Cloud Practical Exam Invigilation Control Systems with the Objective of Enhancing Quality Control for Online Exams

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Could Practical Exam Invigilation Control Systems with the Objective of Enhancing Quality Control for Online Exams

Volume 1 of 2

GORDON O'REILLY
CLOUD PRACTICAL EXAM

INVIGILATION CONTROL SYSTEMS
WITH THE OBJECTIVE OF
ENHANCING QUALITY CONTROL FOR
ONLINE EXAMS

VOLUME 1 OF 2

By
Gordon O’Reilly
Supervisor: John Creagh

Submitted to the Computer Science Department
Cork Institute of Technology
In fulfilment of the requirements for the degree of
Master of Science

MCOMS5001 Master of Computing

Submitted to Cork Institute of Technology June 2016
Declaration

This thesis is submitted in fulfilment of the requirements for the Degree of Master of Science in Cloud Computing at Cork Institute of Technology. It represents substantially the result of my own work except where explicitly indicated in the text. The thesis has not been submitted for an award at any other institution. The report may not be copied or distributed without the permission of the author.

Gordon O'Reilly

3 June 2016

John Creagh

3/6/16

Date

Date
CLOUD PRACTICAL EXAM INVIGILATION CONTROL SYSTEMS WITH THE OBJECTIVE OF ENHANCING QUALITY CONTROL FOR ONLINE EXAMS

By Gordon O’Reilly
Supervisor: John Creagh

Abstract

Online cloud computing courses are becoming more common place facilitating a student to study from home from anywhere in the world. Coupled with this trend is a need for educational institutions to facilitate students to take tests or exams online from home. It reduces the remote student’s time and cost of travel to an exam invigilation centre as well as reducing the educational institution’s test administration overhead. It does however introduce potential quality control concerns. A new industry called online proctoring has emerged that attempts to provide quality control in these online test scenarios.

This research provides an insight into the vendors and the mechanics of online proctoring. It also looks at why students cheat and whether cheating is more prevalent online. The research outlines how IT vendors, who offer online courses, test and mitigate the cheating threat in their certification programs.

Presenting online proctoring in a structured framework is the second theme in which a categorization of proctoring terminology is presented. Quality control considerations are researched. A CIT investigative case study on potential online proctoring solutions for a complex cloud based virtual hands on lab scenario is also considered.

Key words
Online proctoring, online testing, cloud computing, cloud based exams, online practical exams, categorization, framework, guidelines, decision tree.
Acknowledgements

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A special thanks too goes to my wife Pauline for all her support.
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<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
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<tr>
<td>ADF</td>
<td>Assessment directive form</td>
</tr>
<tr>
<td>AdobeConnect®</td>
<td>Software that enables live online conferencing for multiple users all over the world</td>
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<tr>
<td>BFCP</td>
<td>Brocade Fabric Certified Professional</td>
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<tr>
<td>Brocade</td>
<td>A data storage and networking vendor</td>
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<td>CCENT</td>
<td>Cisco Certified Entry Networking Technician</td>
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<td>CCIE</td>
<td>Cisco Certified Implementation Expert</td>
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<td>CCNP</td>
<td>Cisco Certified Networking Professional</td>
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<td>CISCO</td>
<td>A IT networking vendor</td>
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<td>CIT</td>
<td>Cork Institute of Technology</td>
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<td>DaaS</td>
<td>Desktop as a Service DaaS</td>
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<td>EMC</td>
<td>The largest data storage company worldwide</td>
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<td>FERPA</td>
<td>Family Educational Rights and Privacy Act</td>
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<td>HOL</td>
<td>Hands on lab</td>
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<td>IaaS</td>
<td>Infrastructure as a Service</td>
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<td>Institution</td>
<td>Means educational body or vendor that is conducting tests</td>
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<td>ITIL</td>
<td>Information Technology Infrastructure Library (Practices)</td>
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<td>LMS</td>
<td>Learning Management System like Blackboard</td>
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<td>MCQ</td>
<td>Multiple choice question</td>
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<td>Microsoft</td>
<td>A software company</td>
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<td>OS</td>
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<td>Subject matter expert</td>
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<td>Students</td>
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<td>URL</td>
<td>Uniform resource locator</td>
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<td>vAPP</td>
<td>VMware virtual appliance</td>
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<td>VMware Certified Associate</td>
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<td>VMware Certified Advanced Professional</td>
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Chapter 1: Introduction

This chapter introduces the research explaining why the research was conducted as well as the aims and objectives of the research. It also defines a number of key concepts that are used throughout this paper.

1.1 The context of the research and why it was started

This research was initiated because of a practical challenge that arose at Cork Institution of Technology (CIT), when the online MSc in cloud computing was implemented. What follows is an outline of the backdrop that lead to this research.

1.1.1 Contextual background to research

The MSc in Cloud computing is taught online to students all over the world using a tool called AdobeConnect ®. A module called Managing Virtual Environments (Horgan, 2015) is a 100% continuous assessment module with no end of semester written exams. Two thirds of the learning outcomes are measured using written assessments, which were handed in via Blackboard ®, the colleges learning management system (LMS). A third of the learning outcomes measures student’s practical hands on competency skills in implementing and configuring a representative virtual environment. This is done by providing the students access to a VMware vSphere ®, virtualization lab which the students are able to access online, from home.

The virtual lab is not a simulation but is VMware software running in a nested configuration and is representative of a real life deployment. The student’s competency, at the end of the semester, is measured on how this virtual lab is built. See sample of exam in Appendix V. The students have to show an understanding of the technology by configuring a lab provided to solve a number of use cases as set out in the exam.

Being a continuous assessment module, there are no end of semester exams for this module. Even if a practical exam were scheduled as part of the end of semester exams it would be very difficult to arrange an examination lab that could seat and scale to accommodate all the students, on campus. Furthermore, as the students are able to access the lab online, it was decided to explore new boundaries and facilitate an online practical test. This would allow the student to do the test, online, from home or in a
room at work, negating the need for the student physically travelling into the college to do the test.

Running an online exam in 2010 turned out to be completely unknown territory for the college with no known expertise on how to conduct an online exam while ensuring that the quality control standards measure up to traditional on campus exam standards. The CIT code of conduct exam guidelines apply to exams with face to face invigilation in an exam hall (Code of Conduct for Examination Candidates, 2015). Perceptions exist that there are potential quality control gaps in conducting an online exam from home, without the traditional invigilation controls. This research started out to investigate the feasibility of developing or leveraging an online invigilation control system, which would facilitate the student doing the online practical exam from home while maintaining quality control.

1.1.2 Research focus shift
The initial intention was to create a proof of concept online invigilation control system however while searching for tools to create such a system it was discovered that there are a number of companies who offer a solution called online proctoring (OLP). This changed the research and it was decided to investigate the capabilities of these OLP companies instead of attempting to develop a system from scratch. This turned out to be a very new area with a number of start-up companies providing this service.

The process of researching the OLP companies involved trawling these company’s websites and calling the sales and technical representatives to ask questions about the capabilities. Interviews were also conducted and a number of proof of concepts (POC) were conducted with the intention of discovering the most suitable OLP solution to fit the particular CIT online examination use case. The interviews and POC’s with these companies were done in the capacity as CIT adjunct lecturer. The reason for this is that when proctoring companies were called and it was indicated that research was being conducted, the reception to this was not very positive. Most of them indicated that they don’t have time. One can only surmise that they were concerned that their intellectual property would be comprised as this is a very competitive environment. On the contrary when they were approached under the auspices of a lecturer at CIT indicating that CIT was interested in running a proof of concept to conduct research and to decide on an
OLP company to partner with for CIT’s online exams, a very positive response was received.

1.2 The research objectives

The objective of the research is to first and foremost find a suitable online invigilation system suitable for the CIT online practical exam that would provide quality controls comparable to the traditional on campus invigilation. In so doing this would limit CIT’s exposure to cheating while the students do the exam online from home.

The research objectives are:

- **RObj1**: Outline a new OLP service industry and explore, discuss and explore potential quality control gaps in OLP solutions.

- **RObj2**: Provide a systematic review of OLP in the form of a categorization perspective.

- **RObj3**: Provide an unbiased, vendor neutral, insight into OLP.

1.2.1 Summative discussion of objectives:

An investigation into the many OLP options available with the intention to select a vendor can be fraught with challenges as quality control standards are not all the same. A particular vendor should only be used if their quality controls meet standards as set out by your institution’s examination bodies.

A systematic review will provide educational institutions and vendors a decision making framework. This will give guidance and fast track the investigation time by providing a generic guide that defines OLP terms and highlights key questions and decision making criterion that need to be considered when selecting an OLP solution to match a particular online exam type. It will highlight potential risks and determine what quality standards in a proctoring situation are reasonable and attainable.
1.3 Research Questions

The research questions are:

- **RQ1**: What solutions are available to facilitate online testing for complex practical exams like the CIT MSc Cloud practical exam?

- **RQ2**: What methods do vendors like Cisco and VMware use to ensure quality control in their complex practical exams?

- **RQ3**: Is cheating more prevalent in online testing?

- **RQ4**: What categories need to be considered in this new industry called OLP?

- **RQ5**: What are the guidelines for implementing OLP?

1.4 Summary

Online teaching is being adopted more and more within educational institutions and corporates. A trend that is following this is online testing, fostered by the rapid advances in technology (Gosh, 2015). Not having a bullet proof online testing program has the ability to ruin the reputation of a college or institution (Schulson, 2014). OLP is a new industry aimed at filling the need to ensure quality control in this area.

In the space of this research (3 years), the number of OLP companies has grown from 8 main players listed as OLP organizations (Foster & Layman, 2013), to the currently 14 worldwide at the time of writing. The techniques and technologies employed to improve OLP is also continually improving.
Chapter 2: Literature Review

This chapter outlines the growth in online education and the corresponding growth in online testing. It highlights the quality control concerns in this context of online testing. It reports on research done on the level of cheating in education and IT certifications. It also looks at research on why students cheat in exams and reviews studies to understand if cheating is more prevalent in online exams.

2.1 The growth of online education

Across the world universities and colleges online education strategies vary, however, what is apparent is that many universities and colleges now offer online courses and the number is growing. Research by Allen and Seaman (2013) indicated that 32 percent of higher education students in the United States now take at least one course online. A survey of Online Learning, conducted by the Babson Survey Research Group in 2014 revealed a 6.1% growth rate, the lowest for a decade but still representing over 400,000 additional students taking at least one course online (Allen & Seaman, 2014).

In a Forbes article, according to McCue (2015) the online learning industry in 2015 is going to be worth $107 Billion. The drivers for this industry are flexible schedules and lower tuition rates offered by the internet based programs ("Global E-Learning Market Outlook (2014-2022)", 2015).

2.2 The growth of online training in corporates

Not only is online education growing in the area of formal educational institutions like colleges and universities but also in the corporate world. Pappas (2015) indicates that online corporate training is expected to grow by 13% year on year to 2017 and that today 77% of USA Company’s offer online training to improve the professional development of their employees. In the case of VMware, one of the leading software virtualization companies, their technical support training worldwide in 2014 was 48% online and 52% in-classroom deliveries (Appendix W) and the expectation is that online training in 2016 will overtake in-classroom training. This is down to staffing and budget constraints and also - according to Yang (2012) - that a remote workforce is making online training a necessity. Online training also negates the need of having subject
matter expertise duplication in each geographical area and also cuts down the need for travel to facilitate face to face training.

2.3 Tests and testing methods

When it comes to testing students there are a number of methods that are deployed. Firstly, what is a test, or more specifically, what is an educational test? Simply put, an educational test is a formal attempt to determine a student's status with respect to specific variables, such as the student's knowledge, skills, and attitudes. The adjective "formal" in the previous sentence is important, because it distinguishes a test from the many casual judgments that teachers routinely make about their students (Popham, 2015).

In terms of testing methodologies and the corresponding quality control systems, these have evolved over time. The frame of reference being the traditional on-campus invigilation, where the teacher, lecturer or exam invigilator is present in a room or exam hall with students. They would check students' identity, either formally or informally, verify attendance, ensure exams start and end on time and monitor students to ensure they are doing their own work and abiding by exam quality control standards as set out by the institution.

Distance education as offered by the Open University was the next evolution within the teaching and formal examinations context. Testing methods evolved in parallel with the concept of distance education. Formal exams changed in the distance educational framework in that they also do not use the traditional on campus examination methods but rather rely on distributed examination centres. In the case of the Open University students can sit their exams at established examination centres, in the UK, the Republic of Ireland and in most countries in Continental Europe. These are typically a university or British Council office, near to the student that the Open University has established a formal agreement with to ensure exam quality control standards are adhered to ("Exams and assessment | The Open University", 2015). Utah State University refers to invigilators as proctors and in the context of distance education has what they call materials and testing services sites, to locate a certified proctor to invigilate an exam. Utah State University Online lists examples of acceptable proctors as; College or professional testing centre staff, Full-time school or public librarian, Military education
director, Embassy education officer but also lists not eligible candidates as relatives, co-workers and friends ("Proctored Testing", 2015).

Online education is the next metamorphosis of distance education. Just as testing services evolved in distance education to cater for the remote student, so they are evolving with online education.

Formal testing within the framework of online education, takes on a number of derivatives. Some colleges who offer online course still deploy the traditional examination methods. Colleges like CIT who offer online courses have formal end of semester written exams using the traditional exam hall examination methods where students who have taken the online course travel in to the college and sit the arranged exams on campus.

IT Vendors like Microsoft, Cisco and VMware also utilize exam centres run by a third party. For example to register for a Cisco computer based test exam the student has to contact Pearson VUE the authorized test delivery partner of Cisco who will administer a student exam in a secure, proctored environment ("Cisco Certification Exam Policies", 2016). Pearson VUE has test centres throughout the world offering testing services that range from American Academy of Implant Dentistry and Alaskan Nursing aids to tests for IT Companies like VMware. These tests could take the form of written or computer based exams ("Pearson VUE test center network", 2016).

2.4 Online testing, the new wave in online education

In the rise of online education with its flexible features, learning anywhere, anytime (Berkey & Halfond, 2015), educational institutions offering online courses facilitate students from across the world the opportunity to learn from home. Not only is the learning landscape changing, the examinations and testing scene is changing too. Education or corporate institutions that choose to offer an online course have further challenges around the assessment and exam strategy in this online context. The challenge is in the next wave of change which is facilitating students to take exams and tests from home in the environment they have studied and learned. As a result there are also now a host of new systems, tools and services available, called OLP that allows students to take exams from home. OLP aims to provide a secure and convenient way
2.5 Online proctoring, the race to preserve quality control in online testing

In online education when it comes to online exams, instructors, students and administrators want testing solutions that are easy to use, that don’t distract, that address credibility and cheating concerns effectively and at low cost (Berkey and Halfond, 2015).

Schulson (2014) says Doug Winneg CEO of SoftwareSecure suggests that, not having a water tight online exam and testing strategy, has the potential to ruin your college reputation. This is very concerning when one considers that Hartley, (2013) in an Eduventures paper states that 95% of online exams offered, are taken by the honour system and may explain why Prnewswire states that today’s job markets in America tend not to take the online degrees as seriously as their traditional counterparts. “One reason for this is the lack of faith in the integrity of online education, the examination process in particular” ("Voice Proctor Administers 20,000th Exam", 2014).

Research done by Harmon and Lambrinos (2008), investigated if online exams were an invitation to cheat in an economic test conducted in proctored and un-proctored online exam scenarios. This study’s results concluded that when students were not proctored, cheating was taking place. When doing remote OLP the challenge is students who use their own devices to write the exams could potentially be using technology that outsmarts the OLP mechanism as highlighted by Dawson (2015), who wrote a paper on “Five ways to hack and cheat with bring-your-own device electronic examinations.”

In an attempt to address this concern the US government amended the PUBLIC LAW 110–315 Higher Education (2008). HIGHER EDUCATION OPPORTUNITY ACT. United States Government Printing office, p.249. to state: “the agency or association requires an institution that offers distance education or correspondence education to have processes through which the institution establishes that the student who registers in

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1 The honour system is a way of running a test trusting the student’s honesty not to cheat.
a distance education or correspondence education course or program is the same student who participates in and completes the program and receives the academic credit."

It is against this backdrop that OLP companies are growing both in number and in capabilities. These companies claim that by providing an online invigilation service, it makes testing easier and more secure ("About Us - Online Proctoring - ProctorU", 2015). The question is how well do these OLP companies solve potential quality control gaps? What technologies do they implement and how do they stay abreast of technology advancements that students have access to? From an educational perspective the question is how does an education institution or corporate choose which OLP solution to implement?

OLP refers to monitoring an exam over the internet using amongst other technologies a webcam. It includes the processes and automation occurring at a distance for authenticating the examinee as the person taking the exam (Foster & Layman, 2013). OLP can use the remote student webcam, microphone and use biometric technologies like facial recognition, fingerprinting, network monitoring and browser lockdown.

### 2.6 Main online proctoring research contributors

In the field of OLP one of the main researching contributors whose name appears again and again in papers and research related to the field of study, but who is not embedded within one of the OLP companies and offers an unbiased perspective, is Dr David Foster. He is currently chairman and CEO of Caveon a test security company. He is a past President of the Association of Test Publishers (ATP). He has served on the certification accreditation committee and Board of Directors for the American National Standards Institute. He has participated on a number of technical advisory boards and committees for testing programs. Currently he sits on the council for the International Test Commission ("Caveon | Our Team |", 2015).

Then also outside of the OLP companies there is also the Babson Survey Research group ("About Us - Babson Survey Research Group", 2016) and online schools centre started by Linda Weems ("About Online Schools Center - Online Schools Center", 2015).
The online learning consortium is another body but is sponsored by Pearson one of the test centre service leaders and that also recently moved into the field of OLP.

2.7 Review of research on cheating in education

In a study done by Simkin and McLeod (2010) on why college students cheat, the study found that cheating in general could be described as rampant. A meta study by Whitley (1998) in Simkin and McLeod (2010) found that across 46 studies an average of 70.4% of the college students have cheated.

Research has also shown that college cheating in exams is growing. Ogilby (1995) in Simkin and McLeod (2010) found that self-reported cheating increased from 23% to 84% from 1940 to 1982.

The Times, Mostrous and Kenber (2016), reported that almost 50 000 students at British Universities have been caught cheating in the past three years amid fears of a plagiarism epidemic caused mostly by foreign students. It was reported in the same article that students outside of the EU were four times more likely to cheat. Queen Mary University of London indicated that 75% of postgraduates that plagiarised were from overseas with more than half from China. The BBC reported in a related article that freelance academic’s charge anything from £10 to £20 000 for coursework answers and dissertations and even an 80,000 word PhD (Morrison, 2016).

2.8 Review of research on cheating in IT exams

If one looks at the technology sector, vendors like Microsoft, VMware, Brocade and Cisco (to name but four) provide a variety of information technology exams such as Microsoft MCSE, VMware VCP, Brocade certified fabric professional (BFCP), Cisco, CCNA and CCNP. Online brain dump industries like Testking (www.testking.com) and Pass for Sure (www.passit4sure.com and www.passforsure.co.uk) have spring up. They specialize in delivering “mock exams” that most often exactly match the online multiple choice exam questions. This has caused the vendors to make the exams more difficult, generate a larger bank of questions and also move to hand on competency testing to work around this challenge and stem the prevalence of rote, off by heart, learning that the multiple choice Testking exams facilitate. These Testking questions are apparently captured by “students” who go into test centres and dump back the questions
on these sites. Experts then review this, answer the questions and the questions are packaged and sold via these online vendors. This in effect amounts to a student having the capability of knowing all the questions before going in to take the exam, in test centres like Pearsonvue.com (Williams, 2008).

In August 2006 Microsoft filed a law suit against Testking.com ("Microsoft Sues Test King!", 2006). According to an article that appeared in Redmondmag.com even though the parent company of Testking.com called certification Trendz is registered in the United Kingdom it was seemingly owned and operated by Shahzad Shahnawaz, based in Faisalabad, Pakistan (Nagel, 2006). The uncertainty over who owns Testking.com as well as opportunities for legal discovery - however difficult with a Pakistan-based company - may be why Microsoft filed the suit against “John Doe” instead of naming Shahnawaz, said Paul Lesko, head of patent and intellectual property litigation Simmons Cooper LLC. “It could be one of those things…at least it will keep it open to potentially conduct discovery [or see] if there are other names out there. If Microsoft cannot identify the owners, or if Testking chooses not to defend itself, Redmond could get a judgment in its favour fairly quickly - months versus years - as long as it proves its case”, Lesko said (Nagel, 2006).

In 2007 Microsoft obtained a permanent injunction against Certification Trends. The owners of Testking settled out of court and agreed to certain conditions proposed by Microsoft (Robart, 2016). According to Williams (2008) in a Networld.com article, it is easy to see that most of these conditions have been violated because we have seen actual test material on the sites that postdate the April 2007 injunction.

Another example of professional exam cheating is what Certguard, an organization founded in 2006, calls gunmen. These are hired professionals, that are paid to take exams for candidates who are too incompetent to pass the exams ("CertGuard | Gunmen", 2016).

Seeing as students’ cheating is rampant in the academic as well as IT sector, the next question is: what does research show as to the reasons why students cheat?
2.9 Review of research on why students cheat?

Deci and Ryan (2000) said that “cheating is not random, accidental or impulsive, but a premeditated, intentional, deliberate act that requires forethought and planning.”

Simkin and McLeod (2010) explained college cheating with the theory of reasoned action, lists a number of potential cheating motivators, namely: opportunity, the desire to succeed, non-existent penalties, the reluctance of college professors to pursue cheaters, the lack of what is defined as cheating and or the students moral code. In this study statistical findings reported it was students’ attitude to cheating and the subjective norm within that student society that were significant determinants of cheating.

However Simkin and McLeod (2010) also found that not all factors influence cheating equally. They found that the students desire to get ahead was the strongest motivator but that opportunity to cheat or time demands were not strong influencers. They also looked at what deters a student from cheating and identified only one statistically significant deterrent and that was moral beliefs. They also found a marginal influencer to their sample group as family. They also interestingly found that neither culture (the acceptability of cheating) nor risk (fear of penalties) in their group affected cheating behaviour. The same study also speculated that the absence of risk may be because students do not worry about getting caught perhaps because the risks of detection in that school were abnormally low or because the penalties were too mild.

A different perspective was provided by Salter, Guffey and McMillan (2001) who said that students’ propensity to cheat can be explained by 1. The perceived severity of the act 2. The degree of cynicism about the education process/life experiences and 3. Demographic and cultural issues.

The perceived severity of the act Salter et al (2001) can be related to student’s attitude to cheating and the subjective norm (Simkin and McLeod, 2010). The same study found that culture did not affect cheating whereas Salter et al (2001) found that culture had a big impact. They found that U.S students are more likely to cheat than their British counterparts. They also found that punishment and the threat of punishment is effective in the U.S but not in the U.K. They also found that “students within a more uncertainty
avoidance culture are more likely to cheat and will see the certainty of sanction as a guide to make decisions of an ethical nature.” They expressed concern that the issue of cheating is so serious for audit firms especially in global companies, that when adopting a clan solution the auditors need to be aware of the indigenous population.

2.10 A review of research on whether cheating online is more prevalent?

In a study by Harmon and Lambrinos (2008), investigating if online Economics exams are an invitation to cheat, they concluded that if the end of year exams were not proctored students were more likely to cheat. A later study by Harmon, Lambrinos and Buffolino (2010) uncovered six published empirical studies of cheating in online courses. The three studies examined the correlation of cheating with course format (online v face to face (f2f)) and three studies examine the correlation of cheating with assessment format (unproctored online v proctored). The results of the study are shown in the following two tables.

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stuber-McEwen et. al (2009)</td>
<td>225 students</td>
<td>cheating less frequent in online</td>
</tr>
<tr>
<td>Kennedy et. al (2000)</td>
<td>172 students</td>
<td>cheating more frequent in online</td>
</tr>
<tr>
<td>Grijalava et. al (2006)</td>
<td>800 students</td>
<td>cheating as frequent in online and f2f</td>
</tr>
</tbody>
</table>

*Table 1 Studies into Cheating (Harmon, Lambrinos and Buffolino, 2010)*

They also found that when considered collectively, cheating risk in online vs face to face testing was indeterminate.

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watson &amp; Sottile (2010)</td>
<td>635 students</td>
<td>cheating more frequent in unproctored online</td>
</tr>
<tr>
<td>Harmon and Lambrinos (2008)</td>
<td>60 students</td>
<td>cheating more frequent in unproctored online</td>
</tr>
<tr>
<td>Charlesworth et. al (2006)</td>
<td>175 students</td>
<td>40% say cheating more frequent in unproctored online, 40% say cheating as frequent in unproctored online and in proctored in-class</td>
</tr>
</tbody>
</table>

*Table 2 Studies on Cheating: Unproctored Online v Proctored in-Class (Harmon, Lambrinos and Buffolino, 2010)*
These studies concluded that there was a greater risk of cheating in un-proctored online exams than proctored in class multiple choice exams which matched their 2008 research.

A study by Boyd Davis, Rand and Seay (2016) on accounting students taking online exams supports these findings in a different way as the results were that students who were proctored during online exams scored lower than students who were not proctored suggesting that the use of proctoring services in online courses has the potential to enhance the integrity of online courses by reducing the opportunities for academic dishonesty during exams.

In a study done of 635 undergraduate and graduate students by the onlineschoolcentre.com reports that 33% of students admitted to cheating in online classes while 32% admitted to cheating in traditional classrooms ("About Online Schools Center - Online Schools Center", 2015). This supports the research done by Harmon et al (2010) that there is not much difference in cheating online vs cheating in traditional classrooms.

In a report by Littlefield (2014) on a distance learning website called about education, it reports that 72% of students reported cheating when taking online quizzes. One of the reasons was given as students not believing they can succeed honestly (Littlefield, 2014).

The same authors found in another case that received scrutiny was students who were also involved in athletics were encouraged by coaches to take online classes to get any easy grade, completing the online course in days and receiving A’s for their work (Littlefield, 2014).

In a study done on E-cheating “Incidence and trends amongst college students” by King and Case (2014), when surveying students about cheating in online exams 74% of students felt that it was either very easy or somewhat easy to cheat on an online exam. Only 7% reported that it would be difficult to cheat on said exams. This percentage increased substantially since 2009 when only 63% of students felt it was easy or somewhat easy to cheat on such exams. Similarly, roughly 29% of students taking an
online course in 2013 cheated on exams. On average, they committed this action 3.3 times during the course. King and Case (2014) suggested that with the increased number of online classes being offered, faculties must be aware of the increased potential for cheating in online exams.

For computer based exams where students bring their own device (BYOD) Dawson (2015) indicates that there are 5 ways in which students can cheat. These are copying contents to hard disk, using a virtual machine, USB and keyboard hacks, modifying software and a cold boot attack. The first four all being confirmed hacks and the last a theoretical status. He suggest invigilators may need to expand to look for signs of these.

In online tests where students use their own devices to sit an exam this adds to the quality control risk and high lights the need for educational institutions that offer online exams to invest in a system that ensures the necessary due diligence is done to prevent cheating.

2.11 Summary

Online education is growing and online testing follows this trend. This introduces quality control concerns because in this context new scenarios emerge that are not catered for in traditional educational testing quality control standards. Research indicates that online testing is not necessarily more prone to cheating than traditional on campus testing methods but cheating in tests, on the whole, is rising year on year. Unproctored online tests are however definitely at a higher risk of cheating than proctored tests. OLP is a new industry that is attempting to provide solutions to these quality control concerns.
Chapter 3: Overview of Exam and Test Types and Techniques to Ensure Quality Control

The objective of this chapter is firstly to outline how traditional tests or exams are conducted. Secondly the aim is to discuss traditional invigilation quality control standards and the frameworks that exist to ensure adherence as set out in the examination procedures and regulations.

This chapter also discusses testing and examinations within the IT sector and how two vendors, Cisco and VMware, conduct their certification exams to mitigate quality control risks.

3.1 A prediction for future testing methods

According to David Hanson, chief executive of the Independent Association of Prep Schools in the UK traditional pen and paper type exams will be scrapped in favour of online testing within the next 10 years. There are a number of reason for this anticipated change. The first is that there is a new generation of teachers that have grown up with technology, the second is the human error factor in exam marking and the third is the logistical problems that exist with these “Victorian” era exam methods (Paton, 2013).

3.2 Standardized tests definition

A standardized test is any form of test that firstly requires all test takers to answer the same questions, or a selection of questions from a common bank of questions, in the same way. Secondly the test is scored in a standard or consistent manner, which makes it possible to compare the relative performance of individual students or groups of students (The Glossary of Educational Reform, 2013).

These examinations modes are examples of standardised testing:

- Pen and paper exams
- Oral exams
- Practical exams like music exams, physical medical procedure tests, chemistry laboratory tests or wood work tests
- Computer based testing.
- Complex online practical exams.
3.3 The quality control steps involved in traditional tests or exams

In traditional written testing in schools, colleges and universities, standardized tests or exams, are conducted under supervision of an invigilation system which is a person or multiple people in the same room. The testee takes the test under controlled conditions and normally in the presence of an invigilator. The invigilator monitors the testee to ensure that no cheating occurs. The purpose of the invigilator is to establish and maintain quality control of the testing framework.

The key points here are the student or testee:

- Firstly has to be on time for the examination.
- The candidate then undergoes an authentication process:
  - This is to verify that this is the person who is registered for the course is the same person that is going to sit the exam. This is to avoid a proxy or imposter sitting the exam on the registered student’s behalf. This process could be informal or formal. An informal example would be where the lecturer or professor who teaches the class sets a standardized test that is conducted in the classroom. The professor knows each person by name and does that mental check when handing out the papers. Any strangers or imposters will immediately be recognized and questioned.
  - An example of formal authentication would be where a student would be required to present a government issue ID to an independent exam invigilator, so that the invigilator can compare the photograph in the drivers licence or passport to the person presenting the document. The exam guidelines for a college will stipulate this, as in the following CIT example. “For the purposes of identification and registration at examinations, all candidates are required to present a current CIT Student Identity Card” (Code of Conduct for Examination Candidates, 2015).
- The test phase then commences:
  - The student is provided with a test or exam paper that contains the standardized test questions that need to be answered to measure competence.
The student uses pen and paper to answer the questions, or under some conditions, is allowed to answer the exam using a computer.

During this test process invigilation occurs.

This is where a person sometimes called a proctor is in the same room to ensure that the guidelines of the exam are met and that the testee adheres to the exam quality control standards. According to the CIT, Code of Conduct for Examination Candidates, 2015:

- The invigilator will ensure that no book, bag/handbag, notes, or other unauthorised material may be brought into the Examination Hall without the prior approval of the Invigilator
  - This includes writing on set squares, rulers or calculators
  - No electronic devices or mobile phones or communication devices are allowed to be brought into the exam.
- The student may not leave their seat during the examination.
- The answers the students provide are their own work produced and answered in the exam hall or classroom under exam conditions.
- It is ensured that the student does not copy or get answers from another student or collude and discuss answers.
- The student is not allowed to bring any material into the exam that may aid in the answering of the test.
- The student cannot use any device like a phone to email, chat or communicate with any person outside the exam environment.
- Open book exams under an invigilated environment: Student has permission to bring specific resources to the exam.

In an informal exam setting, an invigilator could be the teacher, lecture or professor, but in formal exam’s this could be a totally independent neutral person or team employed to do the invigilation in an exam hall.

On completion of the exam all exam material must be handed in to the invigilator after the candidate has finished his/her examination (Code of Conduct for Examination Candidates, 2015).
3.4 Testing examination categories.

This section outlines the different exam types that are used in standardized testing. The traditional pen and paper exams have been used since the Victorian era. These are classified into simple and complex exam types.

3.4.1 Simple tests

In terms of classifying simple exams these are where the student is provided with an exam or test which he or she is expected to answer on an answer sheet which can be either physically on paper or answered in electronic format. They contain the following categories.

- **Pen and paper written tests**
  
The student is provided with a question paper and has to answer the questions on a separate answer sheet or on the question paper that is to be handed back. These can take the form of:
  - Multiple choice
  - True false questions
  - Fill in the blanks
  - Essay type questions
  - Maths science or financial calculations

- **Oral tests:**
  
The student is asked questions by the examiner and has to provide verbal answers.

- **Computer based tests**
  - Multiple choice
  - True false questions
  - Fill in the blanks
  - Completing a document electronically
    - Writing up an essay in electronic format
    - Completing statistic calculations in excel or a spreadsheet

3.4.2 Complex exams
• **Medical procedures**
The scenario whereby a student’s knowledge is tested in having to perform a medical procedure.

• **Practical exams**
The scenario whereby a student is expected to build a model like in carpentry or do a chemical analysis.

• **Online cloud delivered practical exams:**
Students are expected to configure a lab environment that is provisioned online or available as an Infrastructure as a Service (IaaS) cloud model. Examples are Cisco CCIE (Cisco Certified Internet Expert), VMWare VCAP (VMware Certified Advanced Professional) exams ("Lab Exam - The Cisco Learning Network", 2016; VMware Certified Advanced Professional – Data Center Design Exam Blueprint, 2015).

  o In these complex lab scenario exams for example the Cisco CCIE routing and switching exam, the student connects to a remote lab that has multiple network switches to configure to meet a particular use case with a specified configuration in 8 hours. This consists of a 2 hour troubleshooting section, a 30 minute diagnostic section, and a 5 hour and 30 minute configuration section. ("Lab Exam - The Cisco Learning Network", 2016).

  o The student will use a computer and have multiple console interfaces open and GUI’s of various switch configurations during the exam.

  o In the VMware VCAP certification there are two exams. Each exam has two tracks. The one is called data centre administration (DCA) and the other a data centre design (DCD) exam. Each of these exams are 180 minutes, or 3 hours in duration. In the DCA exam the students access the remote lab exam online from a Pearson VUE test centre. This runs in a VMware infrastructure as a services (IaaS) cloud environment and is accessed online. Using a computer in the Pearson VUE test centre, the student has to configure multiple virtual machines in around 23 live lab
activities in 3 hours. Live lab activities consist of multiple tasks, where each task is scored. (VMware Certified Advanced Professional – Data Center Design Exam Blueprint, 2015).

3.5 Cisco and VMware Case study

Tables 3 & 4 summarize how Cisco and VMware have approached the delivery of their exams to ensure quality control.

Both Cisco and VMware exams current state are an evolution of practices and there is not a great deal of information about the testing evolution as much of the information is proprietary. The objective is to show the certification types, the exam formats and testing methods that are used by these two major industry technology companies. The purpose of this is to allow a comparison of the testing models used in the IT industry to the testing model deployed by the traditional educational institutions and by the OLP industry in future chapters.

The other reason why VMWare and Cisco have been chosen as case studies is that they both offer a wide range of certification types but more pertinent to this research is they both also have advanced hands on practical exams. As this research is focusing on the OLP industry with a particular focus on complex practical exams, this chapter aims to highlight how these vendors solve that challenge.
<table>
<thead>
<tr>
<th>Certification &amp; cost</th>
<th>Exam format</th>
<th>Id validation</th>
<th>Exam format &amp; time</th>
<th>Exam interface</th>
<th>Quality control format</th>
<th>Exam content hosted by</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware VCA ($120)</td>
<td>Online from home or office</td>
<td>None</td>
<td>Multiple Choice 60 minutes</td>
<td>Browser interface</td>
<td>Un-proctored</td>
<td>VMware</td>
</tr>
<tr>
<td>VMware VCP ($240)</td>
<td>Taken at a test Centre</td>
<td>Government ID, driver’s license or passport</td>
<td>MCQ /scenario questions With MCQ answer selection 85 questions in 90 minutes</td>
<td>Browser interface</td>
<td>Test Centre administrator</td>
<td>Pearson VUE fully managed service. Pearson VUE obtain the tests from VMware and providing the full testing service</td>
</tr>
<tr>
<td>VMware VCAP / VCLX ($400)</td>
<td>Taken at a test Centre</td>
<td>Government ID, driver’s license or passport</td>
<td>Hands on configuration of virtual labs 3 hours</td>
<td>Browser interface</td>
<td>Test Centre administrator</td>
<td>(Third party shared responsibility mode) Pearson VUE provide authentication and test centre quality control – Exam is hosted via an online portal</td>
</tr>
<tr>
<td>VMware VCDX Registration $300 + defence registration $900</td>
<td>Paper submission and interview panel</td>
<td>Government ID, driver’s license or passport</td>
<td>Submission of design paper followed by an interview by a defence panel</td>
<td>Interview &amp; defence of design</td>
<td>Exam panel</td>
<td>VMware</td>
</tr>
</tbody>
</table>

*Table 3: Summary of VMware IT exam formats* ("VMware Certification", 2016)
<table>
<thead>
<tr>
<th>Certification &amp; Cost</th>
<th>Exam format</th>
<th>Id validation</th>
<th>Exam format &amp; Time</th>
<th>Exam interface</th>
<th>Quality control format</th>
<th>Exam content hosted by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco CCENT $120</td>
<td>Taken at Pearson test Centre</td>
<td>One means of identification: Government ID, driver's license or passport</td>
<td>Multiple Choice 90 minutes</td>
<td>Browser interface</td>
<td>Pearson VUE test centre</td>
<td>Pearson VUE fully managed service. Pearson VUE obtain the tests from Cisco and providing the full testing service</td>
</tr>
<tr>
<td>Cisco CCNA $120</td>
<td>Taken at Pearson test Centre</td>
<td>One means of identification</td>
<td>Multiple Choice / scenario questions with MCQ answer selection, 90 minutes</td>
<td>Browser interface</td>
<td>Pearson VUE test centre</td>
<td>Pearson VUE fully managed service. Pearson VUE obtain the tests from Cisco and providing the full testing service</td>
</tr>
<tr>
<td>Cisco CCNP $240</td>
<td>Taken at Pearson test Centre</td>
<td>One means of identification</td>
<td>Multiple Choice / scenario questions With MCQ answer selection, 120 minutes</td>
<td>Browser interface</td>
<td>Pearson VUE test centre</td>
<td>Pearson VUE fully managed service. Pearson VUE obtain the tests from Cisco and providing the full testing service</td>
</tr>
<tr>
<td>Cisco CCIE $1500</td>
<td>Taken at Cisco Test Centre</td>
<td>Two means of validation: Passport and licence</td>
<td>Practical exam 8 hours</td>
<td>Browser interface &amp; Terminal sessions</td>
<td>Cisco Test Centre</td>
<td>Cisco provides the test lab and test administrators.</td>
</tr>
</tbody>
</table>

Table 4 Summary of Cisco IT exam formats ("Certifications - Training & Certifications", 2016).

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3.6 Summary

This chapter outlines the types of tests from simple to complex in traditional on campus exams and the corresponding invigilation quality control standards that have evolved to reduce the risk of cheating. Traditional testing quality controls which have evolved over a considerable period of time, are the frame of reference that online testing quality controls are compared to.

It also compares the methods that two IT vendors, who offer complex practical exams, utilize to minimize the risk of cheating. Both IT vendors take a cautious approach. VMware partners with a third party vendor Pearson VUE for quality control. This is for the authentication and invigilation process. Cisco on the other hand take an even more conservative approach entrusting Pearson VUE with the quality control for all exams up to the professional CCNP level. For the high end expert CCIE lab exams Cisco minimize risks as far as possible and take all exam operations in-house.
Chapter 4: A Categorization of the Online Proctoring Industry

4.1 Introduction

By the end of 2014, 80% of higher education institutions in the USA are expected to take some or all of their classes online (Schulson, 2014). Online teaching takes a number of forms and could be blended. In an online class, all of the instruction is provided online and no face-to-face classroom instruction is normally needed. Students may be required to attend an orientation session or take invigilated exams on campus or at an approved location ("Definitions of Online Instruction | Richland Community College", 2015). With online educational models the need to provide online exams is growing, especially from the student’s convenience perspective, thereby reducing the need to take exams at an approved location in the traditional format.

According to McCue (2015) “Pluralsight, an online training service for technology professionals, announced in 2015 it closed $135 million in American Series B funding.”

Pluralsight’s online learning service offers a capability whereby the learner’s skills can be assessed. Their post assessment course tracks the learner’s progress and on course completion, a certificate with a transcript is provided ("Assessments, Certificates, and Transcripts", 2016).

The question arises however, that when an individual with a Pluralsight certificate arrives at a job interview, how does the prospective hiring company know that it is the candidate who has completed and passed this online assessment? How does the hiring company know that the candidate did not have anyone helping him or her with the assessments?

It has to be asked what value a hiring IT company would attach to a Pluralsight certificate. How would it rate when compared to certification that a candidate may acquire through companies like Cisco, Microsoft or VMware who have a rigorous certification program? These technology companies invest millions to have a very robust testing regime coupled with tried and tested quality control mechanisms to ensure their accreditation can stand up to scrutiny. At this moment it does not seem as if
Pluralsight has any such mechanism in place. Pluralsight does a great job in providing the learner with the technology material and tools to learn. The assessments provide the learner with a measure of how they are doing, however, the assessment methods and certification value is questionable from a credibility and a scrutiny standpoint when compared to Cisco (see Chapter 3).

Education has gone through a number of transformations to provide solutions to students’ changing needs. The traditional on campus model was supplemented by distance education. Now widespread adoption of the online learning model, by corporates and institutions, is a further supplement in response to the need to make education even more widely available, while also reducing costs and overheads. When it comes to assessment time, evaluating the learner’s capabilities in this online model, allowing students who have consumed online courses to take their tests from home, is the next major addition to the educational portfolio offering. This however brings a whole new set of challenges as the on campus exam regulations and quality controls are difficult to implement and police in this scenario.

The last publicity a university, college or corporate wants is reports of cheating incidences that compromise the value of their education. Within this context allowing testing and examinations from home can only happen if there are mechanisms to bring quality control in this environment in line with the standards of the traditional on campus exams.

The challenges with online testing and the growing need to allow the convenience of the off campus students to take the exams or tests in the environment they have studied and learned, is what is driving a number of new companies providing a service called online proctoring. This is a relatively new service that has emerged in an attempt to solve the quality control gaps in online testing. Online proctoring in this chapter shall be represented by the following acronym OLP first defined by David Foster (Foster & Layman, 2013).

According to O'Reilly and Creagh (2015), educational institutions and companies that offer online courses and want to offer online learner validation by the means of online
testing will have to look into methods of ensuring their tests and exams meet quality control standards.

4.1.1 Why do we need online proctoring?

A number of factors have led to the emergence of OLP. The first being the education institutions who offer online courses who then want to go the additional step of offering online exams. If they do this they need to protect their exam integrity. Below is a case in point.

At the American Board of Paediatrics, The future of testing conference, in the Proctoring options panel summary report, concluded that if the purpose continues to be assessment of knowledge, to provide assurance to the public, then some level of proctoring in either a secure test centre, or online, remains necessary (The future of testing conference, 2015).

The second is around convenience and cost savings.

The benefits of OLP were outlined as “the ability to take the exam in a familiar environment instead of travelling to a test centre, lower administration costs, the ability to access the web, and providing feedback during the exam, all which are difficult to do in a test centre” (The future of testing conference, 2015).

The third major factor is protecting the intellectual property of a formal educational institution or IT corporate certification program. Sites like Testking.com and passforsure.com who offer practice exams have obtained the material from the vendor exams because the practice exams are – in most cases – exact replicas of the exam (Williams, 2008).

4.1.2 Online proctoring outlined

A proctor is a supervisor especially of an examination or dormitory in a school. Proctoring is to supervise an examination ("proctoring", 2016).

Stcloudstate.edu defined a proctored exam in the traditional exam environment, “A proctored exam is an exam that is administered by an individual who supervises the student while they are taking the exam. The proctor’s function is to ensure the integrity and security of the exam in a secure environment.” All traditional exams have an
invigilator or a proctor who are in the same room as the student or students ("definition of proctored exam", 2015).

In “online” proctoring, the individual or system doing the supervision and the student taking the test, are not in the same physical room. They are connected by a network, mostly over the internet. OLP is where a proctor system monitors a student or students over the internet through a computing device or devices such as a webcam and microphone. However it should be noted that an automated system could also be used for proctoring. There are many techniques, methods and variations in this new industry of OLP.

Each educational institution that wishes to investigate the use of OLP faces a ramp up time and a significant challenge understanding the industry. This is understanding the terms used and also getting to grips with all the caveats and options available.

4.1.3 The importance of choosing the correct vendor to partner with

At the American Board of Paediatrics, the Future of Testing Conference (2015). The importance of selecting a reputable vendor was highlighted. It was also said that this was as important as the levels of security they provide, which varies significantly.

One of the mechanisms to select an OLP solution is to put out a request for a proposal see as was done by Miami University (Miami University Request for Proposal, 2015). This lets the online vendor do the work by submitting to defined criterion. At some juncture, however, the submissions have to be compared against defined criterion and a short list of vendors have to be drawn up to run a number of proof of concept tests or pilot testing. Another approach is reading up on the OLP industry and selecting a few vendors to call and start doing a proof of concept. This can be onerous and tedious.

A number of companies offering the OLP service have emerged in the last few years, the first being Kryterion that began large scale operations in 2008 (Foster & Layman, 2013). Selecting an OLP vendor for online test quality control can be overwhelming and time consuming as this is a new area of technology, undergoing significant change. New vendors are emerging continually. Services and technologies used in this industry are rapidly adapting to cope with online cheating. Information about this industry is
scattered all over the web with each vendor offering having certain advantages and disadvantages depending on the type of online testing conducted. Categorization and indexing of the OLP industry at this juncture will aid educational institutions and corporates understand the terminology used and highlight what to look out for and which solutions will best suit the online tests they wish to conduct.

Whatever method is used to select an OLP vendor, it would be beneficial to have the following

a) The terms used in the industry and the appropriate context.

b) Selectable criterion, to consider and use when selecting a vendor best suited to the educational institution’s online testing needs.

The next two chapters are aiming to achieve that objective by providing

a) A categorization perspective with the set of terms used in the industry

b) A framework that can be used as a reference when making considerations in choosing an OLP vendor.

A categorization system optimizes the ease of conception and the importance of being able to communicate those systems (Levitin, 2014). The categorisation of OLP is in this manner intended to conserve energy and decision making time for institutions and corporates wanting to use OLP (O'Reilly & Creagh, 2016).

This chapter on a categorisation of OLP is aimed at organizing this field by gathering and classifying the expertise in the form of resources and references currently available.

This whole area is an exciting new arena for colleges offering online education as it must be ensured that a reliable, cost effective and suitable system is available in order for online testing to be permitted. To do this educational institutions need to be able to choose one company from another.

The format of this chapter on categorization will have the categories listed with a discussion, where necessary, that follows to give a detailed description about the defined categories. This is not an exhaustive list of each OLP vendor’s capabilities as this is constantly changing and by the time this is captured in a document, the document...
is out of date. The focus of the categorization and discussion of these items are to give an understanding of the concepts that need to be considered in the decision making process.

4.2 Online proctoring concepts

This section defines and categorizes the types of OLP currently available in the market place. It highlights that currently all OLP falls into one of two categories when classifying with respect to a time line. The two cost models that exist in OLP are shown as well as the test phases that both the exam administrator and the student need to be aware of.

4.2.1 Online proctoring definition

OLP is an online service provided and purchased from a third party company. It allows exam takers to complete their assessments online, from home, while attempting to preserve the integrity of the exam for the institution ("ProctorU: Overview and Technology Requirements", 2016).

This is achieved by a proctor system which monitors a student or students over the internet through a computing device or devices such as a webcam and microphone. It should be noted that an automated system could also be used for proctoring. According to Foster and Layman (2013), "It includes the processes for authenticating the examinee at a distance, verifying firstly, that this is the person that should take the exam. Adding to the definition, OLP includes any automated processes that aim to stop cheating in a test administration event."

The proctoring system (Human or automation) via means of software, uses the standard student PC web camera and microphone to authenticate and monitor the student. All forms of communications and monitoring are via applications and devices that use internet protocols.

4.2.2 Types of online proctoring

- **Human OLP or live proctoring**
- **OLP using humans aided by technology**
- **Automated or on demand OLP proctoring (Schulson, 2014)**
Discussion

- **Human online proctoring or live proctoring**

Doug Winneg CEO of Software secure, says there are three tiers of proctoring companies today. The first involves live proctoring, the second combines live proctoring and technology, and the third is pure technology (Schulson, 2014). Live proctoring is where humans do the online invigilation and proctoring.

The live proctoring approach applies an old-school solution to the new challenges of online education. While the class transpires online in virtual space, exams are held at a specific time with humans monitoring students live via webcam. Generally speaking, there is one proctor for every 4-10 students; each proctor monitors an array of computer screens simultaneously (SoftwareSecure, 2015).

- **Online proctoring using humans aided by technology**

The second is where human proctors are aided by technology to monitor the test taker. Technology would involve for example, tracking algorithms that monitor web traffic, use facial recognition software to track the test taker and use remote control software that monitors applications running. Most OLP companies fall into this category today.

- **Automated or on demand online proctoring**

The third is where only automation software is used to authenticate the student and record the test session. The software then flags anomalies that may occur that may be viewed by a test administrator after the exams have taken place. This is done online using the proctoring company’s portal.

On-demand proctoring embraces and leverages technology, only involving humans where they can be the most effective. Under this approach, students agree to allow cameras to “watch” them while they take exams; if the cameras pick up anything out of the ordinary, the anomalous behaviour is flagged in the recording by multiple reviewers after the exam. These reviews occur off-site and are performed independently. If the review process determines a student has cheated, the reviewers refer the case to the educational institution for follow-up (SoftwareSecure, 2015).
4.2.3 Time dependent categories

This section highlights the time lines in the various methods of OLP from the white paper sourced from SoftwareSecure (Watchful eyes - A Comparative Look at Online Test Proctoring Models, 2015).

- **Proactive OLP aka Live OLP.** (“Correct suspicious behaviours as they occur.”)
- **Reactive OLP aka automated OLP.** (“Needs multiple reviewers to scale, responds to cheating afterwards”)

Discussion

- **Proactive online proctoring aka live online proctoring**

Live OLP using human proctors ensures immediate correction or action when a violation occurs: Companies that offer live proctoring advertise that because their proctors observe students while taking an exam, they can correct suspicious behaviours as they happen (Watchful eyes - A Comparative Look at Online Test Proctoring Models, 2015). They also then submit an incident report to the college afterwards. This attempts to replicate the traditional proctored setting. These vendors also claim the approach is meant to do for online learners what human proctors do in traditional exam rooms (Watchful eyes - A Comparative Look at Online Test Proctoring Models, 2015).

The responsibility for quality control is passed onto the OLP Company. This has the advantage of offloading the onus of quality control onto a third party company. Doing that has the disadvantage of not having the full insight into the quality control operations and depends on trust that the service level agreement is being strictly adhered to. These are the reasons that a reputable company with a track record should be chosen and secondly that the OLP Company has audit controls and conforms to the industry standards setup out in 7.3.2 below. The live OLP model has a higher initial cost than automated proctoring but firstly matching the type of exam, and whether this is a low or high stakes exam to the most suitable OLP model has to be done. The additional overheads incurred when using fully automated proctoring may outweigh the perceived initial cost benefits of fully automated proctoring.

- **Reactive online proctoring aka fully automated online proctoring**

Timing: Critics allege that this approach doesn’t prevent cheating before it occurs but instead responds to cheating afterward.
Institutional Responsibility: In cases where video review leads the examiner to suspect a student of cheating, the onus is on the educational institution to review the ‘marked’ anomaly events (suspicious activities) in the recording and carry out discipline as necessary (Watchful eyes - A Comparative Look at Online Test Proctoring Models, 2015).

Fully automated OLP has an initial cost benefit because of the flat rate, see figure below but the extra time and related cost investment post exam sessions need to be considered.

4.2.4 Online proctoring post models

- **Variable rate per student dependent on the duration of exam: tends to apply to Live OLP (Foster, 2013)**

- **Fixed cost per student per duration of exam: the model used by fully automated OLP. e.g. $15 per student independent of duration of exam (Proctorfree, 2015)**

![Exam Duration vs Cost per student](image)

*Figure 1 Typical exam costs per student for Live vs Fully automated OLP*

**Discussion**

- **Variable rate for Live OLP**

The OLP cost models for live proctoring has three variables:

- cost per student
- cost per exam duration
- Live proctor to student ratio or quality factor

Exams proctored through ProctorU cost $8.75 (30-min. exam), $14.75 (1-hr. exam), $21.50 (90-min. and 2-hour exam), or $30.25 (3-hour exam) billed when you schedule the exam ("ProctorU: Overview and Technology Requirements", 2016).
• **Fixed rate for automated online proctoring**

Fully automated or on demand OLP has a fixed rate per exam independent of the exam duration. Ball park figures are around $15 per student per exam.

### 4.2.5 Online proctoring test phases

Online testing procedures and examination quality control standards communicated to student taking exam online.

- The student checks to see that their device meets the minimum required specifications and performs a device test to see if their laptop or computer is setup correctly.
- The student connects to the OLP portal and registers. This involves uploading an electronic image of himself or herself. This step may not be necessary if the OLP company’s software has been integrated with the institution or college LMS.
- The student initiates a connection through the OLP portal or LMS.
- Software installation on remote student’s computer.
- A virtual handshake occurs. The live proctor can see and communicate with the student, or in the case of fully automated OLP, the webcam and microphone is able to start recording.
- Video recording initiation. When this is used the capability to record the students attendance, face and eye movements, environment sounds or ambient noise and student desktop is started.
- Identity verification: ensuring the student that has registered for the course is the one sitting the test.
- Environment check (Live OLP only) ("Student Responsibilities - GC Proctoring Services", 2016). This is to ensure that there are no devices or other human contacts in the room that would compromise the validity of the examination. This is to ensure that the test is conducted along the lines of the quality control standards and regulations specified by the examinations body.
  - Room check: scanning the room with the web camera to verify that there are no devices that could be used for communication.
  - Ear check: checking that the student has no ear pieces to communicate with.
o Pocket check: ensuring no phones or devices that allow outside communication.

o Mobile device check: clearing the room of any mobile devices.

o Application open check: ensuring only allowed applications are open on the desktop.

- Test phase: Student performs the test.
- OLP report back to college. This applies to Live OLP only.
- Post-test review of video material by educational institution or corporate.

![Online proctoring test phases]

Figure 2 Showing Online Proctoring Test Phases

4.3 Online proctoring vendors and technologies

The section lists the vendors offering the OLP service and indicates the type of service they offer. It also lists the technologies that are utilized in this industry.

4.3.1 Technology vendors

Table 1 below provides a list of current OLP vendors investigated by this paper. Each vendor provides a solution to OLP where the approach and service provided may be very different.
<table>
<thead>
<tr>
<th>Company name</th>
<th>Website</th>
<th>OLP category</th>
</tr>
</thead>
<tbody>
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<td>SoftwareSecure</td>
<td><a href="http://www.softwaresecure.com">www.softwaresecure.com</a></td>
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</tbody>
</table>

Table 5: OLP Vendors - in alphabetical order that this research has investigated

Discussion

Live proctoring was available before automated proctoring. Live proctoring vendors like Kryterion, ProctorU, SoftwareSecure, Loyalist and BVirtual are amongst the first companies to offer the OLP service. The likes of Kryterion having spun out of Drake who had founded Prometric test centres in 1990 (Foster, 2013).

Vendors like Softwaresecure.com and PearsonVUE.com started out offering live proctoring and then diversified into the automated arena.

Proctorio is a company offering fully automated proctoring that was founded late 2015 after being named in the 10 finalists of the most exceptional start-ups around the globe at the SXSWedu Festival & Conference March 3-6, 2014 (SXSWedu Conference, 2014).

Live proctoring uses humans to conduct the proctoring service. The proctors are generally well trained to perform the student authentication as well as monitoring the testee and spotting any attempts to cheat during the online exam. The proctors also are
technically trained to assist the students with technical issues such as their microphone is not working, or the web camera is not working.

Vendors like Kryterion, ProctorU and Mettle offer Live proctoring with trained staff and at face value the services between vendors may be very similar but from experience the mechanics of the implementation differs sometimes significantly. For example in the proof of concepts conducted the students involved in the proof of concept reported a more thorough approach from one vendor when compared to another. The one vendor did not conduct any room scanning whereas the other vendor’s human proctors took their time doing the environment check asking the student to scan the room with the web cam, ensuring it meets the agreed quality control standards. They also asked the student to use a mirror or DVD (reflective surface) to check under the desk and behind the computer screens.

Vendors may also have more than one product for OLP differentiating by the degree of security offered. For example Kryterion 101 has less security than Kryterion OLP (Foster, 2013). Software secure had a high stakes test that used a hardware device called remote proctor Pro which included a 360 degree camera and a fingerprint reader (Bellefeuille, 2014).

In fully automated proctoring there is no human involvement in the lead up to the test, during the authentication and while the student is taking the exam. The only human involvement is after the exam when a person has to check the recording to see if there were behaviours that indicated the student was cheating.

During the student authentication a script is presented to the student requesting the student to display their relevant ID. In the background the automation software can use facial recognition software to compare the student photograph to the person taking the test.

4.3.2 Technologies used in online proctoring

Foster (2013) discusses the following technologies.

- Web camera: for monitoring the student, especially the testee’s face, eye movement and area of focus. In the case of live proctoring, scanning the room, doing an environment check.
- Remote viewing software: for monitoring student desktop screen/s.
- Recording software: for recording face of testee via webcam and in some cases desktop and all desktop actions.
- Network monitoring: to monitor source and destination traffic and detect any behaviours of aberrant application usage.
- Application monitoring: to ensure only applications used for the test are in use.
- Where applicable, application lockdown. To ensure that only the particular application or browser and URL is to be used for the test.
- Location verification. Determining the testee location to verify if it matches the stated address.
- Biometric's:
  - Facial recognition software: to compare the identity of the testee against an image captured at course registration to detect if a proxy person registers for the test or if a person swaps with the testee during the test.
  - Keyboard input recognition: Each individual has a unique style of typing. This style is monitored to detect changes which could mean cheating.
  - Fingerprint scanning.
  - Iris identification.
  - DNA testing (Test Taker Guide Online Proctoring Series, 2016).

4.3.3 Educational institution online proctoring integration categories

- Online proctored test launched from LMS
- Test independently launched via OLP portal

Discussion

Some vendors like Proctorio only provide the capability to launch the test from a LMS like Blackboard®. This will involve the installation of plugins at the college Blackboard administration level. Students then registered in Blackboard can then launch the test once the test administrator has scheduled this for them.

Other vendors like ProctorU offer the option of both integration options, either using their independent portal from which the tests can be setup by the test administrator and from which the student can register for and launch the test or using the LMS integrated option as above.
4.4 Online proctoring services

Many OLP vendors are now in the market place, each offering different services. This section classifies the services provided by these vendors.

4.4.1 Primary service offerings

- Test taker authentication and verification
- Exam quality control ("Kryterion Online Proctoring", 2015)
- Protecting exam intellectual property (Foster, 2014)

4.4.2 Secondary service offerings

- Testee account administration (via portal)
- Technical account management ("About Us - Online Proctoring - ProctorU", 2015)

4.4.3 Online proctoring authentication

- Automated authentication: mostly used in fully automated proctoring but can be used with live proctoring
- Live authentication. Human proctor does the authentication and verification ("AA | Examity", 2016)

4.4.4 Online proctoring service adoption phases

- Sales representative discussion with OLP vendor
- Signing OLP service agreement
- OLP proof of concept with institution or corporate
- Educational institution or corporate OLP service full time adoption

4.4.5 Live online proctoring student test taker phases

This section is derived from "ProctorU: Overview and Technology Requirements", (2016)

- The student tests out their equipment (computer, broadband, web camera and microphone) to ensure end devices and software are operational
- Create an account on the OLP portal. This is necessary if the education institution has not integrated the OLP into their LMS
- The student schedules a test
• The student takes the test at the scheduled time

4.5 Online Proctoring Security and Governance

This categorization highlights the compliance standards that apply to the OLP industry and lists the risks and risk mitigation that security measures and governance are to counter.

4.5.1 Online proctoring compliance and standards


To state: “the agency or association requires an institution that offers distance education or correspondence education to have processes through which the institution establishes that the student who registers in a distance education or correspondence education course or program is the same student who participates in and completes the program and receives the academic credit”

• FERPA ("Family Educational Rights and Privacy Act (FERPA)", 2008)

The Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. 1232g; 34 CFR Part 99) is a Federal law that protects the privacy of student education records.

• ADA ("Americans with Disabilities Act Technical Assistance: Testing Accommodations", 2010)

Americans with Disabilities Act (ADA) Standards for Accessible Design in September 2010. These standards state that all electronic and information technology must be accessible to people with disabilities. Individuals with disabilities have the opportunity to fairly compete for and pursue such opportunities by requiring testing entities to offer exams in a manner accessible to persons with disabilities. When needed testing accommodations are provided, test-takers can demonstrate their true aptitude.


Provides a global benchmark for personnel certification programmes to ensure that they operate in a consistent, comparable and reliable manner worldwide, thereby allowing individuals to have skills that translate across national lines.
• **ISO 22398 - Global exam development & delivery** ("ISO 22398", 2013)
It is intended for use by anyone with responsibility for ensuring the competence of the organization’s personnel, particularly the leadership of the organization, and those responsible for managing exercise programmes and exercise projects.

• **ISO 19011 - Global internal audit** ("ISO 19011", 2011)
Is an international standard that sets forth guidelines for management systems auditing. It is developed by the International Organization for Standardization.

• **ISO 31000 - Global risk management** ("ISO 31000", 2013)
Is a family of standards relating to risk management codified by the International Organization for Standardization.

### 4.5.2 Online proctoring Security standards

Foster (2014) outlines the security standards.

- **The OLP system is able to authenticate and verify the test taker’s eligibility to test**
- **OLP provides for the effective observation of the test taker and the test environment throughout the testing session**
- **The OLP system provides the capability for interaction with the test taker both before and throughout the testing session**
- **OLP provides for the video and audio recording of the testing session and interactions between the test taker and online proctor**
- **The testing computer is effectively secured and monitored throughout the testing session**
- **The OLP system adheres to general standards of security and professional practice**

### 4.5.3 Online proctoring quality control levels

- **Student ID authentication only**
  This is where the educational institution only needs to verify the student’s identity before the test ("AA | Examity", 2016).
- **Random sample tests proctored**
Used where the consequence of students cheating is minimal and a statistical random sample of students is chosen to proctor ("AA | Examity", 2016).

- **Record and review**
  Using automated proctoring where additional time and resources need to be available to work through and check the recordings once the test has been taken. Proctorfree.com and Proctorio are two vendors whose automation software checks for anomalies while recording the test and these anomalies are then flagged for the reviewer’s attention (Proctorfree, 2015).

- **Live proctoring**
  Used where the consequence of cheating is significant and everything possible needs to be done to minimize the cheating. Recording could be done in addition to the live proctoring which gives the highest level of quality control ("AA | Examity", 2016).

### 4.6 Online proctoring risk mitigation

#### 4.6.1 Proctors

- Proctor training (ProctorU Educational Seminar, 2011)
- Proctors working from the office (Live proctoring) (Kolowich, 2013)
- Monitoring the proctors (Live proctoring) (Kolowich, 2013)

#### 4.6.2 Testee controls

Global campus discusses testee controls that generally apply to OLP scenarios ("Student Responsibilities - GC Proctoring Services", 2016).

- System check prior to exam
- Identification passport and or student card
- Environment check using mirror test
- Multiple monitors (in some cases only 1 allowed) or computers in the room
- No phones or phone calls
- No texting
- No hats
- No sun glasses
- No other person in the immediate exam area
- No conversations with anyone else other than the proctor
- No food or drink unless in clear container
• No bathroom breaks, exam to be completed in one sitting with no breaks
• Head visible to proctor at all times

4.6.3 Categorization of online proctoring risks
These categories are summarized from security threats (Foster, 2014).

• Test taker has technical challenges when connecting to test
• Test taker cheating using cheating aids
• Test taker disconnects accidently or on purpose from test
• Opening application or web browser or an unsupported application
• Other human contact
• Utilizing the phone to make contact with another human
• Chat or instant messaging
• Use of social media
• Virtual machine supporting non-compliant applications
• Test taker copying answers from other test taker
• Test taker copying of exam papers
• Test taker using proxy
• OLP proctor collusion with student
• OLP proctor sharing recorded session with exam information

4.6.4 Incident categorization response (live proctoring)

• Time and incident recording
• Log a response ticket
• Student question category (Live OLP)
• Why are you opening x?
• What is that I see (at this position on the screen)?
• Why are you talking/or reading out the questions?
• A person entered the room
• Warn student over violation
• Alert the testing institution by phone or email
4.6.5 Incident categorization (Automated proctoring)
These are anomalies that were provided to the researcher by ProctorFree in a slide deck during a conference call 24 Sept 2014 – see email exchange Appendix N.

- **Camera/Visual Activity**
  - Additional persons in the background.
  - Test taker moves out of the screen.
  - Irrational eye movements.
  - Books/Papers/Tablets.
  - Lack of Facial Recognition.
  - Room Lighting/Flashes of Light.

- **Behaviours**
  - Cutting/Pasting.
  - Keystroke Pattern Changes.
  - Erratic movements.
  - Test Response Times.

- **Noise Levels**
  - Printer.
  - Papers.
  - Talking/Whispering.
  - Consistent detectable noises.
  - Camera Noises.

- **Computer Activities**
  - Web Browser activity.
  - Cutting/pasting.
  - Internet.
  - Connection loss.
  - Internet connection loss.
  - Computer Shuts Down.

The monitoring software will track these anomalies and flag them for review by the test administrator after the time via a portal provided by the proctoring company.

4.6.6 Categories that online proctoring looks for to spot cheating

- **Eye movement, sporadic focusing on an area away from the screen (Kolowich, 2013)**
• Student leaving their seat (Kolowich, 2013)
• Use of head gear (Kolowich, 2013)
• Use of phone
• Use of any physical material not specified in the exam guidelines, like books.
• Another person appearing in the room
• Use of applications that allow student to gather information or communicate with another person. (Social Media, instant messenger, Virtual Machine, email)
• Disconnecting from exam incidental or deliberate

4.7 Main Independent Online Proctoring groups and researchers
• Caveon.com
• Onlinelearningconsortium.org
• www.onlineschoolscenter.com

4.8 Test type Categorization
• Physical tests
• Medical tests
• Oral tests
• Written tests
• Financial tests
• Maths tests
• Practical tests e.g. woodwork and music
• Computer based tests
  o MCQ’s
  o True false or alternative response
  o Fill in the blanks
  o Matching type
  o Electronically written essay
  o Financial – completion of spreadsheet
4.9 Categorization of applications that could be used for testing during online proctoring

- Browser
  - E.g. Simple MCQ in browser
  - Simulation in Browser e.g. Microsoft or Cisco tests
- Word processor
- Spreadsheet
- Multiple browser or GUI application interfaces as in a complex lab test
- Online lab using browser or terminal interfaces
- Custom application test portal

4.10 Award categories to consider when selecting an online proctoring company

- Quick and responsive turnaround (Kapanjie, 2015)
- Solution demonstrates optimum suitability to test type and quality control requirements (Foster, 2013)
- Different proctoring levels available that matches test types and quality control standards ("AA | Examity", 2016)
- Proctoring management easy to work with (Kapanjie, 2015)
- Easy to use web portal for exam scheduling and setting exam requirements (Kapanjie, 2015)
- Proctoring diligence (Kapanjie, 2015)
- Robust evidence of academic integrity during the examination process (Miami University Request for Proposal, 2015)
- Cost effectiveness of system (Miami University Request for Proposal, 2015)
- Where applicable, ease of integration into the LMS (Miami University Request for Proposal, 2015)
- High degree of transparency around the proctoring process (Miami University Request for Proposal, 2015)
- Ease of use by students and staff (Miami University Request for Proposal, 2015)
- Strong technical support for students and staff (Miami University Request for Proposal, 2015)
- Secure storage of data related to student and test information (Miami University Request for Proposal, 2015)
- Clear and unambiguous documentation of any breaches of academic integrity including, but not restricted to, recorded evidence demonstrating academic integrity (Miami University Request for Proposal, 2015)
- Solution saleability, reliability, robustness and reputability (Miami University Request for Proposal, 2015)
- Clear evidence of adherence to compliance standards
- Clear easy to use process documentation
- Hidden costs communicated up front

4.11 Summary

There is a great deal of information available in this new industry called OLP. Selecting an OLP company to partner with can be very laborious and the consequences of getting this wrong, significant. This chapter has provided a categorization of OLP to help educational organizations eliminate irrelevant information in this field to allow them to pay attention to what matters most.
Chapter 5: A framework of guidelines and considerations for implementing online proctoring.

5.1 Introduction

This chapter is aimed at educational institutions or IT vendors that offer an online educational program that includes online testing and are considering utilizing a service provided by one of the online proctoring (OLP) vendors.

This chapter is not a prescriptive definition, but rather aims to create awareness of the consideration scope that needs to be taken into account when selecting an OLP vendor.

This module commences by defining a decision tree in section 8.2 that outlines the steps for consideration.

This chapter covers the following:

- Proactive or live proctoring vs reactive or automated proctoring.
- Live proctoring:
  - The terms and OLP vendor roles
  - Key questions to ask when discussing human OLP
  - Key decision flowchart
  - Recommendations for conducting a proof of concept
  - Registering a proctoring vendor
  - Setting up a test
  - Quality control follow ups
- Fully automated proctoring introduction:
  - Technologies used in full automated proctoring
  - Key questions to ask when evaluating fully automated proctoring
- A framework that can be used as a reference when making considerations in choosing an OLP vendor
5.2 An online proctoring selection guideline

Figure 3: Decision Tree for selecting OLP Services
The decision tree in Figure 3 above sets out a process that can be followed to select an OLP vendor to partner with for online testing. The decision tree steps are labelled A to O in blue text in the decision tree diagram. This is to aid clarity in the explanation that follows. The following sections list the decision tree step number and provide more information about each step.

A Define the test type category:
Start with documenting or defining the test type or testing types that are used and how many students are going to be tested. For example 1: this is a simple test namely a computer based MCQ and is performed in a browser window accessed at a particular URL. This is a closed book exam and no other web sources are to be used.
Example 2: This is a complex practical exam that students access using multiple terminal consoles which are launched from a browser based application at the following URL: http://vcloud.cit.ie/cloud/LABS11/html
Further detail about this topic is found in Ch 4.2, Ch 7.8 and Ch 7.9

B Define risks
This step is necessary to ensure the type of risk is captured so that it can aid decision making in step H.
Example 1: This is a MCQ quiz with a large question bank of questions. As this is an introductory test the implications of a student cheating is minimal. It is also of no consequence if the student copies and shares the tests questions.
Example 2: This is a high stakes computer based medical quiz that forms part of the student's final grade. A student cheating would not look good for the college and also compromise the profession. The consequence of test questions getting out would compromise the college's academic integrity.
Example 3: This is a complex cloud based practical exam. As this forms part of the students final grade the stakes are high and the risk of the student using outside sources needs to be avoided at all costs as this exam has considerable credibility. Everything possible must be done to ensure the student who registers for the course is the student sitting the exam and this has to be done before the student is allowed to start the exam.
C Quality control
This step follows on from the previous step in defining the desired quality control. The college may consider that OLP be arranged for a random sampling of students because of low stakes tests with minimal consequences if students cheat or copy the exam questions.

D Making the decision to use an online proctoring service or to develop an internal online proctoring service in house.
Once the Test types, the number of students, risks and quality control has been defined the decision needs to be made if the college is going to use a OPL service or develop an in-house system.

E Setup a development team
If the decision is made to run a bespoke in house OLP system this is management independently and is out of scope of this research.

F Starting the process to select an online proctoring vendor
Selecting an OLP company is outlined in steps F to P in the decision making tree

G Decision to put out to tender yes or no
The college has two options to select an OLP system. This will be to put it out to tender or start investigating OLP companies.

H Putting out to tender
Putting out a tender requires the interested OLP companies to indicate how they propose to meet stipulations set out by the college. This puts the onus on the OLP company to document and show how they aim to meet these requirements. This works well if there are a large number of students involved and when OLP companies see the revenue benefit of investing time to tender. If the number of students to start off with are small then the college will have to invest in doing time and effort for research.
I A number of decision making criterion.
This section uses a decision tree structure as per reference (Decision Tree Diagrams on Factors Affecting Choice of Fuel Strategy in Humanitarian Settings, 2009). Options 11 to 14 lists four of the key decision criterion that will clarify the optimum type of OLP solution. The four determinants, cost, risk, test types and high or low stakes tests will ultimately lead the college down a particular path. The decision making tree will assist the stake holders to consider the weighted options in making an informed decision. The decision tree shows how high stakes, complex, high risk impact test types are potentially better served by utilizing live proctoring. Automated proctoring lends itself to simple, low stakes tests that have very strict budget constraints.

J and K Automated or live online proctoring
The decision making tree will guide the college down a particular route to approach either a number of automated or live OLP vendors for shortlisting in L.

L and N A online proctoring shortlist
These steps will involve contacting a number of OLP vendors and determining the capabilities.

M Questions to consider
The questions to consider when discussing the OLP vendors options are covered in Section 8.18. These are questions that ensure all aspects of the OLP are covered so that the college understands exactly what the capabilities are.

O Select an online proctoring vendor
A vendor is selected that best meets the criterion set out by the college.

5.3 Online proctoring selection methods
Delivering an online course may cause the educational institution to consider the use of online testing. Doing so could be done via one of the following methods.

The department can nominate individuals to do research, browse the web, find OLP companies, read up on the capabilities and report back to the head of department of the institution.
The other option is to put out a tender request or a request for proposal as done by Miami University (Miami University Request for Proposal, 2015). This University stipulated the number of students to be tested per annum, the test duration and the award criterion such as secure data storage of student information, ease of adoption into the LMS, ease of use by students and staff, strong technical support and cost effectiveness (Miami University Request for Proposal, 2015).

One stipulation that was not mentioned was that they did not list the test types and methods that will be used, for example if the test will be a MCQ or an essay completed as an electronic document.

5.4 Proactive online proctoring vs reactive online proctoring

This research has classified OLP into two broad categories, namely proactive OLP and reactive OLP. This is intentionally done to highlight how the quality control response is delineated. In the reactive OLP model which is commonly called automated proctoring, the quality control occurs after the exam is recorded.

Proactive OLP or live proctoring utilizes methods to proactively interject and halt the student’s online test process to investigate and prevent any accidental or intentional violation of exam standards during the exam.

Reactive proctoring utilizes methods like automation and or live recording of the student in the exam environment to capture proof of potential exam quality control violations or cheating incidences so that they can be appropriately dealt with after the exam.

One of the fundamental decisions that have to be made when selecting an OLP vendor is either to use live OLP or fully automated OLP. This section looks at the two main modes of OLP in more depth to aid making a more informed decision.

5.4.1 Proactive or live proctoring performed by humans

Live OLP does not cover the use case where an online proctor monitors a whole classroom of students in the same room taking an exam. Live OLP is only intended as the monitoring of a single student in an isolated environment. An example of this is the...
monitoring of a student in his or her study at home, where the student is alone, in front of a computer, with a web camera and operational microphone, connected to the internet and proctored by a person in the OLP company.

The proctor will be monitoring more than one student, typically between 4 to 8 students. The upper limit is not hard set but is rather more limited to the capabilities of the proctor. In the future this ratio may rise as the proctor is aided more and more by technology (see mail discussions Appendix M). This ratio is important as it generally means that the lower it is (1:4 vs 1:8) the higher the cost but the better the quality control and vice versa. It is important that the maximum proctoring ratio in effect at the time of the examination be agreed and that this is specified in the service level agreement (See 8.4 below).

Exam sessions using live proctoring have to be scheduled as the OLP company needs to manage the number of proctors on shift (ProctorU, 2011). There will also be an upper limit each OLP company can have on the number of students that can sit the exam at the same time.

Proctoring companies like ProctorU or Kryterion have human proctors that go through extensive training. They perform the student authentication and student monitoring remotely, using the student PC web cam and microphone and use these devices to proactively alert the students to suspected actions, items or individuals in the room that may be seen to potentially violate the quality control standards set out by the educational institution setting the online test. If the student takes no remedial action then the proctor can end the exam and will submit a report to the institution (see Chapter 9).

Examples of the extra attention live proctoring can provide is shown in the following:
• In a Western Governor's Universities web blog, students reported innocent red flags caught by online exam proctors. These are examples quoted to show the proactive nature of live or human proctoring. In one instance a proctor stopped a test because of an inconsistent rumbling noise they believed could be someone trying to contact the student or signal answers. "I just moved the camera to show it was my snoring cat. I am glad they watch as I want my hard work to be worth it" ("6 Innocent ‘Red Flags’ Caught by Online Exam Proctors | Online University", 2013).

• Another example quoted in the same blog was a student was taking a test, read the questions out loud, and never realized she was doing this until her test was stopped three times.

What is important to note in this situation is that the online proctors were proactive in the monitoring and took steps to ensure that in their interpretation of the quality control standards there was no violation. This service reduces the educational institutions' overhead in dealing with exam violations after the time, by ensuring many potential incidences are "nipped in the bud" before they become serious cheating incidences. Fully automated proctoring cannot provide this level of proactive monitoring.

Selecting the appropriate exam proctoring solution also depends on the type of exam. Live proctoring is more suitable for high stakes exams complex exams - like practical hands on labs from the proof of concepts. This is backed up by Foster (2014) where he indicates that live proctoring is used where the consequence of cheating is significant and every possible precaution needs to be taken to minimize the opportunity for cheating.

5.4.2 Reactive or fully automated proctoring
Reactive online or fully automated proctoring uses software technologies only to authenticate and monitor the exam student via the student PC web cam and microphone. There is absolutely no human supervision during the proctoring process.

Fully automated proctoring has exactly the same objective as live proctoring, the main difference is firstly the authentication and monitoring of a student exam session is done
by automation software only. The exam session is recorded and the software has algorithms that use various technologies to track potential cheating incidences and flag them in the recording as anomalies that can be checked by a test administrator afterwards.

The second difference, as mentioned before, is that fully automated proctoring is reactive and the exam violation or cheating incident is only detected after the time and cannot be dealt with during the exam. The quality control responsibility is solely depended on the educational institutions or paid reviewers for checking the exam violations flagged in the proctoring software. The exam administrator or teacher would view the student exam sessions, using the OLP company portal, would go to the to the particular student, check the high risk anomalies and view the recording snapshot at that time to determine if the student was cheating.

The third difference is that there is not the same restriction on scheduling as with live proctoring. As the proctoring mechanism is software, there is no human dependency for running the exams. This means the exams can be arranged on demand at any time of the day or night. In the case of live proctoring it would be dependent on the availability of live proctors.

Automated OLP is best described by an analogy provided by Schulson (2014) where she says OLP systems are comparable to red light (traffic light) cameras. They don't necessarily deter you from cheating until you know they actually work. But once you receive that ticket in the mail or the notification that you have violated the exam policy, you have learned your lesson.

Fully automated proctoring records the online exam from the student authentication to exam completion. It is the algorithms in software that acts as the red light camera. When anomalies or suspected cheating incidences occur, the software flags this as a suspected red light violation.

Technologies like facial recognition, are used to detect anomalies. An example would be, another person entering a room, which then is detected by the software and flagged as a potential violation in the recorded session. An exam administrator will be required
to review the recorded exam sessions afterwards and can go directly to the flagged anomaly and review the incident to see if it is considered to be a violation of exam quality control standards.

Figure 5: Recording time line of exam and anomalies for review (Proctorfree, 2014)

Figure 6: Description of anomalies and the associated severity (Proctorfree, 2014)
Figure 6 shows the exam portal, which contains the student exam recording. The software has tagged potential anomalies at various instances in time during the exam. These anomalies and their severity make up what is called a student trust score—visible in top right hand comer of figure 5— which gives the test administrator a general indication of the number and severity of the anomalies. According to Proctorfree (2014) “TrustScore” will mean the following:

*The heuristic evaluation of all test taking metrics assessed through the Application Service to provide a high, medium, low or flawed designation with respect to the Test Taker’s cheating probability on the applicable exam or test.*

The levels are flagged from unclear, minor, medium, to major and the test administrator can then select the anomaly flagged at a time in the video viewer and see the students recorded actions at that time. The objective being to determine if the student’s actions violate the exam standards.

In contrast to proactive or live proctoring, it is not until this anomaly is reviewed by the educational institution test administrator that it is known as a cheating incident or not. The student could potentially violate the exam quality control in all kinds of manners during the exam, but it would only be dealt with after the fact. What is important to note is that even though there is no human intervention during the proctoring process it is required afterwards.

This is highlighted on Proctortracks website. “Proctortrack does not decide if a student cheats or not. The software records evidence and then uses algorithms to decide what behaviour is abnormal. That abnormal behaviour is then highlighted for professors to review” ("Proctor Track's support page", 2015).

This means that the restrictions on the number of people that can write the exam simultaneously do not apply as with live proctoring as this is a service that students connect to. The algorithms in fully automated proctoring software tracks, and in the exam recording, flags a number of anomalies as described in chapter 7.6.5.
5.4.3 Comparative tabular summary of proactive or live proctoring vs reactive or fully automated proctoring

The following table provides a summary of the similarities and differences in Proactive, live proctoring vs Reactive fully automated proctoring:

<table>
<thead>
<tr>
<th>Type of proctoring</th>
<th>Proactive proctoring</th>
<th>Reactive proctoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example Vendors</td>
<td>ProctorU</td>
<td>ProctorFree</td>
</tr>
<tr>
<td></td>
<td>Kryterion</td>
<td>ProctorTrack (Verificent)</td>
</tr>
<tr>
<td></td>
<td>Softwaresecure</td>
<td>Proctorio</td>
</tr>
<tr>
<td></td>
<td>PearsonVue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Examity</td>
<td></td>
</tr>
<tr>
<td>Proctoring performed by?</td>
<td>Proctoring performed by human proctors.</td>
<td>Performed by software in a fully automated manner. The software performs the authentication and monitoring via web cam and microphone. There is no human engagement during the process but the test administrator has to review the exams after the time</td>
</tr>
<tr>
<td></td>
<td>Humans do the authentication process and monitoring via web cam</td>
<td></td>
</tr>
<tr>
<td>Can the Proctoring session be Recorded?</td>
<td>The session can be recorded for review afterwards which provides additional quality control if needed</td>
<td>The authentication process and monitoring process is recorded for review afterwards</td>
</tr>
<tr>
<td>Recording viewing Capabilities</td>
<td>If the recordings are available they can be reviewed in their entirety by the institution afterwards.</td>
<td>The recordings are reviewed in its entirety or by looking only at the highlighted anomalies flagged by the proctoring software. They can be reviewed in its entirety if desired.</td>
</tr>
<tr>
<td>Quality control responsibility?</td>
<td>Shared. The proctor can correct behaviours as they happen. The proctor is the judge and the jury SoftwareSecure (2015) but can defer incidences to the educational institution</td>
<td>The onus is completely on the education institution to review the suspicious activities by looking at the recordings after the exam</td>
</tr>
<tr>
<td>Timeliness in dealing with suspected cheating incidences</td>
<td>The proctor can deal proactively with potential cheating incidences nipping incidences in the bud before they escalate. However the proctoring company can also involve the institution either immediately or submit a report afterwards for any suspected violations</td>
<td>Cheating incidences can only be dealt with after the time once the recordings have been reviewed and have to be deal with by the institution. The proctoring company has no input into the cheating incidences other than have the software controls to flag suspected incidences</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Human proctoring has to be scheduled</td>
<td>Can be run anytime on demand</td>
</tr>
<tr>
<td>Costs</td>
<td>Costs tend to be higher than fully automated proctoring</td>
<td>Costs are less than human proctoring. They are also a flat rate per hour not incrementing for longer</td>
</tr>
<tr>
<td>Type of proctoring</td>
<td>Proactive proctoring</td>
<td>Reactive proctoring</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Costs will scale incrementally with costs starting around $15 per hour and could rise to $20 per hour thereafter.</td>
<td>exams</td>
<td></td>
</tr>
<tr>
<td>Scalability</td>
<td>It is not as scalable as fully automated proctoring as the proctoring is entirely dependent on human proctors.</td>
<td>Since no human proctors are required to watch the exam in real time and students can sit the exam anytime it is more scalable.</td>
</tr>
<tr>
<td></td>
<td>There may be limitations on the number of exams that can be run at the same time as this depends on proctor availability.</td>
<td>There is no limit on the number of exams that can be started and run at the same time.</td>
</tr>
<tr>
<td>Quality control dependencies</td>
<td>The quality control is dependent on the diligence and training of the human proctor (From Survey results)</td>
<td>The quality control is dependent on the software's ability to track cheating incidences called anomalies AND the diligence of the educational institutions test administrator to follow up and track the anomalies afterwards</td>
</tr>
<tr>
<td></td>
<td>It also has a dependency on the web camera field of vision. But this can be mitigated by a diligent proctor.</td>
<td>The quality control also has a dependency on the web camera's field of vision together with the software's capability.</td>
</tr>
<tr>
<td>Devices and technology used</td>
<td>Web camera, pc microphone and in some cases facial recognition software, Finger print scanning</td>
<td>Web camera, pc microphone, advanced technology facial recognition, keyboard input patterns, mouse controls</td>
</tr>
<tr>
<td>Authentication mechanism</td>
<td>Human proctor requests for government issue ID and compares to records on file. Can also use fingerprint scanning or facial recognition software in conjunction with the software. Unique questions from Axiom</td>
<td>Software requests student to show government issue ID, and using facial recognition software the image is compared to previous ID logged</td>
</tr>
<tr>
<td>Type of proctoring</td>
<td>Proactive proctoring</td>
<td>Reactive proctoring</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>database in the USA can also be asked from to validate US citizens.</td>
<td></td>
</tr>
<tr>
<td>Replication of</td>
<td>Vendors claim that this approach mimics the traditional exam monitoring</td>
<td>Extremely advanced and leverages cutting edge technology. However very dependent on software and detection algorithms. As technologies advance may become better than traditional invigilation controls</td>
</tr>
<tr>
<td>traditional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>invigilation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Similarities and differences in proactive, live proctoring vs reactive fully automated proctoring

5.5 Online proctoring service agreement

This is a document which is drawn up by the proctoring company’s legal department which has to be signed by the relevant authorized person in the testing institution. This specifies the terms of service, charges and capabilities. It is important that this document is scrutinized by the institutions legal department and the faculty heads to ensure that terms and conditions provide a clear framework in the event of a legal dispute or claim by either student or institution. The OLP Company will ask to have the service agreement signed before they are prepared to conduct a proof of concept.

Live proctoring or fully automated proctoring do not have significant difference between the service agreements. Three OLP service agreements are shown in Appendices Q, R and S.

5.6 Online proctoring software

This section discusses the software that is installed to facilitate the OLP installation. Live OLP is discussed separately from the fully automated OLP.

5.6.1 Live proctoring software

This section discusses software that is utilized and installed to facilitate the OLP for live proctoring. There are a number of steps involved:

1. The institution has to register with the OLP Company before students can access or test the software.

2. The OLP company then provides an external portal with a unique URL address which the institution forwards to the for student registration
(ProctorU, 2011). For example the ProctorU’s sign up site for CIT is https://www.proctoru.com/portal/cit. If the test is integrated with the college LMS this will be embedded and the LMS access point will point to the relevant URL.

3. The student then goes to the portal, selects the exam, and selects the date and time he or she wishes to take the exam and this is confirmed back in an email. The date and time is provided in parameters set out by the institution.

   The student is now ready to sit the exam.

4. At the time of the exam the student connects to the OLP exam monitoring portal which could be a different URL to the one provided for the OLP registration e.g. in the case of ProctorU http://go.proctoru.com. The instructions are “click on the blinking button, asking you to “click here to start.”

   Some vendors like SoftwareSecure have indicated that the students have to launch the exam from a dedicated portal specifically for the exam. The students for exam take the exam in the OLP browser. Delivering the exam in their browser makes it a lot more secure because they can close unsolicited application or stop them altogether. For example if a student is doing a closed book exam and wants to launch a screen recording tool, they can prevent that from happening. If you did it the other way allowing it to be launched from example blackboard they have to give up a certain amount of security and that is not acceptable (Bellefeuille- SoftwareSecure, personal email communication, 2015 Appendix O).

5. When connecting to the portal an applet is installed that enables the web cam; microphone and chat capabilities. This facilitates the online proctor to connect to the student and to monitor the student actions via web camera and to see the student’s actions on the desktop ("ProctorU’s new rules", 2015).

6. The proctor may then ask the student to install a further application. Examples of this are customized versions of logmein. This allows the proctor to then see the student desktop as if he were sitting next to the student looking over his shoulder ("ProctorU’s new rules", 2015). The online proctor uses this in conjunction with the web cam and microphone to monitor the student during the exam. The software does not allow the proctor to see the student PC files or applications but only allows the proctor to see what the student is seeing on the personal computer desktop.
7. The proctor will then perform the initial authentication (discussed in 8.4.1) this step may require the student to respond to pop up questions to verify the student's identity.

8. During any time that the web camera or microphone is not operational there is a text box chat window that allows the student and proctor to communicate. If for some reason either the web camera or microphone is not operational the software allows the proctor to chat to the student using the text chat facility, to ask the student if he or she may take over PC controls and do low level technical support and fix the issue. The reason for the remote control capability is that the OLP company wants to ensure the student focuses on the test and does not get distracted with having to resolve any technical issues that are required to do the proctoring (ProctorU Educational Seminar, 2011).

5.6.2 Fully automated Proctoring software

Vendors like Proctorfree and Proctorio who provide a fully automated service, claim that all the student needs is a computer, the standard microphone and a standard webcam and that their application runs on a modern browser and does not require any additional download or installs. This is because the like of Proctorio use HTML5 and Javascript ("Scalable Online Proctorless Software", 2016).

Once the student connects to the vendor's web site, the software goes through the sequence of authenticating the student. It is all automated so there is no human intervention required. As discussed in 8.4.2 above the software has algorithms that flag certain anomalies and pair that to the recorded session.

5.7 Authentication and identity verification process:

This section discusses the authentication and verification processes in live and fully automated proctoring.

The USA Higher Education Opportunity Act of 2008 (PUBLIC LAW 110–315 Higher Education, 2008) states institutions offering online courses have to have processes in place to verify that a student who signs up or registers for a distance education course is the same student who completes the program and receives the academic credit. The
following two sections 8.7.1 and 8.7.2 outline how live and automated proctoring works to achieve that.

5.7.1 Live proctoring authentication and identity verification process.
In OLP the first step after ensuring that the proctoring software is operational, is the remote proctor validating the student identity. This is done when the remote proctor asks the student for a photo ID. This requires the student showing the proctor a passport, college ID or drivers licence which the proctor validates using the web camera. It could also involve using BIOMETIC validation techniques like finger print scanning or facial ID recognition, whereby the student would have provided BIOMETRIC data on registration and the proctor uses a device to check this against the registration data.

An example of this is the device Softwaresecure call the “Remote Proctor PRO” which is an integrated solution with hardware purchased independently that provides a 360 degree view of the exam environment and has biometrics to authenticate the identity of the student ("Software Secure Solutions | Remote Proctor Pro", 2016).

Some vendors ask you to sign your name with a mouse, as every time you do this it is unique and is tied to your identity. Others ask you to type a particular sentence and apparently every time you do this it is the same and uniquely identifies you. The problem with these methods is they are unproven (Bellefeuille, 2014).

Additional authentication steps that are performed in USA is the proctor could ask the student to complete further user authentication questions that are pulled from US national Axiom database (ProctorU, 2011). This pulls unique information about that person, the place they lived last and the year they graduated. This ensures that the student registered for the course, matches the student taking the test.

5.7.2 Automated authentication and identity verification process
Once the student connects to the fully automated proctoring website and has the camera and microphone operational the student authentication process starts.
ProctorFree (2014) calls this credentialing. The student is asked to capture a photograph of themselves, e.g. press the spacebar when you are in focus. The student is asked the question via text, "does this show a clear picture of yourself, and if your face is visible side by side in the frame and is your name readable on your picture ID". The photograph while low resolution can be compared with the user to confirm some characteristics and also that the system can compare this to previous credentialing systems if used before (ProctorFree, 2014).

The student is then asked to enter the first and last name as it appears on the student records. They are then asked to press on the record button in the browser and read a prescribed passage. This says "I am about to take a time proctored exam. I understand that my actions are recorded and that I agree to submit this recording and evaluation as part of my institutions honour code. I attest that the test I am to take is the result of my own study and preparation and that I will not cheat or attempt to circumnavigate this test or its monitoring on penalty under my institutions honour policy" (ProctorFree, 2014).

![Image of ProctorFree interface]

**Figure 7: Steps taken to verify student identity (ProctorFree, 2014)**

Once this step is completed the student can start the exam and the student’s actions are recorded and in parallel the software algorithms are tracking anomalies as described in section 8.4.2 above. This is all then made available to the test administrator in the recorded session afterwards.

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Proctorio have the following verification options:

- **Verify Video**: Ensures the student image is centered and the lighting is good or not pointing the camera to the ceiling.
- **Verify Audio**: Ensures the microphone is set to the correct volume to hear someone whispering and pick up background noise.
- **Verify Identity**: Requires the student to present a photo ID and uses facial recognition to confirm the ID matches the person in the camera, to be reviewed by the test administrator later.

These options determine what will be verified prior to the exam.

*Figure 8: Proctorio's options for verifying student identity ("Scalable Online Proctorless Software", 2016)*

Verify video is to ensure the student image is centered, lighting is good or not pointing to the ceiling. Verify audio ensures the microphone is set to the correct volume to hear whispering and pick up background noise. Verify identity requires presenting a photo ID, using facial recognition to confirm the ID matches the person in the camera, to be reviewed by the test administrator later. These are part of the settings in the Proctorio profile that the test administrator or lecturer would set up before the time.

Proctorio also verifies the student's location via IP address and compares it to the known address of the student. If there is a mismatch, it will contribute to the validity profile of the student ("Scalable Online Proctorless Software", 2016).

### 5.8 Room check procedure

This section discusses the room check procedure. The scenario is this: The student ideally is at home or at work in a suitable room free of devices or materials that could provide help or assistance. In the case of CIT, this is to ensure compliance with CIT's code of conduct for examination guidelines (Code of Conduct for Examination Candidates, 2015). This means students should not have books, bags, notes, or any unauthorized material without the invigilator's approval. It explicitly states that "MOBILE PHONES, ELECTRONIC DEVICES (except pocket calculators) or MOBILE COMMUNICATION DEVICES ARE NOT PERMITTED IN THE
EXAMINATION HALLS.” OLP should then aim to meet the same exam requirements and for this a room scan is an important part of compliance with exam regulations.

5.8.1 Room check procedure with live proctoring

After the student verification process has completed, the proctor will check the room and environment to ensure this meets exam standards. The proctor will ask the student to scan the room with the webcam and may ask to remove items like phones or flowers from the room. A vase with flowers may contain a remote connectivity device. The proctor may also ask the student to use a reflective object like a mirror, reflective iPhone or DVD to scan the screen from the users’ perspective to verify that there are no sticky notes pinned to the screen edges. They may also ask to look under the desk. This process could take 15 – 30 minutes and this extra time has to be factored in when planning the exam times. It is important also that the student be informed that the test will start after the authentication, verification and room checking process has completed. If the session are to be recorded, the student also needs to be informed prior to the exam taking place.

If this is the first time the student is using the proctoring process then it is best that additional time has to be factored in. The reason for this is the first time the student uses the facility the student may have a problem with ports that are being blocked or may have a microphone which is not correctly enabled. This will take additional time to resolve.

5.8.2 Room check procedure with fully automatic proctoring

In this case the student will be connecting to the proctoring portal without human intervention. With Proctorio the examiner has the option to select the room record option when setting up the test conditions in the portal.
This will then cause the automation software to ask the student to pan the room with the web camera which will be recorded for review by the institution examiner. This procedure is however entirely dependent on the student diligence in doing it. When asking Proctorio about this and how to overcome this loophole, the answer was the institution examiner should have communication prepared and sent to the student to ensure that if this option is selected, the expected operation is performed with diligence so that the student can present to the institution that all reasonable doubt is removed ("Scalable Online Proctorless Software", 2016).

At the time of writing it is not known if Proctorfree or Proctortrack have the record room capability.

5.9 Monitoring process

After the initial verification and room checking process the student has to be monitored while conducting an online exam. A case in point as applies to the CIT exam policy is:

"It is generally not permitted to access any sources of information during an examination, such as books, study notes, the internet or another student's work. Exceptions to this will be clearly identified in the programme guidelines.

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Communicating with others during an examination: It is generally not permitted to communicate with any third party during an examination except for the examiner and/or the invigilators."
Malfeasance: It is not permitted to commit any act which is intended to subvert the fairness and integrity of the Institute's examination and assessment processes. Examples of actions that fall under this heading are obtaining an examination paper in advance of the examination and impersonation of an examination candidate.

Electronic Devices: Due to the fact that electronic and communication devices such as MP3 players and mobile telephones may be used to facilitate infringements, all electronic and communication devices, apart from authorised calculators, are prohibited in all examinations. It is important to note that the possession of the device during an examination is prohibited and not just its use.” (Code of Conduct for Examination Candidates, 2015).

If utilizing an OLP company, it needs to be demonstrated that OLP can stand up to these guidelines.

5.9.1 Live online proctoring monitoring

According to Schulson (2014) this is the process whereby the remote proctor monitors the student screen activities and physically monitors the student's face, eye movement and activities in the room using the web camera. The students desktop would also be monitored.

When setting up the session the proctor would ensure that the whole of the students face is in the field of vision. The application installed allows the proctor to see the student's desktop. Some proctoring companies support two monitors or dual screens but this needs to be checked ("ProctorU: Overview and Technology Requirements", 2016).

The proctor may be supported by facial recognition software, internet blockers, network tracing to see what the student is accessing. The remote proctor will respond or note any anomalies or suspected cheating as per the service level agreement. If an incident occurs the proctor will log the incident and provide a report ("ProctorU: Overview and Technology Requirements", 2016).
5.9.2 Automated proctoring monitoring, testing incidences or anomalies

Automated proctoring used test incidences during the authentication process or during the test itself that are tracked either by proctor. These are incidences whereby the quality control of the test scenario may be compromised. Examples are:

- A person walking into the room while the student is doing the online test.
- The student has his phone or a second laptop on the desk
- The student’s eye movement is abnormal. He or she is constantly staring at a location away from the screen.
- The existence of remote control software is found on the student’s computer.

The student is accessing books or paper and this was not set out in the exam descriptor.

5.10 Quality control incident tracking

There are two methods of dealing with quality control issues during live OLP. This is specifically when dealing with incidents that could result in them being classified as cheating and violating the exam quality control standards. As the OLP company is a third party company offering a proxy quality control service, it merely notifies the exam body of suspected violations and provides the facts for the exam body to take action. The way the proctoring service functions is it can operate in a near real time proactive mode or in a time delayed mode and the type of proctoring selected will determine this ("ProctorU: Overview and Technology Requirements", 2016).

Live proctoring allows the proctor to question the student about actions that may arouse suspicion. The proctor may see a phone on the desk and prevent a student from violating the exam regulations. The student may be told that is not allowed and if you proceed it will be logged as a violation and your school or institution will be informed. If an exam violation occurs then the exam institution can be alerted immediately if a candidate is suspected of cheating. However the exam institution may have indicated that it chooses to be informed after the time by the means of an incident report. This detail is specified in the OLP Service agreement see Appendices Q and R. It is important that institutions identify what method of quality control would meet the internal exam bodies’ legal requirements.
5.11 Online proctoring fees

This charge is normally defined in the Proctoring Service agreement. The Proctoring Company will have a cost table which defines the test time period and the associated cost. The costs are normally defined according to the test duration and will fall into a defined cost category.

Fully automated proctoring fees tend to be a flat rate charge per hour whereas live proctoring hourly rates increment per hour as can been seen from the two examples below from a fully automated OLP company- ProctorFree.com and a live OLP company - Kryterion.

<table>
<thead>
<tr>
<th>Exams</th>
<th>Price Per Exam</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>$15</td>
<td>$225</td>
</tr>
</tbody>
</table>

Figure 10: Fees quoted for automated proctoring an exam (Appendix R)

<table>
<thead>
<tr>
<th>Exam Duration</th>
<th>Standard Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 60 minutes</td>
<td>$14.00</td>
</tr>
<tr>
<td>61 to 120 minutes</td>
<td>$19.00</td>
</tr>
<tr>
<td>121 to 180 minutes</td>
<td>$24.00</td>
</tr>
<tr>
<td>181 to 240 minutes</td>
<td>$29.00</td>
</tr>
</tbody>
</table>

Figure 11: Fees quoted for live proctoring an exam (Appendix Q)

At a high level, the education institution could take one of two payment models. It could choose to pay all fees involved with OLP and the fees would be absorbed into the overall course charge. The second model is that the student would be responsible for payment of all proctoring fees. Whatever model is selected this has to be communicated clearly to the student.
A ball park starting figure for an exam is $15 per exam per student per hour. Depending on the cost model, the student could also be expected to pay an optional fee for one of the following: registration fee or a take it now or take it soon fee and can be made chargeable to the examinee or the institution.

These charges are normally paid by credit card but could be billed electronically by email or billed and paid online via a portal.

The testing institution needs to discuss all possible charging scenarios with the registrar and students because instances have happened where fees are agreed and then a scenario arises where students may be faced with a charge to register. If this was not agreed beforehand it can cause delays or unnecessary student confusion and dismay and will distract the student from the exam task at hand.

5.12 Exam instructions or assessment directive form

The OLP company has to know what the exam stipulations are so as to ensure that quality control standards are adhered to.

The OLP company will either send a form for completion by the institute or provide access to a portal that allows the institution to upload or specify the exam instructions.

The document with the exam instructions is called the assessment directive form (ADF) as seen in Appendix Q for Kryterion exhibit C.

The proctoring company sends this form to the examination institution or department for completion. It describes the special instructions pertinent to the exam, the student resources permitted and the exam procedure. It also contains the contact details for assistance with exam questions, who to contact if there are issues with the exam and exam time limit.

This is an extremely important document and imperative that this is filled out accurately as all test procedures are taken from this document. In live proctoring, proctors deal
with multiple different institutions’ test cases daily so exam procedures and instructions need to be clearly spelt out and checked before the first test or exam proceeds.

Figure 12: Assessment directive details (Appendix L 23/10/14 Exam instructions)

The following is an example of how a portal can be setup for a site offering fully automated proctoring. This example is taken from ProctorFree.

ProctorFree provide a portal that facilitates the examiner to enter the test criterion. This allows the examiner to specify if the user may or may not open an additional browser or if there is a specific site that the examinee may use. It also allows the test administrator to specify any of the possible exam violation criterion set out in 8.4.2.1 above.

Figure 13: Assessment directive settings in ProctorFree’s portal (ProctorFree, 2014)
5.13 LMS integration

Some proctoring companies’ solutions integrate or plug in with institutions’ course management system (CMS) or learning management system (LMS) or can be operated independently. The objective of integrating with the LMS is to allow easier administration, and when configured allows scheduling and launching the test from the student LMS portal. Online payment can also be done if the student is responsible for the test payment.

This integration feature is enabled via a vendor specific OLP plugin that has to be installed into the LMS (BVirtual BlackBoard demo, 2014).

5.14 Online proctoring portal

Some live proctoring companies have a web portal that allows the test institution to see student exam registration and do exam progress monitoring. This allows the lecturer or teacher to see which students are registered for the test. When the test starts it also allows the course lecturer to see which tests are still in progress and which students have completed their tests (Kapanjie, 2015). The ADF specifications will also be viewed in this portal.

A proof of concept was conducted with an OLP company that did not provide portal capabilities. The ease of administration was markedly improved when conducting a proof of concept and scheduling further exams with an OLP company that had a student exam tracking portal.

There was a great deal of time consuming email exchanges and phone calls with the OLP vendor that did not provide a portal whereas the time spent setting up and tracking the exams were significantly reduced with the latter.

A college in the United States indicated that this was one of the main differentiators in choosing an OLP company. The ability to use a portal to do the following was what made them choose the particular live OLP company (Kapanjie, 2015):

- Manage an OLP exam from the company portal or web interface. Not having to depend on filling out excel sheets and emailing them to the OLP Company was a major decider (Kapanjie, 2015).
• Have settings or rules that apply to the exam and not to the whole college (Kapanjie, 2015)
• The ability to upload a formulae sheet knowing that all the proctors would get this at the start of the exam and not having to email the proctoring company hoping that the proctors will get the relevant document (Kapanjie, 2015).

5.15 Roles within the proctoring company

These roles were obtained from communications with a number of various different proctoring vendors and are generalized where possible. The objective of stating these roles is to ensure communication is with the correct person. One of the deciding factors stated by universities selecting an OLP is responsiveness of the management and key stakeholders in the company (Kapanjie, 2015).

Regional Partnership manager / Partner relations manager or Director: (L Brymer, personal communications, April 2015)

This is the main point of contact for any institution wanting to utilize an online testing service and is the person that will be the first point of contact and will work with the institution to negotiate and setup the partnership agreement and test rates. This is the person within the organisation that you will escalate to if any issues arise, once you have entered into an agreement to using their service.

Client experience Co-Ordinator: This person assists with administrative questions and issues before the exam is scheduled. An example of this is: the test institution or online lecturer running the online program will contact the client experience co-ordinator if a problem exists accessing the online portal that shows student registrations or if a student has issues registering for on online exam that has been scheduled.

Assessment Services Co-ordinator: This is person who co-ordinates the proctors operations during the online exam while students are taking the institutions online exam. For example, if online exam proctors are having an issue with the exam or there are questions about the exam then the assessment services co-ordinator will contact the lecturer or institution for clarification or resolution.
Quality control Co-Ordinator: The person that will contact the lecturer or institution when a quality control issues have emerged and a student is suspected of cheating.

Billing Co-Ordinator: The person that contacts the institution for payment once testing has concluded.

Online proctor: The person employed by the OLP vendor who connects to the student over the internet using the student webcam and microphone and acts as an invigilator. The online proctor has a number of functions. The first is to perform the student verification and authentication process before the start of the exam. The second is to check the room to ensure it is suitable, that no other person is in the room and that there are no devices, like phones or other computers that could cause the student to violate the exam standards. The third is to monitor the student during the exam. Online proctors are also well trained to deal with technical issues that the student may run into when connecting to the proctoring service or issues during the exam. For example, why the student may have issues installing the OLP software, why a web camera may not work, why the student’s microphone may not work. The online proctor will also perform environment checks to verify that the room the student is using complies with the exam regulations and that the student does not have a phone or another PC in the room.

The online proctor will be monitoring more than one student at a time. The number of students proctored can vary between 4 and 8 at any time. Online proctors tend to be well trained and can have up to 100 hours of training although at this stage there is no certification program for them.

In fully automated OLP no human is involved in the proctoring process. The online proctor is all automation software that authenticates the student through the web camera and microphone and records and monitors all student activity during the exam, highlighting any anomalies that may occur.

5.16 Online tests and integration with online proctoring

This section discusses the types of testing that can be used with live or human proctoring.
The following table is intended to be used as a generic guideline based on research and is compiled to list test or exam types and their suitability to online proctoring. Institutions may have unique requirements, however, and these would have to be checked individually with the OLP vendor. The individual items are discussed in more detail after the table.

<table>
<thead>
<tr>
<th>Exam Description</th>
<th>Exam condition</th>
<th>Suitability to live proctoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer based MCQ’s Quizz or MCQ test in Browser</td>
<td>Only one browser window open with the MCQ quiz or test.</td>
<td>X</td>
</tr>
<tr>
<td>Computer based essay completion or financial analysis</td>
<td>Only the application like word or excel open in addition to the electronic test paper. Other apps and browsers closed. (no scratch paper)</td>
<td>X</td>
</tr>
<tr>
<td>Hands on lab configuring computer equipment through a GUI or terminal window</td>
<td>Only the console applications open, or the virtual machine interfaces. May contain virtual machines and multiple layers of machines</td>
<td>X</td>
</tr>
<tr>
<td>Open book exam’s</td>
<td>It depends on if open book is electronic documents or an electronic manual. If printed material then would have to be discussed with the proctoring vendor</td>
<td>Depends</td>
</tr>
<tr>
<td>Exams with scratch paper</td>
<td>The same conditions would apply with the addition of allowed scratch paper</td>
<td>cheating would be very hard to monitor and determine in this instance but would have to be discussed with the OP vendor</td>
</tr>
<tr>
<td>Pencil and paper tests</td>
<td>Student answer paper needs to be completed</td>
<td>Very specific use case and</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Exam Description</th>
<th>Exam condition</th>
<th>Suitability to live proctoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vendor needs to be contacted</td>
</tr>
<tr>
<td>Oral exams</td>
<td>Tester and student having to talk to each other</td>
<td>X</td>
</tr>
<tr>
<td>Practical work exams, like medical</td>
<td>Tester and student having to talk to each other</td>
<td>X</td>
</tr>
<tr>
<td>observations or piano playing exams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or more students in 1 room</td>
<td>A classroom of students sitting an exam</td>
<td>X</td>
</tr>
</tbody>
</table>

*Table 7: Summary of exam type listings and suitability for OLP exams*

**Discussions that follow on from the table summary.**

Examinations with questions that requires computer input via keyboard or mouse, are generally online proctor capable. Computer based exams are a broad term used to mean client server based exams but now days can mean exams offered through a web browser whereby the examinee answers questions in either a MCQ or text box or simulations. The results could be made known immediately on completion of the exam or the results marked by the teacher. These are all generally suitable for OLP.

The OLP can implement what is known as a lock down browser which limits the exam session to a single browser session with the test session allowed URL.

Online exams whereby the student has to complete an electronic document can be proctored in the following manner. SoftwareSecure offers SecurExam whereby the student providing access to a secure work processor and spreadsheet for essay formatted or statistic-centric examinations prevents access to illegal external resources by locking down the test takers OS (“A Comparative Look at Online Test Proctoring Models”, 2016).

Another example would be essay exam types which are a form of electronic document completion. In an essay type of document students can write the essay in a word processor and save and submit to the online proctor who can forward to the SME for marking.
It must be noted that any computer based tests, in particular Maths or any other tests that allow the use of scratch paper are very difficult to fairly monitor to ensure quality control is maintained while proctoring. If allowing someone to use scratch paper it is very difficult to know via a web camera that the person is using scratch work or does not have any other paper with answers (ProctorU, 2011).

**Complex practical exams.** In lab exams there are a number of scenario’s that are listed below:

- Students from a single computer are expected to configure a physical lab, using terminal consoles and graphical user interfaces.
- Students from a single computer are expected to connect to multiple virtual machines and configure an IaaS virtual lab infrastructure.

Where the labs are all configured from a single computer, this can be proctored online with human proctors. Some OLP companies have indicated that they are reluctant to take on this complex exam scenario. The reason for this is having so many where multiple virtual machines and consoles is difficult to track. The proctor will find it difficult to know what is allowed and what violates the exam conditions.

**Open book exams,** fall into a very grey area. The exam could be proctored online but the value of quality controls would be very much dependent on the open book material. If this is an electronic manual or e-book that the student needs to have, if this is specified and listed and no other physical material is allowed then this would be suitable for OLP. If physical books or papers were allowed and the exam could be compromised by an answer sheet slipped into the other documents, then this would be very difficult to monitor though a web camera. The student would be looking down at the papers from time to time and the proctor would not know if they are looking at permissible material or not.

There may be instances where a test could fit OLP but may produce quality control risks. The institution could then work with the OLP Company to modify the test and test constraints to suite OLP.
**Pencil and paper tests.** For situations where pencil and paper testing is the only option, Kryterion has the capabilities to create paper and pencil test forms, provided the student or students have a printer available. They facilitate administering the test using the print out facility from word or utilizing a third party system such as Scantron® to gather and collate test results, although this test method is not that common. However this is an edge case example and would require further discussion with the vendor.

Oral exams and observation exams like examining medical procedures don’t suit the OLP environment.

**If any of the following items are true then online proctoring is not recommended.**

1. Mathematical tests or any testing that requires the student to use scratch paper would make the value of using OLP questionable because the quality controls under these circumstances will be diminished. The live proctors or automated software will not be able to differentiate and check that students have not brought answers into the exam.

2. If students live in a rural area with low bandwidth connectivity, for example bandwidth that is lower than 1 MB/sec upload and download speed then OLP will not be successful. Some vendors quote min upload and download as 300Kb/sec and latencies of 1000 ms⁻¹, but this is not recommended as many technical issues and constant disconnects may potentially occur.

3. OLP whereby students have to leverage the mobile networking is not recommended.

4. If students have stress anxiety caused by tests then this may need to be considered.

5. If institutions, students or businesses do not allow photographs or facial imagery then OLP will not work.

**Factors that may pose a major risk to a particular online proctoring model deployed**

For institutions or businesses that have privacy concerns or data confidentiality concerns, the OLP data storage model needs to be considered. For example if a business indicates that student data photographs or imagery may not reside out
of country, then the OLP vendor may or may not be able to provide this capability depending on where their data is stored.

5.17 Starting the online proctoring company selection process
Before starting the process of selecting an OLP company it is important to:

- Discuss and identify the preferred quality control incident tracking process with the exam body as this could save a great deal of time having to go back and renegotiate agreements or having to choose another OLP vendor could be very time consuming.
- Review the OLP company’s website to review all the types of offerings available. It is important that the OLP company caters for the particular test use case that the institution aims to use.

Call the proctoring vendors sales department

5.18 What to look out for, questions to ask and why
How does the educational institution register with the OLP company?

The proctoring company should explain how an institution registers and discuss legal documentation that needs to be signed. Once the education institution has indicated a desire to run a proof of concept the OLP company will ask the institution to sign an OLP Service agreement. This document outlines the legal framework.

What are the exam fees and how is this calculated and how is payment made? Define the cost structure? Is this a flat rate or is this linked to a particular proctoring ratio? Are there hidden costs. Are students expected to pay a late registration or late for exam fee?

These are important questions to ask early on. The proctoring company should be able to provide a table demonstrating the fee paying framework. This will be in the order of $15 per hour of exam per student and may increase depending on the proctoring to student ratio's and the authentication methods used. If biometric validation is used this will cost more and the cost structure needs to be discussed in detail. It is also important that students be made aware of the fact that they may incur late registration fees or late for exam fees. The
educational institution may want this waived and may choose to absorb these types of fees.

Give an overview of the OLP process?

This is important to get an overview of the OLP company. Capture a flow of the process which should include an overview of a) how the student connects to the proctoring company and b) how the proctor connects and communicates to the student, c) dealing with potential issues at this stage, d) the authentication process, e) the student environment validation, e) the exam start, f) the exam processing and proctoring.

What are the functionality and performance requirements?

The OLP vendor should be able to provide detail on the minimum bandwidth required, the student operating system supported, the Browsers supported and browser functionality, the devices needed like for example the web camera and the microphone requirements. Some proctoring companies require students to have web cameras that are detached and separate from the personal computer. The ports on the student broadband device that need to be open also need to be disclosed.

How are issues with the student connection dealt with? What decides if an exam is go/no go and how does the student reschedule?

The student may face technical issues when connecting to the proctoring portal to do his online exam. The proctoring company should have these procedures defined. They should be able to demonstrate that the proctors are able to deal with technical issues, that they follow a series of trouble shooting processes and provide the most common causes of issues. For example if the student's microphone does not work the proctor can still communicate with the student via chat, but if the microphone cannot be made to work the exam should not go ahead as the proctor will not be able to listen to ambient noise and hear when for example a hidden phone may ring. Another scenario is the student may have ports blocked on his or her home router and how to resolve this. The proctoring vendor needs to be able to provide the steps then that need to be followed when the student needs to reschedule the exam and whether or not this is in the
bounds of the exam. This needs to be available to share with the students to ensure they take all steps necessary to prepare their student personal computers for an error free exam. Proctoring companies generally have a portal that allows you to check your device now, so that the students can verify that all necessary ports are open, that their web cam is functional and that the microphone is operational, before the start of the exam.

Describe the student authentication process? What form of documentation does the student have to provide to identify himself/herself? What student authentication abilities exist?

Why is this important? The OLP Company should be able to provide detail on the exact steps followed to perform the student authentication process, what documents the student is asked for, how this is validated against the student taking the test. This should also outline the steps taken if the proctor suspects fraud. Is the exam allowed to continue and the proctor alerts the educational institution exam administrator after the time or is the exam administrator alerted immediately.

Does the authentication process provide the capability for biometric identification?

Some educational institutions may require the highest form of student authentication to have the lowest risk and take all steps known to mitigate breaches. Biometric identification is currently the most secure way and proctoring companies should be able to facilitate this capability if required.

Are the images for the student authentication process stored by the OLP company to be viewed by the institution exam administration after the time and if so, how are they accessed, where are they stored and are they encrypted?

The proctoring company should be able to provide a mechanism to facilitate the lecturer or exam administrator needing to validate and verify that the students signing in are indeed the students who are registered.

The image below shows a particular student who has taken an online exam and allows the test administrator to check the student ID against the college records which normally contain a photo ID.
OLP companies normally have a portal that the administrator authenticates to, that allows this. The security protection mechanism and the encryption methods, to ensure the data is not readable if copied, should be made available.

What portals are made available to track student registration and exam start and completion?

Why this is important? The OLP portal makes the administration of exams much easier. They can allow you to view scheduling of exams, monitor the students registering for the exam, and then that they have the capability to monitor exam progress and completion through the portal.
<table>
<thead>
<tr>
<th>Exam</th>
<th>Term</th>
<th>Instructor</th>
<th>Type</th>
<th>Next-Takers</th>
<th>Status</th>
<th>Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFT8019 Data Centre Virtualisation - Practical exam</td>
<td>Semester 2</td>
<td>Gordon O'Reilly</td>
<td>Classic</td>
<td>9</td>
<td>Active</td>
<td>04/08/2015</td>
</tr>
<tr>
<td>OSM8082U (Practical Text)</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Figure 15: Online portal showing the number of students registered to take the exam

<table>
<thead>
<tr>
<th>Exam</th>
<th>Term</th>
<th>Instructor</th>
<th>Type</th>
<th>Next-Takers</th>
<th>Status</th>
<th>Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFT8019 Data Centre Virtualisation - Practical exam</td>
<td>Seminar</td>
<td>Gordon O'Reilly</td>
<td>Classic</td>
<td>9</td>
<td>Active</td>
<td>04/08/2015</td>
</tr>
<tr>
<td>OSM8082U (Practical Text)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 16: Online portal showing the number of students who completed the exam
What are the monitoring capabilities while students are taking the exam? What applications and ports are monitored?
Why this is important? Students need to know the ports that need to be open on their home configuration. This will normally be caught by the pre-test checks that the students perform but it is helpful if it is communicated well beforehand to avoid problems.

Further questions that are useful to ask if relevant are:

Is facial recognition software used and how?
Is keyboard key stroke analysis used and how?
How many monitors are allowed?
How is the web camera used?
How is the student room checked for potential aids?
What type of web cameras are supported?
How does the proctor check behind the student desk, under the desk, and are any plants vases, phones allowed.
What training do the proctors receive?
During an exam session are proctoring change overs taking place?
End user technical requirements need to be discussed.
Is there a maximum time limit for the exam?
What is the evidence of academic integrity demonstrated during the examination process?
What is the process followed during a suspected exam integrity breaches?
Do exam sessions have the capability of being recorded?
If the exam session is recorded where is the recordings kept and what are security measures taken to protect the data? How long is this data available after the exam period? How are they accessed?
What mechanisms are put in place to ensure student ease of use?
What are the processes followed if the student has a technical issue at:
   - The initial stages
   - Authentication process
   - During the exam for example loses connection
   - Indicates that he or she needs to take a washroom break?
### 5.19 Online Proctoring selection Checklist

**OLP selection framework**

<table>
<thead>
<tr>
<th>1.1</th>
<th>What is the name of the proctoring company?</th>
<th>Please fill in the name?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>What type of proctoring service is this?</td>
<td>Live or human proctoring?</td>
</tr>
<tr>
<td>1.3</td>
<td>Has the service level agreement been reviewed and signed?</td>
<td>Yes</td>
</tr>
<tr>
<td>1.4</td>
<td>Signatories for service level agreement?</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>What is the exam type for online exams?</td>
<td>MCQ exam in application</td>
</tr>
<tr>
<td>2.0</td>
<td>Does the online proctor have an external portal that can be used to administer the exam?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.1</td>
<td>Does the exam have to be collected by the proctor?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.2</td>
<td>Exam duration?</td>
<td>..........hours</td>
</tr>
<tr>
<td>2.3</td>
<td>Is the OLP rate a flat rate?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

If yes what is the rate?

<table>
<thead>
<tr>
<th></th>
<th>$ per hour</th>
<th>€ per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the rate is not a flat rate what is the cost student per hour?</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; hour $</td>
<td>€ per h</td>
</tr>
<tr>
<td></td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; hour $</td>
<td>€ per h</td>
</tr>
<tr>
<td># of students taking the exam?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there any additional hidden costs?</td>
<td>Yes</td>
<td>no</td>
</tr>
<tr>
<td>Type of costs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Take it now costs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late fees?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registration?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total costs for # ...... students?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are the quality control measures the OLP company offers?</td>
<td>Authentication via web camera &amp; microphone</td>
<td></td>
</tr>
<tr>
<td>What are the Identification types accepted?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID accepted for authentication</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Passport</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Drivers licence</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>College ID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the OLP proctor to student ratio?</td>
<td>1:4</td>
<td>1:5</td>
</tr>
<tr>
<td>Quality control subjective analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*Table 8: OLP Selection checklist*
5.20 Summary

- This chapter complements the OLP categorization in chapter 4 and provides further detail around the different aspects of OLP.
- Test types from simple to complex and low to high risk needs to be matched to the most appropriate OLP technology.
- Automated proctoring has a lower initial price point but has additional costs that need to be considered as reviewing the recordings can be time consuming and still depend on human reviewers.
- Live proctoring is more suited to high stakes complex online tests whereas automated OLP is very suited to lower stakes tests.
- Where LMS integration is not a requirement a OLP portal for managing student testing is a significant benefit.
Chapter 6: A case study of how online proctoring can improve quality control in an online practical exam

6.1 Introduction
The objective of this chapter is to outline research done in improving quality control for a Cork Institute of Technology (CIT) online exam. This is an exam that is part of the assessment in a module of the MSc Cloud computing online degree ("MSc in Cloud Computing – Cloud Academy", 2016).

The module is called managing virtual environments and the online exam is a particularly complex practical exam ("MSc in Cloud Computing – Cloud Academy", 2016). This case study was initiated because there were perceived quality control shortcomings in the online exam and research was conducted on how best to close these gaps.

This chapter is divided into the following sections.

Section 9.2- Historical perspective.
Section 9.3-How a student connects to the test.
Section 9.4-The post graduate cloud program and why complex lab exams exist.
Section 9.5-Quality control challenges with the online practical exam.
Section 9.6-Defining the problem statements.
Section 9.7 -Proposed solution by:
1) Determining the quality control in the baseline.
2) Surveying the baseline.
3) Defining hypotheses 1 to 6 (H1 to H6).
Section 9.8 –Results of the baseline survey.
Section 9.9 –Researching capabilities of vendors that provide OLP.
Section 9.10 –The Kryterion proof of concept.
Section 9.11 –The ProctorU proof of concept.
Section 9.12 –Experiences with OLP companies that were not successful.

6.2 Historical perspective
CIT offers online MSc and BSc Honours cloud computing post graduate degrees the only non US programme listed by Forbes.com in its round up of online cloud computing programmes (Adams, 2015).
Students from all over the world have registered for this CIT degree. Their location ranges from students in St Petersburg, Russia to Boston in the USA with the majority of the students being in Ireland. The modules are delivered by experts in the cloud industry, and is offered fully online with some of the lecturers not even based in Ireland and not on the CIT campus.

The online delivery tool is AdobeConnect® which facilitates teaching online in a virtual classroom. Students can connect to the virtual classroom and listen to the live online lecture or if they are not able to attend in person then they are able to listen to the lecture recording that is also facilitated by AdobeConnect ®. This is done through a link posted on the CIT Blackboard ® LMS.

6.3 How a student connects to the test

CIT partnered with VMware, the leaders in Virtualization and Cloud computing, to provide a Cloud based infrastructure that facilitates students learning about the cloud using a private cloud infrastructure.

As the students are all remote, a Desktop as a Service (DaaS) infrastructure running on VMware View or Horizon View (as it is now called), is used to provide students a connection to a standard on campus virtual desktop.

Students connect to their own Windows 7 Virtual desktop using a client called the Horizon View client (see Appendix A). The benefit of the Horizon View configuration is that it allows students to connect on campus, using their own devices but it gives them a standardized desktop with all the necessary software and configurations that they will need for the course. This configuration has a number of benefits:

a) It allows students to connect to the campus LAN securely. The student, via the client, uses a protocol called PCoIP or RDP to send screen refreshes only to the student device. The bandwidth requirements to the student’s home device are significantly reduced using this method (Pubs.vmware.com, 2015).

---

2 PCoIP and RDP are remote desktop protocols updating screen refreshes only with very light bandwidth requirements.
b) This ensures students that live in remote areas are not compromised if they have a low bandwidth connection. This allows students to download large files to the virtual on-campus desktop and NOT be affected by slow network response times to their home PC. The only communications between the client and the virtual desktop are screen updates using one of these protocols mentioned above. There are low network thresholds below where this will not work. For most Broadband speeds above 1Mb/s this setup works very well.

c) As they connect to a virtual desktop which is on the campus LAN, they have high speed access to all the campus web services and are not compromised by their own potential slower connection. They can download and copy files to the virtual desktop over the campus network at the campus network bandwidth capabilities. This is significant as it optimizes connectivity to their virtual labs which are discussed below.

d) It allows the student to utilize their own device because the View Horizon client supports a wide number of operating systems and hardware. For example Apple MAC OS’s, Windows OS’s from 98 – Windows 10 and Linux OS’s are supported ("VMware View 5.2 Documentation Library", 2015).

Once the students connect to the Virtual on Campus desktop, one of the services they can access, via a web browser from the virtual desktop, is a virtual lab configuration which runs on an infrastructure as a Service (IaaS) provided by VMware vCloud Director 5.5.

The students connect to this service using a Browser (Firefox, Microsoft Internet Explorer or Google Chrome). This lab service allows the instructor to configure a base lab and then save it as a template which the students can deploy.

The figures below show the templates that are created by the lecturer and saved in a particular state called a template to a catalogue folder. These can then be deployed to what is called a Virtual Appliance (vAPP). A vAPP is a collection of virtual machines which are running applications that jointly form an IT solution ("Virtual Appliances (vAPP)", 2016). This can be deployed as many times as is needed and each student can be given access to a vAPP. Each student has independent access to his own vAPP.
Figure 19 shows the vCloud director interface in the Virtual Desktop and highlighted in the figure in yellow are:

A. "Catalog" (American spelling) folder that contains templates to be deployed.

B. Sample of a template in this case one that was used for a Practical Test.

Figure 19: vCloud director interface in the Virtual Desktop

The next figures show a template being deployed to a vAPP for a student. The name of the vAPP in this case is 2014_PRAC_TEST_FINAL_2014_REV3.

Figure 20: Template deployed to vAPP for a student
In Figure 22 it shows the student’s vAPP name being entered as part of the vAPP deployment.

Once the vAPP is deployed the network configuration and the virtual machines running their corresponding operating systems and applications can be seen in the figure below.

Each virtual machine operating system can be accessed by double clicking on the relevant virtual machine in the vAPP. In the figure above this would correspond to clicking on - for example the ESXi-1 virtual machine - which will open up virtual machine remote console within another browser pop up window as shown in the Figure 24 below.

The security is setup in such a way that the vAPP is fenced off from all network access. Students cannot browse the internet or connect to any external website from within the
vAPP consoles. They can however connect to the internet from their virtual desktop and also from their home computer.

Figure 23: Showing how security is setup so that vAPP is fenced off from all network access

Students can then work in the Brower console and configure the virtual machine as needed as specified by the lecturer in the test or lab exercises.

Summary:

To access the virtual lab:

- Students, from their home computer, connect to a virtual desktop, which is a virtual machine running Windows7 running on VMware Horizon (View).
- They open an internet browser from their virtual desktop and connect to a vAPP that is pre deployed in the VMware IaaS solution.
- They can connect to the console interface of the individual virtual machines in the vAPP by selecting the virtual machine and double clicking on the representative interface of the virtual machine.
- They may have multiple virtual machine console interfaces open at one time.
- Students cannot connect to any network share or internet connection from the vAPP console windows.
- They can connect to the internet from their home computer and from the virtual desktop on campus.
6.4 The post graduate program and why complex lab exams exist.

In both the CIT postgraduate MSc and BSc degrees there is a module on Computer Virtualisation. In the BSc degree this is called "Data Centre Virtualisation" and in the MSc this is called "Managing Virtual Environments". The modules are graded using a continuous assessment model and consists of two written assessments and a practical assessment component which is examined by means of a practical exam ("MSc in Cloud Computing – Cloud Academy", 2016).

The MSc virtualization module practical exam, is a 4 hour exam. This requires students to configure a virtual infrastructure to requirements as set out in the practical exam test (Appendix V). This test can and has been offered online with the students performing this from home, at a set agreed time.

The date and time of the exam is arranged beforehand. At the agreed time the students connect to the prepared vAPP, download the test paper from BlackBoard ®. The students connect to vAPP using the VMware View desktop after they have entered their CIT login credentials. After that they launch the vCloud configuration test from their virtual desktop. The objective of the test is to configure the software in the vAPP to a required specification within the time provided.

6.5 Quality control challenges with the practical exam

Over the past 4 years this test approach, using the online practical exam testing method has been run using the honours based system. It was feared that it would be only a matter of time before students would come up with some free solution on how to crack the practical exam. The examiner’s objective is to ensure that:

i) The students who are registered for the course are the same students that sit the exam.

ii) The student’s true ability to configure the environment is captured. Also this is to ensure that the students that put in the required effort to acquire the skills get the best marks.
It was clear that this approach therefore had security holes and the concern was that quality control could be easily compromised. This case study set out to prove this and to find a potential solution.

There were four key challenges using this method of assessment in an online mode.

i) The students ID authentication and verification. Ensuring students that registered for the module were the same students that performed the test in the online practical exam.

ii) Ensuring quality control during the online exam situation.

iii) Complexity of the exam.

iv) Time duration of the exam.

6.6 Defining the problem statements

This section defines and describes the problem statements that are investigated.

Problem statement 1: Quality control in an online exam situation

As the students were spread out across the world it would be optimum for them to access the exam from home to optimize their travel time and cost and to reduce the college test administration overheads. That means that if the lab practical test could be arranged from home, for the student, this would mean no travel and accommodation cost and no time spent in arranging this.

For the college no additional invigilation room arrangements need to be made and the time overheads, spent by the college, would be reduced if the exam could be done online from the student’s home.

The objective of the practical hands on lab (HOL) test is to ensure that the student that is registered for the course module has acquired the necessary hands on skill and has the knowledge to configure the Virtual infrastructure to a required specification.

The issue at hand is that allowing practical exams from home could potentially compromise quality control. This is because:
a) There is no way to know that the student registered for the exam is actually the student connecting in and doing the exam. This could be done in the following way:

- The student may have another person in the room with them.
- Or may ask another person in a different location to do the exam for them.

b) There is no way to ensure the student is not phoning a friend for help or getting another person to assist. As the test is run using the honours based system, this depends entirely on the student's integrity and trustworthiness. It would be easy for the student to engage someone else to assist.

c) Students could be using any application not allowed in the framework of the exam to gain assistance. For example:

- Have recorded the lab proceedings and could be playing the recording back, doing the lab in another window and getting full marks.
- There is no way to ensure that the student is not leveraging the internet or any other application to look for answers.
- Students could be using social media and chat to communicate with a friend or colleague to get the exam done.

This would be opening up CIT to credibility concerns and could cause the validity of the CIT MSc to be questioned.

**Problem statement 2: Exam monitoring challenges due to the complexity multiple layers of VM's introduce.**

As can be seen above from the student connecting into the virtual desktop the exam type is very complex. Requiring the students to connect to a virtual desktop from home and then connect to a virtual infrastructure on which to perform the configuration is complex as there are layers of virtual machines. In this situation there are 3 different layers that the student or anyone monitoring the exam needs to monitor. The physical student desktop, the Virtual desktop and the vCloud interface with the virtual machines running in a VMware remote console (VMRC) browser interface. This is very complex
to administer and monitor as one is not sure what layers of VM's the student may be using and there are also many windows open simultaneously.

**Problems statement 3: Time duration of exam.**

With the exam being 4 hours in length the duration of the exam is beyond the bounds of most standard exams and this may introduce invigilation problems.

**Alternatives**

The alternatives were that the practical exam would have to be arranged on campus. As students write other MSc exams at the end of the semester this could be arranged but the complexity would be that a lab room housing all of the student and computers would have to be arranged to allow them to perform the practical exam.

**6.7 Proposed solution**

It was decided that a solution would be sought to allow students to sit the practical exam from home or in the environment they have studied in. Initially it seemed that a "Practical exam invigilation system" could be developed and tested but on conducting research it was discovered that there were already services available called OLP which would facilitate remote online exams.

Research into the OLP companies would be conducted and a number of companies would be selected to do a proof of concept with the students currently studying the cloud MSc degree.

**9.7.1 The research methodology**

The following method would be used to understand the problem and find a solution proposal:

1. Survey past students who have done the online practical exam using the honours based system.
2. Prepare a mock exam for the current batch of students (12) on the honours based system who would then complete a questionnaire after taking the exam to record their feedback.
3. Conduct research on OLP vendors.
4. Select a number of companies with the following criteria:
   - Reputability gauged by the information on the website.
• Availability and willingness to run a proof of concept exam.

5. Arrange a proof of concept and allow the set of students who are doing the course to do a mock test with a number of proctoring vendors. It would be explained that they would do so in preparation for the practical exam and also to protect their investment in the online degree.

6. This group would be surveyed after each test.

7. The results would be analysed.

6.7.2 Determining the baseline by surveying and conducting a practical test in original current format using honours based system.

The steps performed to obtain survey data for the original method of testing the practical exam:

• A one hour practical test was arranged in September 2014 for the current batch of CIT students.
• The test was posted on Blackboard.
• The vAPP was deployed for each student.
• Each student connected from home to the CIT vDesktop and worked on the vAPP via the Browser and VMRC connection to each VM in question.
• After the test the students were asked to complete a survey. See Questionnaire A: Appendix C.
• Past MSc students who had just completed the Managing Virtual environments module the previous semester were also surveyed to increase the data set.
• They were asked to complete the same questionnaire as the students who had written the first mock test.
• The questionnaire was a mixed methods questionnaire with both quantitative and qualitative questions. The reason for this was to obtain students personal experience of the exam and proctoring process.
• The size of the data set in this instance was 25 students. 12 were students who were doing the CIT MSc Managing Virtualization module and 13 were students who completed the module the previous semester.
6.7.3 Defining the hypotheses

Hypothesis arose from perceived failures with the honours based system.

**Hypothesis 1 (H1):** A person not registered can do the Online Practical exam instead of the registered student.

**Hypothesis 2 (H2):** A person can be present in the room with the student assisting the student.

**Hypothesis 3 (H3):** The student can use social media and instant messaging to obtain assistance during the exam.

**Hypothesis 4 (H4):** The student can use the phone to contact a friend or colleague to assist.

**Hypothesis 5 (H5):** The student can use an additional laptop or device during the test.

**Hypothesis 6 (H6):** The student can use any application on their desktop to gain an unfair advantage, for example: using remote control software to get another person to assist them remotely. Opening up a browser to search for answers, opening up a recording to play back lecture recordings.

6.8 Survey 1: Results of the control group using the honours based test system

The survey results were captured in a table and analysed and the results and discussions follow below.

**6.8.1 Honours based test questionnaire results**

- The questionnaire is shown in Appendix C.
- 25 students were surveyed in total.
- 20 different questions were asked.
- The results of the questionnaire are tabulated in Appendix F.
-
To test H1: A person not registered can do the online practical exam instead of the registered student.

To determine what percentage of students felt that someone else can do the practical exam two questions were asked:
a) If students felt the supervisor could check their identity.
b) Sources could be used without detection, including to have someone else do the lab instead of the student.

If the supervisor could not check their identity then there should also be a high correlation that someone else could potentially sit the exam instead of the registered student.

In the first question 80% (20 out of 25) said that the supervisor could not check their identity. In the second instance 72% (18 out of 25) said that someone else could have done the exam (see Appendix F for full data set).

This provided a high certainty above 72% taking the lowest value, that hypothesis H1 was correct.

To test H2: A person can be present in the room with the student helping the student.
The following questions were asked:
a) During the hands on lab (HOL) practical test did the supervisor have the opportunity to monitor if another person was in the room or would he/she be able to monitor if another person enters the room at any time? 
b) Which outside sources could be used, one of the options available to select were, someone physically in the room helping you?

In the first question 76% (19 out of 25) indicated that the supervisor would not be able to monitor or know if another person entered the room.

In the second instance 80% (20 out of 25) students indicated that they could have had someone in the room helping them.

This indicated that above 76% of the students confirmed the hypothesis.
To test H3: The student can use social media and instant messaging to obtain help during the exam. The two questions were asked.

a) Before or during the test had the supervisor the opportunity to detect if you use social media or chat at any time?

b) Which outside sources could be used? One of the options available to select were online social media and instant messaging tools.

88% (22 out of 25) indicated that the supervisor would not detect if they used social media or instant messaging and 64% indicated chat or social media are tools that could have been used during the test (See Appendix F).

To test H4: The student can use the phone to contact a friend or colleague to assist them. Students were asked what outside resource could be used with the phone as one of the options to select.

80% (20 out of 25) of the students indicated that this was possible.

One of the students commented: "I had a need to contact the supervisor directly and used my mobile to do so."

Another commented, "I don't see how before the test is relevant, but during is relevant. Supervisor has no way to know if I use my phone during the test."

To test H5: The student can use an additional laptop or device to use communications to gain assistance. The survey question asked.

a) If there was an opportunity to use a separate laptop or computer?

b) If the supervisor was able to monitor the room?

The results were that 48% (12 out of 25) indicated they were NOT able to use another laptop, with 44% indicating that they could. 12% (4 out of 25) of the students did not answer. 80% (19 out of 25) of the students indicated that the supervisor was not able to monitor the room, which effectively means that they could have used these devices if they wished. As using an additional laptop was not mentioned when they were asked...
what other resources could have been used does not mean that they could not have used a laptop. They may have not thought of using an additional laptop.

Furthermore the test was structured in a way that meant the student had to have practiced the lab scenario’s and would have to diligently know how to configure the hands on lab, else they would not complete the exam in time. This could be a factor as to why they may not have felt that using an extra laptop would NOT gain any benefit and was not worth mentioning.

Two students commented about the lack of visibility and a possible solution of the use of a webcam solving the problem, “Unless by prior arrangement, the supervisor did not have the opportunity to see on an ad hoc basis. If requested a webcam could be setup for the duration of the HOL” (Appendix I).

To test H6: The student can use remote control software to get assistance. In the survey students were asked if the supervisor had the ability to monitor their desktop and 84% (21 out of 25) of the students indicated that the supervisor was NOT able to monitor the desktop with 0% indicating that the supervisor could.

6.8.2 The examiner (researcher’s) perspective:
From the examiners perspective (the researcher) the test was designed be as time demanding as possible to ensure that only those students who had practised and were well versed with the subject would finish in time. The students, even if they had had the opportunity to search the web, they would have found it difficult to finish on time if they were distracted looking for potential solutions. This was borne out by the following comments.

“There was very little time. Cheating would cost more time than just finishing the assignment myself”

“The ability to search the web and even chat to others should not matter. If you have not learned during class then you will still struggle to understand what you find on the web, or what you might be told by others.”
Nevertheless it indicated that the students felt cheating could occur as 80% of the students indicated that they could have used a phone or had someone physically in the room with them and 64% of the students indicated they could have used social media or an instant messaging application to communicate with other students or use someone else to get help. Table 8 and 9 show a summary of the survey results (Appendix F).

<table>
<thead>
<tr>
<th>Outside sources used for help</th>
<th>% students indicating this source can be used</th>
<th>The number of students who selected this method can be used</th>
<th>The total number of students who completed the question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone</td>
<td>80%</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Online Social media</td>
<td>64%</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Instant messaging</td>
<td>64%</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Someone physically in the room</td>
<td>80%</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Someone other doing the lab instead of you</td>
<td>72%</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

*Table 9: Summary of results of Honours based results*

<table>
<thead>
<tr>
<th>Category</th>
<th>% of students</th>
<th>Number of students</th>
<th>The total number of students who completed the question</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of students who felt the supervisor could see what applications were open on their computer.</td>
<td>0%</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

*See Appendix F for full data set.*

*Table 10: All students reported the instructor could not see their desktops*

6.8.3 Conclusions from the honours based system

1. Despite the test being made as time consuming as possible to mitigate the risk of cheating, there are clearly serious gaps in quality control. The surveyed student validation and monitoring gaps are unacceptably high meaning the risk of a person not registered for the course doing the exam was 80% and someone else being in the room 72%.

This highlighted the need to have:

a) Student authentication controls to ensure that the student registered for the module is sitting the exam.

b) Monitoring is needed to ensure that another person does not enter the room.
2. The use of online, social media and instant messaging was not as high as another person doing the exam or someone in the room but the use of the phone was also high at 80%.

3. What was surprising was that each category was not 100% as this was completely an honours based test system.

4. Quality control was dependent only on the student’s moral code and the quality control could be compromised at will.

The next phase was to conduct research on a select number of OLP vendors.

6.9 Researching the capabilities of vendors that provide online proctoring.

The initial plan was to run a proof of concept with 4 (four) proctoring vendors.

- Kryterion,
- Software Secure
- Proctor U
- Proctorfree

The first three proctoring vendors utilize human proctors.

ProctorFree – who utilizes fully automated proctoring - was also selected to get a perspective of the automation capabilities of OLP.

6.10 The Kryterion proof of concept

Kryterion, with the parent company being founded in 2000, is one of the earliest vendors offering OLP. William Dorman, who is the CEO, was also instrumental in founding the company and was also CEO of Drake Prometric a computerised testing company (Kryteriononline.com, 2015).

Kryterion was contacted on 21 October 2014 and initial screening discussions and expressions of interest in OLP were had with the Senior Development Manager (Turnquist, 2015). A further discussion was arranged with the Technical Account Manager.

There were initial concerns from Kryterion about the complexity of the exam. They were not sure if they could monitor the complex practical exam.
After a number of discussions it was decided:

- The proctors would conduct the student authentication,
- They would check the student environment, and verify that the room was adhering to exam standards and that no other people were present or at any time coming into the room.
- That they would monitor the student's physical machine as the CIT Virtual desktop was launched from the physical student computer and, any applications outside of the exam operation would be seen and action taken if considered out of exam bounds.
- They would monitor the room environment to ensure that no other person entered the room.
- The exam would be an hour in duration. They expressed concerns that a four hour exam would not be possible and that the maximum duration would be three hours. This would mean if the vendor was selected the exam duration would have to be reduced.

The details of the exam were to be captured in the “KOP Exam Upload Spreadsheet Instructions.docx and KOP Exam Upload Spreadsheet.xlsx” (Roden, 2014).

Note: Another name for the exam upload information is the assessment directive form (ADF).

The vendor also sent the online proctor service agreement which was to be signed by the college before the proof of concept was allowed to proceed. The Proctoring service agreement was signed and returned.

6.10.1 The Kryterion proof of concept details

The following steps outline how the Kryterion proof of concept was run:

- The students were set a test 1 hour in duration and the time and date were agreed.
- The list of students who would be taking the exam were sent to the Kryterion using the appropriate forms.
- The exam was scheduled with Kryterion.

3 The ADF is a document that captures the exam information sent to an online proctoring company.
• The vendor setup the student registrations on the vendor exam portal.

The email below shows the time and date the first test was scheduled.

From: do_not_reply@kryterion.com [do_not_reply@kryterion.com]
Sent: 27 October 2014 17:37
To: Gordon O'Reilly
Subject: Kryterion Online Proctoring: Your exam has been scheduled

Dear Gordon O'Reilly,
Your exam in Kryterion Online Proctoring has been scheduled:
Client Name: Cork Institute of Technology
Term: Semester 1 - 2014-15
Class: CIT Demo Instructor: Gordon O'Reilly Exam: CIT Demo Exam
Exam Time: Monday, October 27, 2014 05:45 PM Greenwich Mean Time
To see your schedule, please login at http://www.onlineproctoring.com.
If you need further assistance you can call Kryterion Online Proctoring Support at 866-4xx-1
Thanks
Kryterion Online Proctoring Team.

• The students registered were listed in the upcoming sessions listed in Appendix F.
• The online test was executed.
• The students were asked to complete the survey.

6.10.2 Test proceedings
There were a number of incidences that meant a number of students were not able to complete the proof of concept. The following bullet points captures the details and the objective of the survey.

• Out of the data set of 12 students, Student 5 called in to say they were not able to do the practical test because of work commitments.
• Students 2, 4, 8 and 12 were also not able to sit the test which left a data set of 6 students (Appendix G).
• Student 11’s test was cancelled by Kryterion. The reason for this is they reported that they did not have sufficient proctors available.
• At the agreed time the students connected to Kryterion portal and conducted the online test.
The 6 students who attempted the test using the Kryterion OLP method were asked to fill out survey B (Appendix D) after the test.

The intention of the survey was to firstly understand how Kryterion OLP solved the quality control gaps listed in the 6 hypotheses as well as answering the following questions.

9.10.2.1 Survey questions:

- Do students have to install a proctoring app?
- What is the name of the application?
- If students have to install software, did student have any issues installing the proctoring software?
- What are the forms of communication between the proctor and the student?
- Is the proctor able to perform student authentication and what type of ID was shown?
- What are the monitoring capabilities?
- Would the proctor know if you use one of the following?
  - Phone?
  - Internet, chat or Facebook?
  - A separate laptop?
  - See what applications are running?
- How do the students rate the integrity controls?
- How does the proctoring compare to traditional exams?
- What are the test administrator experiences?
- How does this vendor mitigate the 6 hypotheses that were identified as quality control gaps?

6.10.3 Results and Discussion of Questions

This section is a detailed discussion on the outcomes and results of the survey questions.

9.10.3.1 Kryterion: Do students have to install a proctoring application?

<table>
<thead>
<tr>
<th>Installation of software required</th>
<th>Issues installing software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6 out of 6 (100%)</td>
<td>1 out of 6 (17%)</td>
</tr>
<tr>
<td></td>
<td>5 out of 6 (83%)</td>
</tr>
</tbody>
</table>

Table 11: Number of students required to install software on their PC
On connection to the Kryterion portal via the web browser, 100% (6) students were requested to install a proctoring app. This is a light weight browser integrated application that is installed when the student connects to the portal via Browser either internet explorer, FireFox or Google Chrome. The App is also operating system specific.

- **9.10.3.2 Kryterion: What is the name of the application?**

On the date of the test most of the students did not seem to know what the name of the proctoring app was. This is a comment that was captured:

"Can't remember the name but it was an application that allowed them to have remote control over my PC" (See comments Kryterion Appendix J)

One Student indicated he believed this was called logmein (See comments Appendix J).

In a document on the Kryterion website, dated Feb 15 Kryterion refer to the application as Install Sentinel Secure.™ This is a Windows installable executable application and on MAC a pkg file (Preparing for your exam, 2014).

It would appear that 3 months after the POC was conducted Kryterion released a new application and this may explain why so many issues were encountered.

- **9.10.3.3 If students have to install software, did they have any issues installing the proctoring software?**

Of the 6 students who attempted the test, all 6 (100%) were requested to install an OLP application.

Of the 6 students 1 student (Student 7) had issues right at the outset (see Appendix J).

One of the students was using a Linux laptop could not get the app installed and as a result had to try to switch to a Windows laptop.

"My home laptop is Linux and the proctoring browser plugin couldn't access my Camera or something on Linux. So I had to switch last minute to a half built Windows laptop I had around. Once all the bits (flash, webcam drivers etc) were installed on this I was OK. My own fault, but it could be clearer that Linux wouldn't work perhaps?" (See Appendix J).

The other 5 students (83%) did not report any issues with the installation (see Appendix G). As they did not have any issues with the installation process it does not mean that
the environment operated without fault. As can be seen in Table 11: Number of students required to install software on their PC and in the discussion around the forms of communication below, there were issues with the communication.

The possible reasons can be attributed to the following:

- Bandwidth limitation from the student’s perspective.
- Web camera types that were not catered for (This audience was mostly European and this was one of the first European college’s that the American Company was involved in testing with).
- Microphone/head set and application driver incompatibility.

A year later, Kryterion released a document (Feb 15) that stipulates the operating systems supported. This document specifies that only Windows and MAC OS are supported. If this document was available at the time of the test it was not clearly communicated (Preparing for your exam, 2014).

9.10.3.4 Kryterion: What are the forms of communication between the proctor and the student?

| Able to communicate with the online proctor using the installed app | Form of communication |
|---|---|---|---|
| Yes | No | Voice | Chat/text | Web cam / video |
| 4 out of 6 (67%) | 2 out of 6 (33%) | 2 out of 6 (33%) | 5 out of 6 (83%) | 6 out of 6 (100%) |

Table 12: Ways Proctor and Student can communicate

33% (2 out of 6) reported that they had voice communication with the online proctor. This means that the online proctor could not talk to them and had to revert to using text only.

83% (5 out of 6) reported they had text or text chat capabilities with the proctor.

50% (3 out of 6) reported they had the video/web camera fully functional which meant they could see the proctor and vice versa, but by assumption the real value was 6 out of 6, because the students who did not select the webcam/check box under the form of communion, had later reported that the proctor had been able to check their identity (see student comments in Appendix J).

*Showed my ID card to the cam.*
Out of the 6 students only 33% (2) did not have any issues at all and were able to have full proctoring functionality. That meant that only two students reported that VOIP, text chat and bi-directional video were all used, meaning communication with the proctor with all other students was not optimum which would show later on.

- **9.10.3.5 Kryterion: Is the proctor able to perform student authentication and what type of ID was shown?**

<table>
<thead>
<tr>
<th>Is the proctor able to verify the student identity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6 out of 6 (100%)</td>
<td>0 out of 6 (0%)</td>
</tr>
</tbody>
</table>

*Table 13: The capability of the proctor to perform student authentication*

6 out of 6 students also filled in the comment section indicating how the proctor was able to verify the identity. See Appendix J Student comments question 12 and 13.

- Showed my ID card to the cam.
- Show passport to camera.
- Driving license.
- College ID card held to camera on laptop.
- Putting staff ID card up to the Webcam.
- Passport shown to webcam.

- **9.10.3.6 Kryterion: What are the room monitoring capabilities?**

<table>
<thead>
<tr>
<th>During or before the HOL practical test did the proctor verify that the room was suitable for an exam situation? If yes how was this done?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6 out of 6 (100%)</td>
<td>0 out of 6 (0%)</td>
</tr>
</tbody>
</table>

*Table 14: Did the Proctor verify the room was suitable for an exam?*

All the students (6 out of 6) indicated that the proctor had the ability to view and monitor the room through the web camera and determine that the room was suitable for the exam.

In addition the students added comments which gave further insight into the proceedings. One student indicated that the proctor used chat but this must have been a misunderstanding to the question because the same student indicated that he had shown his ID card to the proctor, which means his web camera was functional.
• Yes but didn't. Could have asked for me to scan the room with webcam but didn't. This is— example of human error similar to potential human error when doing a physical invigilation.

• I showed the supervisor my location by means of the laptop camera.

• Yes. Asked for webcam to be rotated to see entire room

• Yes, lifted my laptop and showed around the room to verify that everything was ok.

• Yes webcam, however I didn’t move the camera around. He didn’t ask to turn around the camera.

• Chat.

The following table shows further detail in terms of the ongoing monitoring capability to see if another person enters the room.

<table>
<thead>
<tr>
<th>Would the proctor be able to see if another person entered the room?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4 out of 6 (67%)</td>
<td>2 out of 6 (33%)</td>
</tr>
</tbody>
</table>

*Table 15: The capability of the proctor to detect another person in the room*

4 out of 6 students indicated that the proctor would be able to detect another person entering a room.

One student’s comments indicated that the proctor would have noticed another person entering the room via the web camera and microphone. The other expressed limitations which are supported by the comparatively lower score than the proctor being able to successfully authenticate the students.

• “via Webcam and mic.”

• “Had the opportunity at start if they wanted to. After exam started could not have seen anyone entering. Possibly could have heard it.”

This was in relation to - is it possible to cheat - but it still shows that if a student is behind the person then if the person looks up or changes focus then an attentive proctor would notice a change in the persons focus.

• “Yes there is never a 360 monitoring of the room. So in theory it's still possible...
But I think this would cover almost everything. If somebody would stand behind the
camera giving advice, I would still have to look at it, which would show on the camera.

- 9.10.3.7 Kryterion: Would the proctor know if you use a phone?

<table>
<thead>
<tr>
<th>Would the proctor know if you used a phone?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6 out of 6</td>
<td>0 out of 6</td>
</tr>
<tr>
<td>(100%)</td>
<td>(0%)</td>
</tr>
</tbody>
</table>

Table 16: The capability of the proctor to know if you use the phone

6 out of 6 students indicated that the proctor would have been able to detect them using a phone. In the comments below one of the students indicated a diligent proctor would have detected by the microphone and another that a diligent proctor would have seen this on the web camera. However one student felt he may be able to get away with texting in silent mode.

- Yes, Microphone was on.
- Probably would have heard it (i.e. the conversation). I may have been able to text using silent mode without really being detected.
- They would be able to see via Webcam.

- 9.10.3.8 Kryterion: Would the proctor know if you used the internet or social media like Facebook?

<table>
<thead>
<tr>
<th>Would the proctor know if you used the internet of Facebook?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6 out of 6</td>
<td>0 out of 6</td>
</tr>
<tr>
<td>(100%)</td>
<td>(0%)</td>
</tr>
</tbody>
</table>

Table 17: The capability of the proctor to know if the internet or Facebook was used

6 out of 6 students indicated that the proctor would be able to see if they used the internet or Facebook. However the comments revealed that there was a certain amount of uncertainty.

- I think so, I thought that was what the Applet that did, and my screen was shared.
- Having control of my machine I think they can probably see any windows I have.
- Probably. She could see both of my monitors and could see my activity. I had so many tabs and virtual machines (VM's) going on that I am not sure if the Proctor would have noticed something sneaky.
The proctor being able or not to monitor the student using Facebook or the internet also tie in with the ability to monitor the students desktop and if the proctor would see what applications the students were using?

The results are tabulated below.

<table>
<thead>
<tr>
<th>Did the proctor have the ability to see what other applications were running on your local desktop during the practical session?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 out of 6</td>
<td>0 out of 6</td>
<td></td>
</tr>
<tr>
<td>(100%)</td>
<td>(0%)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 18: The capability of the proctor to see what other applications were running on the local desktop.*

Again, 6 out of 6 students indicated that the proctor would be able to see what application were running on the desktop however, one of the students felt that the proctor may not see if any background tasks are running.

> Yes, but only as far as Taskbar and open programs. No way to check for running background services.

This would therefore imply that the proctor would also see if there were other virtual machines (VM's) or any applications open on the desktop.

*• 9.10.3.9 Kryterion: Noticing if the student used a separate laptop?*

<table>
<thead>
<tr>
<th>Was there an opportunity to utilize a separate laptop or computer during the practical session?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 out of 6</td>
<td>5 out of 6</td>
<td></td>
</tr>
<tr>
<td>(17%)</td>
<td>(83%)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 19: Proctor's capability to know if a separate laptop or computer was used during the practical session.*

5 out of 6 students indicated that they would NOT be able to utilize a separate laptop with 1 of them believing they would have been able to. This is relevant because a student could be searching for information on a separate device or laptop under exam conditions.

*• That would show on the webcam.*

*• Possibly. I was using a laptop with an external monitor. Not sure if the proctor would have noticed if I was using a laptop below it or set slightly to the side. If the Proctor had thought I was looking very far away she could have asked me to scan the webcam around and caught me I'm sure.*
The ability or lack thereof would depend on firstly the diligent proctor scanning the room to see if there are any other devices and then the web camera’s range and monitoring the students eye and head movements.

- **9.10.3.10 Kryterion: Test administrator/examiners perspective.**

In the notes captured during the discussions with Kryterion on setting up the exam, the registration process involved students connecting to a portal to create an account.

![Figure 24: Registration portal for Kryterion exam](image)

See email exchange from Kryterion (Appendix L).

*The exam is now available for registration with available slots from 8pm until 10pm. Students should visit [http://www.onlineproctoring.com/cit/index.htm](http://www.onlineproctoring.com/cit/index.htm) to create an account. Please look at the above portal page and let me know if you’d like to add any text.*

This was successfully done by 11 out of 12 students. There was one student who had issues with the registration but this was resolved afterwards.
"I have registered with Kryterion however I am having issues scheduling. I am not sure if it's browser related or just if the Kryterion system is down. I will try again morning my time".

In the upcoming sessions report, that Kryterion sent back the student logins and first name and last name were provided (See Appendix G).

To verify that the students had registered, involved email exchanges between the OLP company and the test administrator (researcher) which was not optimum. A preferred method would have been having a portal whereby the test administrator could see and verify the student registrations beforehand and also see and verify the student images before the test commenced.

- **9.10.3.11 Kryterion: Summary and Conclusions**

The question at this stage is how far would the Kryterion OLP solution solve the gaps identified in the 6 hypotheses?

- **H1 Kryterion: A person not registered can do the Online Practical exam instead of the registered student**

As 100% of the students were validated using the students ID card, licence or passport ID in the small data set of 6 students it can be concluded that Kryterion OLP is solving the authentication gap. This is with the following assumptions:

  a) The proctoring app, Logmein Remote help, installed successfully and the web camera, and text chat at the least were working.

  b) The ID presented was valid.

If the proctoring app was not installed correctly or the web camera was not operational then the exam should not go ahead as in the case of student 7 (see Appendix J).

If the student had to go to the time and effort to get another person with the correct skills to masquerade with a fake identification then the following needs to be considered. The student registering with a fake ID could be found out after the time. This is because when the student registers with CIT a photographic identification would be obtained and this could be used as a cross reference. Also as the authentication process and the online exam is recorded, if there were any doubts this could be played
back at any time to cross reference against the photograph ID recorded during the CIT registration process.

This online authentication process would not have any more chance of failure than the authentication process of a traditional exam. In a traditional exam there is probably more chance of this happening in a large exam hall situation. The reason for this is that if the masquerading student had to pass the checking process at the door because unless there is a recording this could not easily be found out after the time. Whereas with the OLP, if the administrator suspects suspicious activity the recording of the exam can be obtained and cross referenced against the ID.

Checking of the student ID’s registered before the exam is not that easy with Kryterion in this proof of concept (POC). This is because there was no portal that enabled the test administrator to verify the student ID’s registered before the exam. This has to be done post the completion of the exam.

- **H2: Kryterion: A person can be present in the room with the student helping the student.**

The risk mitigation in this hypothesis can be split into two parts. The first being someone present in the room at the start of the exam. The second, someone entering the room during the exam.

**Part 1: Detecting another person present in the room at the start of the exam**

6 out of 6 (100%) of the students indicated that the proctor was able to scan the room to see if the room was suitable. This would mean that there is a low chance of someone being in the room undetected. That was assuming the following:

a) That the proctor app was operational and the webcam was fully operational, without which the test should not have proceeded.

b) That the proctor performed due diligence to scan the room. Student comments revealed that proctor diligence was a significant factor in this exercise.

**Part2: Detecting someone entering the room with the intent to provide the student assistance.**
4 out of 6 (67%) students indicated that a person entering the room would be detected and 2 out of 6 (33%) indicated that there was a chance that they would not be detected. This would be an area of high risk as the proctor monitoring capabilities is totally dependent on the range provided by the web camera. A person could potentially enter the room out of the web camera’s range. However this risk is mitigated by the diligent proctor noticing that the student is engaged in activities and interacting with another person which could also be heard via the microphone. If the student had to turn off the microphone the diligent proctor would also notice.

As one of the students commented:

- Yes there is never a 360 monitoring of the room. So in theory it’s still possible... But I think this would cover almost everything. If somebody would stand behind the camera giving advice, I would still have to look at it, which would show on the camera.

- H3: Kryterion: The student can use social media and instant messaging to obtain help during the exam.

6 out of 6 (100%) students indicated that the proctor would be able to see if they use social media or instant messaging as the diligent proctor can see all operations on the students desktop even if the is spread over two screens.

There is a risk however that in a complex lab environment with many console screens open that the proctor may see many screens open and not know which are pertinent to the exam or not.

However if the student is cheating and there is a suspicion of intended cheating this can be found out because all the desktop sessions are recorded. This would very easily be spotted by the test administrator. This is also one area that the online proctor would spot if diligent. What increases the risk of the student getting away with cheating, accessing a website, application that is not permitted is if the proctor was extremely busy. In this instance a lower proctoring ratio 1:4 vs 1:8 would mitigate the risk.

In the comments student 7 reports
“At the start I had one to one. Halfway through if I had a question, I found that it might take the proctor a minute to respond”

In the POC Kryterion indicated this was a busy time for them with college exams and even though in this proof of concept the college was paying for 1:4 proctoring ratio, one is not sure exactly how many students a proctor would have been monitoring. If a proctor is authenticating then the proctor would be focused on that process and could mean that during that time the student may get away with a cheating incident if they tried.

The same factors listed here would also apply to hypothesis 6: The student can use remote control software to get another person assisting them remotely

- **H4: Kryterion: The student can use the phone to contact a friend or colleague to assist.**

6 out of 6 (100%) students indicated that the proctor would be able to detect if they used a phone. The student comments were as follows:

Student3 “Yes, Microphone was on.”
Student6 “They would be able to see via Webcam.”
Student7 “Probably would have heard it (i.e. the conversation). I may have been able to text using silent mode without really being detected.”

Student 7 may have indicated they could use silent text mode as the student had issues installing the proctoring software and with the communications (see 9.10.3.3) so it is questionable if all the proctoring functionality was available.

This indicates that if the proctoring software were fully functional this hypothesis concern would be alleviated.

- **H5: Kryterion: The student can use an additional laptop or device during the test**

5 out of 6 students indicated that they would NOT be able to utilize a separate laptop with 1 of them believing they would have been able to.
The student comments were:

- *That would show on the webcam.*
- *Possibly. I was using a laptop with an external monitor. Not sure if the proctor would have noticed if I was using a laptop below it or set slightly to the side. If the Proctor had thought I was looking very far away she could have asked me to scan the webcam around and caught me I'm sure.*

This could be mitigated by specifying the type of webcam to be used. Also the proctor would have seen the student’s focus move from the screen in front of them to another focus area. The student expressed doubt however that this would be possible.

From the this result it can be seen that there is a major improvement on this hypothesis over the honours based testing but that the desired result would have been 100%.

- **H6: Kryterion: The student can use remote control software to get assistance.**

6 out of 6 students indicated that the proctor would be able to see what application were running on the desktop, however one of the students felt that the proctor may not see if any background tasks are running.

*Yes, but only as far as Taskbar and open programs. No way to check for running background services.*

6 out of 6 students indicated that the proctor would be able to see if they used the internet or Facebook. However the comments revealed that there was a certain amount of uncertainty.

- *I think so, I thought that was what the Applet did. And my screen was shared.*
- *Having control of my machine I think they can probably see any windows I have.*
- *Probably. She could see both of my monitors and could see my activity. I had so many tabs and VM's going on that I am not sure if the Proctor would have noticed something sneaky.*

The 100% student response to both these survey questions pertaining to what was on the screen and what applications were running on the screen means that there is a high degree of certainty that using a remote control application would be detected. However
the doubt expressed by some students could be as a result of the difficulty experienced with the installation of the monitoring application.

In the one year Kryterion moved from LogmeinRescue to custom built application which indicates that as OLP technology is new it is also in a constant flux of change as this arena is very competitive.

6.11 The ProctorU proof of concept.
The objective of this section is to outline the research done with OLP vendor ProctorU. This module covers the background of why ProctorU was selected, the timeline of the research, a summary of the discussions, the survey results, survey comments, the test administrator experience and finally the conclusions.

6.11.1 Introduction
ProctorU started in 2008 by cofounders Don Kassner and Jared Morgan responding to the need to provide OLP ("About Us - Online Proctoring - ProctorU", 2015).

ProctorU was noted by David Foster from Caveon Test Security as one of the leading OLP providers (Foster & Layman, 2013).

6.11.2 The timeline from September to November 2014 was as follows:
• 22 September: OLP and associated costs were discussed with the partnership representative and CIT is sent the ProctorU service Level agreement.
• 29 October: send ProctorU the signed service level agreement.
• 7 November: discussion with assessment services co-ordinator to discuss the ProctorU: orientation and potential exam dates and the use of the ProctorU exam portal.
• 10 November: Orientation call. During this call the assessment services co-ordinator discussed the ProctorU exam portal, the exam procedure.
• 17 November: exam active and students can begin scheduling appointments for the test on 18 November.
• 18 November: 1 hour Online Practical Test conducted with ProctorU providing the OLP. Survey C sent to students via email.
• 18 November: the Assessment Services co-ordinator contacts the researcher regarding a question about the exam format.
20 November: Emails received from the quality control co-ordinator at ProctorU. The first is about Student 7 using a Linux laptop that was not supported. The second is about Student 9 that had issues with his audio and when the technicians were trying to trouble shoot he disconnected and did not connect back. The last was a report about a potential cheating incident with Student 8.

6.11.3 ProctorU online proctoring proof of concept summary of steps:
ProctorU also had concerns about being able to monitor the CIT HOL practical exam because of the complexity. As with Kryterion it was decided that they would start the monitoring and proctoring process from the student personal computer or home laptop.

Once the proctor is connected to the student physical home computer only then would the student connect into the CIT desktop and launch the vCloud interface to start the practical exam (See Appendix A for the connection procedure to the vCloud labs).

ProctorU decided to add an additional step to ensure that students cannot authenticate and start the practical lab before the time. This involved setting a username and password on each practical exam student vAPP. The username and password for each vAPP was created and given to ProctorU in the assessment directive form or the exam blueprint document and was not known to the student.

This meant that the procedure would be as follows:

- The student would register for the HOL one hour test on the ProctorU exam portal.
- The following is the email that was sent to the students to request they register on the ProctorU portal

17 November 2014 at 18:08, Mr Gordon O'Reilly <gordon.oreilly@cit.ie> wrote:

    Hi All
    Could you please register a user account on the following site? This is for the next dry run practical test with ProctorU.
    http://go.proctoru.com
    Sign up as a new user
    Enter your first name and last name
    Please select Cork institute of technology
    Could you let me know when you have this complete?
• On registration the students are requested to check their connections to ensure that they have the appropriate operating system, the correct ports are open on their home or work router, the proctoring application can operate with their web camera and microphone.

• On the 18 November at the specified time, the student would connect to the exam portal, download and install the app and wait for the proctor to connect and start the authentication process and exam.

• The proctor would perform the student authentication process.

• The Proctor would do the room check via the web camera.

• The proctor would then get the student to start the exam.

• The student would connect to the CIT Virtual desktop.

• The student would download the practical exam test from http://citbb.blackboard.com and open this in Microsoft Word.

• The student would launch the http://vCloud.citonline.ie vCloud director interface from the CIT student virtual desktop and enter the username ProctorTest that was setup specifically for this test.

• The Proctor would then enter the password that has been pre-arranged and set.

• The student would then be able to launch the vAPP VMRC windows as needed and start the exam.

• The proctor would monitor the exam proceedings and contact the test administrator (researcher) if there are any issues.

• After the test the students would complete and submit the survey.

The same survey questions asked in 9.10.2.1 in evaluating Kryterion are covered to see how the experience enhances or influences quality control.

6.11.4 Survey results

• 14 Students were registered to sit the one hour Test2 with ProctorU as online proctor.

• 13 out of the 14 students started the exam. One student withdrew due to work commitments.

• 1 out of 13 remaining students, namely student 12 was not able to proceed with the exam because his bandwidth at 1MB/s was not sufficient.

• That left 12 students who were testing.
What follows is the output captured from the survey results with the specific objective to understand the issues that could affect quality control.

- **6.11.4.1: ProctorU: Do students have to install a proctoring app and were there any issues with the install?**

**Installation of software and issues on the student desktop or laptop.**

<table>
<thead>
<tr>
<th>Installation of software required</th>
<th>Issues installing software</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 out of 12 (100%)</td>
<td>Yes 3 out of 12 (23%)</td>
</tr>
<tr>
<td></td>
<td>No 9 out of 12 (69%)</td>
</tr>
</tbody>
</table>

*Table 20: Installation of software to run the exam and problems with this.*

Of the 12 students who started the exam 100% (12 out of 12) were asked to install the proctoring software.

Of the 12 students 3 (25%) reported issues with the install and 9 (25%) reported no problems.

Student 7 aborted the test as he was using a Linux laptop and could not proceed any further.

Student 9 spent a great deal of time with the proctor and aborted the test trying to get the proctoring software installed as it was past midnight in his location.

Student 6 did not report any issues, but the proctor seemed to have problems getting the video and audio to work.

Student comments:

*Student 1:* Well I could not see the person or hear them at all. They tried installing an application but failed. They escalated. Someone then right-clicked the screen and selected a certain option and then I could see & hear them. They could hear and see me from the start. To solve that issue took 30 minutes

*Student 6:* No I didn’t but the proctor seemed to have trouble getting video and audio to work together (about 20/30 min’s to fix this)

*Student 7:* Software didn’t install natively. I had to use WINE to emulate Windows. This didn’t give them the access they needed as Linux is not supported. I offered to install it on a Windows Virtual Machine but after consulting with their supervisor, the proctor said this wasn’t supported either. Could not sit the Proctored Test
Student 9: The microphone of my videocam was not recognized by the video plugin used. After 1 hour of unsuccessful trials with the company’s technical support, I stopped the effort, as it was already almost midnight in Germany.

Again as with Kryterion it can be seen that the initial installation and function of the proctoring monitoring software is key to the OLP operation.

Even though the ProctorU system verification details were sent out beforehand the number of issues incremented slightly.

Compared to Kryterion the overall percentage of students reporting issues with install went up from 17% (1 out of 6) to 23% (3 out of 13). Student 1 would have been familiar with the Kryterion test but had configuration issues. Student 7 was still trying to use his Linux laptop which was not supported.

What can be improved is the student verification of the functional capabilities beforehand. When a proctoring vendor is adopted and becomes mainstream these small technical issues can be caught by diligent up front preparation and thorough understanding of the operating system and bandwidth capabilities.

- 6.11.4.2: ProctorU: What is the name of the application?

Students did not know what the name of the application was but saw this mainly as a browser plugin that allowed the proctor to see the student desktop, connect to the student microphone and also connect to the student web camera to view the student and see proceedings in the room. See Comments Appendix F Question 7

Student 1: Logmein rescue. (I think.)

Student 3: Yes a small browser plugin if I remember correctly.

Student 4: Yes something like “Rescue Me remote support.

Student 5: Yes it was actually some web browser plugin, not full desktop app.

It allowed Remote desktop view, camera and mic remote control.

Student 6: an application that would let them access my machine remotely, don’t remember the name.

Student 7: Software was needed to be installed but it didn’t work on my Linux laptop.
Linux did not work so he could not be properly proctored.

Student 8: Yes ProctorU software to take control of laptop.

Student 10: Yes, Software to control it remotely.

Student 13: Yes, Software to allow them to take control of my laptop for communication reasons.

• 6.11.4.3: ProctorU: Was the student able to communicate with the proctor and what are the forms of communication between the proctor and the student?

<table>
<thead>
<tr>
<th>Able to communicate with the online proctor using the installed app</th>
<th>Form of communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>12 out of 12 (100%)</td>
<td>0 out of 12 (0%)</td>
</tr>
</tbody>
</table>

Table 21: Communication capability with the proctor

All 12 students reported that they were able to communicate with the proctor.

6 out of 12 (50%) of the students reported that they used chat. This number is lower because with some of the students the voice communications were not functional. Only 2 students (student 2 and 9) reported using chat and not the voice communications. Two students who reported using voice communications did not select chat because they did not have to use the chat to communicate.

Student 9 reported, “Student 9: only via chat because of the issue.” The chat function is normally a backup communication procedure, when all else fails. If chat does not work then nothing else normally works.

9 out of 12 (75%) reported that they were able to communicate using voice (VOIP) using their microphone. Student 4 reported that “Voice & Video and quality of video and audio very good.” This showed how key good bandwidth is to the OLP procedure, or put in another way how important it is to ensure that the bandwidth recommendation specified by the OLP is adhered to. This students reported bandwidth was 120MB up and 12 MB down. Also this student reported that the OS was supported that there were no issues installing the proctoring software.

8 out of 12 (83%) reported that the web camera was fully operational.

Student 9 and 7 could not continue because of issues and being unsupported, this left 10 students operational. Student 5 reported the web camera was partially operational but was able to continue the test.
6.11.4.4: ProctorU: Is the proctor able to perform student authentication and what type of ID was shown?

<table>
<thead>
<tr>
<th>Is the proctor able to verify Student identity</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 out of 10 remaining students</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 22: ProctorU – ability to authenticate student identity

10 out of 10 remaining students also filled in the comment section indicating how the proctor was able to verify the identity (See Appendix F Student comments question 12 and 13).

Again as in Kryterion when the students get past any install issues the authentication mechanism works very well.

From the CIT exam administrator perspective, ProctorU have a portal that allows the administrator to login and to see the student profile with photograph which is what the proctor would have been checking against in addition to the government ID checks that would have been performed by the proctor.

Student 1: Yes. I was asked to show Driver's license.

Student 2: yes at the start of the session asked me to hold up ID to screen – It was very blurry looking from my end so I'm not too sure how accurately he could verify my identity.

Student 3: Showing passport.

Student 4: Yes looked at my passport and was thorough. Held passport to the Webcam.

Student 5: Yes, Showing ID, taking still of me from laptop camera.

Student 6: Yes, Had to show driving license (they would not accept CIT college ID).

Student 8: Yes, Asked for ID card.

Student 10: I showed him my national ID card.

Student 13: Yes, College ID held up to the laptop camera.
Student 14: Yes, Showing my ID with the web camera.

There was however inconsistencies between the proctors in terms of the ID’s accepted. Student 13 reported that the college ID was accepted and the proctor for student 6 would not accept the college ID and per standard asked for the Government Issue ID (passport) to be shown.

- 6.11.4.5: ProctorU: What are the room monitoring capabilities?

During or before the testing of the HOT practical test that the room was suitable for an exam situation? If yes how was this done?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 out of 10 remaining students (100%)</td>
<td>0 out of 10 (0%)</td>
<td></td>
</tr>
</tbody>
</table>

Table 23: ProctorU – ability to monitor exam room

10 out of the remaining 10 students indicated that the proctor had the ability to view and monitor the room through the web camera and determine that the room was suitable for the exam.

The comments revealed however that ProctorU was using an additional technique to Kryterion, asking the students to use a mirror to aid the scan of the room.

Student 1: They me to get a mirror and reflect the room and monitors. This took 10 minutes to find a suitable mirror.

Student 2: Asked me to move camera around room and also asked me to hold my phone up to the camera so it reflected the 4 corners of my laptop. I don’t think any of these methods were effective especially as he seemed surprised to learn I had an external monitor attached to my laptop later on in the session.

Student 3: Yes this was weird, he asked to hold a mirror in front of the webcam... Had to find a mirror last minute.

Student 4: Yes, He asked me to move the webcam across my desk and around the room. Told me to close down my work laptop AND REMOVE MY IPHONE FROM THE ROOM.

Student 5: I was asked to show full room view 360 degree with laptop camera.

Student 6: Showed all around the room using laptop camera.

Student 8: Yes, through web cam on laptop had to do a 360.
Student 10: I spun around myself, holding the laptop with the cam pointing towards the walls.

Student 14: Yes, the supervisor requested to get my computer and via camera looked to my dinner table and around the living room. Basically needed to move the laptop around the place I was.

Again there were however inconsistencies with the proctoring. The proctoring on Student 4 to remove the laptop. This proctor was very diligent however the proctoring for Student 2 was not as diligent. This may have been different proctors but could also have been the same proctor.

The following table shows further detail in terms of the ongoing monitoring capability to see if another person enters the room.

<table>
<thead>
<tr>
<th>Would the proctor be able to see if another person entered the room?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 out of 10 remaining (80%)</td>
<td>2 out of 10 remaining (20%)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 24: ProctorU – ability of proctor to detect another person in the room*

8 out of 10 students indicated that the proctor would be able to detect another person entering a room and 2 out of 10 indicated that the proctor would not be able to detect another person entering the room.

Student 1: Yes. Also I have to show the room with my webcam.

Student 2: Yes At the start of the session I was asked to show the complete room and during the session my camera was on all the time.

Student 3: No. Not really, I don’t think this can ever be properly checked

Student 4: Yes, Proctor was checking in on webcam.

Student 5: Yes.

Student 6: Yes, it was very thorough viewed all of the room and had to get a mirror to show my laptop reflection.

Student 8: Yes.

Student 10: Yes.
Student 14: no, as we can understand if we live in a small apartment I won’t tell to my wife to go away.

Student 14 indicated that his wife would have been in and out of the room but the proctor would have spotted if assistance was being provided.

Student 3 was taking the more pragmatic approach, which is true, will an online proctor ever be able to cope with all efforts at cheating, but did not provide any insight into why he or she felt this.

- **6.11.4.6: ProctorU: Would the proctor know if you use a phone?**

<table>
<thead>
<tr>
<th>Would the proctor know if you used a phone, landline or cell?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>9 out of 10 (90%)</td>
</tr>
</tbody>
</table>

*Table 25: ProctorU – ability to detect use of phone – landline or mobile*

9 out of 10 students indicated that the proctor would have been able to detect them using a phone and 1 out of 10 indicate that this would have been possible. In the comments below one of the students indicated a possibility that they could use the phone out of site of the camera.

Student 1: yes. They could see me for the whole test through the webcam and hear me through the mic.

Student 2: Only by capturing it on the camera or using the microphone. However he couldn’t hear me earlier using my mic so this would probably not have been detected.

Student 4: Yes, because under surveillance.

Student 6: yes, they had a camera on me, so not possible.

Student 8: phone could be used out of sight of camera.

- **6.11.4.7: ProctorU: Would the proctor know if you use Internet, chat or Facebook?**

<table>
<thead>
<tr>
<th>Would the proctor know if you used the internet of Facebook?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>10 out of 10 (100%)</td>
</tr>
</tbody>
</table>

*Table 26: ProctorU – ability to detect use of internet or Facebook*
10 out of 10 students indicated that the proctor would be able to see if they used the internet or Facebook. There seemed to be a fair amount of certainty, however Student 2 indicated that the proctor may not have spotted if another laptop was used or used the phone, even though Student 2 mentioned that may not have detected this because his microphone seemed to be marginal.

Student 1: Yes the proctor had access to my monitor and could see what I was viewing. Also they had me reflect the room via mirror. And they could see me via webcam.

Student 2: I presume the logmein rescue application could monitor what application were running. However I could have had another laptop or used my phone without the proctor knowing.

Student 3: Yes : The screen was shared.

Student 4: only allowed specific screens to be open.

Student 5: yes, they could monitor my desktop on PC.

Student 6: Yes, they had access to my PC. They also closed all existing applications before I started.

Student 8: on laptop? Closed down all unnecessary apps.

- 6.11.4.8: ProctorU: Would the proctor know see what applications are running?

<table>
<thead>
<tr>
<th>Did the proctor have the ability to see what other applications were running on your local desktop during the practical session?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>10 out of 10 (100%)</td>
<td>0 out of 10 (0%)</td>
</tr>
</tbody>
</table>

Table 27: ProctorU ability to detect other applications

Again, 10 out of 10 students indicated that the proctor would be able to see what applications were running on the desktop.

This was again a quality control area that students felt were well covered as a diligent proctor could see which applications were open, as they have full view of the students’ functional desktop.

Student 7: Yes the proctor as logged into my station and could see what applications & windows I had open.
6.11.4.9: ProctorU: Would the proctor know if you use a separate laptop?

<table>
<thead>
<tr>
<th>Was there an opportunity to utilize a separate laptop or computer during the practical session?</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1 out of 10 (10%)</td>
</tr>
<tr>
<td>No</td>
<td>9 out of 10 (90%)</td>
</tr>
</tbody>
</table>

Table 28: ProctorU – ability to detect use of a separate laptop or computer

9 out of 10 students indicated that they would NOT be able to utilize a separate laptop. Again this feature depends on the capabilities of the web camera but a diligent proctor would have spotted the student eye focus on something else other than on the screen in front of the student. A change in the type rate or mouse movement would also have alerted the proctor that something is amiss.

Student 2: *What the webcam can see is very limited.*

Student 3: *No, Would have shown on the camera.*

Student 5: *It would be possible though bit difficult I think.*

Student 6: *No, Being watched.*

6.11.4.10: ProctorU: The test administrator experiences?

From the test administrator’s perspective (researcher) the most powerful feature and the differentiator was that ProctorU had a portal that allowed the following:

- Tracking of the student’s registration with ProctorU.
- Verifying that the assessment directive was visible and accurate.
- Viewing the students ID’s before the exam started.
- Seeing the exam schedule and the student’s registration for the exam.
- Seeing the exam progress and seeing which students had completed the test.
Figure 25: The student schedule, when they took the exam and the proctor at the time

Figure 26: Identification process with student photograph
• **6.11.4.11: ProctorU: Summary and conclusions**

The question at this stage is how far would the Kryterion OLP solution solve the gaps identified in the 6 hypotheses?

• **H1: ProctorU : A person not registered can do the Online Practical exam instead of the registered student**

As in the case with Kryterion this risk is well mitigated by the OLP solution. The fact that 100% of the students (10 out of 10) who successfully installed the proctoring APP were able to perform the authentication indicates that this is a low risk. A further risk mitigation is that that the student registers on the portal and has to submit a photograph when registering means that this can be cross referenced by the CIT test administrator and the online proctor.

The proctor standard being that the student has to show a government ID (passport) also means that the student has to go to extreme lengths if he or she wishes to beat the system.

Students who had a marginally functional proctoring experience could have been mitigated by:

a) The exam administrator asking the proctors only to proceed with the exam if all proctoring operations, web camera and microphone were fully operational.

b) Running more diligent student checks beforehand. This ProctorU test was very rushed.

NOTE: A second ProctorU test conducted in July 2015 meant that the second experience provided 100% success rate with all 3 students. The reason is the students had checked beforehand that their systems met the recommended criterion, they also performed the test in a high bandwidth connected room.

• **H2: ProctorU: A person can be present in the room with the student helping the student.**
8 out of 10 students indicated that the proctor would be able to detect another person entering a room and 2 out of 10 indicated that the proctor would not be able to detect another person entering the room.

One student took the approach that if he has a small one room apartment he cannot tell his wife to go out of the room. This means if she was there she would be detected. The other student that said it would not be possible was coming from the angle that can one ever be 100% sure. This again is a relatively low risk area that the proctoring covers much better than with the honours based system. The question is however just how well is that covered and is there still a risk?

- **H3: The student can use social media and instant messaging to obtain help during the exam.**

10 out of 10 students indicated that the proctor would be able to see what applications were running on the desktop and that they would not have been able to use Facebook. Two of the students commented that the proctor ensured that all applications were closed down before the test started.

From the results it can be seen that this option is well covered by the process with a high degree of certainty.

- **H4: The student can use the phone to contact a friend or colleague to assist.**

9 out of 10 students indicated that the proctor would have been able to detect them using a phone and 1 out of 10 indicate that this would have been possible, saying that the phone could be used out of site of the camera. If the student had to do this then the proctor would have seen the student focusing on something away from the screen and if the microphone was functional then the proctor would have heard the student talking on the phone.

From the results it can be seen that this option is well covered by the process with a high degree of certainty.

- **H5: The student can use and additional laptop or device during the test**

9 out of 10 students indicated that the proctor would have been able to detect them using a phone and 1 out of 10 indicate that this would have been possible. The student
indicated that he would be able to use the phone out of site of the camera. This is questionable however. The other students mentioned that the proctor would have seen the focus deflected away from the screen and would have heard them talking. One of the students indicated that during the check of the room the proctor asked him to remove the phone from the room. "He asked me to move the webcam across my desk and around the room. Told me to close down my work laptop AND REMOVE MY IPHONE FROM THE ROOM."

From the results it can be seen that this option is reasonably well covered by the process with a high degree of certainty.

- **H6: The student can use remote control software to get another person assisting them remotely**

All the students who participated in the test (10 out of 10) indicated that the proctor is able to see what applications were running on the desktop. Remote control software running as a service would be more difficult to spot as this could run as a service. The proctoring software would have to detect the services running. At this stage it is unknown if ProctorU is able to detect the running services on a PC.

- **9.11.4.12: ProctorU: Summary**

  - The quality control for the practical exam is greatly improved using ProctorU going from depending entirely on student's honour with no visibility into the exam proceedings to having a great deal of certainty that most angles of quality control are covered.
  - There was variance in the proctor's diligence.
  - The proctor ratio at this stage was unknown.
  - What can be improved is the student verification of the functional capabilities beforehand. However when a proctoring vendor is adopted and becomes mainstream these small technical issues can be caught by diligent up front preparation and thorough understanding of the operating system and bandwidth capabilities.
  - The results of both live proctoring vendors is shown.
<table>
<thead>
<tr>
<th>Feature</th>
<th>ProctorU</th>
<th>Kryterion</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proctor verify identity</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Monitor the room</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Detect if using social media or facebook</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Detect if application not allowed open on the screen</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Detect if you use landline or cell phone</td>
<td>90%</td>
<td>10%</td>
<td>95%</td>
</tr>
<tr>
<td>Detect if you use a separate laptop</td>
<td>100%</td>
<td>0%</td>
<td>92%</td>
</tr>
<tr>
<td>See if another person enter the room</td>
<td>80%</td>
<td>20%</td>
<td>73%</td>
</tr>
</tbody>
</table>

Figure 27: Results of live proctoring by Kryterion and ProctorU

6.12 Experiences with proctoring proof of concepts that were not successful

This section discussed the other attempts at running other OLP proof of concepts.

6.12.1 ProctorFree.com

Proctorfree an automated OLP company was approached. The capabilities of monitoring the complex practical exam were discussed and they arranged a talk providing a slide deck of the capabilities. When, however, it came to the point of arranging a proof of concept, they telephonically indicated that they were too busy to conduct further investigations. Proctorfree concepts and operations are covered in chapter 7 and 8 and the information provided in these chapters are as a result of the information exchange conducted with them.

6.12.2 Loyalist and SoftwareSecure

Loyalist exam services was contacted (Loyalistexamservices.com, 2016). They wanted to know how many students will participate in online testing and when informed that this was 15, they indicated they normally go after colleges who test 1000’s online. They gave me the contact details of SoftwareSecure. This vendor seemed a definite OLP company to investigate. They were one of the long term service providers and were known for their integrated camera fingerprint device (Foster and Layman, 2013).

"Software Secure is a recognized leader in Cloud based (SaaS) online testing and provides convenient scalable and cost effective solutions that protect exam integrity" ("About Software Secure ", 2015).
Timeline:

2014 December 1:
Contacted software secure to look at feasibility of CIT partnering with them to facilitate OLP for virtualization practical exams. Sent them exam access and access methods. See Appendix P for email thread.

2014 December 11:
SoftwareSecure replied that the Practical Exam will not work with their configuration. "This setup will not work with our system. There are issues with their client and our client as well as the amount of system resources taken up when your setup is running with ours (Bellefeuille, 2014).

Results: Software secure were not able to accommodate the practical exam claimed because of a system resource issue caused by the VMware View client and the Software secure client.

Subsequent discussions with Software Secure (Bellefeuille, 2015) about LMS integration have brought to light that it may have been the architecture of their software. This is speculative but here is the reasoning. In discussions with Bellefeuille, (2015) he indicated that they do not facilitate launching the exam from the LMS like Blackboard. This is because SoftwareSecure software only works with an independent browser session. Monitoring capabilities are only fully functional when launched from their portal and they would not be able to detect the launching of another application if the exam was not launched from their own browser. This may be due to design. This may be the real reason behind not being able to run the complex lab practical test.

6.12.3 Proctorio an automated online proctoring company
In December 2015 Proctorio a company based in Arizona was contacted. This was a company that had come online during 2015 and that specializes in automated OLP ("Scalable Online Proctorless Software", 2016). Numerous discussions were had with the founder (Appendix P) and the summary of these communications are discussed below.
Proctorio claim to need only a browser meaning that no other applications need to be installed. The system is well suited to simple online exams. They operate the exam only from an LMS and don’t have an independent portal from which to launch the exam ("Scalable Online Proctorless Software", 2016). This proved to be one of the stumbling blocks for running a proof of concept.

To run an exam and launch this from the LMS, in the case of CIT that being Blackboard®, a plugin needed to be installed in the LMS, to enable the examiner to setup the test and for the students to launch the test. A Proctorio proctored student exam could not be launched independently without the integration of the LMS. The risks of going through a change during the midst of the CIT semester was too great. CIT LMS administrators would not have been able to install the plugin just for a proof of concept as this would have effectively meant the whole college would have the capabilities to launch a test. As a result this proof of concept did not go ahead.

Subsequently as a result of the inability to run a Proctorio proof of concept, two demonstrations were done by Proctorio using their LMS. Further details of this service is covered in chapter 7 and 8.

Additional differentiators of the Proctorio service are:

- Their application is HTML 5 based and hence does not need to have any software installed.
- They use location based services to verify the location of the student and this can be compared to the students registration address.
- Their software cannot run independently from an LMS.
Chapter 7: Discussion and findings

This chapter discusses research findings obtained from reading, email exchanges and discussions with the OLP vendors and from conducting the proof of concepts.

7.1 Online proctoring companies do not claim to be cheat proof

Proctoring companies never claim to be cheat proof they do the best they can do to catch cheating but have to be flexible to adapt. Malone and Hughes from ProctorU said “We are not saying the OLP will prevent all cheating. Cheating even occurs in traditional exam rooms, we have all heard of stories where students have got away with it. We are saying that for the most part we are providing a service that is convenient for the student.” (ProctorU, 2011).

7.2 Online proctoring companies fare no better or worse in providing quality control than traditional methods

In a paper called “The effect of proctoring on Grades”, that examined the effects of utilizing OLP by SoftwareSecure, ProctorU and Kryterion vs not using proctoring in online accounting exams, suggest that the use of proctoring services in online courses has the potential to enhance the integrity of online courses by reducing the opportunities for academic dishonesty during exams (Boyd Davis, Rand and Seay, 2016).

Quality control in OLP also do not fare any worse than traditional exam methods. Foster and Layman, (2013) using data forensics to compare 6794 OPL tests to test centred exams found that OPL tests do not result in a greater number of security incidents.

7.3 In the CIT context online proctoring has significantly improved quality control of the online practical exam

As far as this research is concerned OLP produces a significant improvement in the quality control compared to the honours based method that most educational institutions start using when implementing online testing.

7.4 The influence of online proctoring

A comment captured by Student 6 highlights one of the outcomes of OLP.
The student says "If the proctor is watching then no you cannot cheat. In fact I think it might even be stronger than traditional exam hall as you do not know if you are being watched or not" (Appendix J, Q29).

This an example of the Panopticon surveillance effect mentioned by – Michel Foucault – French Philosopher - Sociology. This effect was creating using an institutional building, designed by the English Philosopher Jeremy Bentham in the late 18th century, with a tower in the centre from which it is possible to see all cells, where visibility is a trap. Each individual was seen but could not communicate with other prisoners or warders. This visibility ensures a functioning of control and power. The prisoner can always see the tower but never knows if he is being watched (Giddens, 2009).

In the same way OLP, where the student knows he or she is potentially being watched, drives down the risk of cheating and improves quality control.

7.5 The difference between live and automated proctoring is not apparent at the outset.

At face value automated proctoring appears to be very similar to live proctoring. There is a significant difference however and sections 10.5.1 to 10.5.5 discuss the differences.

7.5.1 Quality control responsibility

Live proctoring – called proactive proctoring in this research – takes the full responsibility of quality control and in many cases will catch potential violations or innocent acts that may end up being seen as violations. With automated proctoring the actual quality control takes place after the exam during the review of the recorded material. The automation flags potential violations but this still has to be verified after the time.

Live proctoring costs extra up front but once the exams are completed there is no further follow up actions needed unless there were severe violations. It is cut and dried, the delineation of responsibility is clear cut. From the students perspective and also from the college. Automated OLP the responsibility is entirely on the college whereas human proctoring it is all delegated to the OLP Company.
7.5.2 Quality control tolerances

Automated OLP systems are comparable to red light cameras. They don’t deter you from cheating until you know they actually work. But once you receive that ticket in the mail or the notification that you have violated the exam policy, you have learned your lesson (Schulson, 2014).

Live proctoring has more tolerance, you don’t run into the hard barrier immediately because you are dealing with humans who apply the rules. There are the environment checks that would catch any items that violate exam policy and they would be removed if the proctor spots any item that would violate the policies.

Giving the students the softer approach where proctor gives the student a chance to proactively remedy the situation cannot be replicated in automated proctoring. As is seen in the snapshot of the incident that occurred with dealing with ProctorU, the student was able to continue with the exam. The student may have been negligent in allowing papers and a phone to be present in the room with him, never the less the proctor mitigated the risk and dealt with the issue there and then.

Environment checks before the exam can be enabled with automated OLP requiring the student to scan the room. The risk is that when the scans of the room take place the student could show what he or she wants to show. The stipulations and expectations of the examining institution should be clearly spelt out before the time by the college to
avoid students being penalized for violations and students coming back claiming that they were not properly informed of the expectations.

With automated proctoring you are dealing with coded flags that highlight when behaviours outside a norm invoke and cause the software to trigger an anomaly in the recording. Humans then have to interpret these anomalies. The implementation of such a black and white policies may not sit well with some institutions especially as this has to be dealt with after the time and based on a recording which may give only one perspective. Automated proctoring does tend to de-humanize. This could potentially lead to difficulties for the examining body when having to deal with grey areas from a recording.

7.5.3 The timing of the human involvement

The automated OLP reviews have to take place after the time. Unless the college farms out the automated OPL reviews the onus would be on the college to either have the lecturer review the recordings post the exam or in the case of hundreds of students taking an online test, fund the additional staff to deploy a team to review the recordings of the exam.

A proposal for a MOOC Open OLP framework (MOOP) to allow MOOC testing to scale by using automated OLP and having the a final review committee done in the following manner using students. These students peer review flagged material to confirm suspicious cheating behaviours which are sent to a final review committee to determine the punishing decision (Li, Chang, Yuan & Hauptmann, 2015). This again shows that automated OLP only solves part of the challenge of quality control and that the final decision still lies with human resources and in this format the decision is also made after the exam. A fully automated solution in the truest sense of the word, where no human involvement is necessary at all is still not available.

The automation definitely brings in efficiencies reducing the total review time, but the decision still ultimately still has to be made by humans.
7.5.4 Cost of utilizing a online proctoring service
Automated OLP is cheaper than live OLP from the outset because of the flat rate that applies. What is important to consider is the hidden costs for the resources required post the exam which also needs to be factored in. This could be a lecturer’s additional time or a team of resources if hundreds of students are taking the test.

7.5.5 Matching test types to live or automated proctoring
From the research simple exams like MCQ’s and browser based tests are well served by automated OLP, however the recommendation is that more complex tests are better served by live proctoring. This is backed up by studies done by Foster (2013) page 11.

In support of these findings, this research has also found that with a complex practical exams live proctoring worked very well. The reasons for this are:

• The complexity and number of applications and screens open would potentially cause the automated software to flag issues where there are no issues.

• Automated software is still not as capable in applying reason to a decision as a trained human proctor as is shown in 10.5.2 above.

In low stakes simple tests automated proctoring can give a low cost scalable solution.

7.6 Risks
There are multiple factors that can derail an OLP test.

7.6.1 Initial student connection to the online exam
The simple initial process of a student connecting to the portal can produce a number of technical issues. It is vital that students test the device and that the college arranges a dry run to ensure that all facets of online communications are functional. This research as shown that if either screen sharing, microphone or web camera are not fully operational the quality control is compromised.

It is also important that the student be informed of the supported operating system and device capabilities as this can quickly derail a test if incorrect.
The most important facet of risk mitigation was found to be communication. The times that tests were compromised in most cases could have been avoided by diligent communication. Examples of this are:

- Student using an incorrect operating system: Student 7 Appendix J.
- Students being required to make addition payments because they left it late and want to take it last minute. ProctorU calls this “take it now payments.” This will causing students to panic because payments were not discussed: Appendix J.
- Students not being adequately informed of the exam conditions. They were not sure if this was an open book test or not. Appendix U where student did not conform to exam conditions.

7.6.2 Bandwidth and connection quality

It was seen that students in the remote parts of Ireland where broadband speeds are still are 1Mb/s are very exposed to having issues whereas students with high bandwidth and stable connections had no issues.

7.7 The future scene of online proctoring and how it will adapt to market drivers

The number of OLP companies have grown from 8 in 2013 to 14 in 2016. A merger of companies will take place in the future.


It was noted on PRWeb that Exam Master Corporation and Software Secure announce the integration of two key online testing and security platforms, namely Academic Manager and Remote Proctor now ("Exam Master and Software Secure Join Technologies for Secure Online Testing", 2014).

David Hanson, chief executive of the Independent Association of Prep Schools in the UK indicates that traditional tests and our educational systems and exams are sometimes viewed as “Victorian.” Children growing up with IPADs and technology
means the face of testing is going to change and online testing is here to stay (Paton, 2013).

Automation seems to be creeping in more and more into OLP. This is to give scale meaning automated proctoring is here to stay and will become more sophisticated as they try to replace the human involvement.

OLP technology is advancing rapidly and this is influencing the capability of OLP vendors. An example of this is that in 2013 Proctorfree was the first company to introduce the automation into OLP. This technique is not being more widely adopted as OLP’s try to drive scalability.

On the other hand there have not been any new game changing techniques since the inception of OLP. The OLP’s are still trying to replicate the quality control steps seen in the traditional exam hall setups.

It can also be seen that new ideas are being tried and this is constantly changing as the OLP vendors respond to the markets. SoftwareSecure had a device for Biometrics. These biometric devices are no longer sold, however when research started this was the most secure option but this could cost $40 – $50 dollars including shipping. Now they are moving away to using facial recognition and spending time and effort on this biometric capability research rather than a physical device which was too expensive for most markets (Appendix O).

Hardware is also changing – and example of this is Intel announcing its Skylake processor. They suggest that manufacturers should promote their new computers by enabling other add-on’s including an Intel Real Sense Depth camera which can be used it let users log into Windows 10 by looking at the sensor. This is harder to fool than traditional 2D cameras. The RealSense camera can identify users by recognising their face but will not be fooled by someone holding up a photo of the owner says BBC (Kelion, 2015). This will mean that facial recognition software used in OLP will improve.
More OLP vendors are offering both live and automated proctoring as they realise that online testing needs are not a one size fits all scenario. The same educational institution may have different types of online tests and quality control needs and don't want to have to go to a different vendor for each use case. OLP vendors are also offering different service levels ranging from a basic level where there is identity verification only to the highest level of risk mitigation which is live record and review.
Chapter 8: Conclusions and further study

- OLP is a bright new area that is forging new boundaries in online education enabling testing from home.

- Educational institutions offering an online course which has online testing using the honours base system, would be well advised to familiarize themselves with the OLP industry to limit potential exposure to cheating.

- There are many facets to consider when selecting an OLP vendor. In addition the selection criterion are also not well defined. This thesis provides facts, guidelines and points to consider to enable a faster OLP selection process.

- Cost is not the only factor that should be considered when deciding on an OLP vendor. The online exam type, the quality control risks and the broader consequences of a cheating incident also need to be considered and matched to the most appropriate OLP solution.

- OLP, if applied correctly, provides similar quality control capabilities to traditional exam invigilation, thereby solving quality control concerns in online exams.

- OLP is not an invigilation solution for all exam types. Optimally matched to particular online exam types, it can provide a compelling solution where there are advantages for students, educational institutions and IT companies.

- Taken at face value live proctoring and automated proctoring is sold as performing the same function, which is true, but the implementation and application has very different cost, time and resource implications that need to be considered.

- Live proctoring provides the most compelling solution for exam quality control within the context of the CIT complex online practical exam. This exam which is part of the virtualization module in the CIT MSc degree, was delivered using
the honours based system, and had serious quality control gaps. Now live proctoring provides a sufficient cheating deterrent bringing quality control to a level comparable to the CIT traditional supervised exams.

- IT vendors, like Cisco and VMware, who provide professional level certification, have been slow to adopt OLP and rather use the test centre methods for ensuring quality control. PearsonVUE has sole test administration provision contracts with both companies. As PearsonVUE are changing their approach and have now acquired an OLP company, a move to using OLP for both Cisco and VMware will emerge.

- Automated proctoring works very well for simple exams such as MCQ’s.

- OLP quality control’s value is limited in open book exams or exams that use scratch paper.

- From this research proof of concepts there was a variance in the diligence and responsiveness between live OLP companies. With live proctoring, competitive cost drivers, can cause OLP companies to compromise quality control.

- In adopting to market needs more and more OLP companies are offering both live and automated OLP with different levels of proctoring. This is to cater for many different test types and quality control levels needed by institutions.

- OLP is mimicking the traditional exam invigilation process. As such, there are no new game changing invigilation methods since OLP’s inception in 2008. As in the traditional exam hall invigilation proceedings, student authentication and student monitoring still has to be diligently performed to ensure quality control.

- In terms of proctoring techniques automated OLP is new. It is attempting to remove the need for human resources out of online exam invigilation. Automated OLP is the area which is undergoing the most rapid change and where new techniques and software capabilities will emerge.
• There is an opportunity for another level of service, the fully automated OLP service provided coupled with a third party review, offloading the time demands needed to review the examinations and spot cheating.

• If an OLP company is selected that uses automation software entirely then a cheating incident will only be known when the institution reviews the exam videos and checks anomalies. This time delay may not be optimal and could be weeks afterwards, depending on how long after the exam the video is reviewed.

• Future study:
  • Technologies like facial recognition and the web cameras used are rapidly advancing. How this might evolve and be incorporated into OLP would be a useful study.
  • OLP fee structures and the service agreements.
  • How OLP is responding to market drivers and if this aligns with the desired quality control standards.
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