Developing secure online exam capability
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First published 2018 by Online Education Services Pty Ltd ("OES")
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Abstract

Online and blended education have seen significant growth in recent years. This growth has resulted in a number of products and services that can help an institution deliver various kinds of assessments online. One assessment type that remains difficult to translate into an online environment is the traditional closed-book, invigilated exam. While there are a number of vendors providing related solutions, an institution needs to build significant capability internally in order to work with technology vendors to successfully execute online exam pilots and transition to large-scale rollout. Based on experience working with technology vendors and university partners, we outline three high level dimensions of this organisational capability:

1. Assessment digitisation
2. Proctoring or Invigilation
3. Integrated Student Support

We also compare and contrast organising large scale geographically dispersed online exams and face-to-face exams from the point of view of security. If institutions proceed to develop the capability outlined and make considered security decisions, then online exams can offer a valuable complement to an institution’s assessment portfolio. Having developed and tested this capability, Online Education Services (OES) can work closely with partner institutions to help them fast track their own capability to meet the needs of their online learners.
Introduction

There has been significant growth in online and distance education in a number of countries. For example, in the USA, the proportion of higher education students undertaking at least one distance course has increased steadily from 25.9% in 2012 to 31.6% in 2016. In Australia, too, more than one-third of students are either ‘multi-modal’ or ‘external’, meaning that either some or all of their studies are off-campus. This growth has come with the opportunity to design and create more authentic assessments and has also raised the need for secure and user-friendly online assessments. Despite innovation in online assessment design, traditional exams continue to be required for certain courses by professional and academic accrediting bodies. These exams typically contain multiple choice questions, but can also include long form answers (e.g. business studies), sketching graphs (e.g. economics), writing equations and proofs (e.g. mathematics). Such exams have largely continued to be carried out in physical test centres, often relying on traditional paper booklets.

This approach suffers from a number of drawbacks, particularly for an online cohort, which is used to studying using sophisticated online tools and is geographically dispersed. These include, notably, the requirement for students to undertake significant travel to get to an exam location and getting students to engage in the exam in a format (pen and paper) that is completely at odds with how they have been studying and being assessed (online).

These drawbacks can potentially be overcome by enabling students to take exams online from a location of their choice, with exam conditions enforced by a combination of system features and human supervision. There are, in fact, a number of online assessment tools and online proctoring services available, making the selection of the appropriate tool set for an institution complex. However, developing the capability to successfully deliver secure online exams requires more than simply selecting the right tools. Based on experience working with university partners and technology vendors, our OES experts have identified three key dimensions that are recommended an institution develop iteratively to successfully pilot and scale up online exam capability. This paper also presents a security comparison between face-to-face and online exams that makes the case that online exams can provide a level of security that is comparable to (and in some aspects superior to) those of face-to-face exams.

1 | https://onlinelearningconsortium.org/read/grade-increase-tracking-distance-education-united-states/
Since 2014, OES has been piloting and scaling up the delivery of secure online exams. Beginning with a small pilot of fewer than 100 sessions, OES has gradually scaled up to delivering over 5,000 online exam sessions in 2017 in collaboration with a University partner and technology providers. Through this experience, we have learned that for an institution to be able to deliver secure online exams without compromising the user experience, capability needs to be developed across a number of dimensions.

Often a major concern for an institution embarking on this journey is security, and this is absolutely justified. However, the considerations of security are multi-faceted and need to be considered across the entire spectrum of the capability the institution desires (see Figure 1). We present a high-level discussion of these dimensions first, and then discuss security in the following section.

Figure 1: Dimensions of secure online exam capability
Assessment digitisation

Assessment digitisation refers to the capability to convert exam content (instructions, questions and supporting material such as formula sheets), which is typically available in a paper-friendly format, into an online format that is suitable for delivery to the target student cohort. A trivial example of this is the ability to translate an exam composed entirely of multiple choice questions that might be administered using pencil and paper into a multiple-choice quiz in a Learning Management System (LMS) such as Blackboard\(^1\) or Canvas\(^2\). As students have access to the LMS for their learning materials, they are also able to access the exam via this platform. A more complex example of this would be attempting to translate an exam that has significant choice built in, and requires complex responses. Consider for example an economics exam that has instructions like “Answer any 3 questions from part A and any 5 questions from part B” and that includes questions requiring students to sketch graphs and to tabulate numbers. This kind of exam format may not be directly supported by typical LMS functionality. In such cases, a specialised platform may be necessary. Examples of such platforms include Zoomorphix Systems’ Exam Studio\(^3\), Whitecloud Global’s ProTRACK\(^4\) and the Janison assessment platform\(^5\). Alternatively, equivalent assessment items (questions) may need to be devised that assess the pertinent learning objectives.

There are three aspects of this dimension to consider:

> **Authoring:** Multiple SMEs may need to collaborate to author and review robust items (questions and their answers) and to track the mapping of these items back to relevant learning objectives. While this aspect is required for face-to-face exams as well, it is important to consider here as specialised platforms for exam delivery include functionality to support this aspect.

> **Building:** This refers to ‘translating’ the questions (and associated meta-data if available) into the delivery platform (LMS or other). Naturally, this requires expertise in the platform itself. However, it also requires pedagogical knowledge and awareness of the student experience to determine whether the original item from a pen and paper exam will ‘work’ in the platform with a minor edit, or will require revision with a subject matter expert. There needs to be a process set up for the latter option, and availability of staff with the skillset to liaise with the subject matter expert to come up with the alternative item.

> **Delivery:** The ability to present the exam to the target student cohort and to capture the student responses in a way that is user-friendly. This includes the ability to grant alternative conditions e.g. extended time for specific students with accessibility accommodations.

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Remote Proctoring

Remote proctoring is the broad ability to supervise a student taking an exam in a location of their choice by connecting to their computer, viewing what happens on their screen and monitoring their activity via a web camera. There are specialist vendors providing this capability with two broad types of services: supervision of the test-taker in real-time (“live”) and review of a recording of the test-takers activities (“recorded”). Examples of live remote proctoring services include ProctorU, Examity’s Level 3: Live Proctoring and Kryterion’s Online Proctoring. PSI Software Secure’s Remote Proctor Now is arguably the most well-established example of a recorded remote proctoring service.

A high-level comparison between these two types of services is shown in Table 1.

<table>
<thead>
<tr>
<th>Live</th>
<th>Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Method:</strong> A live proctor authenticates the student via a webcam and presented identification papers. The students’ desktop and physical activity are monitored in real-time by a human via a webcam.</td>
<td><strong>Method:</strong> The student installs software that locks down their computer and records them presenting photoID to the camera, video of their desktop and the feed from their webcam. The recordings are subsequently reviewed by staff (often by the service provider but sometimes by supervisors from the institution) with suspected incidents flagged for review by nominated instructional staff.</td>
</tr>
<tr>
<td><strong>Approach:</strong> When it works well, this can be seen as a preventative approach i.e. test-takers can be warned in real-time regarding potential breaches of rules, or if major issues occur the institution can be alerted quickly.</td>
<td><strong>Approach:</strong> When it works well, this can be viewed as a punitive approach i.e. test-takers who have not followed the rules will be detected and face consequences.</td>
</tr>
<tr>
<td><strong>System resource requirements:</strong> Maintaining a live video link and remote desktop link requires significant Internet access and computer resources.</td>
<td><strong>System resource requirements:</strong> The student typically requires more modest Internet access and computer resources.</td>
</tr>
<tr>
<td><strong>Technical support:</strong> Ideally, technical support is available in real time via the proctor (or by escalation to a troubleshooter in a short period of time).</td>
<td><strong>Technical support:</strong> The vendor provides technical support if needed by the student, but arguably not as seamlessly as via access to the live proctor.</td>
</tr>
<tr>
<td><strong>Scheduling by the student:</strong> The student needs to book a specific exam start time with the vendor to be assured of the availability of a proctor to supervise their exam.</td>
<td><strong>Scheduling by the student:</strong> The student can take the exam at any time in the window permitted by the assessing institution.</td>
</tr>
<tr>
<td><strong>Scaling by the vendor:</strong> If the number of test-takers goes up significantly, the vendor needs to source and roster proctors accordingly.</td>
<td><strong>Scaling by the vendor:</strong> If the number of test-takers goes up significantly, the vendor can, to some extent, tolerate this by delaying the review period slightly.</td>
</tr>
</tbody>
</table>

Table 1: Live versus Recorded Remote Proctoring: Live is more system resource intensive and less flexible, but can be more supportive and preventative

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1 | [https://www.proctoru.com/](https://www.proctoru.com/)  
2 | [http://examity.com/level-3-2/](http://examity.com/level-3-2/)  
Depending on the institution’s student cohort characteristics, test-taker volume, specific security requirements, threshold for student experience and budget, one model may be more appropriate than the other, and a particular vendor might be more suitable than another. OES has piloted both models and continues to use live proctoring due to the preference for a preventative approach as well as the availability of the live proctor to provide support.

Student support

Students taking online exams will by default have access to a number of points of support, including support from the institution’s technical services, the LMS or assessment delivery platform’s user support service, their teaching staff, advisory staff and the remote proctoring service. However, this plethora of student support services can actually itself become a problem. A student experiencing an issue may find it difficult to decide who to contact or trigger multiple support requests leading to duplication and inconsistency. A poor experience in resolving a minor technical glitch has the potential to negatively impact a student’s satisfaction with and performance on the exam. Developing an integrated student support capability means establishing and maintaining support materials and channels for the students and staff involved, and iteratively refining them from one exam period to the next. The high-level steps to follow to develop this capability are shown in Figure 2.

“Developing an integrated student support capability means establishing and maintaining support materials and channels for the students and staff involved, and iteratively refining them from one exam period to the next.”
1. Anticipate common scenarios
   
   - Identify common support requests from vendors
   - Walk through processes with internal stakeholders

2. Establish support paths
   
   - For each scenario, establish decision makers and escalation paths across internal and vendor-based support channels
   - Have a mechanism to handle unforeseen requests that quickly escalates to a decision-maker with a high level of authority

3. Set up training
   
   - Set up student training resources such as webinars, practice environments, systems requirement tests, documentation, etc.
   - Carry out staff training and update staff reference materials and process maps

4. Learn from the exam period
   
   - Tabulate data on key metrics e.g. number of support requests, mean marks for students taking online versus face-to-face
   - Reflect on how students can best be supported for the subsequent exam period

Figure 2: Steps to develop integrated student support for online exams
### Security comparison between face-to-face and online exams

Having outlined the different dimensions of online exam capability, we can now discuss security implications. In order to do a like for like comparison, we consider the situation where a large number of students are undertaking exams at widely geographically dispersed locations. We assume that in this scenario it is likely that there are teams of staff required to work on authoring and marking the exams, who may in turn not be physically co-located. A comparison of remotely invigilated online exams with face-to-face exams in this scenario in terms of three commonly raised concerns is shown in Table 2: Security concerns compared across online and face-to-face exams.

<table>
<thead>
<tr>
<th>Concern</th>
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<th>Implications for development of online exam capability</th>
<th>Comparison with face-to-face exam equivalents</th>
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</thead>
</table>
| How do we make sure only the right people have access to the right exam materials at the right time? | Assessment digitisation /Remote proctoring | > Assess the exam delivery platform to be confident that it allows for sufficiently granular access control for different types of staff (e.g. item author, reviewer, exam builder, marker) to allow for rigorous and distributed authoring and review.  
> Identify the appropriate level of browser and system lock down needed to ensure students do not capture and share exam data.  
> Managing delivery to multiple disparate locations and ensuring that student work is safely captured can likely be done more securely in a robust online system than via pen and paper exams.  
> Timely and rigorous marking can be better facilitated for a distributed group of markers in an online exam delivery system. | > How do subject matter experts, review and author exams for face-to-face? Do they share documents and metadata via email/shared drive? How secure is this?  
> How do we ship physical exam booklets to exam venues across the globe? How are they protected at the exam venues prior to the exam period? How confident are we that all filled exams and blank exam booklets are either returned or destroyed?  
> How do multiple geographically distributed assessors manage the process of grading the exam booklets? How much shipping, photocopying, scanning and uploading is required for timely yet rigorous marking? |
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| Are test-takers supervised adequately and the exam conditions enforced consistently? | Remote proctoring/ Support             | > The remote proctor potentially has a limited field of view in terms of the students’ surroundings, but has a full view of what the student is working on. 
> The student to proctor ratio is typically quite high, leading to a high level of attention for each test-taker. 
> The students’ view of the proctor typically makes it apparent that the proctor is watching them closely. 
> The path and outcome for student requests for support and allowances made for technical issues are recorded and can be reviewed. | > The in-person invigilator has a good field of view overall but do they have a close view of what a particular student is doing at all times? 
> The student to proctor ratio can be relatively low, how much attention does each test-taker actually get? 
> Students are more aware of when the invigilators’ attention is likely focused on them, does this mean the invigilators are at a disadvantage? 
> Do incident reports from venues capture all incidents of interest and sufficient detail for each incident? |

| How do we know the test-taker is the student they claim to be?      | Remote proctoring                      | > The remote proctor views a photo ID through the students’ webcam and captures photographs of both the student and the ID for later auditing. 
> There may be additional challenge/authentication questions for the student. 
> There is potential to implement more biometric authentication measures such as keystroke recognition and fingerprint. | > The invigilator notionally verifies student ID, however depending on the invigilator to student ratio this may be brief. Is there an auditable trail of ID presented and verified? 
> Are there feasible opportunities for biometric or other authentication? |

Table 2: Security concerns compared across online and face-to-face exams

Running geographically dispersed exams securely both online and face-to-face requires careful analysis of risks and security measures. It is not the case that relying on pen and paper exams is perfectly risk-free. Equally, it is not the case that remotely proctored online exams are an automatic and instant remedy for all concerns with paper exams. However, Table 2 demonstrates that remotely proctored online exams can be secured to an extent that is comparable to, and in certain aspects arguably superior to, a feasible pen and paper alternative.
> Conclusion and recommendations

Institutions needing to administer high stakes exams for geographically dispersed cohorts of students (potentially at high volumes) can benefit from developing the capability necessary to deliver online exams. This paper provides a starting point to consider the capability holistically and to discuss how to develop it. Institutions may choose to develop secure online capability pragmatically (i.e. to better meet current or near-term needs) or strategically (i.e. in anticipation of future requirements). In either case, institutions should consider how they can find ways to leverage the potential of remotely proctored online exams to find the best possible balance between institutional requirements and student experience. This includes making informed decisions around the dimensions of the capability we describe with due consideration given to the security comparison we highlight. Working closely with a partner organisation that has experience across all dimensions of the capability can help institutions benefit from prior experience and shorten the time needed to mature the capability.
> About the author

Dr Samar Zutshi,  
Director of Innovation,  
Online Education Services

Samar was one of the two founding Program Directors in the academic leadership team when he joined OES in 2011. In this role he led the setup of academic processes and was responsible for governance of a suite of academic programs. He also played a significant role in a number of strategic projects, including the design of OES’ custom competency-based education platform ‘MyQuest’ and the selection of OES’ Learning Management System. He led the pilot program for enabling remotely-invigilated online exams. He subsequently served as the Director of Teaching, leading the remote teaching workforce. In his current role, Samar is responsible both for OES’ internal innovation work stream and for working with OES’ partners to realise joint innovation opportunities.

Prior to starting at OES, Samar was a lecturer in Information Systems at Swinburne University of Technology, where he was program coordinator for the online Bachelor of Technology (Information Systems). He has a PhD in Information Technology from Monash University, Melbourne, Australia.

> About Online Education Services (OES)

Online Education Services (OES) was established in 2011 by SEEK and Swinburne University of Technology to give people the opportunity to change their lives through online education.

OES is an online program management provider that partners with universities to deliver on-campus higher degree programs online, thus expanding educational opportunities to more people. It designs, promotes and delivers high quality programs online on behalf of its partners while universities remain responsible for curriculum assessment and quality assurance.

Rather than build an online capability internally, universities are increasingly turning to centres of excellence like OES to provide best practice in online learning to new cohorts of students who may be unable or prefer not to study on-campus or blended mode.

For further information please email enquiries@oes.com.
In education, technology can be a life-changer, a game changer. The Internet can connect students to their peers in other parts of the world. It can bridge the quality gaps. Queen Raina of Jordan...