E-PROCTORING IN THEORY AND PRACTICE: A REVIEW

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QQI
Insights

Foreword

Since the start of the COVID emergency, remote assessment has been high on everyone's agenda across the education sector. Invigilated examinations were impossible under lockdown conditions and this led to the implementation of alternatives including remote examinations. The latter stimulated interest in e-proctoring.

In response to this, and with the support of the National Academic Integrity Network (NAIN), Quality and Qualifications Ireland (QQI) commissioned a landscape review of e-proctoring (i) literature (ii) policies and practices and (iii) experiences of:

- Irish and foreign higher education institutions;
- academic and professional support staff;
- students, including international students;
- professional, statutory and regulatory bodies.

The review aims to inform higher education academic staff and managers about the opportunities and challenges of implementing e-proctoring. It begins by looking at the main drivers for the adoption of e-proctoring, the various approaches that are used and the extent of the adoption nationally and internationally. It then considers the practicalities involved in implementing e-proctoring and follows-up this with some case studies, including successes and failures. The review goes on to explore some of the challenges that institutions will face when implementing e-proctoring, outlines some of the services that are available and presents some alternatives to e-proctoring. The review concludes with recommendations for institutions thinking about implementing e-proctoring.

Assessment is complicated and e-proctoring, like most items in the assessment toolkit, has limitations but in the right setting and properly implemented it can be useful. I believe that you will find the report interesting, insightful and practically useful when considering the integration of e-proctoring into your organisation's assessment toolkit.

Dr Padraig Walsh,
CEO, Quality and Qualifications Ireland (QQI)

This report, produced by Professor Paul Giller, is both timely and apposite. On behalf of the National Academic Integrity Network, I would like to both congratulate Professor Giller on such a comprehensive and reflective report and thank QQI for facilitating its development and publication. As the COVID emergency struck, and all institutions had to find alternatives to traditional assessment methods, e-proctoring has gained prominence as a potential solution to the challenges to academic integrity that arise with remote assessment. Therefore, the guidance in this report will be very valuable in enabling reflection and in supporting the development of valid policies and practices. As the NAIN Chair, I have no hesitation in endorsing the report and recommending it to all of us as essential reading when constructing our approaches to remote e-proctoring as a part of our online education and assessment strategies.

Mr William Kelly,
Chair, National Academic Integrity Network (NAIN)

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1. Context and Definition

Online higher education has become a well-established and growing phenomenon over the past several decades as exemplified by the success and international reach of the Open University and MOOCs and the increase in online offerings across the higher education sector at home and abroad. For example, the 2018 Babson Survey Research Group reported that distance student enrolments in the USA had increased for the fourteenth year in a row and that between 2015/2016 over 30% post-secondary students—some 6.5 million—had taken at least one course online, over 70% of which were from public institutions (Seaman et al., 2018). Likewise, a national survey of post-secondary online learning in Canada indicated significant growth of 11% in 2017 across 200 higher education institutions (Bates, 2018). An online Education Market Study in 2019 led to projections for the overall global market for online education to reach $350 billion by 2025 (Li and Lalani, 2020).

This steady growth in online teaching and learning rapidly accelerated during the COVID-19 pandemic as an emergency response following the closures of campuses across the globe in the spring of 2020 (Langenfeld, 2020). This, in turn, resulted in a very rapid move from traditional face-to-face classroom-based education to almost total online delivery, including remote online examinations, the speed and scale of which was unprecedented (QAA, 2021b), in order to allow continuity of learning for enrolled learners. In Ireland for example, data from the Central Statistics Office website[1] shows a sharp and significant increase in the percentage of individuals conducting online learning activities when comparing the last three months of 2019 to 2020. Onsite, invigilated, closed-book examinations were often impossible and were largely replaced by remote, online, open-book assessments in offsite locations, typically in the students' own homes (QAA, 2020).

One of the growing criticisms of online/distance learning, is that there is a lack of academic integrity in the online environment (Daffin and Jones, 2018) and particularly in assessing learning. Academic integrity underpins every aspect of higher education and is the cornerstone of ethical education practice premised on

a set of values described by the International Center for Academic Integrity (ICAI) as honesty, trust, fairness, respect, and responsibility (Bretag, 2020), with a 6th value of courage added recently[2]. There is widespread concern that online teaching and assessment enhances the opportunity for cheating. Advances in technology, and the growth in online content available, as well as the speed of the internet, provides students with the opportunity to find information rapidly. This can of course be beneficial for researching topics, sourcing references and enhancing learning, but it has also opened up the opportunity for the rise of websites and unscrupulous companies (often termed 'essay mills') providing students, for a fee, with unauthorised assistance that can be difficult to detect (Newton, 2018; Ison, 2020; Alessio and Messinger, 2021). Extrapolating from his survey of students, Newton (2018) estimates that, based on UNESCO data of 200 million students in higher education globally in 2017, approximately 7 million were engaged in paying other people to do work for them and Lee (2019) reports that less than 1% of the UK university students that have admitted to paying someone online to do their work for them were being caught (an average of about 5 cases per year per university). What has become known as 'contract cheating' (where students outsource their work to third parties for a fee, be it for previously written or bespoke essays, examination answers or even impersonation for online examinations) is now big business. Estimates from a couple of years ago described a £200/$277 million industry (Dawson and Sutherland-Smith, 2018) and profits approaching £72/$100 million annually (Newton, 2018), but it is now most likely substantially greater. An article by Draper et al. (2021) provides a detailed exposition of how these commercial companies work and on associated student rights.

Whilst several jurisdictions have enacted laws prohibiting provision of contract cheating, as in 17 states of the USA (California, Massachusetts, Pennsylvania, Nevada, New Jersey, Colorado, New York, Connecticut, Texas, Virginia, Florida, North Carolina, Washington, Illinois, Oregon, Maine and Maryland), Australia and New Zealand (in the Federal Education Act), they have proved either ineffective or are rarely used (Amigud and Dawson, 2020; Draper et al. 2017, 2021).

1   CSO (2021) Central Statistics Office Ireland. https://www.cso.ie/en/releasesandpublications/ep/p-isshh/informationsocietysta-tistics-households2020/onlinelearning/ [Accessed 27 October 2021]

2   ICAI (2021) International Center for Academic Integrity https://academicintegrity.org/resources/fundamental-values [Accessed 11 October 2021]

More recently similar types of legislation have been introduced in Ireland (a new provision was included in the Qualifications and Quality Assurance (Education and Training) (Amendment) Act 2019 which was enacted in July 2019) and work is nearing completion to introduce similar legislation outlawing essay cheating companies in the UK as one of several new measures being introduced into the Skills and Post-16 Education Bill[3]. In Australia, they have gone even further and promoting academic integrity and seeking to detect cheating are a legal requirement (Australian Government Higher Education Standards Framework (threshold standards) 2015, 5.2 CFR; Dawson, 2021). Even where such legislation exists however, contract cheating companies can be based outside the national jurisdiction and be freely accessed from anywhere in the world through the internet.

Traditionally, to mitigate potential cheating by students during on-campus assessment, in-class/on-site live invigilation of written examinations and use of plagiarism-detection software like Turnitin are the norm. Similarly, online invigilation, or to use the more common term 'e-proctoring', of computer-based exams has been a feature of online education for over 20 years (Selwyn et al., 2021).

Remote, online or e-proctoring is a general term that covers a range of different approaches that try to simulate on-site supervised examination conditions in digital assessments (Dawson, 2021; QAA, 2021). Definitions of e-proctoring differ to various degrees within the literature. At its simplest, e-proctoring is a form of invigilation that involves monitoring of student behaviour during electronically administered examinations. For the purposes of this report, the following, more comprehensive, definition is proposed:

'Online or e-proctoring involves the systematic monitoring of student behaviour in real time during examinations administered electronically to verify the identity of the student, that the work completed is the student's own, and to ensure test conditions and academic integrity are maintained. Monitoring is usually carried out through the camera/webcam and/or microphone on the device on which the student is completing the online examination and can include monitoring of the student's screen and computer activity. E-proctoring can be conducted live by an invigilator or through Artificial Intelligence (AI) software or a combination of both, or is based on a recording of the student's activity through video, photographs, microphone, keyboard or mouse use during the examination which can be reviewed at a later date.'

It is worth noting that a number of institutions (particularly in the US and Australia) have developed and deployed their own in-house e-proctoring systems, at the simplest level based around Zoom or Teams conferencing software or using some functionality inbuilt into VLEs (such as Canvas or Moodle), both approaches using in-house proctors (invigilators). These tend to be restricted to relatively small-scale exams and tend not to be recommended for online examination invigilation (Eaton, 2020; QAA, 2020). In the vast majority of situations, e-proctoring is more usually provided by third party commercial companies. Technological developments have increased the sophistication of e-proctoring, which is now reportedly a multi-million-dollar industry. For example, 'ProctorU' claims it proctored more than 367,000 exams in 2020 in Australia alone[4], 'Proctorio' claims to have proctored over 4,000,000 exams in 2019 and over 20,000,000 in 2020[5], and 'ExamSoft' reports that over 61 million exams by October 2020 and 75 million exams by June 2021 have been proctored since its foundation in 1998[6]. As Selwyn et al. (2021) point out, even before the COVID pandemic, online proctoring was a profitable niche of the 'EdTech' industry, with established companies such as 'Proctorio', 'ProctorExam', 'Honorlock' and 'Examity' commanding shares in what was identified as a US$19 billion market by the end of 2019.

The adoption of additional assessment security measures and use of e-proctoring by higher education institutions (HEIs) has surged during the coronavirus pandemic restrictions to access to third level campuses (QAA 2021a), but so too have concerns about the practice. The initial developments did not always reflect best, or even good, practice, but did provide an opportunity for both providers and regulators to learn from experience and to plan for a longer-term,

3   The Times (2021) University essay-writing companies to be outlawed https://www.thetimes.co.uk/article/university-essay-writing-companies-to-be-outlawed-887mkv22d [Accessed 27 October 2021]
4   ProctorU (2021) Can It Scale? — Online Proctoring in a Pandemic: Part 3 https://www.proctoru.com/industry-news-and-notes/can-it-scale-online-proctoring-in-a-pandemic-part-3 [Accessed 10 October 2021]
5   Proctorio (2021) https://proctorio.com/about/history [Accessed 30 September 2021]
6   ExamSoft (2020) https://examsoft.com/resources/turnitin-acquires-examsoft-a-leading-assessment-platform and https://examsoft.com/about-examsoft [Accessed 31 August 2021]

more sustainable approach to online learning and assessment. In the following sections, the rationale for e-proctoring is considered in more detail, the various approaches reviewed, and the extent of use both nationally and internationally considered. Policy approaches and practices are outlined, and a number of case studies are presented highlighting both success and failures. A range of issues have become apparent and are considered and alternative approaches that have been advocated highlighted. A brief overview of the range of services available is presented and finally some overall considerations are drawn, and tentative recommendations made related to the potential use and future of e-proctoring within the Irish higher education landscape.

2. The academic/ pedagogical rationale

What are the main drivers for the adoption of e-proctoring? In essence, the use of invigilation or proctoring of examinations results from a concern, on behalf of the academic institutions and examiners, that there is a likelihood that some students will cheat and thereby gain unfair advantage. There is also the reassurance that invigilation/proctoring provides to students, academic institutions, professional bodies, potential employers, and the public at large, that best efforts to deter and detect cheating are being made and that academic integrity and qualification standards are being upheld.

2.1 Types of cheating

There are basically two different types of cheating recognised in university courses; cheating during an examination (e.g. using illegal notes, copying from other students, accessing material on phones) and cheating outside an examination (e.g. plagiarism and contract cheating or assignment outsourcing (for continuous assessment)). Unlike traditional plagiarism (presenting a copy of someone else's work as your own without full acknowledgement), bespoke assignments completed by contract cheating sites and essay mills for a fee can contain original content that can undermine the value of text matching software, which is designed to find similarity in textual data (Amigud and Dawson, 2020). However, with the advent of, and increase in, online assessments, along with the technological advances available to, and speed in response achievable by, contract cheating providers, both types of cheating are now possible for remote online examinations. Dawson (2021) goes further in describing four e-cheating methods/approaches available to students: a) providing access to unauthorised information (through unauthorised devices, web browsers, essay banks etc akin to smuggling notes into an exam hall); b) cognitive offloading to a software tool (such as translation, algebra-solving and bespoke essay-writing tools); c) outsourcing work to a person (such as contract cheating, online course-taking sites and remote coaches); and d) disrupting the assessment process (e.g. thwarting anti-cheating software, bypassing website blocking).

There are several ways that students can outsource their assignments including essay mills, bespoke assignment services, essay bidding services, and peer-to-peer file sharing sites (peer-sharing sites) and, equally problematic, obtain work from other students, colleagues, friends and family members (Awdry, 2020). In the online arena, all of these are potentially accessible during examinations. This includes contract cheating services where sites allow users to request a piece of work written to their specifications and to their timeframes (often within the timescale of an examination). Similarly, essay mills more commonly have pre-written assignments and users can search for their topic and purchase/download instantly. Whilst these sites usually provide services for a monetary fee, users may also gain 'loyalty credits' and can obtain assignments for free, or at reduced rates (Awdry, 2020). The marketing and promotional methods used are advanced (Dawson, 2021) and are frequently considered to be predatory, with advertisements regularly appearing in students' social media feeds promoted by social media influencers, Google searches, and on campus through unauthorised campaigns using seductively friendly and supportive language. Somewhat surprisingly, Awdry's (2020) study found that outsourcing from friends and family was in fact the most common method used for cheating internationally. From this large international study, 16.9% of respondents indicated that they had used some form of assignment outsourcing and 7.4% cheated through formal outsourcing methods.

2.2 Extent of cheating

 There is widespread concern that cheating has become easier through advances in technology which provide students with the opportunity to gain unauthorized assistance, particularly through contract cheating and often in ways that are difficult to detect (Newton, 2018; Ison, 2020; Alessio and Messinger, 2021; Dawson, 2021). It is not surprising therefore that cheating scandals internationally have become more prominent and more public in recent years (see for example Harper et al. (2019) and Flaherty (2020)). They are also being taken more seriously by authorities as

seen in a very recent case in the UK reported in The Times.[7] In this case the student hacker broke into his university's computer system using sophisticated tools to track login details of academic staff and to access exam papers and answer sheets which he proceeded to sell for thousands of pounds over a two-year period. The hacker was finally tracked down and given a 20-month jail sentence.

Bretag et al. (2018) identified three major factors which seem to influence a student's engagement with contract cheating services and essay mills (at least at institutions where English is the main spoken language); a) English is not the student's first language, b) the perception that there are 'lots of opportunities' to cheat, and c) dissatisfaction with the teaching and learning environment. To this one can add the more explicit d) a breakdown in trust or a poor relationship between student and teacher negatively influencing the environment of academic integrity (see Dyer et al., 2020). Rowland (2018) details a range of drivers that include societal, family and intrinsic pressures to succeed and the fear of failure, high stress levels, peer pressure and pressure to help a friend, laziness and apathy, a sense that 'everyone else does it' and finally accessibility to contract cheating websites. It has also been suggested that the student's nationality and culture, as well as the nature of their home education system, can influence the propensity for, and extent of, academic misconduct (Miller et al., 2015). Indeed, between 58-73% of contract cheating cases reported by UK universities involved non-EU students in 2017-18 (Lee, 2019).

In light of the opportunities now available, it is not surprising that many students appear to believe that it is easier to cheat in online courses and it is more likely to occur, particularly in courses that lack examination-monitoring systems (Brown, 2018, Hussein et al., 2020 and references therein). Such cheating is seen as more acceptable in non-proctored rather than proctored examinations (Dyer et al., 2020). There have been a number of studies exploring the degree of academic dishonesty in online education, often based on self-reporting by students, and with somewhat variable results. Daffin and Jones (2018) identify a couple of studies that have reported instances of academic misconduct in online classes no different or even lower than those in traditional classroom settings

(with values in the order of 3% for example). Eaton (2020) also pointed to some studies that indicated less academic misconduct and self-reporting of same in online compared with face-to-face courses, although these were almost all pre-2010 and, as Eaton pointed out, students enrolled in online courses were typically older than on-campus equivalents and the probability of committing academic misconduct seems to decrease as students mature (Newton, 2018; Eaton, 2020). However, other examples reported by Dyer et al. (2020) from various sources included evidence of a higher incidence of cheating online, such as by 15% of a 300-strong hybrid information systems class with online quizzes, and levels of self-reporting of some form of cheating of between 40-70% have been documented in a range of online programmes (Awdry, 2020). Watson and Sottile (2010) noted that students indicated that they would be more than four times more likely to cheat in an online class than in face-to-face courses. Surveys of teaching staff also find a significant level of contract cheating occurs, as exemplified by a study of over 1100 teaching staff in 8 Australian Universities that indicated over 67% of staff had encountered assessments suspected as being written by someone other than the student and for 40% of staff this had occurred on more than 5 occasions (Harper et al. 2019). An extensive meta-analysis by Newton (2018), based on some 65 studies covering over 54,000 participants in total, showed just under 16% of students admitted to having engaged with contract cheating at some time and that contract cheating appears to have increased over time (at least up until 2017) from a long period with low levels followed by a sudden rise post 2009 (Fig 1). It is worth reiterating that commercial contract cheating represents only a proportion of assignment outsourcing opportunities to students who wish to cheat.

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7   Humphries, W. (2021) Hacker student at the University of South Wales who sold exam answers jailed. The Times. https://www.thetimes.co.uk/article/hacker-student-at-the-university-of-south-wales-who-sold-exam-answers-jailed-hdkgjsb7x [Accessed 27 October 2021]
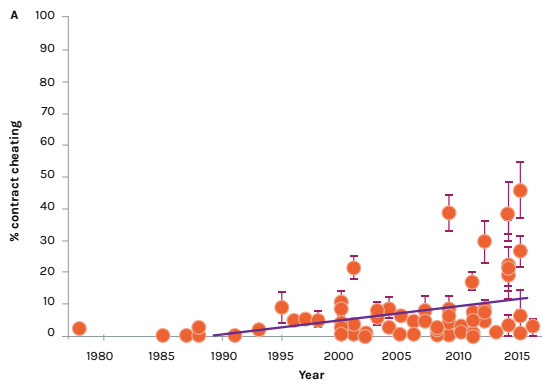
FIGURE 1 Self-reports of commercial contract cheating by students over time. The plots show the percentage of respondents, in individual samples, who answered "yes" to having paid a third party to undertake assignments for them, (with 95%CI). (From Newton, 2018)

2.3 Variation in student performance

There are clear examples of students performing better in non-proctored than proctored examinations. A well-designed 'experiment' over two years from two online courses in Principles of Economics showed exam scores were higher in non-proctored exams, ascribed by the authors, Harmon and Lambrinos (2008), to be a result of cheating. In their study in Washington State University, Daffin and Jones (2018) included nearly 1700 students across 14 different online psychology courses over four semesters (with at least one proctored exam switch across the two years). Results were unequivocal: student scores and the time taken to complete the exams were significantly lower for proctored than non-proctored examinations (scores increasing from 64% to 77%), and the proctoring provider (either Washington State's own in-house proctoring service - Global Campus Proctoring Service or ProctorU) made no difference to the pattern of results. The authors concluded that either students were negatively affected by anxiety during proctored exams, or some students at least were effectively cheating when not proctored. In another study, where students were taught one year prior to and one year following campus-wide adoption of online video proctoring software during examinations, Alessio and Maurer (2018) compared final grades across 29 online courses in 10 different academic departments. The average course GPA on a 4-point scale was significantly reduced (by 2.2%) after adoption of the proctoring software which backed up the results of an earlier study (Allesio et al., 2017) where there was a large reduction in scores and less

time used in proctored versus non-proctored tests in medical terminology at Miami University, Ohio, USA (Table 1). Similarly, Eaton (2020) found that with the emergency shift to online delivery and testing during Covid -19 restrictions, and prior to establishment of an e-proctoring service at Calgary, students were gaining higher grades in tests, particularly multiple choice, than they ever did during face-to-face classes. In a large meta-analysis of 49 studies covering over 100,000 test-takers, Steger et al. (2020) showed a clear and significant effect favouring students in non-proctored than in proctored internet-based testing. However, this effect could be reduced to near zero when there were strict time limits, the test content was not internet-searchable, and a lockdown browser was used.

Table 1. Results of the Allesio et al. (2017) study comparing student test scores and percentage time used across three different states of proctoring.

Proctor status	Average + [SD] Test Score (% correct)	Average + [SD] Percent Time Used (% of time given)	Number of Tests	Number of Students
Unproctored	89.4 [12.3]	41.2 [14.1]	471	147
Proctored with video monitor	74.3 [5.9]	20.4 [13.9]	125	66
Lockdown (no video monitor)	93.2 [9.0]	40.0 [10.1]	40	20

Other general research findings summarised by Dyer et al. (2020) suggest that academic dishonesty runs particularly high among students in disciplines of engineering, business and nursing. Whilst several studies have indicated that female students cheat less than male students, others do not, but do point to different approaches used by each (see references in Dyer et al, 2020). The data also indicates that students with lower grade points averages tend to cheat more often than those with higher scores and international students are more likely to be identified as cheating than domestic students, although this is dependent on the country of origin (see also Awdry, 2020) and in which country they were studying. There are reports of increases in the incidence of violations of academic integrity during the Covid -19 pandemic; for example, in the University of Calgary, Canada (Eaton, 2020) but there is a general absence of data on this issue at present.

2.4 Combating cheating

To maintain the integrity of online assessment tests and examinations it is important to (a) ensure identification of the students submitting assignments or undertaking tests and examinations, (b) prevent communication between students and any other individuals who might provide unauthorised assistance during testing, (c) restrict access to the Internet unless permitted, and (d) impede the use of secondary devices and technical aids while taking tests and examinations, these latter two points in order to restrict the opportunity of accessing third party contract cheating sites and other potentially fraudulent information sources to gain unfair advantage. In the UK and Australia, the quality agencies such as QAA (QAA, 2017) and TEQSA (TEQSA, 2017) have commenced work to address and combat contract cheating, and in Europe, multi-country initiatives have also been underway (Glendinning et al., 2017). This level of oversight has been established within a legal framework within a few jurisdictions. For example, the United States Higher Education Opportunity Act, which was enacted in 2008 (and currently (2021) appears to be under a reauthorisation process), included provisions to require institutions to have processes in place that ensure that students who register in distance education courses are the same individuals participating in and completing the course. The act identified three methods to accomplish this goal: (a) secure login and passwords, (b) proctored exams, and (c) new technologies or practices that verify the students' identities (see Brown, 2018). This is effectively what e-proctoring services aim to provide: to allow students to take assessments offsite while ensuring the integrity of the assessment.

There is evidence that e-proctoring has a deterrent effect on cheating in online examinations (Dawson and Sutherland-Smith, 2019). According to Dyer et al. (2020), proctoring is seen by the students as a reflection of the seriousness of the assessment, and also of the value the institution sets on academic integrity. If a student believes classmates are cheating on a test, this will support their belief that cheating on that test is acceptable.

The expansion of use of e-proctoring and its increasing penetration into the HE sector reflects a number of perceived benefits to both students and the institutions which are highlighted across the literature and commercial proctoring websites.

For the student:

- E-proctoring offers students the option to take tests remotely (independent of location) which is a valuable option for students who are geographically dispersed.

- For some e-proctoring systems, the student can also choose when to sit the examination as the exam provider is not necessarily confined to one specific exam day or time; students can potentially schedule online exams 24/7/365.

- The privacy of the private exam venue may be important compared to the potential stress of a public exam hall.

- A familiar and quiet environment together with access to the student's personal computer may also help the student to concentrate and perform better.

- E-proctored exams meet growing demand in professional healthcare and other professional disciplines for enhanced identity verification and other digital security.

- E-proctored examinations can also meet a recognised demand by students for fair and secure assessment opportunities in the expanding on-line education provision.

For the HE institution and the academic:

- E-proctoring can offer an ideal solution to assess massive open online courses (MOOCs), as well as to cater for the assessment of students undertaking programmes whilst based abroad, as exams can be run in remote locations.

- The technologies associated with monitoring of the online examination can help to provide exam security and ensure that the importance of academic integrity can be reinforced.

- Some e-proctoring approaches can scale very efficiently.

- The institution does not have to concentrate all of the exams during a short period of time and online proctoring potentially reduces instructional time dedicated to testing, allowing instructors and students to engage more with the course content.

- Online proctoring can therefore be used to make the education process more flexible.

- E-proctoring can reduce potentially high costs of provision and administration of exam halls as well as

reduce infrastructure or computer lab requirements or pressure on exam hall space.

- Some e-proctoring systems allow for more efficient exam paper distribution and ease of access for marking

- Online proctored exams are reportedly relatively easy to set up and customize

- Detailed reporting of student activity during the examination can provide insight into learner behaviour and patterns.

- Digital assessment security, if implemented correctly, can enhance confidence in assessment outcomes especially for professional programmes and act as a deterrent to cheating during online assessments.

3. Approaches to e-proctoring

According to Selwyn et al. (2021), online proctoring of computer-based examinations has been a feature of distance education for the past 20 years, with various forms of 'virtual proctoring' and 'online invigilation' being developed over the 2000s and 2010s. Online proctoring using human proctors was first championed by 'Kryterion' in 2006 with large-scale operations starting in 2008 (Foster and Layman, 2013). 2008 was also the year the largest commercial e-proctoring service, 'ProctorU', was established. These developments were based around the basic legal definition that in order to detect and prevent fraud during an online examination, it is necessary to both identify a test-taker and monitor the exam process. Selwyn et al. (2021) also makes the very cogent point that the e-proctoring services provided by commercial companies are not intended to provide a form of automated decision making, but rather to 'flag' potentially suspicious behaviour or activities to the HEI officials who then make the final decision on whether academic misconduct or malpractice has taken place.

In terms of the process of e-proctoring, there are four major system features (Hussein et al. 2020);

i.   authentication: ensuring the registered student is the valid student taking an online proctored exam,

ii. browsing tolerance: setting the limit of the student's ability to use their computer and access applications for tasks other than completing the examination itself,

iii. remote authorising and control: enabling the invigilator/proctor to start, pause and end the online proctored exam, and as well as flag, and in live proctoring, investigate, any suspicious student behaviours,

iv. report generation: which is the creation of reports of a student's activities during a proctored exam or following post-exam review of recordings.

3.1. Basic technological elements

There are four basic technological elements involved to some degree or another in e-proctoring systems.

1. **Lockdown browsers.** One of the first attempts to deal with the challenges of ensuring academic integrity in online assessments involved the lockdown browser (Brown, 2018), developed by 'Respondus' about two decades ago. They have a high degree of invasiveness from the student's perspective (Dawson, 2021) and can monitor the computer preventing students from accessing the internet and external information, restrict computer use to authorised applications and prevent other computer-based functions such as copying, pasting and printing, prevent the student from leaving the examination screen and even allow the proctor to view the screen ('screen capture'). However, they cannot prevent students accessing books or notes, leaving the room, using another device or calling somebody for help. It is often noted that most lockdown browsers can be bypassed with sufficient IT knowledge.

2. **Surveillance.** Using video and often auditory surveillance through the student's computer webcam provides an element of 'normal' invigilation to try to ensure test conditions are being maintained. Some systems require a second webcam provided by a phone or tablet placed behind the student (Sietses, 2016). Students can verify their identity using a photo ID card and facial recognition, the room and physical learning space/desk surface can be scanned at the start of the examination, and the student's behaviour and activity can be monitored remotely during the examination. The latter may include tracking eye movements away from the computer and ensuring the student does not leave the desk or room and ideally catching anyone else entering it. Such activities can then be flagged as potential integrity violations either at the time during live monitoring by an invigilator/proctor or from recordings reviewed later. Clearly this approach is highly invasive (Dawson, 2021).

3. **Biometrics and Stylometry**. Biometric software is often incorporated into e-proctoring services. This can use the student's fingerprints, face, irises, voice, signature and keystroke analytics (stylometry) or a combination to confirm that the individual is the intended examinee (Sietses, 2016; Langerfeld, 2020). Of course, biometric software (other than

perhaps keystroke analytics) cannot guarantee the user's continued presence and this approach does raise issues around the use and storage of personal and sensitive information (see later). This approach involves building profiles of the student and is seen as moderately invasive (Dawson, 2021).

4. **Artificial Intelligence.** Search algorithm analysis or Artificial Intelligence (AI) systems offers another approach to detect behaviours or activities on the computer or through the webcam that meet an explicitly defined list of integrity violations and hence can identify potential cheating. Invigilators have a dashboard that allows them to observe testing in real time through live monitoring or recorded sessions (Brown, 2018). Similar to surveillance, this approach can be highly invasive.

Brown (2018) has produced an extremely useful summary of the pros and cons for online proctoring technology elements (Table 2) and Dawson (2021) describes the different approaches to assessment security in some detail.

From the student's perspective, certain minimum specifications for computer and internet connectivity are required to support e-proctoring. According to the commercial provider 'Talview' (Talview, 2020; with offices in US, India, Singapore and the UK), to undertake an online proctored test from a remote location a student requires i) a suitable device (Desktop PC/Laptop/Tablet/Mobile), ii) an Internet connection with at least 256kbps speed, iii) a functional webcam and a microphone and iv) access to any of the modern internet browsers.

The IT Sligo Examinations website sets out a number of specifications for students to engage with e-proctoring (in this case run through Moodle using 'Examity' services). Students must i) take the examination on a desktop or laptop using the Chrome browser, ii) have a working USB port, iii) wide angle webcam and iv) a working microphone, v) the internet speed available must be at least 2Mbs upload and download. Students are also expected to pay the proctor company directly a sum per examination.

Table 2. The pros and cons of different approaches to online proctoring (Brown, 2018)

Approach	Pros	Cons
Lockdown browsers	• Prevents the use of other software applications during the exam	• Students can use books, notes, call a friend, or second device to search answers
Video monitoring	• Monitors students' behaviour during an exam • Allows identity verification with student ID cards • Require environmental scan to identify potential secondary resources in the room can be a requirement • Allow the students to be observed without the intrusion during the exam when review of recorded videos is set bu the faculty member	• Systems require looking directly at the computer screen and sitting upright which are not required in a classroom setting • Students are disrupted during the exam by some services when aberrant behaviour occurs whether the student is cheating or not • Results in many false flags • Companies using live proctor ratio which may result in missed aberrant behaviour
Biometric identification	• Give a unique identifier for the individual which is difficult to replicate • Increased accuracy in the indentification over time	• Biometric signatures can change over time • Family members can bypass the facial screening • Students are blocked from the exams until reset missing exam deadline when biosignature changes
Search algorithm analysis	• Identifies the use of alternative devices in search of answers • Takes down the test study guides during the exam times • Identifies potential groups working through exam questions together • Provides vidoe of both the alternate search and the student aberrant behaviour • Use of algorithm does not require live proctors.	• Students when caught think they are cyber staked because they do not understandhow the service works.

At a more technical level, the Canadian University of Waterloo (2020) specify the following requirements from students (Table 3).

Table 3. Specified technical requirements to support e-proctoring at the University of Waterloo (from the University Online proctoring webpages for students[8]).

Type of Infrastructure	Minimum requirement	Recommended
Webcam	640x480 resolution	1280x720 resolution
PC Users	Windows Vista	Windows 10 (10 S not supported)
Mac Users	Mac OS X 10.5 or higher	Mac OS x 10.13 High Sierra
Internet Download Speed	.768 Mbps	1.5 Mbps
Internet Upload Speed	.384 Mbps	1 Mbps
RAM	1024 MB	2 GB
Connectivity Ports	1935, 843, 80, 443, 61613, UDP/TCP	1935, 843, 80, 443, 61613, UDP/TCP
Screen Resolution	1366 x 768	1920 x 1080 and above
Chromebook Users (Only for Automated Proctoring. Is not Supported for Live Proctoring)	Chrome device is running the latest version of Chrome OS.	Chrome device is running the latest version of Chrome OS.

3.2. Main e-proctoring approaches

There are basically three major approaches to e-proctoring offered by commercial services, or developed in-house by HE institutions, that are widely described to varying levels of detail in the literature as well as on the commercial proctoring websites. The following summarises the key features based on a number of sources (including Sietses, 2016; Dimeo, 2017; Eaton et al., 2020; Hussein et al., 2020, Lagenfeld, 2020; QAA 2020, 2021b; Talview, 2020).

1. **Human-led, live invigilation /proctoring**
   Online invigilators (either staff of the institution or employees of the proctoring vendor} use audio and video during the actual examination to supervise the exam virtually, online, and identify issues as they arise. These can be dealt with at the time, with possibilities to stop testing, or later after review. This approach most closely resembles traditional,

exam hall, invigilation with the invigilator/proctor monitoring the exam remotely. Proctors are usually trained professionals. Varying levels of service may be offered by commercial services to (a) verify test taker identity, (b) observe the test taker behaviour to minimize cheating, and (c) secure test content. A proctor can potentially monitor up to 16-32 candidates at a time depending on the provider although some companies offer lower ratios which can make higher levels of scrutiny possible.

A number of drawbacks to this approach have been highlighted, such as limited scalability (e.g., the size of the exam class is limited by the number of available proctors), the need to have a fixed examination schedule within which all students commence and must complete the exam, and cost (this is the most expensive of the e-proctoring solutions as this has equal human involvement to traditional on-site examinations). Live online proctoring also requires competence by proctors in the use of the technology and intricacies of the system.

2. **Recorded invigilation/proctoring**
   Audio, camera (video or stills) and other data from the online assessment are recorded and reviewed at a later date after the examination, to assess the integrity of the exam and identify any suspicious activity. This review can be undertaken by a proctor (from the commercial service provider or the institution) with recordings played back in fast-forward mode (3X-20X speed is usual) or through automated proctoring. Artificial Intelligence software can monitor behaviours it is programmed to flag as suspicious for review later by a human.

Recording the examination overcomes the need for fixed exam schedules and means the student can potentially sit the exam whenever they are ready. This approach is also more scalable, potentially with large numbers of students able to sit exams at the same time and assessment of the recordings can take place over a longer time frame as required. Proctors are still required however and hence cost can be a drawback if sourced from the vendor. Without the live proctoring, no intervention is possible during the exam, for example to alert the student to a potential issue or highlight incorrect positioning of the camera etc.

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8   ProctorU (2021) Equipment Requirements https://support.proctoru.com/hc/en-us/articles/115011772748-Equipment-Requirements [Accessed: 30September 2021]

3. **Artificial Intelligence approaches [fully or semi-automated proctoring]**

Software developments have led to the possibility of AI bots, using advanced video and audio analytics and algorithms, replacing proctors during live proctoring or during review of recorded examinations. With AI proctoring, two general types of protocol are offered:

(a) during live proctoring the AI bot can authenticate the test taker's identity, provide standardized instructions, check room conditions, monitor internet browsing history, searches and online interactions etc, and observe the test taker, searching for pre-programmed behaviours that may constitute an integrity breach. If the algorithm identifies an irregularity, it flags the testing event and takes a specified action e.g., in the event of a serious issue bring the assessment to a halt.

(b) Artificial Intelligence software can monitor behaviours it is programmed or 'trained' to flag as suspicious for review of the recorded activity later by a human proctor to determine the appropriate follow up action. A combined approach is part of 'premium' online proctoring packages and is claimed to be more secure with live human invigilation and student access to technical help during the test as well as monitoring by AI.

The AI approach offers the most scalable solution and is potentially more efficient in terms of time and cost as it is not reliant on human proctors, as well as potentially eliminating the need for specific scheduling of exams when the exams are recorded (although the premium package will of course be more expensive and likely less scalable). Potential drawbacks include the software relatively easily producing false positives (innocent events flagged as integrity breaches) and, where technologically adept students know how the software works, they may evade the fraud prevention measures more easily than with a human proctor. Increased and more accurate surveillance also leads to increased workloads for academics subsequently reviewing the recorded exams.

As an example of commercial proctoring 'in action' so to speak, Drew's (2020) article in the Boston Post is illuminating. At the start of a 'ProctorU' live proctored test, students must show the proctor their ID cards, their rooms and desktop. The system uses facial recognition software to match the student present to the image on their ID and random scans during the exam prevent another test-taker from replacing the candidate. The proctor (Fig 2.) can also verify identity using a typing test where the student is asked to type 140 words at the beginning of the course and then again just before commencing the test to verify the speed and rhythms of the keystroke use (Stylometry).

Fig 2. Proctors in 'ProctorU's office in Hoover, Alabama, USA, watch over students. (ProctorU, from Harwell 2020).

During the test, the microphone must be on so that the proctor can check for any conversations with someone out of view. The proctor also gains access to the test-takers computer screen and is alerted by the student accessing unacceptable programmes or functions such as opening a new browser link or copying and pasting text. A software system operates through the webcam to analyse the student's eyes and if they look off-screen for 4 seconds more than twice in a minute, the motion is flagged to the proctor – a possible indication the student is accessing notes.

Another service provider, 'Proctorio', uses a completely automated, software-driven approach (Drew, 2020). Students must consent to 'Proctorio' monitoring their webcams, microphones and computers and 'any other means necessary to uphold integrity'. The system can lockdown the student's computer and a range of actions, and tracks their speech, eye movements,

number of mouse clicks and time to complete the test. The automated system then provides the academic staff with a report ranking test-takers by so called 'suspicion level' (based on predetermined behaviour settings and severity thresholds established by the academic/exam administrator with 'Proctorio') and the number of identified 'abnormalities' (again based on those enabled for the specific test). The suspicion level is calculated as shown in the panel below with an example output (Fig. 3). The 'Proctorio' website indicates that each noted behaviour gets an automated written incident log which can be accessed from within the assessment platform and exported as a PDF document (The Proctorio Gradebook).

New developments are ongoing and commercial proctor companies often offer new and novel proctoring services. 'Honorlock' for example offers advanced features such as cell phone detection, live pop-in

The suspicion level is a percentage that represents low, medium, or high suspicion for an exam and will increase or decrease depending on how heavily each Behaviour Setting is weighted and which Abnormalities are enabled.

The severity of each metric sets the weight of a suspicious behaviour in relation to the other behaviours. These metrics are calculated with each image. The Proctorio Frame Metrics will compare one test taker's actions to the rest of the exams in the class. This will highlight statistically significant differences in a test taker's behaviour. The severity of these metrics can be changed at any time which will result in a re-calculation of the Suspicious Level in the Proctorio Gradebook.

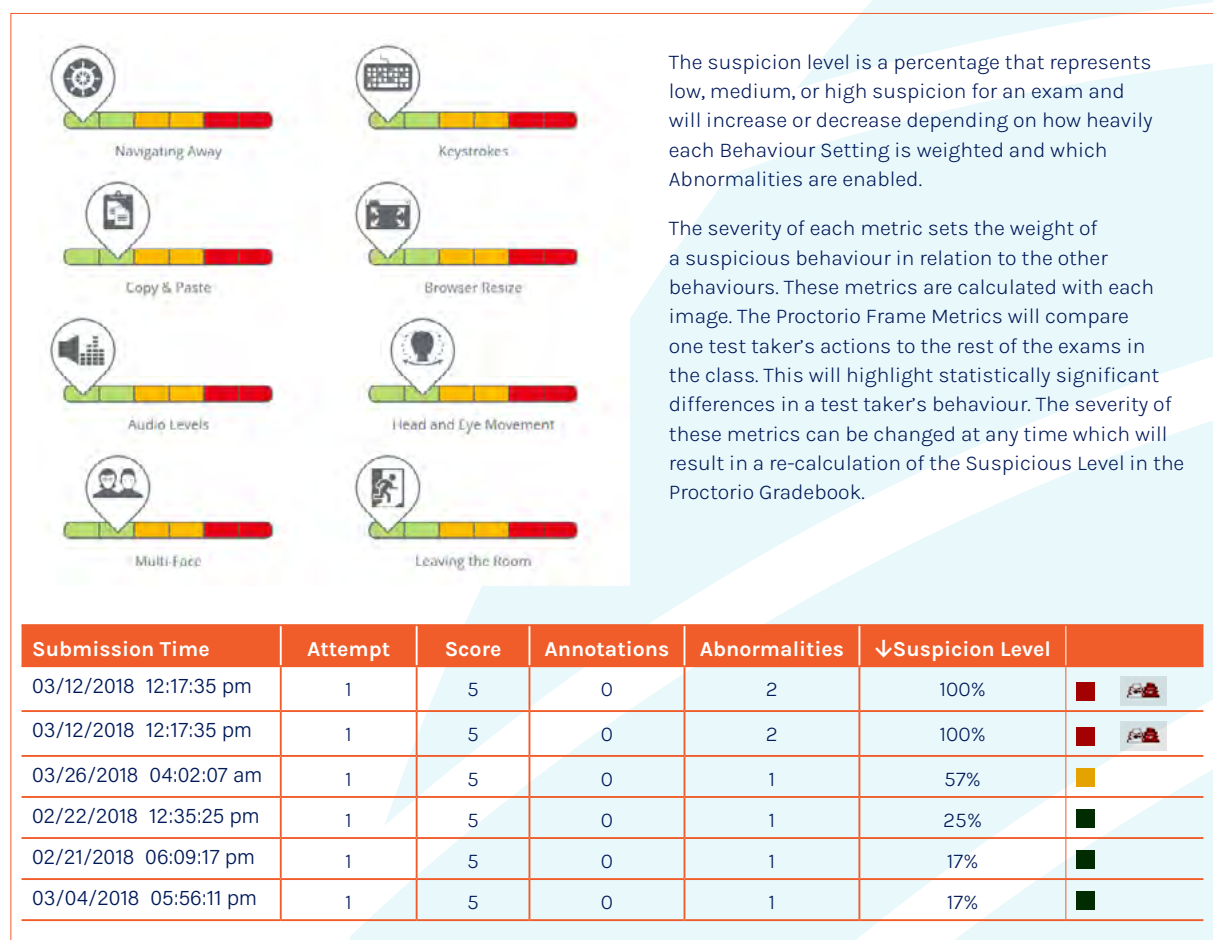| Submission Time	Attempt	Score	Annotations	Abnormalities	↓Suspicion Level		
03/12/2018 12:17:35 pm	1	5	0	2	100%	🟥	🚗
03/12/2018 12:17:35 pm	1	5	0	2	100%	🟥	🚗
03/26/2018 04:02:07 am	1	5	0	1	57%	🟨	
02/22/2018 12:35:25 pm	1	5	0	1	25%	🟩	
02/21/2018 06:09:17 pm	1	5	0	1	17%	🟩	
03/04/2018 05:56:11 pm	1	5	0	1	17%	🟩	

Figure 3. Top - The approach used by 'Proctorio' to calculate suspicion levels for an individual student's examination (an example from the Fox School of Business, Temple University, Philadelphia https://foxonline.temple.edu>sites>default>files Proctorio-Best-practices-and -Recommenmded-Settings.pdf , October 2021; Bottom - an example page from Proctorio Gradebook on Canvas VLE showing the information collected during a proctored exam with abnormalities counted and suspicion level scored (colour graded from green through yellow to red) (from Moodle Proctorio Gradebook Guide PDF, California State, Fullerton website www.fullerton.edu › proctorio › Moodle Proctorio Gradebook Guide; October 2021)

(combining AI and live human proctoring), limiting candidate logins to specific IP addresses, exam content protection, and voice detection ('Honorlock' website).

Most proctoring companies operate out of several countries, often with different functions split internationally. 'Examity' for example is based in the USA, project-manages in Europe from the UK, has data storage in Germany and proctors based in India. 'ProctorU' (like other commercial e-proctoring companies) shares a large amount of often very sensitive data with the proctors and institutions (see below Sections 7.1, 7.2)

3.3 A risk-based model to identify the appropriate approach

Sietses (2016) recommends different approaches of e-proctoring depending on the level of risk of fraud in, and importance of, the assessment/examination in question. The useful matrix-based model suggests the best approach ranging from no checks needed, through three levels of e-proctoring oversight, to recommended use of the regular invigilated exam hall process (Fig. 4).

In this model, the Importance is determined by the (immediate) effect of the particular exam, and the value placed on the assessment. 'Low' has no recognised value, 'Medium' has some consequences attached to the exam even if not directly contributing to the final assessment grade or transcript, 'High' relates to exams that have a direct and significant impact on study credits and 'Very High' is for assessment in courses demanding higher standards of fraud prevention e.g. professional practice exams or in final award assessments. The Risk depends primarily on the nature of test format. 'Low risk' occurs where the student work is entirely unique such as a thesis, practical assignment, essay or oral and where fraud prevention focuses on plagiarism and that the student has done the work (no contract cheating). 'Medium risk' exams require unique answers such as written tests with open-ended questions of sufficient length to be unique to each student. 'High risk' exams are those where only a single answer is possible and student answers are not unique, such as closed-ended questions (the answer is limited to a predetermined list of response options), MCQ etc. Whilst this particular model may not cover every type of assessment, and it was developed over 5 years ago prior to the recent advances in e-proctoring systems, it does offer a very useful approach and the possibility for customisation by institutions in much the same way as standard risk assessment matrixes are created.

IMPORTANCE

Risk of Fraud	Low	Medium	High	Very High
Low	Formative test Practice test **No check needed**	Interim oral test **Level 1**	Essay or argument Practical assignment Oral test **Level 1***	Graduation assignment Dissertation **Not applicable**
Medium	MOOC open-ended questions **Level 1**	Interim test open-ended questions **Level 2**	Interim test open-ended questions **Level 3**	Test with 'civil effect'[35] with open-ended questions **Regular exam hall**
High	MOOC Closed-ended questions **Level 1 or 2****	Interim test Closed-ended questions **Level 2**	Exam Closed-ended questions **Regular exam hall**	Test with 'civil effect' with close-ended questions **Regular exam hall**

* Online proctoring is unsuitable for essays and work performed over long periods of time but is particularly suited to oral exams.
** For MOOCs, the Level depends on the value placed on the MOOC and its assessment.

Figure 4. Sietses (2016) assessment security selection model. The resulting recommended proctoring levels identified in the risk-importance matrix are: Level 1: screen capture and a single camera; Level 2: screen capture and two cameras; Level 3: full logging, screen capture, two cameras and only live proctoring or a recording. "civil effect" exams are those which allow access to professional practice such as a lawyer or in the judicial system, medical practitioner, civil engineering etc and programmes governed by professional bodies.

4. Extent of use of e-proctoring

4.1 Internationally

As discussed earlier, e-proctoring has been growing rapidly across HE institutions worldwide and as detailed in Section 1, proctoring companies are now overseeing millions of examinations each year across the globe. By far the greatest use of e-proctoring has been in Australia and the USA although its use in Europe has been growing, particularly during the Covid epidemic.

By the end of 2019, Selwyn et al. (2021) reported that around a quarter of Australian universities had trialled online proctoring in the previous few years, although at that time none had implemented it at scale. STEM subjects, business subjects like finance and accounting, and computer science and IT were the dominant areas, subjects often using relatively closed assessments. Most universities allowed tutors to 'opt in' for online proctored examinations.

In the USA, a significantly higher usage of e-proctoring has been reported, with a recent snap survey showing over half (54%) of the institutions polled (which did include a few institutions from other countries) were using e-proctoring services for exams, whilst a further 23% were considering using them (Grajek, 2020; Fig. 5). Active restriction of software and passive video surveillance of students were the most common reported approaches although 80% of the institutions using e-proctoring used more than one type of approach and 18% all four. Approximately two thirds (65%) of the institutions polled in this study that were using e-proctoring were using 'Respondus' with 'ProctorU' the next most popular provider (23%). 'Proctorio' (17%), 'Examity' (12%), 'Honorlock' (12%) and 'ExamSoft' (7%) were also identified. Zoom was used by a number of institutions (7%), other service providers by a further 7% and a few (1%) used home-developed systems (note institutions may well be using more than 1 provider).

Interestingly, Berkeley allows students to opt out of e-proctoring and have alternatives in place, a position adopted by other institutions (see Section 6), whilst San Francisco State University passed a resolution restricting or banning third-party proctoring on the basis of perceived or evident flaws identified (QAA, 2021).
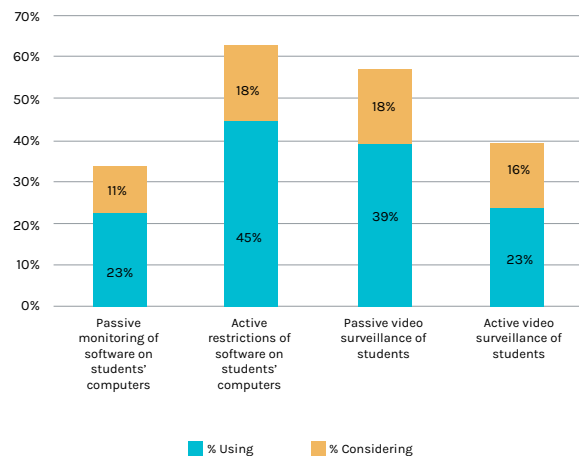
Figure 5. The extent of use of four types of e-proctoring approach as estimated based on a 'quick poll' survey of 312 HEIs (294 from USA, 18 from 8 other countries) conducted on 7th April 2020. (from Grajek, 2020)

In the UK, QAA ran a survey in October 2020 for higher education providers and found that approximately half of the 21 respondents were using e-proctoring (with in-assessment restrictions and online invigilation and most using video and identity verification) although most were small in scale or in development (QAA 2020).

A number of other examples of the use of e-proctoring internationally include:

- the University of Modena and Reggio Emilia in Italy which uses 'Smowl' online proctoring (which complies with the EU general data regulations) and offer departments three different options (live proctoring, live proctoring with browsing control, and automatic proctoring and monitoring of behaviour based on photos every 30 seconds) (De Santis et al., 2020)

- In Canada, Simon Fraser University for example offers a choice of either using Zoom (equivalent to live proctoring conducted by its own staff) or Auto Proctoring using 'Proctorio' for a pilot set of courses (Simon Fraser University (2020). The University of Manitoba indicates that most instructors will require students to use 'Respondus' lockdown browser and monitoring tools, the University of Waterloo have used 'ProctorU' for several courses (University of Waterloo, 2020), whilst Vancouver offers its

in-house fee-based proctoring services to other institutions. The University of British Columbia uses 'Proctorio' and the university Learning Technology Hub provides an informative instructor guide covering the technological set up advice, how to set up and review exams, FAQs and tips[9]. McGill University on the other hand does not recommend use of e-proctoring (QAA, 2021). This was due to risks of technical failure and student-related issues (such issues will be considered later in the report in Section 7). Similarly, the University of Michigan – Dearborn took the decision to avoid remote proctoring and instead to invest in instructional design staff and to support faculty to transition to authentic assessments (Silverman et al., 2021).

- Sietses (2016) reported that use of online proctoring was growing in the Netherlands and in 2016 the University of Amsterdam conducted around 800 exams using online proctoring software.

4.2 Nationally

The take up and extent of use of e-proctoring across the Irish HE sector has been patchy, even in the face of the constraints placed on teaching and learning during the Covid-19 epidemic. Based on personal discussions and/or correspondence with a range of institutions, the trend has been for greater engagement with e-proctoring in the IoT sector, in some cases covering all examinations, whilst small scale pilots have been trailed within the University sector. Limerick Institute of Technology, for example, conducted nearly 70 e-proctored examinations (using the service provider 'Examity') during the last academic year with over 2000 sittings. This has been supported by specific policy changes (see Section 5 on Policies below). Similarly, IT Sligo have been using online examinations as an option for students overseas at the time of the examination and where the module and assessment is suitable. They first trialled on-line proctoring in 2012 and started using a commercial service provider in 2013 (Clinch, 2015). These exams continue to be proctored (now using 'Examity'), and on the back of their experience some specific regulations have been developed (see later). Recently, TCD have introduced the option to take

exams in the School of Medicine using 'Protorio' from January 2021 following positive feedback from students and have indicated that this will be the primary method for testing going forward[10]. This will apparently lead to policy changes to include proctoring for online exams.

In contrast, NUIG and UCC have piloted a small number of e-proctored exams (mainly in the health and medicine areas), but with limited success[11] (see section 6.2). UCD has undertaken a larger scale set of trials using a Canadian proctoring service that complies with EU GDPR regulations (Canada is recognised by the EU in this regard); this has involved three cohorts and about 1000 examination sittings (involving stage 4 UG medicine, Food Science and an online masters; more detail is provided later)[12]. Maynooth University have not engaged with commercial e-proctoring but a few departments tried live proctoring by the lecturer through Teams, which was only viable for small classes[13].

In relation to private HE providers, one prime example is Dublin Business School which has undertaken significant work with e-proctoring and policies for online examinations (see later). They have established live proctoring on their Moodle VLE platform but do not use browser lockdown as essentially examinations are open book. Detailed sets of guidelines and a video to support students are available on the exams office website[14]).

4.3 Professional Statutory and Regulatory Bodies (PSRBs)

The use of e-proctoring by PSRBs is patchy. Some detailed information is available from the UK following a second QAA survey in October 2020. Of the 25 bodies approached, there was mixed enthusiasm reported, with some leaving the decision to the provider whilst others were fully supportive and likely to require remote proctoring in the near future. 16 of the providers surveyed indicated that PSRBs had made e-proctoring a requirement for their accredited courses when delivered online - these included the areas of law, medicine, veterinary science, actuaries, maths, engineering and business. A somewhat contradictory

9 UBC (2021) Proctorio Instructor Guide https://lthub.ubc.ca/guides/proctorio-instructor-guide/?file=2020/03/proctorio-instructor-guide.pdf [Accessed September 2021]
10 TCD School of Medicine (2021) https://www.tcd.ie/medicine/local/proctorio/ [Accessed 27 October 2021]
11 Information from Professor Pol O' Dochartaigh (Deputy President and Rregistrar, NUIG); Professor Paul McSweeney (VP Learning and Teaching, UCC)
12 Information from Niall Dennehy (Project Manager, Assessment, UCD Registry)
13 Information from Professor Aidan Mulkeen (Vice-President Academic, Registrar and Deputy President, MU)
14 Dublin Business School (2020) https://students.dbs.ie/exams-office/online-exams#Proctor [accessed 30 September 2021]

outcome of the survey was that only 3 of the PSRBs had apparently asked their accredited provider to implement e-proctoring whilst the other 22 had not.

In the USA, there are examples of PSRBs introducing e-proctoring such as the National Council of Architectural Registration Board for its Architect registration Exam (QAA 2021). Also, the National Commission for Certifying Agencies (NCCA), which accredits providers of programmes like nursing and other programmes that assess professional competence, conducted a relatively small-scale assessment of live proctoring for examining students with a focus for ensuring courses meet their accreditation standards (Institute for Credentialing Excellence, 2021). The conclusion reached was that there was no reason to prohibit live remote proctoring as a test delivery and proctoring method

In Ireland, Engineers Ireland have indicated that whilst some of their accredited programmes use e-proctoring services, they themselves do not have any direct relationships with these services (as they do not conduct student assessments directly) nor do they provide guidance on e-proctoring[15]. Chartered Accountants Ireland run examinations for Chartered Accountancy and had already started a development process towards online examinations just prior to the Covid-19 epidemic. Following initial trials with live proctoring they settled on Artificial Intelligence proctored exams for the 1500 or so student examinations they run each year using one of the main international service providers and anticipate using this approach going forward[16] (see Section 6.1). The Insurance industry also runs online proctored examinations (accredited by IT Sligo). The Life Insurance Association use 'ProctorExam' and The Insurance Institute of Ireland uses the Irish-based 'TestReach' proctoring company which has developed its own examination platform also (see Section 5.3)[17]. For both, the style of assessment lends itself well to utilise the automated systems offered by the providers.

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15 Information from Dr Richard Manton (Deputy Registrar, Engineers Ireland)
16 Information from discussion with Ronan O'Loughlin (Director of Education and Training Chartered Accountants Ireland)
17 Information from discussion with Dr Aodhmar Cadogan (Assistant Registrar) and Dr Gavin Clinch (Head of Online Learning, Centre for Online Learning), IT Sligo (20 September 2021)

5. Practices and Policy approaches

In this section, a few examples are provided that illustrate the general practices adopted by a number of HE institutions in the testing and delivery of e-proctoring as well as some of the supporting policies that have been developed. On the face of it, these might appear a rather eclectic set but they do help to show how the institutions have approached the introduction of e-proctoring and provide a sense of the issues that have had to be dealt with along with some examples of potential good practice.

5.1 The use of pilot projects

One of the important elements to the introduction of e-proctoring is in the use of small-scale trials/ pilot projects. The example provided by UCD is an interesting case[18]. The initial consideration was what form of e-proctoring should be used and through which provider. Following review, they selected 'Integrity Advocate', a Canadian-based provider that does not use live video or audio, has strong protections with respect to privacy, and integrated well with the UCD VLE environment. An additional selling point was that Canada has third country status with respect to EU GDPR requirements (something that the US proctoring companies do not). This provider adopts a Record and Review monitoring with still photos rather than video, full screen monitoring with review of the records from each student by company staff flagging the occurrence of potential, pre-selected, rule violations. In this case a student could take the exam without successfully verifying their ID, although the issue is flagged, and action can be taken at a later stage. This was seen as an advantage over systems that require successful verification prior to entry. UCD had also determined not to consider live proctoring and they did not modify their main policies or exam regulations for the pilot (what the student can and can't do is basically the same for on-campus and remote online exams).

The pilot consisted of 719 exam sittings, taken by 272 individual students from 3 cohorts, (2 UG and 1 PG) in March, May and August of 2021. One major finding was that the initial introduction of e-proctoring is the critical period, and it does not take much to derail the process. Secondly, it was concluded that e-proctoring acted as a deterrent rather than being able to provide sufficient evidence to convict an individual of cheating except in the most obvious of cases (out of 719 student exams, no disciplinary action has been required although there were a few follow-up queries). Thirdly, the amount of support required for the first cohort examined in the pilot was enormous before and during the exam and involved 15 staff on call to respond to any technology-related queries. Less support was required for the second and third cohorts and it is not envisaged that significant live support would be necessary once the systems are well established. UCD also prepared significant documentation to advise students.

A review of the outcome of the pilots is ongoing, considering the future role of e-proctoring post-covid, identifying what e-proctoring can and cannot do, how it can be made more scalable, what level of support is necessary, how flags for cheating vary across subjects and developing strategies to reduce the inclination or possibility to cheat. Student feedback has apparently been mixed and varied by cohort and whether or not the students had been exposed to e-proctoring previously. The postgraduate students in the third cohort appeared to be the most positive towards the e-proctoring system adopted which had benefited from the learnings of the earlier cohorts in the pilot.

5.2 Engagement with students

Engagement with students is seen as a vital component to the successful introduction and operation of e-proctored online examinations. The University of Manitoba (2020) provides a specific guide and set of recommendations to students for online examinations. These are mostly carried out using the in-house UM Learn VLE quiz tool and most instructors will require students to use 'Respondus Lockdown Browser' together with the 'Respondus Monitor' service which carries out monitoring through the student's webcam and microphone, providing an online proctoring function. It was noted that 'Respondus' does not work on Chrome.

Whilst not specifically identifying the institutions concerned, QAA (2020) describe a number of cases where the important engagement with students during the development and establishment of e-proctoring has been used. One provider carried out staged briefings, followed by student consultation, mock examinations, and then additional briefings. Another conducted early

18 Information from discussion with Niall Dennehy (Project Manager, Assessment, UCD Registry)

discussions with the students' union, explained the process to their students in advance of the exams, provided a helpline and regular communications and encouraged them to download and try the software in advance. Surveys with student representatives, guidance notes, tutorial videos, and dedicated IT staff were also provided. One provider used the feedback from remote proctoring on a low credit-bearing test on one module to inform their processes, and also produced written guides and videos for their students. The use of 'trial' or 'mock' exams in order for students to test their systems and get used to the proctoring process is an important theme raised by some Irish HEIs (e.g. LIT and UCD). Flaherty (2020) describes an even more detailed example of the practice of student engagement in delivering e-proctoring. At Daemen College, New York, one of the assistant professors in Biology went to quite extraordinary lengths to engage students in the use of Lockdown Browser and Respondus Monitor by the e-proctoring provider 'Respondus'. The academic concerned polled students about their technology access at home, took screenshots of herself going through the 'Respondus' monitoring process to demonstrate what test behaviours might get flagged and prompt a review by

her, and showed them what a final video would look like to help them feel less self-conscious.

Limerick Institute of Technology (LIT) offers students significant advice in relation to preparing for and undertaking e-proctored exams as exemplified by the essential steps to prepare for and complete proctored exams as in the flow diagram in Fig 6 as well the 'LIT Practitioner Guide for Assessment and Examinations During Remote Emergency Teaching, Academic Year 2020-2021'.

5.3 Rollout of e-proctoring

Full scale rollout of e-proctoring requires significant commitment of both staff time and resources. The procedures adopted by Limerick Institute of Technology (LIT), and their resultant observations and key learnings, offer useful pointers[19].

LIT had already carried out work on online teaching over the previous couple of years before Covid-19 and following the first lockdown in March 2020, moved to alternate assessments and no final exams. However, for academic year 2020-21, LIT adopted a planned assessment modality which enabled

ESSENTIAL STEPS TO PREPARE FOR AND COMPLETE YOUR ONLINE PROCTORED FINAL EXAM

Step 1:
Be Familiar with Essential Process Information

Step 2:
Meet the General Exam Conditions

Step 3:
Check Hardware/Internet Requirements

Step 4:
Check Software Necessary to Complete Your Exam

Step 5:
Check Your Equipment

Step 6:
Identify Your Moodle Exam Page

Step 7:
Setup Your Examity Profile and Schedule Your Exam

Step 8:
Conduct Your Pre-Exam Live Proctored Test

Step 9
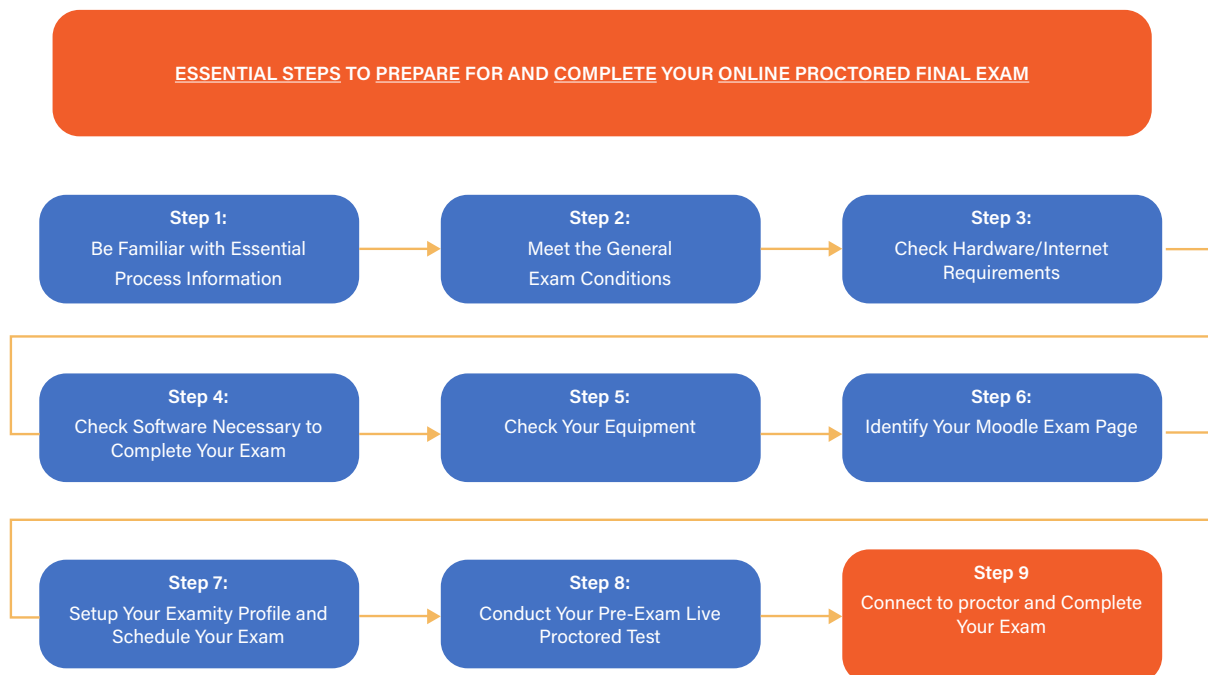Connect to proctor and Complete Your Exam

Figure 6. The essential steps advice to LIT students to prepare for and complete an online proctored final exam (provided by Marian Duggan, LIT VP Academic and Registrar).

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19 Information from discussions with Dr. Marian Duggan (VP Academic Affairs & Registrar) and Dr. Brendan Murphy (head of Quality, Teaching and Learning) LIT

early communication of assessment approaches to students while taking full account of the prevailing and evolving public health contexts. This involved providing a range of assessment approaches including formal Final Examinations in addition to Continuous Assessment options. The availability of formal final exams was viewed as important for the requirements of Professional, Regulatory and Statutory Bodies and for Award Years. Throughout the period of the pandemic the Institute prioritised the development of staff capacity in assessment practice. This was achieved through a series of initiatives including: seminars and workshops on current assessment practice, using open book exams, re-designing assessment with one-to one support for staff; the development of a series of best practice guidelines including an Assessment Rubrics Guide and an Open Book Exams Guide; and supporting documentation and guidelines for proctored exams.

For proctored exams, the initial work involved selection of the type of e-proctoring required and of the service provider that best met their requirements. Two key issues related to compatibility with the LIT VLE (Moodle) and operability with both the assignment and quiz functions in Moodle and secondly, GDPR considerations and the need for data storage to be within Europe. Following interviews with 3/4 providers one was selected ('Examity'). In this particular system with 'Examity' and Moodle, connection to the proctored exam was a two-step process; the student first connects to Moodle then through Moodle connects to the proctor. An essential step involved a pre-exam test for all students to familiarise them with the system and help troubleshoot any issues that might arise in connecting to the proctor system.

LIT entered a full rollout in Semester 1 2020-21 for 30 exams and 800 sittings. Programme Boards were offered a choice of e-proctored or non-proctored online open-book exams, but proctoring was used for online exams for Accountancy, Science and IT and for award years. A number of teething problems arose related to initial set up and enabling issues which informed refinements for Semester 2 examinations. These included the importance of an integrated 1-step communication to staff and students explaining how proctoring works and data protection and GDPR compliance (e.g., a detailed proctored Exams Information sheet and FAQs), training of staff to establish and manage open-book exams and proctoring and centralisation of online exams in the Exam Office rather than allowing distributed, locally controlled (i.e. departmental/school) Moodle programme pages.

In Semester 2 LIT ran 35 proctored exams and also retained the option of formal institute online open book final exams running a similar number of these. The type of exam was important as to whether e-proctoring could be used. The proctoring system operated in LIT precluded handwritten elements (such as drawings, mathematical symbols etc) which would require interaction with the internet or another device to upload material. Unless template materials could be provided by LIT staff for use during the online exam, proctored exams were limited to on-screen only. The online open book exams facilitated an examination option where handwritten material could be developed and submitted as part of the exam. Live proctoring was employed where programme boards opted for proctored exams (using the service provider proctors), but as an additional integrity and safeguard measure, the entire screen and student behaviour was also recorded. All exams were password protected and the proctor provided the password. Comfort breaks were allowed for a certain time but extended and/or multiple comfort breaks were flagged for review.

In addition, LIT established a team room which monitored the proctored exams live on the system (to identify who was not connected, why, provide an opportunity to contact the student (students were asked to leave phones on) and Exam Office contact was inset into the Moodle Exam system). It was reported that exam results were comparable with previous years (where on-site invigilated exams were used) and feedback from staff was positive. Out of 2000+ proctored exam sittings it was reported that there were less than 10 emails received from students identifying issues with the process.

Some general findings and outcomes from the LIT experience in relation to operational issues include:

- Students realise they are being invigilated in the proctored exams which is seen to act as somewhat of a deterrent.

- Nevertheless, a small number of integrity breaches occurred and were identified by the safeguards of the proctoring process.

- Where a student did not have the appropriate hardware or where they had difficulties in engaging online with the exam, institutional hardware was made available, and students could come on campus to sit the exam.

- There will always be a proportion of students unable to connect to the proctored exam on the day (with

some able to connect one day, not another). In Semester 1 there was 90% connectivity, Semester 2, 92% (higher than the stated norm by the proctor company).

- Students who could not connect, and were verified to have tried, could contact the Exams Office and were then given access to the exam, non-proctored, directly in Moodle.

- There was a minor problem with a small number of students reporting difficulty in understanding the instructions of proctors due to language issues.

- Staff appreciated the choice of setting either proctored exams or non-proctored open-book exams.

- Providing a comprehensive series of training opportunities and best practice guides to staff to further develop capacity in assessment was a key enabler.

In relation to the overall experience with e-proctoring at LIT, a number of further points and recommendations can be made:

- It is technically challenging to establish e-proctoring first time around and strong project-management is required.

- Very close collaboration between the Registrar's Office, Exams Office, Curriculum Office, Computer Services and Quality, Teaching and Learning is viewed as an important element in ensuring successful outcomes.

- A student pre-test is critical as it alleviates stress on the day of the exam and helps eliminate technical issues.

- Direct budget for the e-proctoring scale adopted at LIT in 2021 was less than on-site invigilation [although it is acknowledged that this would be more expensive with a larger cohort taking proctored exams and when taking into account the extra workload in support, establishment and monitoring internally].

- Regulations related to breaches of assessment (centred around the existing code of conduct) did not need to be modified for e-proctored exams.

- Staff appreciated the choice of either e-proctored or open-book exams but proctoring is important

for some programmes, especially those related to PSRBs and final year.

- Constant checking of systems of operation etc is needed as e-proctoring introduces variables outside of the institute's control.

- To mainstream proctoring and support larger cohorts in the context of Institute Exams, the issue of proctor connectivity would need to be addressed where the inability to connect to a proctor must become an exception rather than a typical feature (with up to 10% experiencing connection issues).

LIT believes that there is a place for proctored exams in the post Covid-19 context for blended and online programmes and particularly for Flexible and Life-long Learning offerings. They provide an additional assessment option to staff and provide a layer of academic integrity in online delivery. Institutional capacity has now been developed for both setting and conducting online open-book and online proctored final examinations. It is anticipated that these will be a feature of the assessment options, along with formal on campus examinations, available to staff and programme boards going forward.

IT Sligo[20] were one of the first Irish HE institutions to embrace online teaching delivery which commenced in 2003/4 in the engineering area and led to the Centre for Online learning being established in 2011. Whilst initially examining of the few students abroad took place at international exam centres, online proctoring was introduced in 2012 for the Construction Management programme. This attracted students from North America to Australia and led to challenges to establish physical exam venues for each country. At the time there were relatively few proctor services available and the recorded-proctoring system used ('Software Secure') detected cheating after the event but did not deter it. A switch to another international provider offered 24/7 e-proctoring but issues arose as the US-based service provider systems were not well suited to the Sligo systems – the provider focuses on allowing students to take an exam when they wish, which fits well with US institutional approaches but not the traditional Irish model with an exam held on a single day. In addition, time differences between Ireland and the US led to difficulties in access to proctors and technical support for early morning exams in Ireland. IT Sligo have now moved to 'Examity' and report a better relationship has been established.

20 Information from discussion with Dr Aodhmar Cadogan (Assistant Registrar) and Dr Gavin Clinch (Head of Online Learning, Centre for Online Learning), IT Sligo (20 September 2021)

The general approach to e-proctoring developed at IT Sligo includes:

- Online students are offered the option of online proctored examination or the same exam in an exam hall although during Covid restrictions, students required to sit exams had the option of a proctored online exam or to defer. Students taking exams overseen by professional bodies are required to take proctored exams. Approximately 5% of online students avail of the e-proctored exams, the rest attend physical exam centres.

- Access to the proctoring system is through the VLE Moodle.

- Only live proctoring is used, involving the service providers proctors. The desired maximum student: proctor ratio is 5/6:1 [which is considerably less than that reported by proctoring companies].

- IT Sligo have introduced tight criteria for initial room scans (including underneath the desk) and are exploring the option of a wide-angle camera on the side of the desk [which could facilitate oversight of handwritten elements].

- In several disciplines, (e.g., maths, engineering) the use of pen and paper for equations and drawings is required, with the handwritten exam answer sheets subsequently scanned and uploaded on a mobile phone at the end of the exam. It is noted that proctoring companies have not sufficiently developed systems to support handwritten elements to exams to date.

- When offered to full-time undergraduates, some students have reported stress and raised privacy issues.

- Where they occur, technical issues are usually identified at the start (gaining access to the proctor system and exam) and at the end of the exam (uploading hand-written pages to the system).

- In addition to technical issues, proctor companies can change the proctor during an examination (related to shift work) and variation in the response and rules applied by individual proctors have been noticed.

- IT Sligo recommend that an institution should start e-proctoring on a small scale and build up and that building a relationship with the e-proctoring service provider is important.

- Going forward, capacity issues are starting to arise in relation to exam halls thus an increase in e-proctoring is anticipated particularly for some exams (e.g., lower levels), or programmes (e.g., Accountancy). Students to date have been required to pay the proctor company directly for each exam, but as the number of proctored exams and students increases and total costs reach and exceed €25,000, the institution has been required to go to tender for procurement of proctoring services.

- Overall though it is anticipated that the majority of full-time students (and particularly final year) will revert back to physical exam centres.

Dublin Business School has incorporated the e-proctoring process within its academic policy document (see below) and highlights some clear requirements and information for students[21]. Exam papers are 'built' and held within the proctoring environment within the VLE Moodle. Key elements of the information are provided below:

- A timed link to the exam paper in the proctoring environment is uploaded to the relevant module Moodle page. The DBS Exams Team checks all settings in the proctoring platform and within Moodle to ensure **(a)** security is maintained and **(b)** the paper is correct, settings are correct, instructions are clear.

- Students are required to complete a compatibility check for the proctoring platform in advance of their exams. All instructions are provided in Moodle on the relevant module page.

- The link to the exam is automatically set live in Moodle at the appointed exam time.

- Students have access to a 'live chat' function and a contact phone number in Moodle whereby they can contact support staff should they require help. The proctoring provider is also available via phone to take queries should DBS staff be unable to resolve any issues locally.

- Upon entering the proctoring platform from the link in Moodle, students are required to present their photo ID to the camera.

- The exam is then launched from the proctoring platform. Options for uploading include typing the answers directly into the platform, or upload of files such as a Word document (depending on the type of exam).

21 DBS (2020) Dublin Business School, Online Examinations. https://students.dbs.ie/exams-office/online-exams#Proctor [Accessed September 2021]

- Student activity during the exam will be captured via their webcam and by recording their computer screen activity. If this is to be used to evidence possible infringements, students will be specifically notified in advance of the exam. Recordings will be deleted after verification of results.

- Students must make contact with DBS Exams Team via approved channels during the exam to notify and seek help with any technical issues. Issues not notified during the exam cannot be taken into account retroactively or in support of appeals. Approved channels include: the Live Chat function in Moodle, IT Helpdesk phone number, or messaging in the proctoring platform.

- Video monitoring will be used to support any students who have issues during the exam; for example, the team may view the student's computer screen to help identify and resolve technical issues.

- Features of the proctoring platform such as browser/window/software lock down may be used to control the exam environment and will be specifically notified in advance of the exam if such restrictions are to be in place.

- Notwithstanding restrictions enforced through the online proctoring service, students are required at all times to comply with DBS policies with respect to plagiarism and cheating.

- An announcement will be made 30 minutes before and again 5 minutes before the close of the exam to warn students to complete uploads.

- Submissions after the close of the exam will not be accepted.

- For any student experiencing severe technical difficulties, an option to submit via Moodle may be made available during the exam, but acceptance of the submission will be subject to further verification and approval after the exam.

- Students must not contact lecturers directly during exams.

As an example of roll-out of e-proctoring in a PSRB[22], The Insurance Institute of Ireland (The Institute) is the professional education and training body for the Irish general insurance industry and is an end-to-end course provider and examiner. It operates as a distance learning provider currently offering two Level 7 Special Purpose Awards (Certificates) comprised of 8 modules and a Level 8 Higher Diploma comprised of a further 8 modules, awarded through IT Sligo. Prior to the Covid-19 epidemic, it held exams at a number of major centres across the country.

On average, each of the exam sessions (January, May and September) would host 2,000 - 2,500 students. Some exploration of online exams had begun as far back as 2015 but was deferred on cost grounds. The Institute had planned incremental development of online exams over a period of time but had to convert to full online exam delivery following the implementation of Covid restrictions in March 2020. Due diligence was carried out with two international proctoring companies but neither were pursued owing to the requirements for operation through a VLE system which The Institute did not possess and because of time-zone differences with the provider in the USA and their proctors based in India. Experience from similar professional bodies The Institute spoke with found that the use of AI proctoring posed significant challenges for post-exam review of recorded exams around the huge additional staff workload in reviewing recordings and the difficulty in doing anything about an issue after the exam from recordings.

The Institute engaged the Irish-based 'TestReach' who operate their own online delivery platform (allowing the Institute to upload exams directly), use live local invigilators in Dublin and also record sessions for later review as necessary. The TestReach App, which students download to their laptops, provides access to the exam as well as locking down other systems and cannot be exited until the finished exam is submitted by the student. Other described benefits include the ability of the proctor company to offer different accessibility options for students with a disability and flexibility to offer students extra time and to facilitate scribes when needed. A favourable 6:1 student: proctor ratio is used along with audio connection, an on-boarding process to validate identity, room scan, check for earphones and a gradient of exam violations (which are built into The Institute's Examination Regulations and operated by the live proctors). Staff can access the TestReach system to mark papers, students are required to undertake a pre-test to ensure connectivity and systems compatibility and a range of material and guides were produced. Exam regulations have also been modified to cover e-proctored exams. Initial issues that arose during the first online exam sessions in 2020 were quickly ironed out through close cooperation between

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22   Information based on an interview with Graham Kavanagh, Assessment QA Manager, The Insurance Institute of Ireland, 1-10-21.

the provider and the Institute. These included slow post-exam reporting of statistics and problems with firewalls preventing access to the TestReach system when students take the exams in their workplace. The ongoing challenge of student access and connectivity to TestReach has proved minor, with 1-3% of students reporting problems, although it is noted that the students are mature. There have been very few exam violations and the policy is to let the exams finish and review later. Student feedback has been very positive with only 3-5% giving negative comments and even fewer refusing to undertake the online proctored exam (currently being deferred to a later date). Also pass rates have remained consistent with pre-Covid exam-hall exams across all 8 modules offered.

Based on the experience the Institute has had in the implementation of e-proctoring the following points and recommendations are offered:

- The Institute's assessment for its Level 7 modules (of MCQ exams (5 modules) and short answer written exams (3 modules) is very appropriate for online proctored exams and made the switch over from exam hall to online examinations relatively seamless.

- Live proctored online examinations are more expensive than holding traditional exam-hall exams although there are some efficiency and other hidden savings evident in the system used by the Institute in terms of the physical management of papers, marking and compilation of stats. There is also a saving for the students on these professional courses in not having to travel to an exam site.

- It is important to make sure that the institution is comfortable with the proctoring provider and that ongoing relationship-building is undertaken.

- In selecting the e-proctoring provider, time zone differences in relation to technical support, proctors and the examination time should be considered in relation particularly to international proctor companies.

- Whilst more costly than AI-based e-proctoring, investment in live proctoring is advised, lowering the potential reputational risk and reducing post-exam costs and use of staff time in reviewing recordings produced by AI proctoring. Students also report that they appreciate the human interactions although privacy issues do arise for some students.

- Clear pre-exam instructions, guides and videos and a pre-test should be provided.

- It is important to make sure that the assessment is the actual exam not the ability to connect to and operate the e-proctored exam system.

- One final point of consideration is the impact of cyber threats on IT equipment and systems provided for industry staff by employers and used for online exams. Firewalls and related protection software may entail laptops and internet access being locked down which can restrict the use of an online proctoring App. Employers are apparently cognisant of this and are taking steps to mitigate the impact for staff members.

It is anticipated that The Institute will continue to conduct exams online rather than returning to large-scale physical exams and to explore the possibility of enhancing its online assessment approaches using a range of technology options offered by the e-proctoring company (e.g., video-based practical questions).

5.4 Policy developments

Policy developments to support e-proctoring vary considerably amongst HE institutions nationally and internationally. Some deem existing policies and regulations covering 'normal' examinations sufficient, especially in relation to academic integrity and cheating. Other institutions have modified their policies and regulations in a relatively minor fashion to simply expand coverage to included e-proctored online exams, whilst some institutions have developed full-blown regulations to specifically cover on-line and proctored examinations. Some examples of each are presented below.

As mentioned earlier, UCD did not deem any new policies necessary during their pilot project. On the other hand, Maynooth University have included a minor modification to their Academic Integrity Policy to specifically deal with online examinations and the issue of potential cheating[23]. The subsection on plagiarism now captures online fraud and reads

'Maynooth University considers plagiarism to be a serious academic misconduct, deserving of academic penalties. This document sets out the procedures for dealing with cases of plagiarism or suspected plagiarism in taught programmes of the University. This includes use of unacknowledged sources in

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23 Information from Professor Aidan Mulkeen (Vice-President Academic, Registrar and Deputy President, MU)

essays, assignments, take home exams or remote examinations, or any other form of assessment. It also includes cases of personation, or of procurement or purchase of essays or other material written by others. Cases of plagiarism or suspected plagiarism in research degrees are dealt with under the Research Integrity Policy.'

The Dublin Business School (DBS) Quality Assurance Handbook, Part B, Section 5.10, sets out a detailed Online Exams Policy, and specifically establishes the principles of Academic Integrity in these assessments (Approved Feb 2021). The policy applies to all formal exams usually managed through the Exams Office. The policy covers assessment format, exams process, the platform (Moodle VLE and live proctoring software), exam deployment and time, exam integrity, verification of student identity, and test comparison (i.e. plagiarism) software (Urkund).

IT Sligo has been using online examinations for some time as indicated earlier. Whilst there is no evidence of modification to the marks and standards policy to cover online exams, there is reference to online exams at various points within the current Exam Regulation Procedure document (EXAM035), Online Invigilation of Examinations procedure for staff (EXAM032) and the specific regulations for online exams for students are provided in Section 4.1.8 following recent (15/6/2021) revisions of the main Regulation (EXASM035) (IT Sligo Examinations Office website). The latter are instructive in terms of the kinds of 'dos and don'ts' students might be expected to comply with during e-proctored exams.

4.1.8 Online exam regulation (ONLY applies to candidates taking their exams online)

a. A proctor will complete a scan of the room where the student is sitting the examination online. The webcam will be used to do this.

b. Students are not allowed to leave the room or the camera focus during the exam for any reason.

c. No other person is allowed to enter the room or be present during the exam. The exam may be null and void should this happen.

d. Students must sit at a clean desk or table located in a room where there is no noise from inside or outside

e. Close all programs or windows on the laptop/ computer before the exam begins.

f. Students cannot access any programs such as Excel, Word, Powerpoint, Skype or other communication programs or any other website unless specified on the exam paper by lecturing staff.

g. Dress as though in a public setting

h. Use of headphones, any listening equipment is strictly forbidden.

i. Mobile phones are permitted for scanning of handwritten work only and must be placed out of arms reach and in view of the camera for the duration of the exam.

j. Students are not allowed to use the toilet during an exam. The following items are allowed on the desk/ table only if specified by lecturing staff that they can be used:
a) Books; b) Paper; c) Pens / ruler / protractor / compass; d) Calculators; e) Textbooks; f) Notebooks.

The Canadian Simon Fraser University has produced an 'Online Exams Procedures Policy[24], updated in June 2020 which offers two different options to manage online exams:

▪ Using Zoom {equivalent to live proctoring). Students are to be allocated to breakout rooms with a maximum of 25 students per invigilator in each 'room'. Students are muted, they must turn off virtual backgrounds, set aside phones and other devices but must not turn off cameras. Invigilators can ask students to show them their work area before starting the exam. Invigilators are required to be available during online exams to answer student queries which can be submitted through the VLE 'Canvas' or in a private chat function in Zoom [the chat function between students is turned off].

▪ Alternatively, academic units can use 'Proctorio' Auto proctoring. The automated software monitors student behaviour to ensure compliance with SFU's academic integrity policy. Recordings of the exam is only available to authorised personnel to review. Invigilators should be available during exams to answer questions submitted through Canvas.

The policy proscribes a range of potential aids such as calculators, reference materials, websites etc unless authorised as specified on the exam. It also specifically retains accommodations for students for in-person testing when exams are online through its Centre

24 Simon Fraser University (2020) Exam scheduling guidelines https://www.sfu.ca/students/scheduling/exam-scheduling-guide-lines.html [Accessed September 2021]

for Accessible Learning and requires unscheduled interruptions during a proctored exam to be raised asap with the invigilator through Canvas (although it is not clear how this could work where internet interruption occurs). Specific acts of academic dishonesty relevant to on-line examinations are identified in the policy.

LIT supported their introduction of e-proctoring (described above) with targeted policy development such as the 'LIT Policy and Procedures on Assessment and Examinations During Remote Emergency Teaching, Academic Year 2020 – 2021. Semester 2'[25] within their Quality Assurance Handbook. This included a range of provisions from facilitating students with no access to internet and/or hardware, to overarching considerations and conducting online closed book (live proctored) final examinations.

Surprisingly, a survey conducted by QAA (2021a) found relatively little formal guidance from professional regulators or quality assurance agencies in relation to the use of e-assessment and proctoring excepting for Australia which has arguably the greatest academic integrity support for HE providers (e.g., the Tertiary Education Quality and Standards Agency (TEQSA) Academic Integrity Toolkit and Dawson Good Practice Guide for online invigilated exams[26]). Thus, institutions globally have largely worked independently. QAA has started to redress this issue in the UK through, for example, a recent membership report (QAA 2021b). In particular, they raise a need for institutions to check that existing procedures and regulations allow for digital security approaches and are compatible with standards and quality assurance frameworks. They point out that specific procedures may be required, e.g., to deal with misconduct identified through online proctoring or related to use of and access to video recordings and other data, compliance with legal requirements, complaints procedures etc.

25 LIT (2021) LIT Policy and Procedures on Assessment and Examinations During Remote Emergency Teaching, Academic Year 2020 – 2021 Semester 2 https://lit.ie/getattachment/31334bfa-289b-43bb-8fea-f60848839151/Approved-By-Covid-19_LIT-Policy-and-Procedures-on-Assessment-and-Examinations-During-Remote-Emergency-Teaching_SEM-2.pdf?lang=en-IE [Accessed September 2021]
26 see TEQSA website at www.teqsa.gov.au

6. Case studies

6.1 Successes

Clearly, some of the examples of the implementation and use of e-proctoring shown in the previous two sections (such as Dublin Business School, The Irish Insurance Institute, Limerick Institute of Technology and IT Sligo in Ireland as well as institutions in the USA such as Daemon College, and the University of Amsterdam in The Netherlands) have been largely successful and the institutions have been able to learn from the problems and issues that arose in the early stages to improve the management and delivery of the proctored online examinations. When implemented at an appropriate scale, e-proctoring can evidently be very effective. For example, online proctoring allows Wageningen University to offer an entirely online 4-year part time master's programme in Nutritional Epidemiology and Public health in which 25 students can take their exams from anywhere in the world. Online proctoring also allows elite athletes at Wageningen to take exams while based at their training camp, and seriously ill students can also take exams from home (Sietses, 2016).

Another clear successful example is from the University of South Australia (UniSA). The article by Cramp et al. (2019) identifies issues that arose, and shares the lessons learned and resolutions put in place by the university, during the process of implementing and evaluating e-proctored examinations as part of the newly (2016) established UniSA Online that provides a suite of complete online degrees. The remote invigilation application used authenticates students' access to the exam and records the students' computer screens and their behaviour via their webcam. Following the exam, the students' recordings are reviewed by the (unnamed) third party service provider invigilators who identify any possible exam breaches. Cramp et al. (2019) suggest that e-proctored exams require more systematic and effective design compared to traditional paper-based exams and early and clear communication with students is paramount. Students are encouraged to rehearse the exam service access procedures prior to their exams and practice exams are available from the beginning of each 10-week course to enable students to familiarise themselves with the format of the online exams and use of the spreadsheet software. Students are also provided with real-time

responsive technical support for any ad hoc issues that may present during the exam. [As discussed elsewhere in this report, these factors play a critical role in ensuring the successful implementation of e-proctored examinations]. A further, and vital, element in the successful implementation of e-proctored exams at UniSA has been the extensive collaboration across the whole University, with the Exams Office, teaching team, student services and IT Help Desk working closely together.

A further success has been demonstrated by the PSRB Chartered Accountants Ireland (CAI)[27]. They had previously run full exams for 1500 or so students at one time at large centres such as the RDS but started a 3-year development programme towards online examining 3-4 years ago. The reasons included the rising costs of venues, meeting GDPR requirements, to better provide for students with disabilities and the desire to more widely use technology to better mirror every-day life, to more practical issues of challenges around the legibility of hand-written scripts and ways to improve the efficiency of exam management and transmitting scripts to exam markers. The first year of development had been completed using trials with interim assessments before the imposition of Covid-19 regulations prevented exam-hall examinations which left approximately 3 months to complete the development and trials before the major exams of 2020.

CAI engaged the US company 'ProctorU' for proctoring and a Dutch online assessment platform (Cirrus) to host the exams. A detailed GDPR review was conducted to help limit the amount of student personal data collected and ensure GDPR compliance. The proctor system has a keystroke verification facility, but this functionality was not used as it requires longer term monitoring of student keystroke profile with long term storage of such personal information (given the GDPR issues with an offshore service provider). Exam Regulations were changed to manage online exams which needed to be approved by the two regulatory bodies. The new regulations require students to engage with e-proctoring unless they have specified medical or other issues. (This is in contrast to the Institute of Chartered Accountants in England and Wales which made e-proctoring optional with 15% uptake, the

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27 Information and insights from Ronan O'Loughlin (Director of Education and Training, Chartered Accountants Ireland)

remaining 85% taking the online exams in a physical exam centre).

The initial proctoring approach involved live proctoring and the proctors governed student admission to the exam individually. However, connectivity issues on the first day of examinations resulted in quite a number of students needing to re-log into the system, and the human proctoring created a bottleneck. Hence a decision was made to adopt a system of AI proctoring which has subsequently reportedly worked well. The AI proctoring process involves monitoring and recording of the exam by video, including eye movement and audio, the use of screen lock down and disabling of the computer mouse and other external devices. Proctors scan the room at log-in and can request the student to allow further scans during the exam if necessary, as well as monitor connectivity and duration of connectivity loss. The videos are reviewed after the examination.

The overall exam process in CAI was supported by a specialist team of 10-15 dedicated staff to monitor students during the exam and pick up IT and other issues. Students were encouraged to undertake a Pilot Exam in advance of the full exam and to also to test their hardware and connectivity to the platform. The first year of full implementation was reported as challenging given the rushed nature of the project but 2021 was much more successful (students were more used to the system) and the engagement rate (number of students completing the exam) was around 99%.

Cheating levels were reportedly no different from exam hall exams. It was remarked that exam hall invigilation does not eliminate all exam fraud (e.g. use of micro earphones), and often pursuing a fraud case relies on the word of the invigilator against that of the student. E-proctoring provides some direct evidence in the form of computer logs, videos, audio etc. There was also a noticeable increase in efficiency and controls over marking of scripts.

The e-proctoring was not without issues however, e.g. in an April interim assessment online, the server suffered an overload which led to an outage and cancellation of the exam. Student feedback also raised some issues such as with connectivity (e.g. mid-August 2021 exams had 70-80 students raising such problems) and complaints about the prevention of using extra-

large screens and the mouse, prevention of highlighting text and the lack of bullet point functionality. However, overall, the implementation and use of e-proctoring in this specific case is seen as a very successful process and outcome, involving significant change management and in fact CAI has decided not to use exam halls again in the future.

6.2 Failures

Notwithstanding the successful use of e-proctoring as illustrated above, review of the international literature and discussions with various actors in Ireland point to problems that have either limited the extent and scale of use or even led to the complete abandonment in a range of institutions. Problems have arisen in a number of areas from privacy and data retention to cost and reliability which will be dealt in some detail in Section 7 below. Here, a few examples are provided that highlight some of the challenges in introducing and successfully operating e-proctoring.

Several institutions in Ireland have carried out pilot projects that failed to deliver on expectations. As an example, UCC established a pilot project in October 2020 trialled with the School of Medicine and the School of Mathematical Sciences to provide an online tool that would address the absence of in-person invigilation for these two accredited programmes[28]. Following review of a range of potential suppliers and with the requirement for integration with the UCC VLE 'Canvas', a leading international online proctoring provider was procured. The trial examinations, using live invigilation supplied by the service provider, were supported by detailed training for both instructors and students (including videos) in addition to communications and technical support prior to and during the trial examination held in March 2021. Unfortunately, the examinations were deemed a failure with over 100 emails from the 206 students sitting one of the three exams requesting support from the IT Services helpdesk as well as directly from the School.

The problems (which included login failures leading to cancellation of a trial exam, delayed exam, exam system freezing, high level of student complaints) appeared to be related largely to technical issues with the proctoring product and server provision. There was also lack of confidence in the output (reliability and consistency) from the invigilation software to detect and establish suspected breaches of the examination process. NUIG

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28 Information from Prof Paul McSweeney, VP Learning and Teaching, Kathryne Neville, School of Medicine Manager UCC, and a report on the Online Invigilation Project to the UCC Academic Leadership Forum

apparently have had similar technical problems with the same provider supporting a pilot project over 2020-2021[29] and like UCC will be reverting to in-person exams where possible. UCC at least will also focus on modifications of assessment design.

The Royal Melbourne Institute of Technology (RMIT University)[30] has campuses in Melbourne and Vietnam, as well as offshore partnerships and found different locations have different challenges in terms of delivering exams and online proctoring. As a proactive measure, the University made a pedagogic decision to move away from examinations where possible towards alternative forms of assessments (e.g. personalised assessment questions, authentic professional practice rather than generic assessment). E-proctoring re-emerged as a sector issue in 2021 due to Covid. A number of service providers were tested by RMIT and the limitations of e-proctoring from a privacy and surveillance perspective were considered. RMIT has not embedded e-proctoring into the examination process and is currently recommending using e-proctoring on an as needs basis and only in specified areas where the academic unit has exhausted all alternatives, such as changing the type of assessments. It is felt that e-proctoring software has not caught up with face-to-face exam hall invigilating in detecting cheating.

Furthermore, whilst HE institutions, their examination boards and senior decision-making managers have a lot of experience in running and managing examinations in exam halls and are therefore well able to make appropriate assessment of the associated risks and act accordingly, the same cannot be said for online proctored exams, where the institutions have yet to build up the same level of experience. As Sietses (2016) points out, this is further complicated by the fact that different service providers tend to use different proctoring methods and technologies, (in the same way that different institutions use different VLE systems) so the experiences of one institution (either positive or negative) may not necessarily be directly applicable to others. This may, in part, explain the different outcomes of e-proctoring trials and pilot projects discussed above.

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29 Information from Professor Pol O'Dochartaigh, Registrar and Deputy President and Sinead O'Connor, Head of Quality, NUIG
30 Information provided by Dominique Barker, Associate Director of Learning Technologies, Royal Melbourne Institute of Technology – following online discussion

7. Issues arising from e-proctoring

For the majority of institutions that try, the introduction and ongoing use of e-proctoring is found to be challenging for a variety of reasons. A recent rapid survey of 312 institutions (Grajek et al.,2020), which was discussed above in the context of the extent of use of e-proctoring, also sought information on the key challenges. Respondents reported, on average, three challenges. Cost and concerns around student's privacy were identified in over half of the respondent's replies. Resource limitations to implement the system and concern over whether the products would actually work in identifying different forms of exam fraud were also highly cited. Other issues included accessibility of tools, inexperience of the institution with remote proctoring and lack of faculty buy-in (Figure 7).

The following subsections deal with a number of the key problems that have been identified in the use of e-proctoring.

7.1 Privacy and legal issues

There is a sense that students perceive e-proctoring as an invasion of their privacy (Karim et al., 2014; Brown, 2018; Langerfeld, 2020), a view backed up by a recent, albeit relatively small scale, survey which demonstrated 53% of the 150 staff and 70% of the 78 students supported this view (Alessio and Messinger, 2021). E-proctoring can also convey a sense of mistrust by academic staff in test-takers (Beck, 2014). The privacy issues commence for some individuals while being observed and video- and audio-recorded but also extend to issues around use of personally identifiable information, security of transfer of data to a host server, application of various algorithms and data forensics to evaluate occurrence of unauthorised behaviours and data and video storage (Langerfeld, 2020).

These concerns are natural, where, for example, 'ProctorU's privacy policy for test-takers in California[31] shows that the company shares reams of sensitive student data with proctors and the student's academic institutions including their home addresses, details
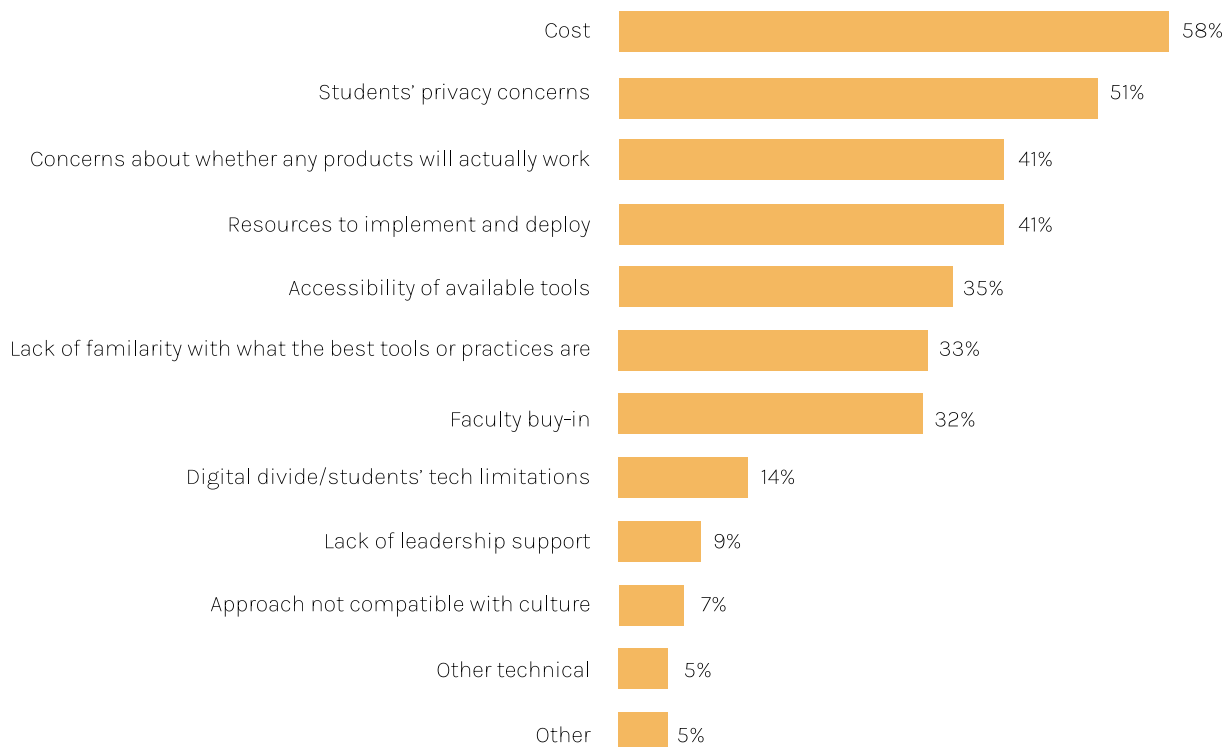

Figure 7. Institutions' reported challenges with e-proctoring from a quick survey of 312 HE institutions (the majority of which were in the USA) (From Grajek et al., 2020)

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31 ProctorU (2021) Privacy Policy updated July 1, 2021 https://www.proctoru.com/ca-privacy-policy [Accessed 27 October 2021]

about their work, parental and citizenship status, medical records (including their weight, health conditions and physical or mental disabilities), and biometric data such as fingerprints, facial images, voice recordings and iris or retina scans (Drew 2020). The company also reports that it shares test-takers' browsing history, searches and online interactions with a group of unnamed website analytics providers. The company apparently retains the right to share all video and audio recordings of the students with their academic schools to ensure that "no exam protocols were violated." The policy also states that student data is retained "for as long as necessary". The policy does state that the company does not share or sell on any personal information to third parties. On the positive side, 'ProctorU' has also drafted a "Student Bill of Rights for Remote and Digital Work" that includes seven essential 'rights' students should expect while participating in online learning and assessment[32]. For example, the document states that students can expect to have their questions answered, be presumed to be honest and accurate, and be served by entities that are compliant with laws and regulations related to student privacy and student data. Students also have the right to a review, the right to understand why specific and limited data are collected and whether they're shared (Flaherty, 2020).

It is worth noting that, in a recent court case (June 2020) brought by the Amsterdam University Student Council under Europe's privacy law, the Amsterdam District Court denied a preliminary injunction against 'Proctorio' Inc. and ruled that remote proctoring processing of student personal information 'is not unlawful" (The court ruled that measures brought in against Covid-19 did not allow for a suitable alternative and the processing could therefore be based on Article 6(1)(e) GDPR)[33]. On this basis, the Dutch Minister of Education indicated that, as long as all legal requirements are met, the use of online proctoring software by universities is GDPR-compliant. How such a Court would decide outside of the Covid-19 scenario is unknown.

Camera images fall under a separate category under the EU Data Protection Directive (Sietses, 2016) and video recordings of test-takers are legally defined as personal data in most jurisdictions and are therefore covered by data protection laws and regulations (including Ireland under GDPR Article 5). Camera images can be used to track medical data, race and ethnicity, thus permission from each individual student should be sought before proceeding with e-proctoring. Sietses (2016) provides an example of such a text that the student could be asked to sign "I grant permission for key logging and the making of video recordings and screen captures from my PC. These images will be stored for a period of ## weeks. The proctor of <company X> and my examiner will receive this data in order to assess whether I have taken the exam in accordance with the rules." Further, Sietses (2016) advises that online proctoring must not, therefore, be made compulsory and an alternative assessment process must therefore be made available. This is an interesting perspective and one with some obvious consequences for the management of examinations online, and which is, therefore, an issue that needs to be considered by institutions introducing e-proctoring.

7.2. Data retention and GDPR issues

The topic of e-proctoring of examinations and the consequent collection and storage of data has been mentioned in multiple academic and media sources and has been quite prevalent in the news internationally during the Covid epidemic (Eaton et al., 2020). As an example, on August 6th 2020, The Sydney Morning Herald reported that 'ProctorU' was investigating a breach of data security involving the publication of in excess of 400,000 individual records by hackers (including names, addresses, user names for computers and unencrypted passwords) for students from the University of Sydney and other institutions worldwide (QAA, 2021). The data covered the years 2014-17 and the breach was confirmed by 'ProctorU.'[34] This clearly illustrates the potential dangers and care that is needed in handling the vast amount of personal data gathered by third parties during e-proctoring, particularly involving identity validation, video recordings and monitoring of computer use.

An excellent discussion of the general legal background to e-proctoring, privacy and data processing in the

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32 ProctorU (2021) Students Bill of Rights for Remote and Digital Work https://studenttestingrights.org/ [Accessed September 2021]

33 ATP Global https://atpu.memberclicks.net/amsterdam-court-case and GDPRHUB https://gdprhub.eu/index.php?title=Rb._Amsterdam_-_C/13/684665_/_KG_ZA_20-481 [Accessed September 2021]

34 Bleeping Computer (2020) ProctorU Confirms Data Breach After Database Leaked Online https://www.bleepingcomputer.com/news/security/proctoru-confirms-data-breach-after-database-leaked-online/ [Accessed 27 October 2021]

Netherlands is provided in the white paper of Sietses (2016). At the time of that paper, the legal requirements were covered under the Personal Data Protection Act (DPA) which was underpinned by European legislation. This act preceded the European General Data Protection Regulation (GDPR) (implemented in May 2018) and was a lighter touch, relating to information used to identify an individual or their personal data, whereas the GDPR broadened the scope to cover online identification markers, location data, genetic information etc. The Netherlands, like Ireland, has now adopted the GDPR. The sensitivity of personal data and the legal protections around its collection, use and storage means that institutions introducing e-proctoring should take great care in ensuring compliance with GDPR itself and must agree separate arrangements regarding what the proctoring service provider can do with such data and should be guided by their own legal advice. As case law is gathering, parameters are changing over time and the court case mentioned in the previous section is again relevant here.

Based on the experience in The Netherlands, Sietses (2016) provides some clear advice and guidance to institutions around the data privacy and data retention aspects of e-proctoring. Although, as mentioned above, this article was written pre-GDPR, the advice is still relevant, and it is useful to highlight some of the key proposals here:

i.   Draft a separate privacy statement for e-proctoring, making clear the purpose, what data will be collected and what will happen to the data.

ii. Request permission from the student to undertake the e-proctored exam and provide an alternative if the student refuses.

iii. Agree with the supplier that they provide detailed information, (including for updates), to be included in the privacy statement and on how their proctoring tools work.

iv. The use of the data should be supervised, ensuring that the only people who have access are those who require it for the performance of their duties (e.g. the examiner and the exam board) [although some access to data will be required by staff of the service provider undertaking proctoring activity].

v.   Conclude data processing agreements with the suppliers of online proctoring tools, ensuring that they are liable for data leaks, and that they cannot use the data for their own purposes.

To these points, as discussed above, one might now also add:

vi. Check that the proctor company's procedures and policies are GDPR compliant and be guided by the institution's own legal advice.

7.3 Student stress and anxiety

Educationalists are well aware that examination anxiety can often disguise or distort the true abilities of students, thus it is of no surprise that concerns have been raised about the potential additional stress and anxiety caused by the particular circumstances of e-proctored exams. The reasons include: students being uncomfortable with the loss of privacy in the home; the imposition of quite onerous restrictions on movement during the examination that may raise flags of possible cheating to the proctor or AI algorithm (such as deviations from looking directly at the screen or sitting upright; these restrictions are of particular concern to students with disabilities); interruptions by proctors or distracting alert messages; and heightening of anxiety leading to strong emotional reactions (such as crying or vomiting) during the exams or even test-taker withdrawal (Brown, 2018; Eaton et al., 2020; Flaherty, 2020; Harwell, 2020; Langerfeld, 2020).

Two recent surveys have provided some empirical data on the extent of the problem, but also highlight, unsurprisingly, that not all students are affected in the same way, with both positive and negative impacts identified. One study involved over 540 students across 31 courses covering Medicine, Psychology, Digital Education, Informatics, Biotechnology and Education at the Italian University of Modena and Reggio Emilia (De Santis et al., 2020). Examinations using the e-proctoring provider 'Smowl' (used mainly by Spanish speaking institutions in Europe and South America) were conducted with autonomous proctoring. Over 50% of students reported e-proctoring negatively affected anxiety and concentration whilst a similar number indicated it helped with time management during the exam. The second study involved a large introductory Psychology course at a (unnamed) midwestern US university which involved a comparison of two sets of students, one set voluntarily taking an e-proctored exam (using 'ProctorU') as the experimental group (n=44) and the other set taking the same examination in-person (the control group – n=587) (Woldeab and Brothen, 2019). The study included a measure of 'trait test anxiety' which refers to the tendency to be anxious

in any evaluative situation (assessed across a 10-point scale). Despite the obvious numerical imbalance between the two cohorts, a significant result showed that the relationship of higher anxiety associated with lower exam scores was stronger in e-proctored students than in-person tested students. An earlier study, looking into the use of course management software to conduct face-to-face class exams online (i.e., non-proctored online exams), found that students who typically show high levels of test anxiety in a classroom setting had less anxiety when taking their exams online, while the opposite was true for students showing low classroom anxiety (Stowell and Bennett, 2010).

The possible relationship between anxiety and student mental health in the context of e-proctoring of online examinations has also been raised. A review of recent articles on the relationship between academic integrity and student's mental health during the Covid-19 crisis by Eaton et al. (2020) highlighted that the use of e-proctored exams was associated with an amplification of student stress and anxiety. However, they also highlighted that there is a lack of empirical research on the relationship between e-proctoring and mental health. This whole area appears complex and clearly much more research is needed.

7.4 'Digital poverty' and student disadvantage

One further issue associated with stress and anxiety in the use of remote online exams and e-proctoring relates to so called 'digital poverty'. As QAA points out (QAA, 2020) both the proctoring providers and the consumer institutions need to be aware of the possible disadvantage to students without access to suitable technology, continuous reliable internet connectivity and/or appropriate environments needed for digital exams, as well as with limited IT expertise and a low level of digital literacy. In addition, students with disabilities may require a lot more assistance than is possible while taking remote e-proctored exams (Hussein et al., 2020). These issues raise some ethical questions and the danger of further entrenching existing disadvantages (QAA, 2021b) and point again to the need for institutions to provide alternative offerings (such as on-site exams and/or loaned laptops) to e-proctoring, as well as 'on-tap' support services.

7.5 Gaming of system and detecting fraud

With the growing sophistication of computing and software developments and the increasing technological expertise of the student population, it is not surprising that attempts at overcoming e-proctoring systems and gaming of the systems are increasing. This was highlighted earlier in the report (Section 1). In a critical article in Leiden University's weekly newspaper, Koops (2020) highlights the constraints in detection of fraud in online examinations. For example, taking over an examinee's webcam and computer will not necessarily prevent the use of other digital tools (such as smart phone, smart watch, projection onto wall behind the computer) or another person entering the room given the limited field of vision of the webcam unless frequent surveys are carried out during the exam.

Based on a detailed security audit at the University of Amsterdam, Sietses (2016) has outlined different modes of fraud through which students can game the system and presented a range of suggested countermeasures that could be adopted by the institution to deal with or prevent such challenges. A few examples with recommended countermeasures from the extensive list will suffice to highlight the areas of concern.

i. An extra browser used by the student to look up answers to questions on the internet during the exam.

ii. Countermeasures: This method is easy to combat using a strong lockdown browser, screen captures and an extra webcam

iii. A second person monitoring or controlling the PC being used for the exam through remote access. This person could see the screen, control keyboard and mouse and complete the exam while the student is still sitting at their PC.

iv. Countermeasures: If the proctor can see the keyboard and mouse this would be detectable as the student's movements would not match what was happening on the screen. Better still is use of good logging software which can detect the processes running on the PC and any external connections. Monitoring keystroke dynamics may recognise if the student is actually writing the text on the screen.

v. Use of a virtual machine. This in effect is a simulation of an extra PC hosted within the computing

environment and can make software running on the host PC invisible to the proctor allowing the student to conduct fraud undetected. This is a complex issue as students may need to run a virtual machine where their normal operating system is not compatible with that required for the e-proctoring software.

vi. Countermeasures: if use of a virtual machine is prohibited, advanced software can detect this. A second camera positioned behind the student would show what is happening on the screen such as extra windows being open, but would not detect software running in the background.

vii. Another person in the room to aid the student during the exam or remote monitoring by a third party.

viii. Countermeasures: Use of a microphone and additional cameras could make this type of fraud more difficult, but Sietses concludes it cannot be excluded entirely and when executed well, third party monitoring cannot be readily detected (e.g. placing a small camera behind the student between rows of books) and is easy to execute for multiple choice exams as only small amounts of information need to be communicated between the third party and the student.

ix. Hidden crib sheets. These are more likely to be used at home than in an exam hall, although the later does occur.

x. Countermeasures: Camera images help to combat this, [as can monitoring of eye and head movements]

but the room in which the student is taking the exam will never be entirely visible and thus the use of hidden crib sheets cannot be eliminated entirely [and is difficult to prove, as discussed below]

Sietses (2016) concludes that fraud involving manipulation of hardware or software can usually be detected but can have implications for the student's privacy. Also, if the institution does not have control over the space where the student is taking the exam [which is the usual situation for remote online exams], and given the various possible ways to cheat, some of which are difficult to detect, it is unlikely that online proctoring can be as secure as holding exams in an exam hall with invigilators present.

The level of training of staff to appropriately detect exam fraud is another factor. A study by Dawson and Sutherland-Smith (2019) examined sensitivity (the rate at which markers correctly identified contract cheating), specificity (the rate the markers identified real student work), false positives (proportion of work incorrectly flagged as cheating) and false negatives (proportion of contract cheating classified as real student work). Across a range of subjects, sensitivity improved from 58% to 82% following training of staff although specificity remained unchanged (83%-87%). Similarly, prior to training, 42% of contract cheating was classified as real work by markers whilst this reduced to 13% post training and false positives effectively remained unchanged (17%-18%) (Table 4).

Table 4. The results of Dawson and Sutherland-Smith's (2019) study involving the effect of training of markers on detection of cheating. Definition of false positives and negatives is provided in the text above and that of true positives and true negatives

Table 1. Pre-workshop marking results

	Psychology	Nutrition	Marketing	Biology	Total
True positives	21	14	4	13	52
True negatives	44	48	24	58	174
False positives	12	8	4	12	36
False negatives	3	10	8	17	38
Total	80	80	40	100	300

Table 1. Pre-workshop marking results

	Psychology	Nutrition	Marketing	Biology	Total
True positives	22	23	12	17	74
True negatives	50	52	28	53	183
False positives	6	4	0	17	27
False negatives	2	1	0	13	16
Total	80	80	40	100	300

Whilst the suspicion of cheating might be flagged by the proctor or proctoring system, it may be challenging to prove cheating during a proctored exam. From a natural justice perspective, the civil burden of proof (i.e. 'on the balance of probabilities') of cheating in an examination should apply rather than the criminal approach of 'beyond all reasonable doubt'. This is certainly the approach used in Australian universities (Dawson, 2021). Hypothetically[35], if a student is looking away from the screen quite often or for a period of time, it is frequently flagged as potential cheating by an e-proctor system (using live or recorded proctoring (AI or human)). However, the student may have innocently been drawing a rough sketch or jotting some notes to help answer the question, which is acceptable behaviour, or they could have been cheating by referring to prohibited notes or a book or another device, which is not acceptable. Using a relatively lighter touch proctoring method would not make it possible to tell beyond all reasonable doubt and only a far more intrusive approach could do so. Dawson (2021) quite rightly reflects that assessment security must concern both detection and evidencing. A system may have 100% detection accuracy but if the proctoring system cannot provide sufficient evidence to convince human decision-makers, the system cannot provide real assessment security and as Dawson (2021) puts it "then it is just an expensive and annoying piece of assessment security theatre".

A real example of this particular issue came to light in a quite high-profile case reported in the New York Times involving Dartmouth University Medical School in the USA (Singer and Krolik, 2021). It appears that Dartmouth used the VLE system Canvas to retroactively monitor student activity during proctored exams, taking over the student's computer and webcam. The Canvas system was not designed as a forensic tool in cheating investigations and technology experts had indicated it would be difficult for a disciplinary committee to distinguish cheating from non-cheating behaviour (e.g., related to eye movements) based on the data snapshots used to accuse students of cheating. Exacerbating this issue, analysis of the Canvas software code identified instances where the system automatically generated activity data even when no one was using a computer device. Whilst 10 of the 17 students accused of cheating pleaded guilty, 7 had cases dismissed on the basis of erroneous accusations.

The use of automated, artificial intelligence (AI), proctoring has also raised some concerns in this regard (Swauger, 2020). As discussed earlier, these systems are based on internally developed machine learning algorithms that 'watch' recordings of students taken during the online exam through the webcam and flag suspicious behaviour. Such behavioural signals are effectively 'taught' to the system algorithms by the developers based on large data bases that establish a baseline of 'normal' bodies and behaviours and other behaviours that have been pre-established as evidence of potential cheating. After the exams, flagged sections of the exam recording or stills are sent to the course instructor who must determine if cheating actually took place or not. Evidence has accumulated of a range of issues arising from AI-proctored exams (Swauger, 2020):

- Loud noises or leaving of the webcam viewing area is usually flagged as suspicious which can disproportionately impact women who typically manage the majority of childcare

- Neuromuscular disorders, spinal injuries or other medical conditions may prohibit students form sitting in one place for long periods of time or may lead to the student needing to use the toilet more frequently during an exam. Such cases will be flagged as potential cheating

- Students with visual impairments or who identify as autistic of neuro-atypical may be flagged, as can students who may read the question out loud

- Face detection and facial recognition as used by algorithmic proctoring has led to claims of racial prejudice and inability to discriminate between individuals of certain racial origins (particularly amongst students of Asian origin)

The incorrect detection of potential fraud and hence false positives is a problem for every form of online proctoring but is more prevalent with automated proctoring than with live proctoring (Sietses, 2016). In live proctoring, for example, a proctor can request that the webcam be directed towards the location where the student's eyes are wandering to, which is of course impossible to do retrospectively in a recording of the exam and equally impossible therefore to determine whether the student was glancing at illicit notes or simply glancing away from the screen. These issues have led many institutions, and even some service providers (such as 'ProctorU'), to move away from AI

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proctoring. However, even human proctoring can have its problems. It was revealed that 'Examsoft', which proctored the California Bar Exam for over 8,900 test-takers using supposedly fully trained proctors, had flagged over one third of examinees (3,190) for possible integrity violations, around 98% of which were later cleared of any misconduct, leaving only 47 candidates affirmed to have conducted exam fraud (Kelley, 2021).

7.6 Reliability of Technology and Costs

As reported earlier, the proctor industry accepts that a proportion of students will have difficulty in logging into or engaging with e-proctored exams, although identifying a figure as the industry norm is difficult, particularly as some services providers boast close to 100%. It is reported[36] that Western Governors University in the USA suffer technical issues in around 1% of the 50,000 or so online proctored exams per year. Experience from some Irish institutions (such as CAI, UCD and LIT) report success rates above 90% (see section 6 above) whereas significant difficulties have arisen elsewhere (e.g., in the UCC and NUIG pilots (see Section 6.2 earlier). Institutional and student experience with the systems, as well as significant investment in IT and other supports, clearly improve the student log-on and engagement success.

The apparent AI biases include misidentification, facial recognition problems for students of colour and trans-people, potential discrimination against Muslim women and others that also affect the reliability of the technology (QAA, 2021). Other technological issues such as the misidentification of potential exam fraud have been dealt with earlier.

In Dawson 's (2021) monograph 'Defending assessment security in a digital world', he provides a chapter on metrics and standards for assessment security that explores detection accuracy, proof, prevalence of unproven cheating and learning, teaching, assessment and student experience metrics for evaluating e-proctoring systems. He calls for a clear, widely shared, set of standards that are based on sound evidence around these metrics and that are acceptable across institutions, national regulators and academic researchers in the area. The stakes are very high, as Dawson points out, given that assessment security is the final arbiter of accreditation for life-and-death professions (such as those in the medical and engineering areas for example).

In relation to costs, these vary largely with the proctoring provider, the type of proctoring service and level of security required and also, for the institution, on the number of students and exams to be proctored. Surprisingly, it appears that charges can also vary between institutions even using the same proctoring provider. It is likely that the costs are governed to an extent by market forces. The general price for e-proctoring services ranges from Auto authentication (lowest), through Live authentication, Automatic proctoring, Record-and-Review proctoring to Live proctoring (highest) (Dimeo, 2017). Institutions either charge students a fee for each online test they take, require students to pay the exam fee directly to the proctoring provider or they raise all online students' technology or general fees to cover total online exam costs. In 2017, online exam fees reportedly ranged from $7 to $15 for automated authenticated proctoring to $10 to $25 for an exam proctored in-real time by a person. These do not seem to have changed drastically to date.

A few examples suffice to illustrate the scale of charges that can be expected:

- The University of Illinois Springfield require students to pay 'Examity' directly at the following rates for each 1-hour examination (current as of July 1st 2020 – September 2021)[37]:

  Live authentication $6; Automated proctoring (Standard) $4; Automatic proctoring (premium) $6; Record and review proctoring $15 and Live authentication and proctoring $17 (the later two incur a further $7 cost per additional hour.

- The University of Louisiana, Lafayette[38] quotes slightly different costs for 'Examity' proctoring depending on the level of authentication and proctoring options the instructor chooses:

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36 Information from discussion with Dr Aodhmar Cadogan (Assistant Registrar) and Dr Gavin Clinch (Head of Online Learning, Centre for Online learning), IT Sligo (20/9/2021)

37 University of Illinois (2020) Examity Pricing Guide https://www.uis.edu/colrs/teaching/technologies/examity-pricing-guide/ [Accessed 27 October 2021]

38 University of Louisiana. Examity Fees as at October 2021 https://online.louisiana.edu/student-support/tech-support/proc-tored-exam-technical-requirements-support/examity%C2%AE-requirements [Accessed 27 October 2021]

- Level AA - $4 per exam; Level 0 - $7.50 per hour, per exam; Level 1 - $10 per hour, per exam; Level 2 - $12.50 per hour, per exam; Level 3 - $15.00 per hour, per exam.

- 'ProctorU' price according to exam duration. University of Illinois Urbana report the following 'ProctorU' pricing effective from February 1st 2021: 60 Minutes or Less $16.00 USD; 61 – 120 Minutes $22.00 USD; 121 – 180 Minutes $30.00 USD; and 181 Minutes or more $38.00 USD. Students are billed when scheduling an exam[39].

- Surprisingly Texas A&M University Mays Business School40 indicate lower prices for 'ProctorU' at: $14 (30-60 mins); $19 (61 – 120mins); $24 (121 – 180 mins); and $27 (> 180mins).

- Costs can be higher for professional organisations such as the Institute for Certification of Computing Professionals (ICCP) in the USA which charges $50 for online supervision of an examination by an ICCP proctor.

- There are limited readily available data on costings for e-proctoring in Ireland but currently IT Sligo require students to pay 'Examity' €20 per exam directly and Chartered Accountants Ireland incorporate exam costs in the overall fee.

An alternative budgetary approach to direct student payments is for the institution to pay an annual all-in fee to the proctoring provider. In Ireland, IT Sligo have indicated that they may move to an institutional agreement model as the overall costs of e-proctoring are now expected to exceed the HEA threshold requiring a procurement process. Colleges and universities internationally that have fully embraced e-proctoring and that have tens of thousands of exams proctored annually typically pay lower fees, however, as Dimeo (2017) reported, officials at the institutions interviewed for that article would not reveal their actual costs. It is estimated that thousands of university Schools across the USA spent millions of dollars on e-proctoring during the Covid pandemic, with suggestions that some institutions were charged approximately $500,000 for 1 year of service (Harwell, 2020).

LIT report that whilst the institution saved money associated with exam hall costs and invigilation by switching to online, e-proctored exams, there was a net cost once all support services and fees were accounted for[41]. As Sietses (2016) suggests, reducing costs should not be regarded as a distinct goal for the introduction of e-proctoring or digital assessment in general, but rather consideration of any potential improvement of assessment quality and educational benefits should make the business case for the change.

39 University of Illinois Urbana-Champaign (2021) ProctorU https://online.illinois.edu/proctoru [Accessed 27 October 2021]
40 Mays Business School (2021) Online Exam Proctoring Fees. https://mays.tamu.edu/online-exam-proctoring-fees/ [Accessed 27 October 2021]
41 Information from discussions with Dr. Marian Duggan (VP Academic Affairs & Registrar) and Dr. Brendan Murphy (head of Quality, teaching and Learning) LIT

8. Services available

An online search reveals a large number of e-proctoring providers, and some websites offering overviews of the proctor service offerings, reviews and even some pros and cons[42].

The majority of the main providers are based either in the USA or India, although a growing number are European (Table 5). Most of the main players have a global spread of offices. The providers offer a range of services, some fully automated, others offering both automated and live human proctoring. Browser requirements vary, with some providers restricted to a single browser (often Chrome), others widely compatible. As Brown (2018) points out, it can be difficult for an institution to select only a single product based on the variety of disciplinary areas and types of test/exam required by the institution – providing for more than one product may allow for some flexibility in selecting the best approach and platform for particular circumstances.

Table 5. A selection of the major commercial e-proctoring service providers illustrating proctoring options available, browser requirements and main international base (information based on provider's websites).

E-proctoring service provider	Proctoring Options	Browser	International Base
ExamOnline	Lite, human and auto modes	Google Chrome	India
SpeedExam	Automated	Google Chrome and Safari (IOS)	India
Mercer/Mettl	AI-based and manual remote	Web app, IOS and Android on Amazon web services	India (GDPR compliant) with offices internationally
Examus	AI-based real time	Integrates with Moodle, OpenEdx and MS Teams	USA/EU
ProctorU	Auto to Live	Web app, Windows and Mac	USA
Examity	Auto to Live	Web app	USA
Proctorio	Automated and Live	?	USA and offices in Europe
Verificient (Proctortrack)	Automated remote monitoring	Integrated with range of VLEs	USA
AIProctor	Automated	Web App	USA
ExanSoft	Automated	Web app, Windows and Mac integrates with Blackboard	USA
Proview (Talview)	Automated	Web app, Windows and Mac	USA with offices in Canada, Australia, Singapore and India
ProctorExam	Live, automated and recorded	Linux, Mac, Windows and web app	The Netherlands
PSI Bridge	Automated, Live and recorded	Atlas Cloud	Offices in Americas, Europe, Asia Pacific and Middle East
Pearson VUE (OnVue)	AI and live	?	USA, Asia, UK
MeritTrac	Automated	Windows and Linux	India
Integrity Advocate	Integrated AI and human reviewers	All browsers	Canada (GDPR compliant)
Oxagile	Automated recorded and AI live	?	USA
TestReach	AI and live	Cloud based on TestReach platform	Ireland
ProProctor	Live (with AI assistance)	Bespoke platform	USA
Honorlock	AI live	Chrome	USA
Smowl	Supports human proctors	Compatible with users platform	Spain
Wheebox	Live	?	India
Kryterion	Live	Cloud based	USA
Respondus	Automated	Cloud based	USA

42 Example websites: Das, J (2021) 15 Best Online Exam and Assessment Proctoring Software to Look Up. Software Suggest https://www.softwaresuggest.com/blog/best-online-exam-proctoring-software/# and; Gartner (2021) Online Proctoring Services for Higher Education Reviews and Ratings https://www.gartner.com/reviews/market/online-proctoring-services-for-higher-education [Accessed 30 September 2021]

For example, different solutions and levels of security will be required for low stake exams compared to high stake (see Fig. 4 Section 3.3) or for professional accreditation. In Ireland, compliance with GDPR is clearly important.

Institutions embarking on the selection and implementation of an online exam proctoring system need to consider a range of issues. These include ease and flexibility of integration with the existing institutional VLE, technical performance and robustness of the proctoring system (cognisant of possible low internet bandwidth or unreliable connectivity and poor hardware capabilities for students), level of efficient task automation, reporting capabilities, privacy protection and data management, security standards and anti-fraud measures (Sietses, 2016; Dawson, 2021). Brown (2018) also highlights cost, security and the instructor and student comfort with the system technology and operation and the need for engagement with the three main stakeholders, the academic staff, the students and the IT support staff (to which one should definitely add examinations administration).

One of the common features of the pilot projects and initial implementation of e-proctoring by institutions discussed earlier is a thorough audit and procurement exercise to select the appropriate provider(s). This process can be aided by information and reviews from independent articles, blogs and the general media.

There are also more systematic reviews published. One of the first was by Foster and Layman (2013) who developed a comparison matrix that describes online proctoring functionality, and compares that functionality across various online proctoring services/products, such as proctoring features (human-proctor availability, data transfer encryption, proctor management, recorded review, automated proctoring, incident logs, etc.), lockdown features (browser lockdown, computer operations lockdown, keystroke alerts, etc.), authentication options (facial recognition, photo comparison, keystroke analytics, biometrics, etc.), security capability, webcam features (camera view angles, panning, etc.) and cost. Whilst the conclusions of that study are probably out of date by now given the technological advances made and the emergence of many new e-proctoring providers in the interim, the matrix could support institutional selection of the appropriate service provider for its needs. In a more recent article, Hussein et al. (2020) described the four-stage process (including rigorous desk-based research, pilot testing by a group of experts and by students)

used in the decision-making process for the selection of an e-proctoring system at the University of the South Pacific. The initial large number of providers identified at the start of the process was reduced to 4 primary e-proctoring companies that were evaluated following pilot tests against a comprehensive range of proctoring features mirroring the Foster and Layman approach (see Appendix 1). This process enabled the institution to select the most compatible system.

9. Alternative approaches to e-proctoring

In some sense the traditional assessment system through examinations might suit some disciplines (e.g., mathematics and related areas) but could not be considered optimal for all. Summarising perceived expert wisdom, Flaherty (2020) points out that asking students to recall information under time-limited pressure without access to their course materials [even if it could be seen as an important life skill] may motivate students to game the system and cheat, whilst cheating is what online proctoring services seek to prevent. However, whilst e-proctoring can provide enhanced exam security, a means of helping to deter violations of academic integrity and a method of potentially providing evidence of cheating in remote online examinations, it is clearly not without significant problems as discussed above. Whilst many institutions have embraced e-proctoring to manage online examinations to some extent or another, prior to and particularly during the Covid epidemic and associated restrictions, many other institutions have sought alternative approaches to the traditional examination assessment mode or have decided to move in this direction.

One alternative, which was used in the early days of the Covid restrictions on access to campus, was the open-book exam - 3-4 hour time-limited essay-type non-proctored exams which allowed student access to notes, handwritten materials etc in any format. In LIT[43], It was deemed unnecessary to undertake any student identity validation as all students were required to take exams simultaneously and the open-book exams employed were carefully designed and tied in with the specific course work making it difficult to contract cheat. Identification of possible cheating relied on internal examiners and a plagiarism detector system URKUND. These exams were again managed centrally, started and finished at specified times and uploaded by the student by a specified time. The open book exam process was supported by significant training of staff and a best practice guide (see earlier). Maynooth University similarly introduced some novel approaches to examinations (Maynooth University Academic Council 2020) including problems being set where some of the input variables were unique to the student (i.e. "take the inflation rate as the third digit of your student number").

Based on their survey of UK institutions, QAA (2020) listed a range of approaches including exploring assessment design and question banks, one-to-one vivas with all students, mini-vivas or oral assessments, varying modes of assessments including requirements for students to use examples from their workplace and introduction of honesty statements. Other approaches can also be considered, such as using randomisation test building tools built into VLEs that can create a different version of the exam for each student, random assessment security checks of a smaller percentage of student work which is subjected to more in-depth investigation, moving away from multiple choice to require students to explain their answers and, for smaller classes, using so called 'authentic' or project-based assessments (Brown, 2018; Dawson and Sutherland-Smith, 2018; Dawson, 2021). Stack (2015) found no significant difference in results between tests administered in a fully proctored setting and tests administered online without a proctor but with randomized test questions, a lockdown browser and students being unable to backtrack to previous questions [similar to an approach being trialled in UCC[44]].

Authentic assessments are grounded in an authentic or real-world context where the contents of the assessment changes with real world events or are personalised to the student's experiences. Authentic assessments can include case studies, portfolios, reflections, or projects. They can help motivate students to connect the course material to real-world applications and also do not create the same challenges with respect to academic integrity because each student's submission is unique to them and difficult to copy from another source (Silverman et al., 2021). Furthermore, these assessments can help students avoid the test anxiety and cognitive overload that often accompany traditional, timed exams. An example involves Law in Maynooth University, where

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43 Information from discussions with Dr. Marian Duggan (VP Academic Affairs & Registrar) and Dr. Brendan Murphy (Head of Quality, Teaching and Learning) LIT
44 Information from Professor Paul McSweeney, VP learning and Teaching at UCC

they used 24-hour remote exams that were intended as open book, and involved the students having to prepare a brief on a particular issue. It was considered that this was too short a time window to allow contract cheating (Maynooth University Academic Council 2020) [although this might actually not be the case with some of the more sophisticated, and expensive, contract cheating sites]. Improving relationships between academic staff and students (Harper et al., 2019), and using less boring assessments and developing the student's ability to undertake assessment tasks without cheating (Dawson, 2021) offer further options.

The introduction of an honour code of ethical behaviour for students to publicly sign up to has been adopted by a number of US universities as a further means of deterring cheating (Daffin and Jones, 2018; Dawson, 2021). One such example is from the University of Oklahoma which has produced an Academic Integrity Code [effectively a policy paper] that includes an integrity pledge for students[45]. Instructors are encouraged to advise students of the requirements of the Code and its application to any assignments, examinations, policies and procedures in the course. The Code is binding on student conduct by its own force, but instructors can additionally choose to remind students of its importance formally (where students attest in writing that they have complied with the Code with regard to a specific assignment or examination) or informally (through an oral statement made to the class that the Code is binding with respect to a collaboration or research project). Such codes are associated with significantly lower rates of self-reported cheating although the actual degree of difference is low and Dawson (2021) reflects that, on their own, honour codes are a poor replacement for surveillance through proctoring to assure assessment security.

One of the key lessons learned from the University of Michigan-Dearborn's decision to limit e-proctoring is the necessity of communicating clearly with academic staff the rationale for the decision, to provide clear alternatives and to make available supports to instructors to help them adjust course design and assessment approaches (Silverman et al., 2021). Assessment design or redesign is a challenging process but can be aided by approaches such as the Assessment Design Decision Framework developed by Bearman et al. (2016) and if done in the right way

can support assessment security (Dawson, 2021). The emergence of teaching and learning centres, that include experienced staff with pedagogic and IT skills, as seen internationally as well as in the majority of Irish HE institutions, clearly helps such developments.

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45   University of Oklahoma. (2019). OU and academic integrity. Academic integrity: The University of Oklahoma. http://www.ou.edu/integrity/students [Accessed 30 September 2021]

10. General considerations and recommendations

There is clear evidence of growth in online delivery of higher education over the last two decades or so, and of the associated introduction and gradual expansion of remote proctoring of online examinations. However, the restrictions to on-campus activities caused by the Covid-19 pandemic led to unprecedented major and rapid changes to higher education globally during 2020 and 2021. This was accompanied by a largely unplanned, widespread, and large-scale increase in online delivery and the associated need for remote online assessment. In light of the limited time to respond, and of the increased risks to academic integrity associated with remote online examinations, e-proctoring offered a clear and rational option. It was seen as a 'pragmatic fix' to allow universities to continue to discharge their core functions (Selwyn et al., 2021) and, at the same time, to provide students, staff, employers, professional organisations, and the public at large with some confidence that academic integrity and general standards were being maintained. Whilst some institutions had explored e-proctoring prior to the Covid outbreak and had had the opportunity to trial and refine it to suit their particular needs, for many others the speed of impact of the pandemic on the HE systems offered limited time for such testing and e-proctoring was adopted almost as a leap of faith. Some Irish institutions were able to carry out small scale trials in 2020 and 2021 but the outcomes appear mixed – it worked for some (after initial problems were overcome) but it did not for others. With the gradual easing of Covid-related restrictions and reopening of campuses, along with the return to in-class teaching, what is the future for remote online assessment and e-proctoring?

There are undoubtedly a range of potential positive benefits to remote online examinations and e-proctoring and there are many examples of successful implementation and delivery, some of which have been discussed in detail earlier in this report. When implemented at an appropriate scale, in a planned fashion, targeted at suitable disciplines and types and levels of exams, and with the appropriate level of supports and necessary buy-in by staff and students, e-proctoring can be very effective. However, just as clearly, there is evidence of failures at a number of levels and a range of significant and concerning issues that surround the process and systems of e-proctoring.

E-proctoring has been more widely embraced in some jurisdictions than in others both pre- and during the Covid pandemic, but even in those countries where it is quite widespread, some institutions have consciously decided not to continue with it or have resisted taking it up in the first place. To understand why this might be so, one might consider the differing approaches to HE and learning and teaching across the world and the associated nature of assessment and examinations used, as well as explore some of the rapidly growing literature that highlights some of the unexpected and quite frequently negative effects of, and issues with, e-proctoring. Some of the e-proctoring service providers appear to have responded to these growing concerns and have begun to address some of these issues through developments in technology, recognition of privacy and data collection and retention issues, enhanced staff training etc. Where e-proctoring has been most successful, it has often involved a close working relationship between the service provider and the HE institution in order to meet the institution's particular and individual needs.

There is a large range of e-proctoring products available and a plethora of features across the different systems. As Brown (2018) notes, no one academic integrity product seems to be sufficient to address all the difficulties in protecting and maintaining academic integrity in all distance learning courses, but equally, similar challenges do exist in the face-to-face testing environments. Where the maintenance of academic integrity [and assessment security] is the primary goal, e-proctoring should be part of an assessment system that is designed to be resistant to cheating – a system that considers alternative ways of assessing or verifying performance, and designs assessments so that it is hard for candidates to benefit from cheating (Cormack, 2020). Invigilation of a traditional, exam-hall, examination involves a combination of more or less continuous observation from distance and occasional close inspection. In Cormack's view (Cormack, 2020), as Chief Regulatory Adviser at the Joint Information Systems Committee (JISC) in the UK, e-proctoring

systems that simply reproduce this face to face, focused, invigilation process, by effectively 'seating' the proctor on the candidate's desk via continuous video-conferencing, fails everyone – the proctor has to do as much work [as an exam hall invigilator], the candidate is placed in a more stressful environment and the available technology is under-utilised. Instead, he concludes that online proctoring systems are considered most helpful for continuous distance monitoring, raising an alert of suspicious behaviour to be checked by a human (at the time or later). This is not everyone's view however, as the growing concerns with possible biases and discrimination associated with some AI proctoring systems is leading some commercial e-proctoring providers and many institutions to concentrate on live and/or recorded proctoring based around human proctors. This increases costs and potentially limits the scale of implementation however.

There are alternative approaches that can reduce or remove the need for remote e-proctored examinations whilst maintaining academic integrity, largely through modifications to modes of assessment and delivery of the curriculum, but these usually require significant training supports to, and development of expertise in, teachers and ultimately more of the academic's time, all of which are often in short supply. Flaherty (2020) reports on some interesting perspectives from some interviewees such as "cheating is a pedagogical issue not a technological one. There are no easy solutions. Instead of using an app or a remote proctoring tool, teachers should talk openly to students about when and how learning happens." Another commented that "instead of asking why "traditional" exams are not working online, we need to be asking what exactly it is that we are trying to achieve with them". As Grajek (2020) reflects, technology is no silver bullet and rethinking assessment is the best solution, a view strongly held by Dawson (2021) as well. Somewhat surprisingly perhaps, this point has also been made very recently by Ashley Norris, the Chief Academic and Compliance Officer at 'Meazure Learning', the parent company of 'ProctorU'[46]. She points to the growing cost to institutions from e-proctoring and the unreliability of identifying breaches of academic integrity using AI that led to 'ProctorU' to cease to offer this mode of proctoring (even though it was the most profitable). Norris also highlights the necessary and

growing investment in staff to deal with increases in academic misconduct in the online and remote learning environment, in growing legal costs and in investments in student supports to combat cheating. Norris's key point is that spending our way out of this problem is unlikely to be successful in the face of the essay mills and live contract cheating sites that continue to make massive profits and have no ethical governor to control their conduct. Alternative real and lasting solutions are needed that include reconfiguring assessments and pedagogy to make cheating more difficult (and perhaps reduce the urge in students to do so).

Despite the relative success of moving exams online during the Covid restrictions and of developing alternative assessment modes and practice that illustrated the potential of a move away from final summative exams, there was a consensus amongst the Irish Universities that many academic staff want to return to "the exam hall"[47]. It is suggested that this may be due to the emotional as well as workload stress that the sudden move online brought, but also, with a heightened focus on academic integrity and plagiarism that arose from the switch to large scale online teaching and assessment, there may be more trust in the well-known procedures of the physical exam hall. A similar view that a regular exam hall offers a higher maximum level of security seems to have been evident in the Netherlands (Sietses, 2016).

Decisions taken by an institution as to whether to introduce remote online examinations and assessment through e-proctoring will usually come down to a balance of risks and resources; the risk to academic integrity, maintenance of standards and flexibility of delivery on the one hand, set against the risks of litigation through privacy issues, challenges to student wellbeing and staff buy-in and a range of technological issues affecting the administration of examinations on the other.

Where a decision is made to consider the introduction of remote e-proctoring, the evidence is clear that for a successful outcome, careful planning is paramount. The Association of Test Publishers (ATP) and the National College Testing Association (NCTA) in the USA published as far back as 2015 'Proctoring Best Practices'[48], an industry guide that sets out the steps needed to deliver an online test securely. More recently

46 Ashley Norris, 2021. The Integrity arms race is expensive and unsustainable. Times Higher Education, September 4th.
47 Summary of responses from the IUA Exam Officers group provided by Nora Trench Bowles, Head of Lifelong Learning, Skills and Quality, IUA by Email 30/6/2021
48 ATP & NCTA (2015) Association of Test Publishers National College Testing Association. ARP-NCTA Proctoring Best Practices https://www.ncta-testing.org/atp-ncta-proctoring-best-practices [Accessed 27 October 2021] (see Dyer et al. 2020)

the QAA (2021b) have provided a set of guiding principles to support the introduction of e-proctoring for institutions in the UK. Based on elements from these, along with learnings from the literature and the experiences of a number of institutions in Ireland and abroad, it is recommended that the following points should be considered by an institution planning to introduce e-proctoring into its examination system:

- A detailed procurement process and careful due diligence should be undertaken to ensure that online security methods are actually needed, to ensure that the provider meets the needs of the institution and discipline, that the risks the proctoring system creates are evaluated and that biases do not exist in the software or supporting systems. An evaluation matrix, along the lines of that shown in Appendix 1, could be considered as an aid to the selection of an appropriate e-proctoring provider that meets the precise needs of the institution.

- Close collaboration between all relevant offices and functions should be established to oversee the evaluation, implementation, and ongoing monitoring phases of e-proctored examinations (including the Exams Office, IT Services, Students Union, academic staff representatives and Teaching and Learning centre).

- Strong engagement with students and staff (academic and administrative) is conducted throughout the overall process, from procurement through rollout, continuing operation and periodic review and significant support services are introduced, covering IT services, welfare and training.

- Data processing agreements with the suppliers of online proctoring tools should be drawn up, ensuring that they are liable for data leaks, and that they cannot use the data for their own purposes and a legal review should be undertaken to ensure that the data management processes are GDPR-compliant.

- A separate privacy statement for e-proctoring should be introduced, making clear the purpose, what data will be collected and what will happen to the data.

- Properly planned trials should be conducted within the institution, ideally with more than one e-proctoring provider, initially with low stake exams and small cohorts and across a set of representative disciplines.

- Careful selection of the disciplines and type of examination to be proctored are made. This can

be aided by the development of a risk matrix along the lines of that of Sietses (2016) but modified to meet the institutional needs, that weighs both the importance of the exam and the risk of fraud, to help in the selection of the appropriate security level of the exam(s) in question.

- Ensure that the technical requirements (hardware and software) are met by, or can be provided to, students and are compatible with the institutional VLE.

- A structured communication strategy is designed and delivered, along with detailed guides to students and staff.

- Review current relevant policies and regulations and amend as necessary to encompass remote online delivery and e-proctoring.

- Optionality of remote e-proctoring of the examination should be factored in wherever possible with an alternative provision offered.

- A positive working relationship with the service provider is developed, and

- A system of ongoing monitoring (including student and staff feedback surveys and focus groups), maintenance and upgrading is put in place.

One clear conclusion from a review of the literature is that there is a scarcity of properly constructed scientific trials of the utility and impacts, positive or negative, of e-proctoring solutions. Similarly, Dawson (2021) concludes that there are no peer-reviewed studies involving skilled cheaters attempting to overcome the surveillance technologies to test the security of the proctoring systems. He also makes the very cogent point that marketing claims from commercial e-proctoring vendors that their systems are 'cheat-proof' should arouse extreme suspicion without the clear evidence that such claims have been scrutinised through the peer review process. Further data is needed on the impact of assessment security approaches, and especially e-proctoring, on student learning, the student experience and on the reliability and validity of the assessment.

There is no doubt that e-proctoring has a place in the higher education system, and as some commentators suggest, it will likely become a greater part of the educational experience in the post-pandemic HE landscape (Langerfeld, 2020). To what extent this will happen will likely depend on the degree to which institutions revert to pre-Covid traditional in-class

teaching delivery and exam hall assessment, the extent to which international student movement recovers and on the level of growth of online, particularly professionally accredited, programmes. Going forward, most institutions appear to expect some kind of hybrid approach to become the norm. As Sietses (2016) also concludes, e-proctoring is a useful resource to facilitate the organisation of exams in certain situations. However, it does not suit all disciplines, all types of examinations nor all institutions. It is also evident that an institution, and perhaps the HE sector as a whole, must balance the clear needs for the maintenance of academic integrity against other important and competing concerns in higher education, particularly learning, student welfare and the overall student experience.

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Appendix 1

The evaluation matrix used in Phase 3 of the Hussein et al. (2020) published review process in the selection of an appropriate e-proctoring system for the University of the South Pacific.

Proctoring Features	ProctorU	Respondus	Proctorio	AIProctor
Live human proctors available	Yes	No	**No**	No
Internet required	Yes	Yes	**Yes**	Yes
Secure/encrypted transferring of data	Yes	Yes	**Yes**	Yes
Student able to book exam time	Yes	Yes	**No**	Yes
Training provided	Yes	n/a	**Yes**	Yes
Proctoring provider certified	Yes	n/a	**Yes**	Yes
Students can interact with proctors	Yes	n/a	**Yes**	Yes
Student can message issues to proctors	Yes	n/a	**Yes**	No
Students get live exam instructions	Yes	n/a	**Yes**	No
Proctor able to see students screen	Yes	n/a	**Yes**	Yes
Stop proctor to view students screen	No	Yes	**n/a**	No
Recorded video reviewing option	No	Yes	**Yes**	No
Pause test/ cancel test	No	n/a	**Yes**	No
Automated proctoring	No	Yes	**Yes**	No
Keystroke checking	No	Yes	**Yes**	No
Audio recording	No	No	**Yes**	No
Browser lockdown	No	Yes	**Yes**	No
Authentication option	Yes	Yes	**Yes**	Yes
Web camera needed	Yes	Yes	**Yes**	Yes
Log reports	No	Yes	**Yes**	No
recording storage option	Yes	Yes	**Yes**	Yes
Test review option	No	Yes	**Yes**	No
Incident logs with date & time	No	Yes	**Yes**	No
Customising options for institution	No	Yes	**Yes**	No
Lockdown Features				
Available on both Windows and Mac	Yes	Yes	**Yes**	Yes
Plugin for browser	No	Yes	**Yes**	No
Avoids control options on the browser	No	Yes	**Yes**	No
Stops navigation (forward/back)	No	Yes	**Yes**	No
Stops concurrent tests	No	Yes	**Yes**	No
Stops right clicks using mouse	No	Yes	**Yes**	No
Stops printing	No	Yes	**Yes**	No

Proctoring Features	ProctorU	Respondus	Proctorio	AIProctor
Hides taskbar	No	Yes	**Yes**	No
Hides desktop	No	Yes	**Yes**	No
Stops minimising window	No	Yes	**Yes**	No
Stops maximising window	No	Yes	**Yes**	No
Stops copying & pasting	No	Yes	**Yes**	No
Stops other applications	No	Yes	**Yes**	No
Stops starting of other applications	No	Yes	**Yes**	No
Authentication options				
User required to authenticate	Yes	Yes	**Yes**	Yes
Username provided/required	Yes	Yes	**No**	Yes
Password provided/required	Yes	Yes	**No**	Yes
Student ID required	Yes	Yes	**Yes**	Yes
Keystroke analytics	No	No	**Yes**	No
Ability to do facial recognition	No	No	**Yes**	No
Ability to do voice recognition	No	No	**Yes**	No
Fingerprint scanning required	No	No	**No**	No
Iris scanner required/available	No	No	**No**	No
Webcam Features				
Web camera required	Yes	Yes	**Yes**	Yes
Room panning allowed	Yes	Yes	**Yes**	Yes