enable the uptake of medium to higher stakes digital assessment across educational institutions
- logistical support and attention to detail matters in the high stakes, time-pressured exams. Where organisation, resources, process and communication are lacking, achieving good outcomes with computerised exams is made significantly harder. Examinations office personnel are experts at logistics so leveraging that expertise in collaboration with other key areas such as IT support is important to success
- academic development in terms of digital literacy and digital pedagogy will be important to embedding and scaling authentic e-assessment across the curriculum. While e-Exams are one part of the picture, our current analogue exam practices are one of the 'blockers' to broader systemic change. The need to ensure alignment of practices in classrooms and exam halls means that academic teaching and learning support staff must also have the skills and capabilities to deploy relevant e-exams technologies and tools in their classrooms
- policy is a mechanism to support change, as is managerial support. Policies on examinations that set out to frame e-Exams must extend beyond traditional confines. New systemic connections must be made with broader areas, including developing a holistic digital learning strategy, together with a Bring Your Own Device (BYOD)-focused infrastructure development strategy, IT support, pedagogic professional development and student support to enable an equitable transition
- universities do not stand alone in the assessment space. In Australian schools, NAPLAN (national numeracy and literacy testing) and matriculation exams are tentatively moving online, Other countries such as Finland have already completed the transition with tests and exams in school for Years 10–12, as well as university entrance exams conducted entirely on computers. The e-Exam platform is well placed for use in school-based assessments and matriculation examinations, as well as in vocational and professional education settings.

## Future work

The project was a great success in demonstrating what robust, authentic digital assessment could be like. But the findings show our work is not yet complete. Further technical work is required to improve the e-Exam technology platform, its integration with other systems and its administrative support tools. Further investigation and investment into systemic support mechanisms is required to scale digital assessment at higher education institutions in areas such as process, professional development, policy and infrastructure.

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# Chapter 1. The project

## 1.1 Background

This project 'Transforming exams across Australia: Processes and platform for e-exams in high stakes, supervised environments' was born from the growing disconnect between the way high stakes testing is conducted using pen-on-paper exams and students' everyday experiences of study, work and life. The complexity of problems faced by all industries and society demands the use of sophisticated problem-solving approaches, typically employing advanced software technologies. The use of information and communication technology (ICT) in higher education and, in particular, invigilated higher stakes assessment lags behind the common use of ICT by students in other areas of their study, work and social life. This is despite higher education institutions' ambitions to provide students with core technology literacies required for success in a modern world. The paucity of authentic assessment at the invigilated medium and higher stakes end of the assessment spectrum is holding back the ability for higher education to evaluate students' learning in light of desired 21st century capabilities (Fluck & Hillier, 2016). The Australian higher education sector needs a greatly expanded capability for higher stakes 'assessment and promotion of student learning' if our graduates are to remain competitive in the information-rich, technology-intensive world of today.

This project aimed to explore how authentic forms of assessment could be undertaken if sophisticated 'e-tools of the trade' were made available to assessment designers and students in the invigilated exam room context. The project team set about developing and evaluating a comprehensive technology environment for exams that would enable authentic, complex, constructed assessment. The e-Exams project team recognised that there are contextual challenges surrounding the implementation of ICT in the exam room, particularly in the form of a suitable, scalable and affordable exams technology platform. Surrounding issues were also within the scope of project deliberations included consideration of the efficiency of exam management, the logistics of carrying out computerised examinations, the availability of suitable spaces at institutions, the need for computer equipment to cater for a large number of exam candidates and student acceptance of e-exams.

The predecessor seed project identified the need to further enhance a set of e-exams good practice guidelines across multiple institutional settings. The seed project also provided direction for the further development of a robust e-exams infrastructure with sector-wide relevance and cross-discipline applicability. The team also articulated how e-exams could evolve in the Australian higher education context over the following 10 years (Hillier & Fluck, 2015).

This project set out to:

1. build on the existing e-exam platform (developed under the prior seed project) intended for use in supervised, 'bring your own laptop' (BYOL) settings to include computer-marked questions and electronic reticulation of student responses
2. develop guidelines to assist students, educators and administrators to effectively prepare and undertake e-exams, taking into consideration the whole assessment workflow.

The project has delivered a range of findings on student preferences and a general toolset for ICT-enhanced invigilated medium and higher stakes assessment using an approach that

is designed to be open, modular and as technology neutral as possible. The e-Exam delivery platform developed by the project team enables invigilated high stakes testing on campus at a large scale. It must be noted that this project did not specifically address online-only or distance education contexts.

## 1.2 Project logistics

The project team was organised into clusters at each partner university with the lead institution hosting 'e-Exam HQ'. The organisation showing the relationships between institutions and groups is depicted in Figure 1.

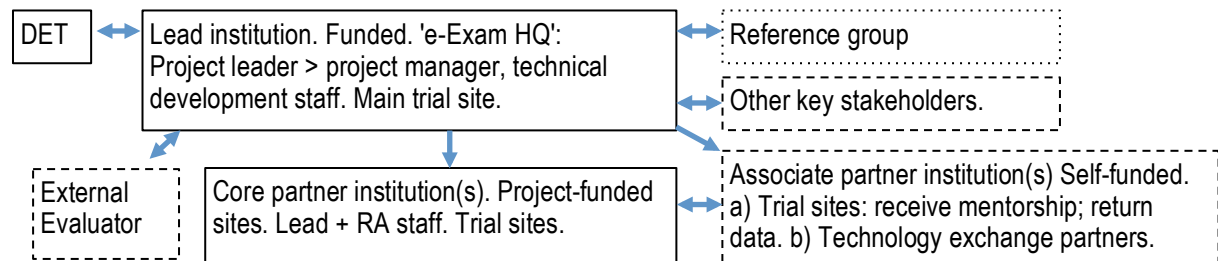


Figure 1 Project organisation

On receipt of the grant the project leader prepared the groundwork for implementation. The activities included:

- recruitment of staff including the project manager and lead technical developers
- obtaining ethical clearance from the lead institution Monash University, which facilitated the approval by project partner institutions: Central Queensland University (CQU), Edith Cowan University (ECU), Macquarie University (MQU), The University of Queensland (UQ), University of South Australia (UniSA), and University of Tasmania (UTAS). The University of New South Wales–Australian Defence Force Academy joined the project in 2017. Note: The Australian National University (ANU) and RMIT University did not participate in e-exam trials
- developing subcontract agreements between Monash University and individual partner institutions that outlined responsibilities and deliverables. Where grant payments were planned, these were made conditional upon deliverables being met at each stage
- holding a preparation workshop in the opening months of the project. Hosted at Monash University, Caulfield Campus, it was attended by 21 project collaborators and team members. The aim was to provide a project overview and detailed instructions on the implementation of the e-exams trials and a hands-on session using the e-Exam system. Attendees included academics, learning designers and exams officers from partner institutions
- developing a package of files to run trials that was provided to each partner. This included templates for a preliminary meeting checklist, ethics protocol draft, participant informed consent information and form, survey and focus group questionnaires and data collection spreadsheet templates. In the lead-up to each trial, meetings were held with course academics by project team members at each institution to arrange context specific action plans
- collecting data during and following trials that was reported to the project leader via project partner institution representatives using the data collection spreadsheet templates.

## 1.3 Project management

The following activities enabled the national scale project to be managed.

- *Regular project management team meetings:* The project management team comprising the project leader and project manager held regular weekly Skype meetings.
- *Project team meetings:* The team had five face-to-face meetings: one in 2016, two in 2017 and two in 2018.
- *Regular email communication:* Team members and collaborators communicated closely via email. Communication was centred on running of particular e-exam trials, arranging site visits and preparing joint publications or presentations.
- *Use of project management tools:* The progress towards deliverables and outcomes was tracked using the online tool 'Basecamp'. This tool allowed project members to communicate with each other, kept track of their tasks, timelines and milestones. It also served as repository for project documents relating to individual e-exam trials. A meta project was established with each partner institution having its own subproject. TeamGantt synced with the Basecamp account and provided an integrated view of all tasks and schedules for the core management team. Cloudstorage services such as Dropbox, Google drive and AARNET Cloudstor were used as repositories for common project documents and to distribute updated e-Exam system files.

## 1.4 Status of project deliverables

Following on from the originally planned project deliverables it was found that the environment and focus of our work evolved over the project period 2015 to 2018. All deliverables were met, although some adjustments were made to the form deliverables as new information came to hand. The status of each of the originally planned project deliverables, along with the achieved project outputs, is shown in Table 1 with further explanation of each provided Appendix B.

Table 1 Status of project deliverables

Original deliverable	Delivered output
e-Exams technical infrastructure	<i>Delivered.</i> A robust and modular e-exams platform resistant to network outages
Good practice guides	<i>Delivered.</i> These evolved into a set of user guides.
A draft set of assessment/exams policy recommendations for institutions	<i>Alternative delivered.</i> See section 6.1. for alternative findings and discussion
A set of example e-exams	<i>Delivered.</i> 35 trials conducted across three modalities and multiple disciplines
Research findings published	<i>Delivered.</i> 15 refereed publications and 60 presentations
Workshop materials to introduce academics to e-exams	<i>Delivered.</i> Several workshops, national roadshow and an international e-Exams Symposium
An 'e-exams foundation' draft terms of reference	<i>Alternative delivered.</i> Recommendation for joint venture or commercialisation

## Chapter 2. An e-Exam platform for authentic assessment

### 2.1 Rationale for the development of an e-Exam solution

At the beginning of the project a number of premises were outlined that formed a rationale for the development of an e-Exams solution. The chief among these was the growing disconnect between current examination practices and the world of work. Similarly, exams were becoming further disconnected from the remainder of students' learning experiences and their extensive use of computers in their studies. There was an overwhelming sense that examinations needed to enable 'authentic e-assessment' while maintaining assessment integrity. There was also recognition that an e-Exam approach had to be scalable and sustainable. The starting rationale was outlined in three broad areas presented in the points below, with further explanation and a concept map provided in Hillier and Fluck (2013).

#### Student requirements:

- students rarely hand-write assessment responses
- students are familiar with their own devices
- high student ownership of laptops
- student-owned devices are diverse
- students dislike interference with their device.

#### Pedagogical requirements:

- technology can enhance the authenticity of assessment
- equivalent software environment for all students
- provide opportunities to practice.

#### Institutional requirements:

- scalability of the solution to serve large student groups
- institutional contexts differ that demands a flexible solution
- resilience and security
- unauthorised data and communication must be excluded from the exam
- workflow efficiency.

### 2.2 Prior e-Exams solutions

At the beginning of the innovation and development of the project a market scan was conducted that looked at existing computerised exam solutions and approaches being used. These were found to be wanting. Typically, solutions focused on security or efficiency but often neglected pedagogical sophistication. This tension is shown in Figure 2 (left). The existing approaches to conducting computerised exams had a number of limitations, such that one or more of the following elements were evident:

- *Limited pedagogic scope.* Limitations in the type of questions and tasks that are possible. Systems often focused on a single type of assessment or modality. Typically as an isolated quiz involving selected response questions or essay question types.
- *Candidates were not prevented from accessing unauthorised materials.* The use of standard quiz tools embedded in a learning management system means that students have access to other tools within the LMS.
- *Candidate numbers were limited to the capacity of on-campus computer labs.* Tests undertaken in teaching labs with a finite capacity can only cater to a small number of

seats, this is insufficient for the normal high volume of candidates. The layout of lab rooms is often unsuitable for high stakes exams without some modification.

- *Proprietary software applications and limited flexibility.* Licensing conditions may limit broader use without additional costs being incurred. Similarly, most systems are presented as a separate environment that is not part of the regular learning and teaching toolset. This creates a discontinuity of experience between learning and summative testing. This 'black box' style separation also limits the data sharing to a final task grade. Thus, it limits the potential for big data learning analytics to include fine-grained detail when assessment tasks are undertaken in separate systems.
- *Invasive technology.* Some solutions, particularly targeting student devices, enforce undesirable conditions on students such as requiring invasive lockdown software to be installed into student's personal devices that may create conflicts within systems.
- *Lack of holistic control.* In particular, solutions that utilised remote supervision services presented risks of exam protocol breaches due to the lack of a holistic control sphere and commonly utilised invasive technology (as per previous point). If outsourced testing centres or services were used, then control is passed to other organisations or individuals. These services were mainly intended for small numbers of external or distance education students and were found to be costly per student, negating their use at scale. However, it has been found that over the duration of the project the use of such services has been increasing, with an ever-larger number of courses moving to online-only delivery. Caution is urged in the race for efficiency and access where the integrity of the assessment system may be placed in jeopardy.

It was felt necessary to develop a new type of technology platform that would overcome many of the issues outlined above, while enabling a much greater degree of authenticity in assessment tasks within the supervised context of exam halls and classrooms. Given the apparent gap in the market, the project team has taken a 'pedagogy first' approach, but has maintained a keen eye on the enabling cost-effectiveness, implementation and integrity. In moving towards a solution, the well-known project management axiom of 'good, quick and cheap—pick two' was apparent in implementing e-Exams projects. This is often shot into stark relief where corporate managerial processes are instigated to select a 'solution'. It was observed that a tension between the speed or ease of implementation, cost and pedagogical affordances often led to the latter losing out. This tension as it applies to e-Exam technology is revisited in Figure 2 (right).

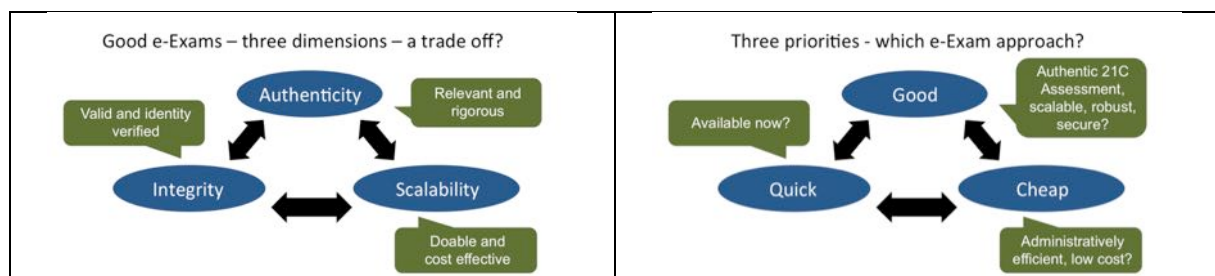


Figure 2 Tensions and trade-offs in developing or selecting e-Exams solutions

## 2.3 Historical development of a robust e-Exam platform

The e-Exam platform started life in 2007 at the University of Tasmania. Initially, in-class e-tests were conducted by booting from CD-ROM and writing answer files to a secondary USB stick. This method centred on using word-processing documents as the question and



response composition environment. This continued in 2008 and 2009 for in-class e-Exams (See Fluck, cited in Lane, 2009; Fluck, Pullen, & Harper, 2009). In 2010, the first Live Linux USB stick was used to boot Windows PCs while CD-ROMs continued to be used on Apple computers. In 2011, e-Exams were formalised with University Senate approval. At this time, a USB stick version was developed for use with both Windows and Apple computers. Senate approval initiated a move out of campus computer labs and into centrally administered examinations venues. In 2013, the Office of Learning and Teaching approved a seed project and development begun at The University of Queensland on version five of the e-Exam system. This phase aimed to streamline and automate aspects of the user experience, add additional software applications and expand the range of compatible hardware. A prototype offline Moodle instance within the e-Exam system was also developed in 2014 (although it was not ready for use in exams). Following the successful award of an Australian Government Department of Education and Training Innovation and Development grant in 2015, upgrades to the core operating system and capability of the e-Exam system were realised, producing version six of the e-Exam system. Early in the Innovation and Development Project the team articulated a phased roadmap (see Figure 3) for the development of system capabilities and the nature of examinations that could be undertaken at each phase. The roadmap set out a pathway towards authentic e-assessment with the intention that each institution would progress at their own pace.

Start >	> > >	> > >	> > >	> > >	> Future >
Get Ready	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Institutional approvals, research ethics, hardware and infrastructure	Paper-equivalent small scale	Post-paper small to medium	Medium to large scale	Whitelisted and logged Internet	Open but fully logged Internet
	Basic doc exams to begin!	Expanding the app and media landscape	Adding the power of an LMS	Networked BYOD exam	Network mixed mode BYOD exam
	Crawling	Walking	Running	Jumping	Flying!

Figure 3 e-Exam system development and adoption roadmap

A series of trials were then implemented that covered phases one to three. These trials included using word processor documents (in both phase one and two), including multi-language translation exams; using a spreadsheet as a form to enable automated marking (see Hillier & Grant, 2018); and a new client-server mode for Moodle quiz-based exams (phase three). Further updates included comprehensive system logging (hardware and software processes) and the development of prototype session recording of user actions (screen video recording, webcam, screen images and text capture). A 'robust' integration of Safe Exam Browser within the Live Linux environment was also developed that allows an exam session to continue in the event of network outages. Live trials of the 'robust' Moodle approach to e-exams were successful (see Hillier, Grant, & Coleman 2018). In 2018, the project team, in collaboration with colleagues at Bond University, developed a prototype Augmented Reality e-Exam to collect spatial data from user actions (Cowling, Hillier, & Birt, 2018). By the end of the Innovation and Development Project in 2019 the project team was beginning negotiations to trial the 'robust' e-Exam system approach in alternative learning management systems such as Canvas and early discussions of joint venture arrangements with European organisations had also begun.

## 2.4 The latest e-Exam platform

At the conclusion of this project the e-Exam platform had reached a state of maturity having been tested in phase three trials with Moodle-centric robust online exams.

There are three main components available for the e-Exam platform:

- student user client 'e-Exam OS' (live USB) for offline or 'robust' online mode
- server to host Moodle LMS and 'robust' plugins
- administration tool (also a live system USB) to use with large USB hubs.

The system as it stands has a number of significant features as outlined in Table 2.

*Table 2 e-Exam system features and affordances*

Pertinent features	Affordances
A 'whole computer' environment (operating system, secure browser, media players and a range of software applications) as an exam delivery environment rather than a single testing application.	Vastly expanded pedagogical landscape over that of a browser window or single testing application. A range of 'e-tools of the trade' can be used to construct sophisticated responses. Examples include office suite, spreadsheet, language translation dictionaries, programming kit such as Scratch or Python, mathematical applications such as R or GeoGebra, augmented reality app.
Responses via a full word processor or constructed via specialist applications (mainly human marked) and responses securely reticulated via a learning management system (LMS) quiz with computerised marking.	Caters for introduction to advanced uses, from paper-equivalent to post-paper modalities. Software components can be added or removed to suit. Computerised response collection facilitates assessment analytics.
Robust against network outages—no or minimal live network connectivity is required during exam, even for LMS questions.	Not dependant on a high degree of network reliability while maintaining the advantages of networked content delivery and response submission. Can be used in isolated areas with poor connectivity.
Live alternative operating system used—means student-owned equipment can be used to host the exam environment but is left untouched.	An ethical approach to scalability. There is no invasive software to install. All candidates have an equivalent software toolset with some accessibility features built in.
Modular, open source code base and commodity 'off the shelf' components. Leveraging Linux security with extensive logging and session video recording.	Leveraging popular and sustainable projects for better efficiency. Fully 'known' to test administrators (no 'black box'). A secure environment with extensive auditing.
One version works on most Intel based laptops—Apple, Windows, Linux, that have a USB port. Can be used in campus labs and BYO laptops.	One software version can serve all. Streamlines development and maintenance. All exam candidates are equipped with the same set of software applications.

User guides are available for: students (Preparation and practice guide), teachers (Preparing exam materials guide), examination process administration (Organising e-Exams guide), technical administration (Administration tool guide, Alternative administration guide, Hardware guide, Laptop requirements guide), general user guides (Quick start guides, Detailed start-up guide). The student client portion of the platform and user guides can be obtained from the project website at <http://transformingexams.com>. The process for using the e-Exam system in a robust online Moodle deployment (phase three) is shown in Figure 4



with further detail available in Hillier, Grant and Coleman (2018). Details of the workflow used for offline deployment (as per phase one and two) is available in Hillier and Fluck (2017).

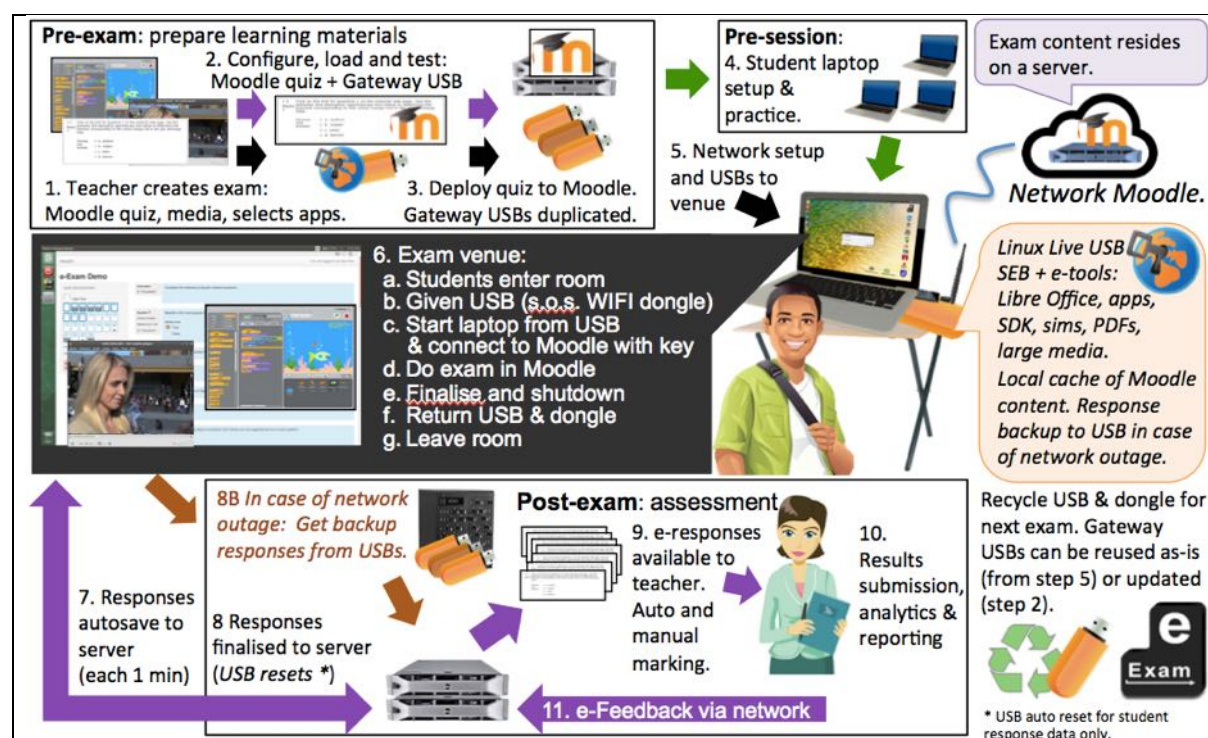


Figure 4 e-Exam workflow for robust Moodle use (phase three)

Exam modalities used to date within the project (in phases one to three) include:

1. *Paper-equivalent word document-based exam.* Primarily these were conducted on opt-in basis and used for early stage trials at each institution (as per phase one). No network infrastructure was required to run these exams. Students were given a choice of typing or handwritten responses. Academics prepared exams using a word processor and students responded within a copy of the document.
2. *Post-paper word document centric exam.* These required all candidates to type (as per phase two) and were generally undertaken following several rounds of opt-in trials at a given institution. Post-paper exams explored assessment tasks that could not be performed on paper (e.g. multimedia prompts, spreadsheet tasks or computer programming tasks). No network infrastructure was required to run these exams. Academics prepared exam questions using a word processor, but also selected and prepared additional prompts and resources to accompany the questions (e.g. video, audio clips, or additional software applications). Students responded using a mix of the exam word document and by submitted files constructed using other software tools (e.g. a Scratch programming file).
3. *Client-server based 'robust' online Moodle exam.* These were similar in nature to the phase two exams but were conducted based on a Moodle quiz via Safe Exam Browser. These exams required network infrastructure to be in place in the form of a Moodle server and Wi-Fi connectivity. Multimedia was also utilised in some exams (e.g. language listening tests using audio files and earphones). Academics prepared exam questions using the Moodle quiz tools and embedded media files as required. Select supporting software applications were added as required (e.g. a Chinese language translation dictionary application). A demonstration augmented reality (AR)

e-Exam was also developed with an Android Virtual machine containing an AR app loaded into the e-Exam system. The AR app collected spatial data pertaining to user actions in relation to markers. These data were then transmitted to a server for analysis. See Cowling, Hillier and Birt (2018) for further information.

Additional features were prototyped but have yet to be trialled in live events. These include:

4. *Access to externally whitelisted internet resources during an exam, with access logging.* This requires a higher degree of network availability for the duration of the assessment event because any external resource needs to be available when the student calls upon it. A demonstration exam featuring this type of question is provided on the project demo Moodle server.
5. *Open online exam with extensive system and user action logging.* The removal of restrictions on internet resources and the addition of extensive session recording. User logging can include video screen recording, screen image capture, webcam image capture, key stroke recording and cursor movement recording.

In comparing our progress to that of other e-exam projects around the world (Fluck, 2019; Fluck, Adebayo, & Abdulhamid, 2017; Fluck & Hillier, 2017), we realise we still have a lot to do, yet it is also evident that the technical strategy and pedagogical goals we have set are also achievable. We highlighted two such examples at our e-Exam Symposium in 2018. The home-grown 'Abitti' Linux USB-based e-exam approach used in Finland senior schools and matriculation exams saw 47,000 USBs distributed nationally in 2018. The network-booted 'SEE' Linux client and Moodle server approach at a university in Austria reached 50 per cent penetration for course exams during 2018. Both examples show our ideas are scalable.

## Chapter 3. e-Exam trial findings

### 3.1 Research data collection

An ethics protocol was approved at the lead institution. Ethics approval was also sought by each partner institution member from their local ethics committee. Both qualitative and quantitative data were collected from student users using an informed consent process. Data collection methods included pre–post session surveys, focus groups, observation and technical data logging. Exam sessions were conducted in classrooms and in exam halls.



Figure 5 Photo: a robust online e-Exam session in progress

Stakeholder surveys included:

- Pre-exam survey*: Done at practice session—two parts: Technical details of student laptop equipment and first impressions following initial use of the exam system.
- Post-exam survey*: Done following a real exam event. Experience of an e-exam and opinions about aspects of responding to assessment tasks and exams. Some trials included a series of exam events providing a small data series within groups.
- Focus groups*: Done following a real exam event. Semi-structured discussion around selected themes or questions relating to candidate's experience of the e-exam.
- Stakeholder and community surveys*: Done following a workshop or presentation to gain feedback on session relevance, e-exam knowledge and interest in the project.

A total of 31 e-exam trials were conducted across eight institutions from 2016 to 2018 (see Table 3). The most recent trials utilised the 'robust' network resilience features for online exams hosted via a Moodle quiz that included written and listening audio response tasks (see Figure 5). Refer to Appendix C of this report for details of these trials, including host institution, date, course, exam modality, question types used, assessment weighting, duration and the number of typists and hand-writers undertaking each exam.

Table 3 e-Exam trials conducted across institutions and years

Instit'n	CQU	ECU	Monash	MQU	UniSA	UNSW	UQ	UTAS	Total
2016			3					2	5
2017	2	2	9	1	1	1	2	1	19
2018	1		6		1		2	1	11
<b>Total</b>	<b>3</b>	<b>2</b>	<b>18</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>35</b>

Participation across the 35 trials consisted of over 1700 students typing their exams with 1300 electing to hand-write their exam (where a choice was provided). Exams ranged from 15 minutes to 180 minutes in duration and ranged in weighting from 5 per cent to 50 per cent of the course grade. These figures are summarised in Table 4.

Table 4 e-Exam summary statistics

Exams	Typists	Pen on paper	Weight	Minutes
Sum	1750	1309	~	4145
Mean	40	37	32%	106
Smallest	1	~	5%	15
Largest	166	~	50%	180

## 3.2 Student perspectives

Student survey results have shown positive feedback from student users with ratings of 4+ out of 5 across most user acceptance measures. When asked in post-exam surveys if students would recommend the e-Exam system to others, a large majority were in agreement with 90 per cent saying they would use it without concern and 70 per cent positively endorsing the e-exam approach (see Figure 6, left).

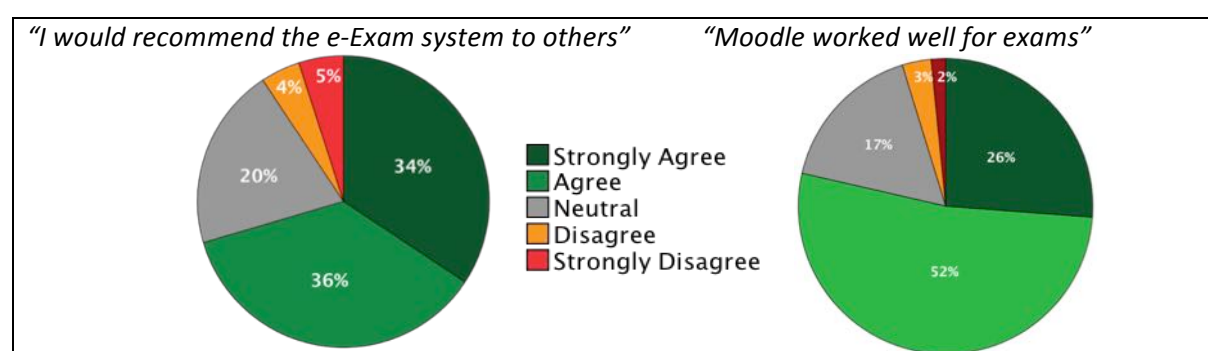


Figure 6 Aggregated student feedback on the e-Exam system

The recent trials also asked for opinions of the use of the Moodle LMS as an exam environment—most reported a positive experience (see Figure 6, right). Students who participated in recent 'robust' Moodle e-exam trials in semesters 1 and 2 2018 provided responses to a series of surveys where a practice session and three exam events were run in each course. This series is presented in Figure 7 with further findings in Hillier, Grant and Coleman (2018). Additional reports of e-exam trials include Hillier (2015), Hillier and Grant (2018), Hillier and Lyon (2018b) and Pagram, Cooper, Jin and Campbell (2018).

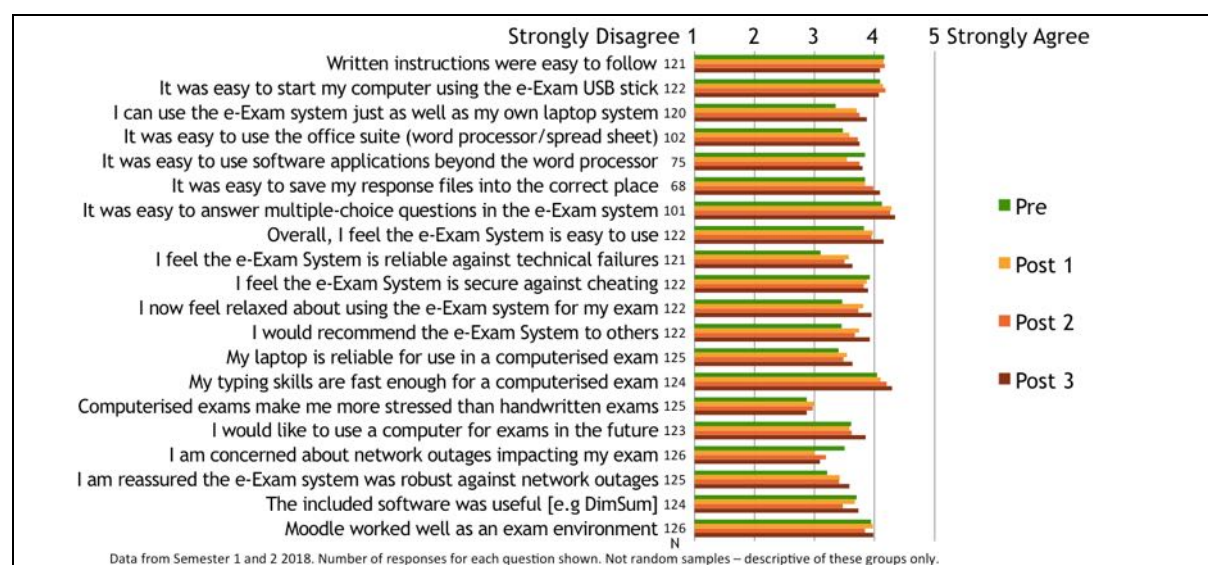


Figure 7 Student survey responses following robust Moodle exams



A range of other issues were also put to students including assessment-writing strategies, habits and styles (see Hillier & Lyon, 2018a). When it came to writing in computerised exams the two issues most frequently raised by stakeholders were handwriting neatness and typing prowess, with the latter thought to be a potential source of disadvantage when adopting e-exams. As seen in Figure 8, students thought that messy handwriting was the more prevalent problem in comparison to the vast majority of students who felt their typing was speed was good enough for an e-exam.

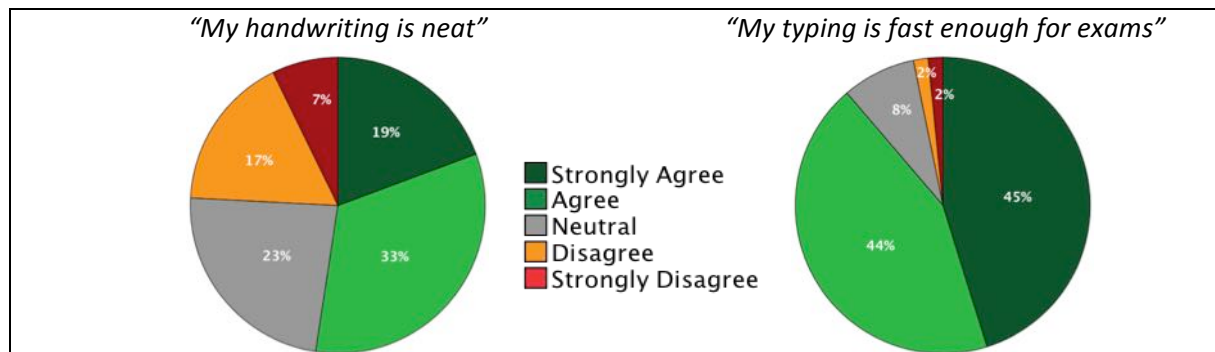


Figure 8 Handwriting neatness and typing prowess

### 3.3 Logistics findings

Our experience with running e-exam sessions raised a number of logistical matters that need attention. Feedback from students and academics, as well as practical experience from team members, provided indications of the variety of issues faced by institutions operating in very different contexts, including in-class, central exam halls, multi-campus and external venues. Many of the participating institutions were running a BYO laptop e-Exam for the first time and this is reflected to some degree in the feedback and in the mini cases of these trials (see section 3.4). The teams at Monash and UTas had prior experience of exams and their focus was on moving onward to use post-paper and networked exam modalities.

The most recent phase of work during 2018 demonstrated the robust nature of the technical approach used in this project for client-server computerised exams. We identified that online exams face a significant risk of failure if network connectivity is relied upon for the duration of the exam session (Hillier, Grant, & Coleman 2018). We have shown how the e-Exam platform addresses this risk with the ability to recover following system crashes and network outages without loss of student data and only minimal disruption to working time in the exam. The e-Exam platform allows work to continue in an exam even if the network connectivity is permanently lost in a session. This means that examinations need not be interrupted or rescheduled and timetables need not be disrupted.

The approach of using a 'BYO laptop first' approach to equipment provision has meant additional challenges than would have been the case if use were limited to institution-owned computers. The added complexity is due to the differing start-up steps required across different devices. This has been recognised with a recommendations to run practice sessions for students and the need to further develop support resources such as an online self-help service for individual users. Short 'Quick start' guides have been developed to advise users how to start their laptop with the e-Exam system. An additional 'Detailed start-up guide' was developed with in-depth instructions and troubleshooting advice for a wide range of hardware types. These are available from the project website.

A range of guidelines are recommended to minimise problems at venues used for practice sessions and exam events:

*Run pre-exam practice sessions to ensure students and staff are prepared.* Check each student has a compatible laptop, its battery life is sufficient for the planned exam duration and that the students are familiar with the procedures. Keep records to ensure exam events can be adequately provisioned with spare laptops, wired mice, power sockets, enough e-Exam USB sticks and spare Wi-Fi dongles (where online exams are to be run).

*When BYO laptops are used, expect to supply approximately 10 per cent of institution-owned computers in the early stages of e-exam use.* A computer lab may be set aside for this purpose or a trolley of laptops made available. Allowing students to book a loan laptop is a viable strategy, especially in the early stages of e-exam introduction or where larger cohorts of low SES students are present. A shift of responsibility can occur as cohorts become accustomed to equipment requirements (i.e. place responsibility on students to source an alternative working laptop). UTas has shown that moving to a pre-certification process (via help desk or self-check) and compatibility certificate is also possible with maturity of an e-exam program.

*Provide power sockets to reduce reliance on battery power*—ideally one socket per student, but this ratio may be reduced for shorter exams and where students have become more accustomed to the requirements of e-exam practice. Power extension cords and multi-outlet power boards can supplement supplies in spaces where installed sockets may be few in number. In exam halls with rows of desks it is recommended to reserve each second row for power supply cables to avoid tripping hazards while still allowing invigilator access to each student (see Figure 9, left). Surveys of 510 student participants conducted during project trials (2016–2018) asked for anecdotal reports regarding the battery life of their laptop from a full charge (See Figure 9, right). A mean of 4.9 hours was found; however, there was a wide range from zero to eight (plus) hours reported with a standard deviation of 2.2 hours. The data were abnormally distributed and this likely reflects the fact that students come along with old and new laptops to the exam in varying conditions. If we exclude new computers (the spike of 8+ hours) then the mean battery life is four hours. Those reporting low battery life of two hours or less accounted for 16 per cent of the group. It must also be noted that battery consumption can be higher when using the e-Exam USB system or Wi-Fi.

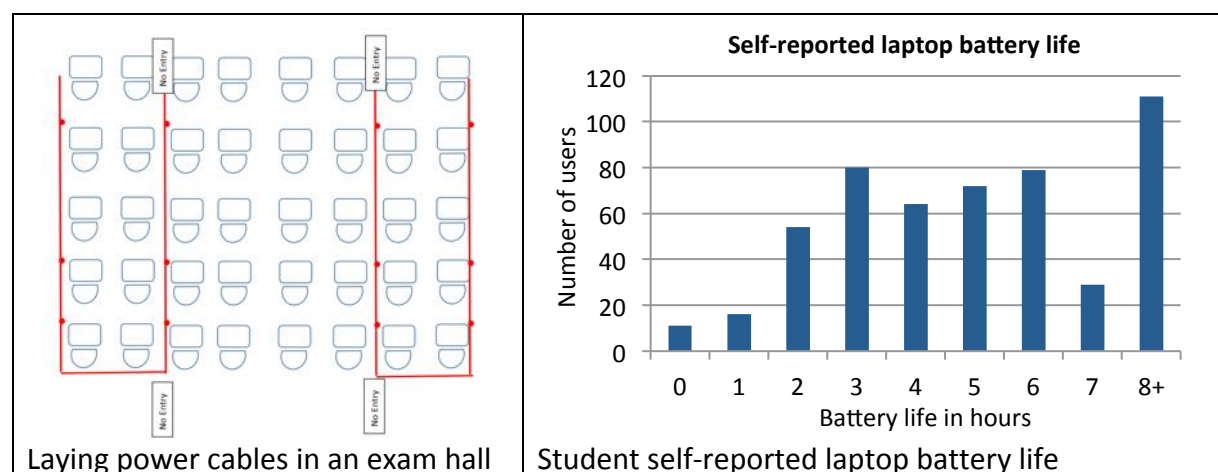


Figure 9 Power supply for e-Exams: laying cables and battery life

### *Rooms and seating arrangements:*

- Utilise flat floor rooms with chairs and tables
- Where group tables are used have students sit at 90 degrees to each other
- Possibility: add cardboard cross screens or dividers on tables
- Possibility: use random order for questions and distractors where available
- Where rows are used, seating all facing front > > > > are satisfactory or alternating face-to-face, back-to-back <><><><> may reduce the visibility of other's screens
- Avoid 'flappy chairs' due to them being unstable for laptops and provide insufficient space for laptops and other exam materials
- Avoid tightly packed tiered rooms due to restricted access to each student and the potential for seeing other's screens
- Prefer rooms with quiet acoustics—carpeted floors are recommended. Out of 1033 respondents, 51 per cent could hear typing, of those 28 per cent found it distracting (12 per cent of the whole group)
- Consider space to allow typists and hand-writers to sit separately
- It is important that room bookings are timely to ensure a suitable venue is secured.

*Good Wi-Fi or wired networking is needed when using networked e-exams.* However, if using the 'robust' e-exam system, network connectivity is most important at the start of the exam event and certainly convenient at the end of the event for response submission. The trials conducted at Monash University found Wi-Fi to be a viable option for BYO laptop-based exams. The Wi-Fi compatibility of laptops was found to be lower than for the e-Exam system in general. A set of USB Wi-Fi dongles (\$12 each from computer parts retailers) can be used to boost the stock of compatible laptops and are quick to deploy in the exam room.

*Multi-campus and external sites need extra precision.* Ensure adequate time is allowed for sending e-Exam USBs to other locations, that additional spare USBs are sent and that clear rules and communication channels are established. Trials at multi-campus institutions or at off-site locations experienced problems when these elements were neglected.

## **3.4 Mini cases**

A series of eight mini cases are available from the project website that represent the range of e-exam modalities that were undertaken. The cases include:

- Central Queensland University semester 1 2017: Paper-equivalent ICT management exam conducted at multiple centrally controlled on-campus venues.
- Edith Cowan University semester 1 2017: Paper-equivalent exam in design education and post-paper exam in programming education conducted in-class, on campus.
- Macquarie University semester 1 2017: Paper-equivalent ICT education exam.
- Monash University semester 1 2017: Paper-equivalent exam using a spreadsheet as a data collection form with 'air gap' separation of response collection and evaluation.
- Monash University semester 1 2018: Post-paper 'robust' online Moodle exams that were resistant to network outages. Moodle quiz including audio prompts.
- The University of Queensland semester 1 2017: Paper-equivalent French language translation exam conducted in-class, on campus.
- University of South Australia semester 1 2017: Paper-equivalent maths education theory exam conducted on campus.
- University of Tasmania semester 1 2017: Post-paper word document exams in ICT education conducted over multiple centrally controlled venues and distance centres.

## Chapter 4. Dissemination

A significant feature of this project was its strong dissemination strategy. The project leader and team members provided numerous presentations and conducted several workshops, both locally and internationally in conferences and other professional forums. These dissemination activities created awareness and generated interest from higher education organisations across Australia and other countries. The main dissemination strategies are outlined in the following sections.

### 4.1 Website and social media

A project website was established at <http://transformingexams.com> to provide public information and most of the project deliverables. It includes links to information, software downloads, documentation, presentations, publications and notifications for events. Over the life of the website it received 16,793 visitors and 37,478 page views were recorded at the home page. Visitors from Australia made up approximately one third of the audience. The top 10 countries are shown in Figure 10.

Social media such as LinkedIn, Twitter and Transforming Assessment email list were used to promote project events such as presentations, the roadshow workshops and e-Exam symposium.

Country	% Users
1. Australia	32.62%
2. United States	12.57%
3. France	6.85%
4. United Kingdom	5.03%
5. Brazil	4.80%
6. South Korea	3.75%
7. India	3.68%
8. China	2.55%
9. Germany	1.84%
10. Canada	1.61%

Figure 10 Website visitors by country

### 4.2 Presentations and publications

Formal outputs of research and project progress were disseminated via:

- over 60 presentations offered at conferences and as part of private briefing sessions at individual institutions
- a total of 15 refereed publications produced from 2015 to 2018. Further publications are being prepared by the project team
- additional informal posters, documents and diagrams were made available.

A full list of dissemination events and published outputs are listed at <http://transformingexams.com/research.html>

These outputs served to spread news about the project and disseminate findings from trials as the project progressed. This also provided opportunities for networking, gathering of interest project among colleagues and eliciting feedback to the project team on progress.

The wide reach of the presentations given by project members is demonstrated in the list of conferences where presentations were offered. These include: ACM International Computing Education Research (ICER) Conference 2016, Australian Council for Computers in Education 2016, Australian Government Office for Learning and Teaching Conference 2016, Australian Learning Analytics Summer Institute 2016, Australasian Society for Computers in Learning in Tertiary Education conference 2017 and 2018, Assessment integrity and the role of examinations 2017, Assessment in Higher Education conference 2017, EDTechPosium (ACT) 2017 and 2018, Examinations Network Conference 2017 and 2018, Higher Education Research and Development Society of Australasia 2015 and 2018, International Conference on e-Learning and Innovative Pedagogies Conference 2019, International Computing Education Research 2016, International Federation of Information Processing Open Conference for Computers in Education (Austria) 2018, International Federation of



Information Processing World Conference on Computers in Education (Ireland) 2017, Open and Distance Learning Association of Australia Biannual conference 2017, Tertiary Education Quality Standards Authority conference 2018 and MoodleMoot 2018.

### 4.3 e-Exam case studies

A series of eight mini case studies were developed to outline the characteristics and outcomes of selected e-exam trials conducted at different partner institutions. Each one-page case study showcases an e-exam using different a format including: offline word-processing document, spreadsheet as a form, computer programming and online LMS use. The cases can be obtained from the project website.

### 4.4 e-Exam workshops

e-Exams hands-on workshops were conducted for the higher education community and for project team members. These sessions were:

**17 February 2017:** 'e-Exam project partners workshop', held at Monash University, Caulfield campus, Melbourne. This private workshop provided an overview for project partners prior to running live trials at their sites.

**8 September 2017:** 'Running authentic e-exams workshop' at Examinations Network conference in Hobart. This public workshop focused on e-exam administration and logistics for exams officers at Australian universities.

**7 December 2017:** 'Transforming exams—How IT works for BYOD e-Exams', ASCILITE conference, Toowoomba. This public workshop provided an opportunity for some hands-on time with different types of assessments that are possible with e-Exams. The session targeted academics, learning designers and administrative staff.

### 4.5 e-Exam roadshow

A series of roadshow presentations and workshops were conducted in 2018 and were hosted by project partner institutions covering most capital cities in Australia. Sessions were free to the education community. Key teaching and learning leaders, academics and support staff were invited from local institutions within the host state. Invitations were issued to staff in universities, vocational education providers and state education authorities.

Each roadshow consisted of two one-hour sessions. The first session explored the rationale and surrounding issues for e-Exams. The second session explored practical applications of e-exams and included hands-on time. The project leader led the sessions and was often joined by members of the local project team at the host institution. An example program is below:

*1 hour: Part 1: Rationale for authentic e-Exams.* For leaders/decision makers, all welcome

- An argument for authentic e-Exams for employability.
- A business case for authentic e-Exams.
- Key findings on student feedback.
- Latest developments on 'robust' Moodle use (phase 3 development).

30 min. break. (catered food/drink).

*1 hour: Part 2: Exploring the details of e-Exams.*

- Workshop the findings on student feedback, logistics, examples of assessments.
- Workshop a selection of proposed project resources (e.g. sample case studies to influence decision makers).
- Time for practical 'hands-on' with our 'robust' Moodle e-Exam system.

The locations, dates and registration numbers for roadshow sessions were: Adelaide (31 August: 50 + 30 online), Brisbane (24 September: 27), Canberra (31 October: 29), Perth (17 September: 40), and Sydney (21 September: 23), Hobart (5 October: 20). The Adelaide session provided online access via live web video conferencing for the first session. The Hobart session was also broadcast via video conference to Launceston (Newnham), Burnie and Cradle Coast campuses of University of Tasmania.

## 4.6 e-Exams symposium

The e-Exam Symposium was organised by the project team and held on 24 November 2018 as a full-day event in Melbourne at Monash University, Caulfield campus. Key representatives from each Australian university, state education departments, medical colleges and other education organisations were invited. The nine speakers and 86 participants from Australia, Austria, Finland, New Zealand and Sweden represented 23 universities, two private providers, four professional medical colleges, four state government education departments (Victoria, New South Wales, Tasmania, Western Australia) and the Tertiary Education Quality and Standards Agency (TEQSA).

A series of plenary-style presentations, discussion sections and a practical hands-on session covered multiple aspects of implementing e-exams (see Figure 11). Two international guest speakers presented on the implementation of e-exams in their context using home-developed approaches and technology that focused on authentic e-assessment. This included computerised national matriculation exams in Finland and university examinations in Austria. The majority of project partners also presented or attended the event.



Figure 11 Photo: e-Exam symposium sessions 24 November 2018

The symposium program is outlined below.

Welcome: A rationale for a focus on authentic e-exams and program overview.

Session 1: The Austrian experience with e-Exams. Gabriele Frankl (Alpen-Adria Universität, Klagenfurt, Austria)

Session 2: The pedagogy of e-Exams—examples and transition. Mathew Hillier (Monash University), Matthew Bower (Macquarie University) and Andrew Fluck (University of Tasmania).

Session 3: Qualitative analysis, student concerns: the good the bad and the ugly. David Meacheam (University of New South Wales, Canberra/ADFA), Amy Hubbell (The University of Queensland) and Cristina Savin (Student, Monash University).

Session 4: A national roll out of e-exams for high stakes Matriculation. Thomas Vikberg (Finnish Matriculation Examination Board, Finland)

Session 5: Trade-offs, benefits and costs. Andrew Fluck (University of Tasmania) and Mathew Hillier (Monash University)

Session 6: e-Exams security and integrity. Michael Cowling and Kenneth Howah (Central Queensland University)

Session 7: Running e-Exams on campus and at a distance. Andrew Fluck (University of Tasmania) and Mathew Hillier (Monash University).

Session 8: Hands on! Technology for moving from paper to authentic e-assessment. Mathew Hillier (Monash University).

Session 9: An e-Exams Society? An open discussion on where to next for the e-Exams project. Mathew Hillier (Monash University) and Andrew Fluck (University of Tasmania) [Not recorded].

The symposium proceedings were video recorded and placed online with open access. An outline of each session (1 to 8), slide set, links and videos are available at:

[http://transformingassessment.com/e-exam\\_symposium\\_2018.php](http://transformingassessment.com/e-exam_symposium_2018.php)

## Chapter 5. Impact

The project has had a direct impact in terms of developing knowledge of e-exams implementation and the adoption of project deliverables in a small number of cases, but larger impacts may become evident in the future. It is still early days for the full impact of the project work to become apparent. The current state of impact as at the close of the project is outlined below. An annotated IMPEL framework is presented in Appendix D.

### 5.1 Changed practices

The project has had direct impact in terms of knowledge of participating academics that were engaged in the running of e-exam trials at their respective institutions. The outcomes varied according to context. Some academics continue to use e-Exam approaches developed as part of the project. These include at the University of Tasmania in education, at Monash University in languages and at the University of South Australia in mathematics education. In other cases, lessons learnt provided a valuable basis for future consideration of e-exams adoption in context. These outcomes were reported as part of the e-Exams symposium and via publications.

### 5.2 Other e-exam projects

The project team was consulted by other organisations in the Australian community on matters relating to e-exams. Projects or evaluations relating to e-exams at other universities and organisations were independently initiated, some of these only discovered after the fact. Often proponents found our publications, our project website or were told about our work via word of mouth. Examples include: UNSW Sydney where separate projects occurred in law and medicine. At UNSW Canberra who later joined the project formally and at UQ in medicine, who sought advice. At NAATI with whom a spin-off project was developed to integrate a multi-language capability. A commercial computerised testing vendor in the United States has sought consultancy and advice from the project leader. Additionally, a professional accounting body recently sought consultancy. We have also reached agreement to pilot 'robust' e-Exams with the LMS (Canvas) during 2019 of a state government education department.

### 5.3 Partnership with NAATI

A significant partnership was developed with the National Accreditation Authority for Translators and Interpreters (NAATI) in parallel with this project. NAATI commissioned work towards building additional multi-language capabilities into the e-Exam system to better cater for multi-language translation examinations. Preliminary rounds of live trials were conducted at Monash University in 2017 and 2018 covering a defined set of languages. At the time of writing, work is ongoing to further enhance e-Exam system capabilities. Lessons learnt from the application of e-Exams technology in the specific context of professional accreditation for language translators has already had a direct impact of how NAATI is considering the conduct of computerised exams in the future. A large, high-level impact could be expected in the area of language translator testing in Australia should the outcomes of this work be adapted by NAATI.

### 5.4 Potential joint venture partnership and commercialisation

Significant interest was garnered from several organisations outside of Australia with a view

to partnering in a joint venture or commercialisation arrangement. At the time of writing, two members of the project team are in discussion with an organisation from the European Union to partner in a joint venture with a view to commercialising elements of the technology and approaches developed as part of this project.

## **5.5 Further research and joint project work**

Significant interest was received from a state-level education authority regarding extending the 'robust' client-server aspect of the online e-exams technology for local use with their LMS (Canvas). A small feasibility study is underway at the time of writing with plans for a small-scale trial in mid-2019.

## Chapter 6. Project evaluation and lessons learnt

While the project was ultimately successful in achieving our aim of enabling authentic e-assessment in exam halls and classrooms, some areas of work were more challenging than first anticipated. Formal external project evaluation and internal deliberations highlighted successes, challenges and lessons learnt.

### 6.1 Project external evaluation

The project management team held meetings with the external evaluators who were briefed on the progress of the project. An arms-length final evaluation was also conducted. The external evaluations assisted in the learning and improvement of project processes and outcomes.

Two external evaluations were produced:

- I. A formative mid-project report was produced in 2017. This was formulated as a survey of stakeholder views by the external project evaluator. The report outlined points of success and issues for the project team to address going forward. Data were gathered via surveying and telephone interviews with project stakeholders. A summary of this formative external evaluation is included as Appendix E.
- II. A summative final report produced at the end of the project in 2019. Refer to Appendix F for the final evaluation report.

As the project progressed two main areas emerged that were different to initial expectations. The first of these was the nature of change needed in institutional policies and the other was in the details of the unexpected logistical challenges we faced.

### 6.2 Policy adjustment

One of the proposed deliverables from the project was to provide policy change recommendations. This was both easy and difficult at the same time.

First the easy part! Following a review of several institutions policies it was found that very little direct policy on examinations stood in the way of using computers in exams at most universities. Typically, current policies or procedures specifically related to the conduct of examinations had phrases such as 'No electronic devices are permitted in the examination venues'. Minor adjustments to policy wording can clear the way for computers to be used in exams. For example, rewording such phrases to: 'No *unauthorised* electronic devices are permitted in the examination venues' or '*Only specifically authorised* electronic devices are permitted in the examination venues'. It is then necessary to establish a process for authorising electronic devices. Once such example was developed at the University of Tasmania. A student self-help practice and laptop-testing process provided a 'compliance certificate' attesting to the student's success at starting and using the e-Exam USB system with the laptop. The compliance certificate is then shown by the student at the exam venue.

Institutions may be inclined to show active support for the use of computers in examinations through a form of official endorsement at senior levels. Examples include: the University of Tasmania senate passing a resolution to support the use of e-Exams. At The University of Queensland a motion was passed by the central assessment committee to support and place conditions around the trialling of e-Exams (since lifted). However, other institutions involved in the project have not seen it necessary to formally endorse or place



conditions on trials. In these cases, the ethics protocol and research subcontract was seen as adequate to frame participation in the project.

Difficulties arise, however, in creating the condition to support of broader adoption. More systemic policy and managerial attitudes were found to be significant in moving on from introduction of e-Exams at an institution to broader, centralised support. The policy landscape is interconnected and interdependent. This can support or detract from e-Exams implementation and use. Contextual policies, procedures and official endorsement is required to actively and systemically support the use of computers in exams at institutions. Examples include developing a 'BYOD strategy' to cover infrastructure (power, Wi-Fi and networking), an 'equipment equity program', 'equipment certification', additions to exam classifications, additions to permitted materials lists, new e-exam templates, development of support resources and help desks for students as well as professional development for academic and professional staff. Much of this valuable work, however, was beyond the scope and resources of the current project to address.

On a positive note for the future, it has become apparent that since the beginning of this project institutions have begun to develop broader 'digital learning' strategies that have encompassed e-exams or e-assessment implementation. An example of this is at Monash University where a 'Digital Learning Strategy' and roadmap was developed that included 'Authentic e-Assessment' as one of the target items alongside a 'BYOD strategy'.

### 6.3 Logistics and communications within partner institutions

The implementation of e-exam trials at partner institutions saw obstacles encountered that generally arose from the divergent objectives of individual groups within an organisation, as well as long chains of communication where key messages became lost or diluted. Examples of manifested problems that occurred at trial partners include (in no particular order):

*The central examinations office had its own survey for students.* This was the case at one partner institution that impacted a couple of trials run at that site. In previous trials at the same site the issue did not arise; however, the exams office themselves decided to evaluate e-exams and so they produced their own student survey, which demonstrated handwriting candidates adjacent to e-Exam candidates were unaffected. A lack of two-way communication resulted in confusion for staff in exam rooms that meant that our survey was not provided to students. This highlights a need for continued and close collaboration with exam venue operators for each trial instance. It cannot be assumed that because an arrangement was in place previously that it would continue in the following semester. Had better communication occurred it would have been possible to develop a combined instrument that would have served the needs of both parties. Fortunately, data were successfully collected during the majority of the trials.

*Low student survey response rates at some venues,* often due to delayed survey availability to students. In some cases surveys were not administered to students immediately following exam events and dramatically reduced response rates were experienced. It was recommended that the survey be handed to each student at the time they completed the assessment (i.e. in the exam room itself). This needed to be arranged with the group running the exam venue (e.g. examinations office) and for them to collaborate with the process, such as to provide an announcement at the end of the exam to complete the survey form and allow a member of the project team to be on-site, if possible, to distribute and collect survey forms.

*Equipment provision and backup.* BYOD was found to be a successful equipment provision strategy but it was not without its problems. Using self-certification of laptops and pre-exam practice sessions is highly recommended to facilitate preparedness of students for BYOD e-exams. In the early phases of implementing e-exams there is likely to be a heightened need to provide spare or backup laptops, with users in need best identified via practice sessions. Hardware compatibility was found to be an issue in 10 to 20 per cent of cases. Similarly, provision of electricity sockets to each student is recommended; however, the ratios of power and backup laptops may be relaxed as students become accustomed to needing a reliable laptop for exams. Most practical issues encountered in exam rooms during the early stages of e-Exam use can be greatly alleviated by providing backup equipment, power and enforcing practice session attendance.

*Provision of spare laptops at remote exam centres.* Some institutions found it difficult due to resources not being allocated or undesirable to provide backup and on-site support were multiple venues or external exam centres were used. At one institution, an e-exam was offered in distance mode at an off-campus external exam centre (e.g. another university by agreement or some other premises by arrangement), however, no arrangement was put in place for the provision of spare laptops. This was exacerbated because no pre-exam practice or system checks were conducted. This resulted in some students needing to revert to paper-based exams on the day of the exam. It is acknowledged that it is a logistically difficult issue to overcome, however, it is something that must be addressed if e-exams are to be widely available.

*Expectations about technical maturity.* The need for guidance and documentation for all users was highlighted (students, teachers and exam venue staff). During the project the e-Exam system was still undergoing active development where iterative improvements to the system were being made following each trial. These circumstances meant that those trialling the system for the first time were more likely to encounter problems that had not yet been encountered by others. Furthermore, local or institutional technical support varied meaning that those who were leading trials had to be substantially self-reliant, beyond what would be expected if the e-Exam system were to be an institutionally supported tool. Although all partners were clearly made aware of these circumstances, issues tended to arise where technology skills or local support was lacking or where stakeholders sought to compare a research project to that of a mature product backed by a full service support contract. Where these circumstances prevailed this tended to result in a degree of disappointment. Supportive elements, such as ongoing refinement of the user documentation, was undertaken to match changes in software and hardware capabilities but the iterative nature of the development, limited project resources and the timing of individual trials did not always result in alignment. Further work is also needed to address the wishes and needs of users. There is also a word of caution in the selection of early trial partners who need a high degree of resilience in tackling the unknown in new contexts. The good news is that for those who were persistent, good outcomes were achieved!



## Chapter 7. Conclusion

This project had great success in demonstrating what robust, authentic digital assessment could be like. But the findings show our work is not yet complete—no technology development project is ever complete! Further technical work is required to improve the e-Exam technology platform, its integration with other systems and its administrative support tools. While we have laid the groundwork and have already achieved much on the pedagogical front, more remains to be done to enhance the scalability and efficiency of the approach. Further investigation and investment is required to ensure systemic support mechanisms can be developed to scale digital assessment at higher education institutions. Further work is needed on refining processes, professional development capabilities, student support, alignment of various institutional learning and technology strategies and policy; as well as enhancing technology infrastructure to cope with the higher demands of time-limited, higher stakes authentic e-assessment. Finland has demonstrated the potential of a national approach—this may also be required in Australia. Tapping into international and cross-sector collaboration involving schools, vocational education, professional learning and international higher education settings will enable further leveraging of the lessons learnt in this project, as well as learning from other's success in deploying digital assessment.

Looking to the future, there is much potential to leverage developments in fields such as learning analytics, open knowledge systems, mixed media technologies or using blockchain technology to enhance security and audit capabilities in e-Exams. While these are relatively underexploited areas they hold great promise, particularly if the integrated, open architecture advocated in our approach to the e-Exam platform can become more widespread. However, Australian higher education is now at a cross roads with significant risks for institutions in how they transition to a greater use of digital assessment. One such example is the use of managerialist technology selection approaches that tend to discount pedagogical affordances for what appear to be quick and easy-to-manage solutions. Similarly, a decision to outsource assessment systems presents real strategic risk that institutions could lose hold of the assessment process to external interests, as has been the case in research publishing and learning content. Assessment is one of the jewels in the crown of learning and teaching that institutions still hold within their grasp and is arguably the most valuable element in the student learning landscape. Institutions would do well to consider very carefully the strategy they adopt in moving to digitising assessment. If the true value and benefits of digital assessment are to be realised, institutions must take back ownership of their educational technology infrastructure and reinvest in more home-grown development and innovation, just as they do in the discipline-based research domain. We urge Australian higher education institutions to stake an invested claim in digital learning and assessment because that will go a long way to securing the future of education for their students, staff and wider society.

The project generated findings on e-Exam system design and use, exam management and logistics, students' perspectives on e-Exams and on their response strategies. These findings equip teachers, assessment developers, technology support, examinations managers and institutional leadership to make informed decisions in matters of policy, practical implementation and transformational pedagogic design. This will enable institutions to deliver rich, relevant, assessment fit for learning and teaching in the 21st century.

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# Appendix A Certification

## *Certification by Deputy Vice-Chancellor (or equivalent)*

I certify that all parts of the final report for this OLT grant provide an accurate representation of the implementation, impact and findings of the project, and that the report is of publishable quality.



Name: Professor Susan Elliott,  
Position title: Deputy Vice-Chancellor and Vice-President (Education) Monash University  
Date: 24 May 2018

## Appendix B Project deliverable details

Discussion points comparing the originally proposed project deliverables and the actual project deliverable outputs are outlined in the table below.

Original deliverable	Delivered output
e-Exams technical infrastructure: developed to facilitate an electronic workflow including: Set-up templates for academics to create exams, set-up tools for students, exam submission server to receive exams from academics, production/retrieval infrastructure for managing the e-exams client USBs, electronic reticulation of responses via networks (possibly wireless), electronic distribution of student responses to markers in formats conducive to e-marking (includes collation of student responses into class groups and merger of Moodle databases to enable computerised marking). However the scope currently excludes the facilities for electronic marking itself.	Delivered. A robust e-Exam platform was developed and used in 35 live exam events. It supports BYO laptop to Moodle server e-exams that are resistant to network outages, even over Wi-Fi connections. Computer based marking utilised Moodle questions while e-submission of complex constructed response files were achieved by using a file attachment to a Moodle quiz question. The originally intended on-board LMS model evolved to use a client-server model due to the relative ease of implementing it as working system. However live networking also presented technical challenges with respect to network outage vulnerabilities during an exam event. These were solved by the project team's e-Exam platform.
Good practice guides: for students, academics, exams office (admin procedures, room setup and invigilation) and IT support personnel. This builds on the seed grant draft versions of some of these guides but adds further guides for academics and exams office functions.	Alternative delivered. These evolved into a set of user guides for students, teachers, examinations officers and technical administration. These were made available via the project website.
A draft set of assessment/exams policy recommendations for institutions: These will be in the form of a set of principles for writing policies with accompanying examples rather than specific fully written policies as it is expected institutions will want to write their own.	Alternative delivered. Following analysis of a sample of assessment policies at higher education institutions it was found that very little change was required to exiting policies. Simple word changes would normally suffice to enable e-assessments to occur. See section 6.1. for a discussion and recommendations for e-Exams to be systematically supported by contextual enabling policies.

Original deliverable	Delivered output
A set of example e-exam templates and questions: This will leverage and adapt where suitable the 'Transforming Assessment' online e-assessment exemplars (Crisp's ALTC fellowship, Hillier's 2014 OLT Extension grant). This will build on example 'paper-equivalent' question formats developed during the seed grant and add further examples gathered from partner institutions.	Delivered. There were 35 trials conducted across three modalities (paper-equivalent, post-paper and robust online) in a range of disciplines using word documents, spreadsheets and online Moodle quizzes. Exams included complex constructed responses such as computer programming files and edited language translation pieces. A prototype Augmented Reality e-Exam was also developed (yet to be trialled). A set of eight mini cases were developed to highlight the different e-exam trials. Further details of each exam type are available from publications. These resources are available from the project website.
Research findings: The published results from trials completed at a multiple institutions that includes analysis of results of student experience.	Delivered. There were 15 referred publications and 60 presentations over the duration of the project. These publications included the results of student experience feedback. A full list is provided on the project website 'Research' section. Further publications are forthcoming.
Workshop materials to introduce academics to e-exams: to be offered at national T&L focused conferences such as HERDSA or ASCILITE in years two and three.	Delivered. Workshops delivered at conferences in 2017, in a national Roadshow for each capital city during 2018, the e-Exams Symposium held on 24 Nov 2018. Workshops are listed on the project website. Recordings on one roadshow session and all symposium presentations are available via the project website and on YouTube.
An 'e-exams foundation' draft terms of reference and a call for membership: The foundation is to provide for the long term technical support to maintain ICT infrastructure and provide licences to commercial service providers. The business and legal model will likely be based on the successful Moodle open source arrangements, which has produced a sustainable outcome for the long term support of that Australian innovation.	Alternative delivered. It became apparent that the sector was not in the financial or managerial position to support a new organisation. A plenary style discussion was held with the 86 attendees at e-Exam Symposium on 24 Nov 2018. This included representation from 23 universities. Whilst some interest was shown, on balance the project team concluded that the most likely way forward would be via joint venture with a European university or commercialisation. The project leadership is now pursuing these options.

## Appendix C e-Exam trial details

The table below displays all known trials conducted using the e-Exam platform to date. Trials conducted under the Innovation and Development project includes those since 2015. Prior work undertaken with predecessor versions of the e-Exam system are also included for completeness. Exam candidate counts are listed for typists and hand-writers where known.

Instit'n	Year	S	Course	Mode	Question Types	Weight	Time (mins)	Context	Typed	Hand	Total	Staff	Grant
CQU	2018	2	Ethics and Social Issues (IT) (COIT11223) TBC	Word doc	Short answer	50%	180	Out of class, central, multi campus, final exam	?	?	?	Michael Cowling	OLT ID
Monash	2018	2	Introduction to Chinese language (ATS1002-2002)	Moodle quiz, audio files	Short text, TF, MCQ, fill in blank. Plus listening test short response.	15%	60	In-class, mid semester exam (all type). 10 min listening test + 70 minute writing test.	74	0	74	Scott Grant	OLT ID
Monash	2018	2	Chinese online media (ATS3038)	Moodle quiz, Dimsum and Syng Chinese dictionary tools	Long text translation, short text, matching, fill in blank	15%	60	In-class, mid semester exam (all type). In-class 1 hour tests. 25% (12.5% x 2) Weeks 7 & 11. Final 2 hour exam 45%	22	0	22	Scott Grant	OLT ID
Monash	2018	2	Language Translation (AGP5048)	Word doc and multilingual. Spelling on.	Short text, long text	30%	180	In Class - 3hr.15min final exam + separate 14 NAATI students (total 48).	40	8	48	Shani Tobias	OLT ID
CQU		?	Ethics and Social Issues (IT) (COIT11223)	Word doc	Short answer	50%		Out of class, central, multi campus, final exam	115		115	Michael Cowling	OLT ID
UQ	2018	2	French language B (FREN3113)	Word doc	Long text	30%	120	In-class, School run, final exam, collaborative learning space	?	?	66	Amy Hubbell	OLT ID
UQ	2018	2	French language B (FREN3380)	Word doc	Long text	30%	120	In-class, School run, final exam, collaborative learning space	?	?	38	Amy Hubbell	OLT ID
UniSA	2018	1	Mathematics for Secondary Teaching 1 (EDUC 5184)	Word doc	Short Answer text responses Approx 600 words each	40%	120	In class	31	2		Ruth Geer, Bruce White	OLT ID
Monash	2018	1	Introduction to Chinese language (ATS1001-2001)	Moodle quiz, audio files	Short text, TF, MCQ, fill in blank. Plus listening test short response.	16%	80	In-class, mid semester exam (limited to 20 typing slots). 10 min listening test + 70 minute writing test.	14	Not Sev 110		Scott Grant	OLT ID



Instit'n	Year	S	Course	Mode	Question Types	Weight	Time (mins)	Context	Typed	Hand	Total	Staff	Grant
Monash	2018	1	Chinese online media (ATS3037)	Moodle quiz, Dimsum and Syng chinese dictionary tools	Long text translation, short text, matching, fill in blank	15%	70	In-class, mid semester exam	27	4		Scott Grant	OLT ID
Monash	2018	1	Language Translation (AGP5690). Practice Friday 25th May from 10 to 12noon + exam Tuesday 5th June from 9am to 1pm	Word doc and multilingual	Short text, long text	30%	180	In Class - final exam	26	5		Shani Tobias	OLT ID
UTAS	2018	1	Education Digital Technologies (ESH380)	Word doc.	Short text, long text, Scratch programming, software appraisal	47%	120	Final	125	20	145	Andrew Fluck	OLT ID
CQU	2017	2	Ethics and Social Issues (IT) (COIT11223)	Word doc, PDF, video file	Short answer	50%	180	Out of class, central, multi campus, final exam	123	0		Michael Cowling	OLT ID
ECU	2017	2	Teaching Introductory Computer Programming (CSE4102)	Word doc and Python IDE	Short text, long text, programming	15%	120	In-class, computer lab	8	0		Jeremy Pagram	OLT ID
ECU	2017	2	Materials Design and Technology OHS (DTE4271)	Word doc	Short text, long text, images	30%	90	In-class, computer lab	9	0		Jeremy Pagram	OLT ID
Monash	2017	2	Introductory Chinese language (ATS1002)	Spread sheet as form.	MCQ, T/F, fill in blank, short text	16%	70	Out of class, mid-sem	16	57		Scott Grant	OLT ID
Monash	2017	2	Language Translation (APG5048)	Word doc and multilingual	Short text, long text, editing task	20%	180	In-class, mid semester exam	23	8		Shani Tobias	OLT ID
Monash	2017	2	Language Translation (APG5048)	Word doc and multilingual	Short text, long text	30%	180	In-class, final exam, some sat as NAATI qualification exam	26	5		Shani Tobias	OLT ID
CQU	2017	1	Knowledge Management Principles (IT) (COIT12205)	Word doc	Short answer	50%	180	Out of class, central, exam hall/centres, multi campus, final exam	30	50		Rahat Hossain	OLT ID
Monash	2017	1	Business Statistics (EFT5900)	Word doc	MCQ, short text	5%	30	In-class test	20	Not surveyed		Charanjit Kaur	OLT ID



Instit'n	Year	S	Course	Mode	Question Types	Weight	Time (mins)	Context	Typed	Hand	Total	Staff	Grant
Monash	2017	1	Language Translation (APG5690)	Word doc and multilingual	Short text, long text	30%	180	In-class, final exam, some sat as NAATI qualification exam	31	17		Shani Tobias	OLT ID
Monash	2017	1	Globalisation x 4 classes (Monash college)	Word doc.	Short text, long text	10%	70	In-class test	40	42		Nathaniel Lyon	OLT ID
MqU	2017	1	ICT in Education (EDUC261)	Word doc	MCQ, extended essay	40%	80	Out of class, School run, final exam	17	181		Matthew Bower	OLT ID
UniSA	2017	1	Mathematics for Secondary Teaching (EDUC 5184)	Spread sheet	Formulae, calculation charts	40%	120	In-class, final exam (two sittings)	9	15		Ruth Geer, Bruce White	OLT ID
UNSW ADFA	2017	1	Air power (ZHSS2424)	Word doc	Short text, extended essay questions	35%	120	Out of class, School run, final exam	42	8		Andrew Gilbert	OLT ID
UQ	2017	1	French language translation (FREN3310)	Word doc	Long text	10%	50	In-class	16	2		Amy Hubbell	OLT ID
UTAS	2017	1	Education Digital Technologies (ESH380)	Word doc, media, Scratch	Short text, long text, programming	47%	120	Out of class, central, multi campus, final exam	88	3		Andrew Fluck	OLT ID
Monash	2016	2	Geography x 2 classes (Monash college)	Word doc	Single essay	10%	70	In-class	25	13		Nathaniel Lyon	OLT ID
Monash	2016	2	Language Translation (APG5048)	Word doc and multilingual	Short text, long text	Zero	45	In-class, mock exam	18	0		Shani Tobias	OLT ID
UTAS	2016	2	Education Foundations of Teaching (ESH102)	Mcqs, word doc	Short text, long text, programming	40%	120	Out of class, central, multi campus, final exam	83	3		Wendy Balassa	OLT ID
UTAS	2016	1	Education Digital Technologies (ESH380)	Word doc, media, Scratch, PDF, Windows software	Short text, long text, programming	47%	120	Out of class, centrally managed, multi campus, final exam	110	14		Andrew Fluck	OLT ID
UTAS	2015	1	Education Digital Technologies (ESH380)	Word doc, media, PDF, Scratch, Windows software	Short text, long text, programming	44%	120	In-class test eexam	110	7		Andrew Fluck	OLT ID
UQ	2015	1	Punishment and Society (CRIM2100)	Word doc	Long text	20%	90	In-class, mid semester exam (includes 20% typed essay section and 15% MCQ using bubble sheets).	4	33		Robin Fitzgerald	UQ TEL

Instit'n	Year	S	Course	Mode	Question Types	Weight	Time (mins)	Context	Typed	Hand	Total	Staff	Grant
UQ	2015	1	Research Processes (DENT4092)	Word doc	Table, short text	20%	60	In-class, mid semester exam	19	66		Arosha Weerakoon	UQ TEL
CQU	2014	2	Systems Analysis (COIT11226)	Word doc	Short answer	50%	180	Out of class, central, multi campus, final exam, opt-in	6	50		Michael Cowling	OLT Seed
UQ	2014	2	Zoology (BIOL2204). Biological Sciences	Word doc	MCQ, short text, diagram	20%	50	In-class, mid semester exam	10	81		David Booth,	OLT Seed
UQ	2014	2	Occupational Therapy for Children and Youth (OCTY7826)	Word doc	MCQ, case study, short text, long text, table, list fill	25%	100	In-class, mid semester exam	3	24		Liz Springfield	OLT Seed
UQ	2014	1	Physiotherapy Specialities Neurology (PHTY3140/7814) (multiple small groups of 12)	Word doc, video projection	Table, short text	15%	15	In-class, mid semester exam (groups of 12. Written 15% section done prior to 20% OSCE)	25	108		Katrina Williams	OLT Seed
UQ	2014	1	Animal and Veterinary Biology (ANIM1060)	Word doc, image	MCQ, short text, image identification	15%	45	In-class, final exam	5	109		Malcolm Jones	OLT Seed
UQ	2014	1	Punishment and Society (CRIM2100)	Word doc	Long text essay	10%	70	In-class, mid semester exam (time includes 10% typed essay section and 25% MCQ on paper).	17	50		Robin Fitzgerald	OLT Seed
UQ	2014	1	Animal Health Technology (VETS2001) (two groups: Internal, external)	Word doc, image	MCQ, T/F, short text, image identification, diagram labelling	15%	90	In-class, mid semester (internal and external groups done 2 weeks apart).	11	78		Rebekah Scotney	OLT Seed
UTAS	2014	1	Education: Digital Technologies (ESH380)	Word doc, media, PDF, Windows software	Short text, long text,	44%	120	Out of class, multi campus, centrally managed, final exam, multi-site	166	16		Andrew Fluck	OLT Seed
UTAS	2013	1	Education: Information and Communication Technology (ESH380)	Word doc, video, GIMP, PDF, Windows software	Short text, long text,	50%	120	Out of class, multi campus, centrally managed, final exam, multi-site	123	25		Andrew Fluck	UTAS TDG
UTAS	2012	3	Education: Information and Communication Technology (ESH380)	Word doc, PDF, Windows software	Short text, long text,	50%	120	Out of class, multi campus, centrally managed, final exam, multi-site	48	5		Andrew Fluck	UTAS TDG

Instit'n	Year	S	Course	Mode	Question Types	Weight	Time (mins)	Context	Typed	Hand	Total	Staff	Grant
UTAS	2012	1	Education: Information and Communication Technology (ESH380)	Word doc, PDF, Windows software, animated PPT with audio	Short text, long text,	50%	120	Out of class, multi campus, centrally managed, final exam, multi-site	88	1		Andrew Fluck	UTAS TDG
UTAS	2011	2	Law: Constitutional Law (LAW205)	Word doc	Short text, long text,	50%	120	Out of class, single campus, centrally managed, final exam	69	179		Michael Stokes	UTAS TDG
UTAS	2011	2	Law: Property Law B (LAW324)	Word doc	Short text, long text,	50%	120	Out of class, single campus, centrally managed, final exam	26	?		Lynden Griggs	UTAS TDG
UTAS	2011	2	Law: International Law (LAW631)	Word doc	Short text, long text,	50%	120	Out of class, single campus, centrally managed, final exam	1	?		Michael Tate	UTAS TDG
UTAS	2010	2	Arts: History - Atlantic Worlds 1450-1807 (HTA249/349)	Word doc	Short text, long text,	50%	120	Out of class, single campus, centrally managed, final exam	3	?		Tom Dunning	UTAS TDG
UTAS	2010	2	Education: Modes of curriculum Inquiry A (ICT and Design & Technology) [EPC353]	Word doc, video,PDF, Windows software, PPT with audio	Short text, long text,	25%	120	Out of class, single campus, centrally managed, final exam	69	4		Andrew Fluck	UTAS TDG

## Appendix D Updated Impact Matrix

The IMPEL matrix (shown on the following page) provides an estimate of anticipated changes outlined in the project proposal along with tags to indicate the status of each proposed impact point. These are: achieved, likely, possible, alternative (These are shown in capital letters in the table below). It should be noted that due to changes in the project focus or the environment some impact points are now considered unlikely, but in all such cases we foresee an alternative outcome being possible. The major areas where alternatives are possible include:

- a) The proposed e-Exams Foundation was thought unsuited to current sector conditions (financial and managerial) however an alternative outcome may be a joint venture or commercialisation arrangement.
- b) The adoption of project developed e-exam technologies. Given the apparent strategies and processes of Australian university management, the adoption of e-Exams at Australian institutions is more likely to be in the form of commercially available solutions rather than 'home grown innovations'. Unfortunately the commercial market has yet to be able to offer a solution with the extensive authentic e-assessment capabilities offered by the e-Exam platform developed in this project. This is in contrast to education organisations in regions such as Europe where a number of home grown e-exam approaches incorporating authentic e-assessment are being adopted with great success (See e-Exam Symposium sessions 1 and 4 for examples in Finland and Austria).

## Annotated IMPEL Matrix

	Anticipated changes at			
	Project completion	6 Months post	12 months post	24 months post
1. Team Members	ACHIEVED Team members knowledgeable about using e-exams to create post-paper examinations in their courses.	LIKELY Research and publications on e-exams findings from research project. Planning next research phase. Further invites to collaborate from institutions. Continued presentations given.	POSSIBLE Application underway for subsequent grant, fellowship (e.g. develop learning analytics tools and techniques to leverage e-exams data), or teaching award applications for team members.	POSSIBLE, ALTERNATIVE Research and practice into exams continues. Continued use in courses by project team members.
2. Immediate students	ACHIEVED Several groups of students under the instruction of team members experienced multiple e-exams.		POSSIBLE, ALTERNATIVE Larger numbers of students experiencing e-exams	
3. Spreading the word	ACHIEVED Website, practice guides, technical infrastructure released. Policy recommendations. Results from trials. Software distribution.	LIKELY Data packages / archives shared online for other researchers to access. Website lives on. Publications, presentations continue.	LIKELY Publications, presentations being cited.	
4. Narrow opportune adoption	ACHIEVED Several courses employing the e-exams. 'Associate' partner institutions continue trials	POSSIBLE Institutions making contact to trial the e-exam system on a self-funded basis.		
5. Narrow systematic adoption	ALTERNATIVE e-exams Foundation initiated. Support partners interest start. Major stakeholder societies, HERDSA, ASCILITE, CADAD acknowledging value of the project.	POSSIBLE, ALTERNATIVE Ongoing data collection. Passive online survey for reporting use. Asking users what impact it had x months after. Core partner institutions 'officially' supporting e-exams.	POSSIBLE, ALTERNATIVE Foundation underway to continue the technical development with commercial technical support. First partners joined and paying contributions to the technical development.	
6. Broad opportune adoption	LIKELY, ALTERNATIVE Several institutions employing the e-exams.	LIKELY, ALTERNATIVE Consultancy service (by project team members) assisting institutions to start e-exams and customise to need.	POSSIBLE, ALTERNATIVE First commercial providers signed up to foundation and providing services to the higher education sector.	
7. Broad systematic adoption	LIKELY, ALTERNATIVE Policy 'shape' recommendations.	LIKELY Policy change considered by institutions beyond project core. Some institutions 'officially' supporting e-exams.	POSSIBLE Consultancy services offering pedagogical / technical e-exams process support.	POSSIBLE Policies adopted allowing e-exams in multiple institutions. More institutions 'officially' supporting e-exams.

# Appendix E Formative mid-project evaluation report

## The e-Exam system

It was the opinion of all project participants that the project has been highly successful in developing a suitable e-exam platform for BYOD supervised assessments. The platform has been found to work successfully on both Windows PC and Apple Macintosh laptops. Some participants noted that students are increasingly buying into the idea, with fewer students opting for handwritten submissions.

The guidelines have been seen to be useful, described as "excellent documentation for the technical aspects of USB production, answer-script collection and recycling."

Further that the project has been used as impetuous for a range of conceptual and technological developments: "Our participation in the trial precipitated unexpected demands from academics for e-assessments. We have serviced those demands by running very low tech e-assessments that have taught us a lot about what needs to be seen to in background, non-technical arrangements."

## Challenges and opportunities

All participants viewed the opportunities afforded by the potential of e-exams as outweighing the hindrances. Where challenges were noted, they were identified as areas that could be enhanced, rather than as rationale for discontinuing any further trials. Participants cited challenges with internal approvals and authorisations as hindrances with the project. An example of one such challenge was the experience in an earlier pilot project conducted in 2014 that saw too few USBs being provided, resulting in student complaints. This experience did provide a positive outcome in that, as a result, "better backup procedures for lack of USB or failure" have been developed and implemented in later trials conducted as part of this project.

In terms of the software, the limited graphics capability was identified as being problematic for some programming exams. Also seen to be problematic was the inability to limit access to particular websites. The thesaurus function within the e-exam system was noted as being particular useful in translation, and also acknowledged to be a hitherto unexplored resource. The potential to expand dictionaries to include both English and French was viewed as potentially beneficial.

## Project team

Overall, all participants were very pleased with the progress of the project and were all pleased with the service and responsiveness of the project team, finding their engagement with the team to be highly productive. "Technical support ran seamlessly in the practice exams and the actual trials. Vilma was very organised and kept us up to date and on time with various tasks throughout the trials. Mathew is extremely knowledgeable about the opportunities in the e-exam system and his background in preparing translation exams was useful for me." The helpfulness and positive responsiveness was cited as the reason behind the successful trials and implementation. Exchanges were noted to assist in developing "our understanding of not just the technical elements of e-exams but also the organisational elements."

## Conclusions and Recommendations

The project participants at 7 of the 9 partner institutions responding to the survey indicate that they are satisfied with the project progress. They are enthusiastic participants, seeking to continue their engagement for the successful outcomes and experiences for their



students. Reviewing engagement data in light of the survey responses, it is clear that the project is progressing as anticipated, and has a wider reach and level of engagement than previously anticipated.

Working with conservative institutional policies and academic and tutoring staff not yet convinced of the benefits of e-exam technologies will need to be considered in the future. It is also worth considering the use of other storage technologies as this technology continues to evolve as an over-dependence on USBs could be potentially limiting in the future.

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15 December 2017

# Appendix F Final external evaluation report

## EXTERNAL EVALUATION REPORT: TRANSFORMING EXAMS ACROSS AUSTRALIA

This final external evaluation report provides an overview of the outcomes from the Transforming Exams Across Australia project conducted between 2016 and 2019 and led by Dr Mathew Hillier.

### 1. EXTERNAL EVALUATION TEAM

The external evaluation was conducted by Deanne Gannaway and Karen Sheppard.

*Deanne Gannaway BA HDipEd (Wits), MEd (USQ). PhD (Flinders)*

Deanne Gannaway is a senior lecturer in the Institute for Teaching and Learning Innovation at the University of Queensland. Deanne's research interests focus on the development of educational evaluation and enhancement of higher education curriculum. Deanne is frequently called on to offer advice on appropriate evaluation approaches and methods for large scale teaching and learning projects and curriculum-based activities and has been commissioned as the external evaluator on a number of large scale ALTC/OLT -funded projects and fellowship programs.

*Karen Sheppard BA (UWA), Dip. Ed. (WACAE), M Ed (Professional Education and Training) (Deakin)*

Karen Sheppard is a learning designer in the Institute for Teaching and Learning Innovation at the University of Queensland.

Deanne and Karen have been actively involved in a number of national teaching and learning funded projects, including nationally funded evaluation of the dissemination strategies used in the Australian Learning and Teaching Council (ALTC) grants schemes: *A Review of the Dissemination Strategies used by Projects Funded by the ALTC Grants Scheme*. This project built on the research completed in 2004 for the nationally-focused, DEST funded research project on dissemination strategies for innovation project outcomes which directly influenced the grant schemes and processes developed by the ALTC.

This final report has been drafted by Dr Deanne Gannaway.

### 2. THE EVALUATION APPROACH

This external evaluation adopted the Key Evaluation Checklist approach (Scriven, 2007) to develop an analytical framework. This checklist has been used to evaluate programs, plans and policies and allows for a multi-layered mixed method mode of investigation. (Stufflebeam, 2001; Davidson, 2005; Scriven, 2007; Martz, 2010). The formative evaluation strategy directed by the checklist approach promoted by Scriven facilitates project team reflection, allowing for agile and responsive project progress rather than solely a summative measurement of project impact or attainment.

In keeping with the Scriven approach, the evaluation aims to ascertain the success of the project in relation to its vision, mission, goals, deliverables and plan, specifically, measurement and identification of:

- achievement of project goals, objectives and intended outcomes;
- whether needs of stakeholders such as students, staff, project participants and

- funding body are being met;
- relevance, appropriateness and quality of the chosen investigation and project management strategies used in the project;
- good practice and areas for improvement across the project life; and
- effectiveness of dissemination and take-up among stakeholders.

The formative evaluation approach adopted required a close working relationship between the project team and the external evaluation team in order to monitor and advise on the evaluation, dissemination, resourcing and investigation strategies adopted by the project team. This approach enabled the identification of good practice and areas for improvement across the life of the project and, most importantly, enables the project team to respond to the areas identified.

## EVALUATION QUESTIONS AND ACTIVITIES

The following data collection strategies were used to collect and analyse the required data against the relevant evaluation questions:

1. *Were project goals, objectives and intended outcomes achieved?*
  - a. Review of project activities conducted**  
Project deliverables are reviewed at regular intervals across the life of the project. The evaluation team is not a content expert and therefore not in a position to evaluate the accuracy or relevance of the resources developed. The external evaluation team acted as critical friends, providing formative input across the development processes.
  - b. Email survey of project partners**  
An email survey was conducted, targeting project participants who are also potential adopters of project outcomes. In acknowledgement of possible survey fatigue, rather than an online survey, a quick email-based survey was sent to participants. A copy of the questions is available as Appendix 1. The survey was sent to 15 individuals resulting in 7 responses, providing input from 7 of the 9 partner institutions. The timing of the survey meant that many of the potential participants were already on leave for the summer break.
  - c. Interviews with project team members**  
The project leader, project manager and the external evaluator have conducted regular “check-in” meetings to monitor project progression and to review project evaluation activities.
2. *How relevant and appropriate were the chosen project plans, activities and strategies for achieving the project aims?*
  - a. Monitoring project progress**  
Progress reports were reviewed and feedback given. Project plans were discussed during the evaluation meetings and project time lines reviewed.
  - b. Review of evaluation data collected**  
Evaluation activities conducted by the project team were reviewed by the evaluation team to ensure the veracity of project findings and conclusions.
3. *Were anticipated project outcomes met?*

**a. Review of materials developed**

Web-based materials and other resources developed as deliverables from the project were reviewed and feedback provided in meetings with the project core team.

**b. Observation of project activities**

Karen Sheppard attended and participated in some of the national symposia, collecting observational data and commentary from other participants.

**Evaluation Outcomes**

**1) To what extent did the project meet and/or exceed its objectives?**

The original project aims were:

1. Building an e-exam platform to be used in supervised, 'bring your own device' (BYOD) settings that includes computer marked questions and electronic reticulation of student responses.
2. Developing guidelines to assist students, educators and administrators to effectively prepare and undertake e-exams taking into consideration the whole assessment workflow.

A total of 35 trials were conducted across eight institutions from 2016 to 2018 with participation from over 1700 students. Students were able to opt into the trials. Project participants regularly commented that, in their opinion, the project has been highly successful in developing a suitable e-exam platform for BYOD supervised assessments. The platform has been found to work successfully on both Windows PC and Apple Macintosh laptops. Some participants noted that students are increasingly buying into the idea, with fewer students opting for handwritten submissions.

The guidelines have been seen to be useful, described as *“excellent documentation for the technical aspects of USB production, answer-script collection and recycling.”*

Possibly more importantly, the project has been used as impetuous for a range of conceptual and technological developments: *“Our participation in the trial precipitated unexpected demands from academics for e-assessments. We have serviced those demands by running very low-tech e-assessments that have taught us a lot about what needs to be seen to in background, non-technical arrangements.”*

**2) How relevant and appropriate were the chosen plans, activities and strategies for achieving the project aims?**

Overall, participants indicated that they were pleased with the progress of the project and were all pleased with the service and responsiveness of the project team, finding their engagement with the team to be highly productive. Project partners unanimously agreed that the project leader and project manager were highly effective, accessible and knowledgeable, facilitating changes in assessment policy and practice and opening up institutional conversations that potentially lead to assessment transformation in the future.

*“Technical support ran seamlessly in the practice exams and the actual trials. Vilma was very organised and kept us up to date and on time with various tasks throughout the trials. Mathew is extremely knowledgeable about the opportunities in the e-exam system and his background in preparing translation exams was useful for me.”*

The helpfulness and positive responsiveness of the project team was frequently cited as the

reason behind the successful trials and implementation. Exchanges were noted to assist in developing *“our understanding of not just the technical elements of e-exams but also the organisational elements.”*

The project participants at 7 of the 9 partner institutions responding to the survey indicate that they are satisfied with the project progress. They are enthusiastic participants, seeking to continue their engagement for the successful outcomes and experiences for their students. There were no negative responses to any of the questions, but some suggestions for future improvements were offered.

Reviewing engagement data in light of the survey responses, it is clear that the project has had a wider reach and level of engagement than previously anticipated.

Participants cited challenges with internal approvals and authorisations as hindrances with the project. An example of one such challenge was the experience in an earlier pilot project conducted in 2014 that saw too few USBs being provided by the institution’s central exams office, resulting in student complaints. This experience did provide a positive outcome in that, as a result, *“better backup procedures for USB lack or failure”* have been developed and implemented at this institution which in later trials conducted as part of this project. Other examples include institutional policy decisions capping the weighting of assessment allowed to be included in such trials, limiting engagement. Other hindrances identified include infrastructure limitations, such as shortages in the numbers of power points available; the potential for some students’ computers to not be compatible. *The fact that the current system doesn't work on all machines (particularly more modern machines) and involves the time-consuming and technically difficult use of USB sticks, is a problem. I am looking forward to future versions of the system that tie in with Moodle as a more efficient way of managing exams.* The changing nature of storage technology and the need to move beyond USB in the future was noted as a potential future direction. Another potential hindrance was the negative response evident in teaching team members outside of the project partners. Some partners described the challenges of convincing tutors and academics not familiar with the software, including having to print student work so that they could be marked as a paper-based artefact. This challenge suggests that there is still more work to be done in terms of refining the messaging and information provided to stakeholders and potential users.

In terms of the software, the limited graphics capability was identified in the interim report as being problematic for some programming exams. Also seen to be problematic was the inability to limit access to particular websites. The thesaurus function within the e-exam system was noted as being particularly useful in translation, and also acknowledged to be a hitherto unexplored resource. The potential to expand dictionaries to include both English and French was viewed as potentially beneficial.

Participants noted the need to monitor the evolution of storage technologies in the future as an over-dependence on USBs could be potentially limiting in the future.

### **3) How effective are the chosen dissemination strategies?**

The Transforming exams across Australia website, roadshow workshops, conference presentations, journal publications and the e-Exam symposium all have served to raise awareness of the project deliverables and outcomes. However, working with conservative institutional policies and academic and tutoring staff not yet convinced of the benefits of e-

exam technologies is a fundamental hindrance to transformation of practice and further spread of innovation. Participants in the dissemination activities have tended to be early adopters or those already convinced that this is a viable option. This project did not have enterprise cultural change as a fundamental aim, so the awareness raising dissemination strategies adopted are entirely appropriate. The adoption of the solution by agencies outside of the Australian university sector bodes well for ongoing collaborations and sustainability beyond the life of the project.

## CONCLUSIONS AND RECOMMENDATIONS

In sum, this project has met and exceeded its objectives. The e-exam solution uses all Moodle question types, and is moving towards more authentic assessment plus providing access to a range of software tools. A key benefit of the solution is the use of the BYOD over wifi or wired networks. Further, the comprehensive network outage protection means that student responses are fully cached and autosaved to local storage even if there is no network.

While the project has developed and tested a hardware and software solution, the most important contribution of the project has been the initiation of a national discussion. The project has ignited activities that have already seen further institution-wide initiatives (see [CMM](#) 17 June, 2019, for example). The project also leaves an important legacy in the form of the <http://transformingexams.com> website that is attracting ongoing international and national engagement.

The high-risk, high cost nature of implementing the technology is still a limiting factor of further adoption, despite increased desire on the part of institutional bodies to move into this space. The move towards more wide scale adoption requires a whole-of-institution commitment, that includes buy-in from academics, is embedded in policy, is trusted by students and has substantial resourcing allocated to ensure that the technology is embedded in a manner that is at an enterprise level. While these aspects were outside of the scope of this project, this project has shifted the sector towards such a future, by developing a working technology and an implementation framework. There is much more work to be done on a sector-wide level before we can see wider adoption. This project has left behind a fertile ground, ready for that work.

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## Final Evaluation report: APPENDIX 1

**From:** Deanne Gannaway [mailto:d.gannaway@uq.edu.au]

**Sent:** Tuesday, 5 December 2017 7:10 PM

**Cc:** Deanne Gannaway <d.gannaway@uq.edu.au>

**Subject:** External evaluation of e-Exams project

The e-Exams project funded by the OLT and led by Dr Mat Hillier is due for completion in December 2018. To date 22 test cases have been conducted across Australia, across multiple universities and over 1400 students have engaged with the tool. The software and associated processes are nearing finalisation, providing an opportune moment in time to take stock with collaborators and partners, so that any feedback can be incorporated into the final stages of the project.

A requirement of OLT funded projects is that the project is externally evaluated. I have been working with Dr Hillier in this capacity across the life of this project and am currently drafting the interim external evaluation report.

I am contacting you as you have been identified as either a user, collaborator or partner in this project. The external evaluation of this project would greatly benefit from your input regarding the following:

1. Your views on whether the materials developed achieve the project aims
2. Opportunities and hindrances you have experienced or envisage in implementing e-Exams into your assessment practice
3. Your experiences with engagement with the project team to ensure optimal trial experiences

A short response to one or both of the above via reply email would be most helpful. You are also welcome to provide commentary on any other aspect of the project deliverables or processes.

Your responses will remain confidential and you will not be identified in the report unless you specifically request to be so identified. The interim external evaluation report is publicly circulated only to the project leader and to the OLT. I can forward a copy of the external evaluation to you if you would like to see a final copy, with Dr Hillier's permission.

If you would be willing to respond, could you please do so by the 15<sup>th</sup> of December? Please do not hesitate to contact me with any questions or queries.

I look forward to hearing from you

Regards

Deanne