

International Journal of Learning, Teaching and Educational Research
Vol. 21, No. 9, pp. 76-94, September 2022
<https://doi.org/10.26803/ijlter.21.9.5>
Received Jun 15, 2022; Revised Aug 29, 2022; Accepted Sep 9, 2022

Mapping the Efficacy of Artificial Intelligence-based Online Proctored Examination (OPE) in Higher Education during COVID-19: Evidence from Assam, India

Afzalur Rahman* 

Nowgong College (Autonomous)
Nagaon, Assam, India

Abstract. The COVID-19-induced lockdown forced education institutes to use different synchronous and asynchronous assessment techniques. The present study is a case investigation of the Artificial Intelligence-based Online Proctored Examination (OPE) adopted by Nowgong College (Autonomous), Assam, India, during the COVID-19 pandemic. It follows a hybrid approach to understand the OPE mechanisms; to consider challenges faced therein; to assess its efficacy based on students' perception and satisfaction; and finally, to ascertain the perceived issues and concerns of students. Information from multiple sources was gathered including semi-structured interview with representatives of the exam controlling body, document analysis, observation and a survey of 209 randomly selected students; different parameters of OPE, constructed as per the attributes of Rogers' Diffusion of Innovation Theory (DOI), were considered. The qualitative data were analysed thematically, while the quantitative data were analysed according to frequency, percentage, mean, sd and one sample t-test. The results revealed that additional costs, lack of compatible devices, low bandwidth in rural areas, technical inability of students are the major challenges in implementing OPE successfully. Students' perception of OPE was found to be significantly positive and the sampled students were significantly satisfied with their overall experiences in OPE. However, students were found to be significantly negative and reluctant about its future use, as they experienced various technical and financial issues, and were concerned about the environmental and psychological aspects. Thus, the insights from this study yield significant implications for stakeholders, which could assist in ensuring a robust and scalable OPE in the future.

Keywords: efficacy; Artificial Intelligence; Online Proctored Examination; Higher Education, COVID-19

* Corresponding author: *Afzalur Rahman, afzalurrahmn@gmail.com*

1. Introduction

The novel Coronavirus that emerged in Wuhan in December 2019 has shaken the world, causing millions of deaths and great suffering. To ensure social distancing to contain the spread of the virus, countries across the globe used partial or complete lockdowns, resulting in unprecedented losses to economies and other indiscernible effects such as loss of lives, stress and frustration among others. Institutions of all kinds, governments, industries and others, including the education sector, stopped functioning as normal. The crisis left academic institutions with no choice but to shift all their educational activities, including teaching-learning and assessment, to online modes of delivery. This pushed educational institutions to revamp curricula, reinvent the learning-teaching process, and redesign the mechanisms used to evaluate students' performance (Ashri & Sahoo, 2021). Consequently, there has been widespread interest among government agencies, educational and research institutions worldwide to explore and adopt innovative approaches and tools for online learning and assessment at all levels of education, especially tertiary level. Concerning assessment, remote electronic examinations have been adopted by most academic institutions as a primary mode (Elsalem et al., 2021). Different synchronous and asynchronous methods for e-assessment, assignments, assessment portfolios, multiple choice questions, open-book exams and oral exams are being used (Khan & Jawaid 2020); this is despite the recognition of many difficulties linked with internet connectivity, e-exam portals, impracticality in assessing specific skills in an online environment and so on.

2. Literature Review

2.1 E-Assessment

Valid and reliable assessment techniques that reflect students' achievements and maintain integrity, are the core of any learning system. Technological advancement in the twenty-first century has penetrated every sphere of mankind and education is no exception. Along with e-learning, e-assessments have emerged as a progressive challenge to the hegemony of conservative paper-pencil assessment (Kundu & Bej, 2020). E-assessment broadly refers to practices where technology is used to improve or assist assessment and feedback mechanisms (Boitshwarelo et al., 2017). There are many pedagogic benefits to it over traditional paper-pencil assessments. Because of the intrinsic characteristics of automated marking and prompt feedback, e-assessments can be highly efficient, fast and reliable (Gipps, 2005). They can save time for teachers (Gilbert et al., 2011); reduce the burden faced by teachers in assessing large numbers of students (Nicol, 2007); and also saving valuable time for academic institutions (Gilbert et al., 2011; Ridgway et al., 2004; Donovan et al., 2007; Sorensen, 2013). E-assessments are also reported to be advantageous in testing a wide range of topics in a short duration of time, as compared to conventional assessment which require responses to be constructed (Brady, 2005). Additionally, they provide learners, teachers, and institutions with a more flexible, efficient, and convenient assessment opportunities (Attia, 2014; Sorensen, 2013; Pedersen et al., 2012; De Villiers et al., 2016; Crisp et al., 2016). Online assessment can also be used efficiently in evaluating high-order thinking abilities, including facilitation of group projects, critique, and reflection on cognitive processes (Ridgway et al., 2004).

Despite promising benefits, e-assessment mechanisms are not free from criticism. Cahapay (2021) pointed out that browser incompatibility, anxiety over tracking tools, poor internet connections, power cuts, distractions in the environment and unknown accessibility issues are the major challenges of online assessment. A lack of confidence among students and teachers due to poor computer skills has also been highlighted by Whitelock and Brasher (2006). Isaias and Issa (2013) revealed that a lack of institutional commitment can be a problematic issue in online assessment. The possibility of academic misconduct, cheating and plagiarism in e-assessments are also all identified as potential issues by many previous studies (Pedersen et al., 2012; Kocdar et al., 2018; Bartley, 2005; Rowe, 2004; Gathuri et al., 2014; Mellar et al., 2018; Hillier, 2014). Apampa et al. (2011), Bartley (2005) and Mellar et al. (2018) categorized different plagiarism and cheating mechanisms in e-assessment, like impersonation, bringing materials into exams, pursuing others' answers and ghostwriting.

2.2. Reshaping E-Assessment Techniques: Online Proctored Examination (OPE)

A more secure and reliable e-assessment method called an Online Proctored Examination (OPE) has arisen in recent years to ensure academic integrity. Online Proctored Examination is a setup that shares the characteristics of face-to-face conventional hall examinations in which a proctor monitors the examinees remotely (Raman et al., 2021). The characteristics of actual exams, such as proctor participation during exams, exam timetable, and various questioning techniques are applicable in OPE (Northcutt et al., 2016). In an artificial intelligence-based OPE set up, the proctor remotely monitors the examinees via webcams, device screens and microphones (Drew, 2020). Thus, OPE has the potential to prevent all types of cheating that could be engaged in by students (D'Souza & Siegfeldt, 2017). Students wait for the scheduled examination time and enter the online examination room using identity verification with login credentials and face recognition to ensure that the actual examinee rather than someone else is sitting the exam. Students must keep audio and visual connections in one position throughout the examination (Kharbat & Daabes, 2021), allowing proctors to monitor them in real time. In addition, there the examinations are also recorded in their entirety so that they can be reviewed later, if necessary, to identify malpractices. Besides live proctoring, OPE can also be automated, whereby, unlike for live proctoring, students do not need to wait for a scheduled time, but can sit examinations at their chosen time. During the test, the examinees' screen sharing feeds and audio-visuals are captured. Advanced audio-video analytics are used by a system to monitor the feeds and look for suspicious activity. Automated proctoring is expanding quickly because it is extremely scalable, saves time, helps with individualised supervision, and prevents potential exam fraud (Raman et al., 2021).

2.3 Experience with Online Proctored Examination (OPE) Worldwide

Harvard University, the University of California, the Georgia Institute of Technology, École Polytechnique, Michigan State University, the California Institute of the Arts, Hong Kong University of Science and Technology, University College London (UCL) and Massachusetts Institute of Technology (MIT) are some of the premier universities around the world that practice OPE (Siemens, 2015, as cited in Raman et al., 2021). Though institutions in relatively inadequate countries

also moved to adopt OPE during the COVID-19 lockdowns, a number of concerns have been reported. Participation in OPEs is difficult for students in developing countries like India, China, and Nigeria due to a lack of access to devices (Raman et al., 2021). Milone et al. (2017) revealed that the advantages of e-proctoring were outweighed by the necessity for technical specifications, the prevalence of technology challenges, and the added cost involved with each exam. Igaz and Adanır (2020), though, reported a positive attitude of students towards OPE, in spite of identifying various technical challenges that need to be resolved to ensure the effectiveness of OPE. Kubiak (2020) stated that in India and Romania, 42% of students who participated in e-learning and OPE could only use smart phones and not laptops. Besides technological issues, Kharbat and Daabes (2021) highlighted that privacy and various environmental and psychological factors are the major concerns for students with regard to e-proctored examinations. In the US, Weiner and Hurtz (2017) revealed that though students' achievements were not influenced by OPE, there were fewer positive reactions of students to remote proctored testing conditions. Karim et al. (2014) reported that in remote proctored examinations, the examinees tend to perceive slightly more pressure and tension, and expressed some elevated concerns over privacy.

Despite the debates, there is no disagreement among academics regarding the out-performance of OPEs over other non-proctored forms of online assessment techniques. However, although many private universities were unaffected by the COVID-19 crisis in terms of their ability to conduct online examinations, underfunded public universities found it difficult to adapt to the situation (Ashri & Sahoo, 2021). In such a situation, OPE has become a panacea in assessing students' performance with some degree of objectivity and reliability.

2.4 The Research Gap

A critical analysis of the related literature, as presented earlier, has shown that Milone et al. (2017) and Igaz and Adanır (2020) identified impending technical difficulties in relation to OPE. Meanwhile, Kharbat and Daabes (2021) and Karim et al. (2014) focused on identifying psychological, environmental and other concerns of students in attending OPE. However, none of the studies were conducted in India or other developing countries. Kubiak (2020) stated that in India and Romania, 42% of students who participated in e-learning and OPE could only use smart phones and not laptops. Raman et al. (2021) argued that OPEs are difficult for students in developing countries like India, China, and Nigeria due to a lack of access to devices. Nevertheless, none of them investigated the other concerns of students, such as environmental, psychological, cultural and personal privacy issues, as the present study does. Moreover, no study explored the technical architecture of OPE modules combining an attempt to identify impending difficulties, issues and concerns from the perspectives of students as well as the institution. The present study is the first of its kind and as such, is expected to fill a knowledge gap in this regard.

3. Context

In a crisis like the COVID-19 pandemic situation, where teaching and learning are facing uncertainty, online assessment has turned out to be a bolt from the blue.

Though online tests have seen considerable growth since the early part of the twenty-first century, especially with the implementation of Learning Management Systems (LMSs) in higher education (Stone & Zheng 2014), in India they are still restricted to top-level institutions. The All India Management Association Management Aptitude Test, India (AIMA MAT), National Law Admission Test (NLAT), India and some other premier examination bodies in the country have adopted Online Proctored Examinations (Berkey & Halfond, 2015). During COVID-19, the central government institutions and some private institutions in the country had sufficient digital infrastructure facilities to conduct seamless online examinations, yet most of the underfunded public institutions, especially state universities and colleges across the country, either cancelled their examinations and assessed students based on past performances or adopted simplified assessment techniques like home assignments, open-book examinations etc.

Assam, being one of the economically backward and geographically remote states in the country, is encumbered with inherent challenges relating to digital infrastructure, with a digital divide across dimensions and a digital literacy gap (Rahman, 2021). The prompt shift to an online mode of teaching in the region left higher education teachers scrambling; and universities and colleges experienced a nightmare in conducting examinations. Most universities in the region had partly cancelled the semester end of term examinations and partly conducted assessments in the form of home assignments and online open-book examinations. However, Nowgong College (Autonomous) in Assam conducted semester examinations using an artificial intelligence-based OPE mode. As such, it is imperative to report on the design and adoption mechanism for the OPE and assess its efficacy. The study will also help identify issues and concerns, which will undoubtedly open the doors for a more secure and reliable online examination system in the future.

4. Purpose of the Study

The primary focus of the study is to assess the design and adoption mechanism for an Online Proctored Examination (OPE) adopted by Nowgong College (Autonomous); and to assess its efficacy on the basis of students' perceptions and experiences. The study also aims to identify the issues and concerns in implementing OPE.

5. Research Questions

RQ-1: What is the technical architecture and flow of the OPE adopted by the case institutions and what are the challenges faced in its implementation?

RQ-2: How do the students perceive Online Proctored Examination (OPE)?

RQ-3: Are the students satisfied with the overall experience of Online Proctored Examination (OPE) and do they prefer it for the future?

RQ-4: What are the perceived issues and concerns of students with regard to Online Proctored Examination (OPE)?

6. Research Model, Methods and Materials

The present paper adopted a case study as a research design. The case study method offers a more detailed and focused approach to investigating a system, event, or attribute by gathering information from multiple sources (Cahapay, 2021). Since the prime focus of the present study is to throw light on the design and adoption mechanism for the OPE adopted by Nowgong College (Autonomous) and to assess its efficacy, the case study method is best suited and, as such, adopted.

A hybrid approach combining both qualitative and quantitative methods was employed and multiple sources were used to gather required information to answer various research questions. To answer RQ-1, a qualitative approach was used and the necessary data were primarily derived through interviews, documents and observation. The Controller and two Deputy Controllers of Examinations at the case institution were interviewed face to face in a semi-structured mode. Relevant data were also collected from documents available from the institution in the form of office memorandums, OPE modalities, a test manual, Standard Operating Procedures (SOP), images and video recordings of the examinations. Moreover, the researcher used an observation technique to validate the information.

With regard to the remaining three research questions, i.e., RQ-2, RQ-3 and RQ-4, which required only the perspective of students, a quantitative approach was adopted. All 1043 students from the 2020-21 batch (UG=879 and PG=164) of the institution who appeared semester end term examination conducted through OPE tool, during the month June-July 2021 made up the research population, of whom 20 percent, i.e., 209 students, were randomly selected as research participants. The data were collected through a self-structured survey questionnaire, which was presented to the selected student participants (n=209) at a physical meeting in the case institution.

The survey was generated for student respondents after consulting the available literature on OPE (Raman et al., 2021; Kharbat & Daabes, 2021; Cahapay, 2021) to ensure that items in the survey pertained to the students' experiences with OPE. The survey was divided into three subsections to solicit the required information to answer RQ-2, RQ-3 and RQ-4. Initially, a total of 20 closed-ended items were included throughout the three subsections, and given to 12 students who experienced OPE, as a pre-survey. After eliminating the irrelevant and ambiguous items, the final survey was reduced to a total of 15 items. The first subsection was designed to assess students' perceptions of OPE and included 12 items, which were presented in a five-point Likert response mode ranging from Strongly Agree to Strongly Disagree, representing scores 5 to 1, respectively. The items in this section were determined based on Rogers' Diffusion of Innovation Theory (DOI). According to DOI, there are five factors, namely relative advantage, compatibility, complexity/ease of use, trialability, and observability, that influence the adoption of an innovation (Rogers, 2003). Therefore, potential adopters must believe that an invention is superior to other innovations, consistent with current practices, simple to use, testable in a small scale before adoption, and provides measurable

outcomes (Raman et al., 2021). The second subsection included two items soliciting students' responses regarding their satisfaction with the overall OPE experience and their future preferences. Items in this subsection too were presented in a five-point Likert response mode ranging from Strongly Agree to Strongly Disagree, representing scores 5 to 1, respectively. The third subsection was designed in the form of a checklist including one item representing six possible issues and four possible concerns that students might encounter during their participation in OPE. The issues and concerns were identified and included, keeping in mind the existing digital infrastructure, socio-economic and geographical scenario of Assam and inputs from the interviews with the exam controlling body regarding challenges experienced. The respondents were free to check or tick any number of issues and concerns according to their perception. The reliability of the scale was determined at .76 through the test-retest method. The initial survey containing 20 items was sent to two experts on OPE and the Controller of Examinations of the case institutions to ascertain the content validity. As per their suggestions, the items were rephrased and five items were eliminated. Subsequently, the final survey consisted of 15 items. According to the experts, the final survey covers all the aspects that the research intends to investigate.

7. Results, Analysis and Discussion

RQ-1: What is the technical architecture and flow of the OPE adopted by the case institutions and what are the challenges faced in its implementation?

The research adopted a qualitative approach concerning RQ-1. Primary data were collected through semi-structured interviews with the Controller and Deputy Controllers of Examinations. Moreover, secondary data were collected through observation and document analysis (Bowen, 2009) of various documents available with the institution like office memorandums, OPE modalities, a test manual, Standard Operating Procedures (SOP), images and video recordings of the examinations.

Immediately after completing the interview sessions, the data obtained were transcribed. Secondary data obtained through observation and document analysis were also organized and reviewed. As per the requirement of RQ-1, the data were analysed thematically according to two themes viz. (a) technical architecture and flow of OPE adopted by the case institution, and (b) challenges faced by the institution in implementing OPE.

a. Technical Architecture and Flow of OPE Adopted by the Case Institution

Educational institutions typically collaborate with for-profit companies to get e-proctoring software (Kharbat & Daabes, 2021). The e-proctoring software increases the reliability of the remote exam procedure and provides a digital trail to track it. Live OPE assigns proctors to invigilate students and keep an eye on exams in real-time (Raman et al., 2021). It is preferable since it allows the proctor to see the students through the screen and remotely oversee the exam (Nie et al., 2020). The case institution adopted a similar OPE, as evident from the Controller's responses to the examinations.

“We deployed artificial intelligence-based live proctoring tool with audit login system ... as the exam started, the question paper was displayed in students’ interface along with the start of exam timer. Simultaneously, webcam and microphone of students’ devices were enabled automatically, and the entire screen of their gadgets was shared too. Several proctors monitored and communicated with the assigned students, sitting at their homes through the weblink. Besides, there was provision of automated recording of the entire examination sessions.” (Controller of Examinations, Male)

The technical architecture and flow of the OPE adopted by the institution is shown in Figure 1, which is prepared by the author and validated with the exam controlling body of the case institution.

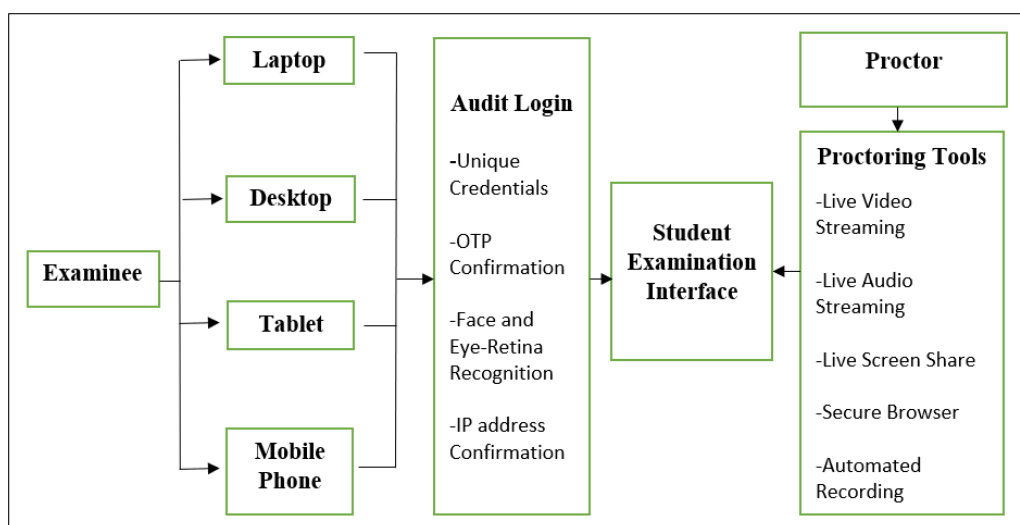


Figure 1: Technical Architecture and Flow of the Adopted OPE

Source: the author

An imposter replacing the actual examinee is an issue which can be associated with online examinations. OPE provides a platform where examinees need to verify and validate their identity in order to log into the examination room to make sure that no imposter replaces the actual examinee (Raman et al., 2021). Hence, an audit login of actual examinees is crucial for the effective implementation of OPE. In this regard the Deputy Controller of Examinations responded that-

“Our OPE tool was robust and scalable. Registered students only could login to the examination portal with their unique login credentials along with OTP confirmation. Moreover, face recognition and bio-metric confirmation through capturing eye-retina were there to allow successful login of students.” (Deputy Controller of Examinations 1, Male)

Maintaining academic integrity is a pre-requisite for an OPE. Besides audit login, live proctor monitoring and recording of the examination sessions, other technical glitches like web browsing for contents, copy and paste and audio cheating need to be controlled. Such examination malpractices can be reduced if OPE is well executed (Corrigan-Gibbs et al., 2015). A safe exam browser can be used to lock

down the examinees' devices and prohibit them from opening other browsers and to stop applications from running in the background (Raman et al., 2021). The institution deployed a similar proctoring tool, as evident from the response of the Deputy Controller of Examinations.

“The provisions incorporated in our OPE tool to maintain integrity were audit login, secure browser, live remote proctoring through image capture, video capture, voice proctoring and screen capture, disabled copy paste feature etc. However, we could not implement the provision of keeping mirror behind the examinee to monitor the physical environment comprehensively due to bandwidth issue of some students inside their rooms at home. They had to went outside their homes to get access to strong bandwidth.” (Deputy Controller of Examinations 2, Male)

The interface of invigilators' access to students' images, audio-video and screen is shown in Figure 2.

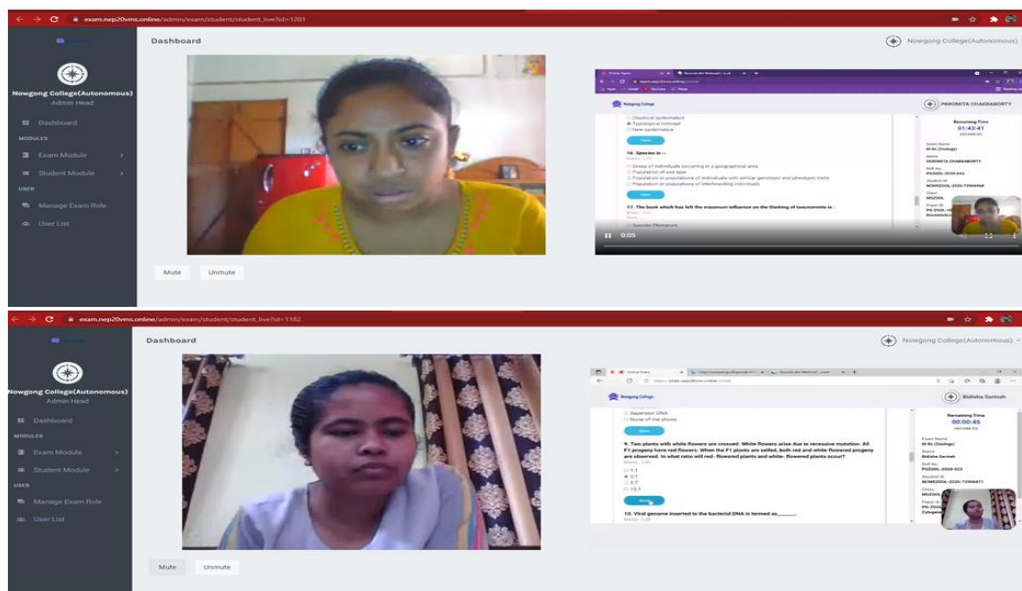


Figure 2: Interface of Invigilators Proctoring Examinees
Source: Nowgong College (Autonomous)

b. Technical Challenges Faced by the Case Institution in Implementing OPE

Milone et al. (2017) stated the advantages of e-proctoring were outweighed by the need for technical specifications, the prevalence of technology challenges, and the added cost involved with each exam. In a developing country like India, it is challenging for students living in distant places to access the internet and digital devices to engage in OPE (Raman et al., 2021). In addition to poor digital infrastructure and the digital divide, insufficient technical know-how on the part of the students is another challenge in the effective implementation of online education in Assam (Rahman, 2021). In line with the previous findings, the present investigation also revealed a similar picture as the exam controlling body expressed:

“We faced many challenges in implementing OPE. Major among these were additional cost involvement in OPE tool development, dearth of

compatible devices among few students, low bandwidth among students living in rural areas and technical inability among a small section of students.” (Deputy Controller of Examinations 1, Male)

The results related to RQ-1 showed that the OPE deployed by the case institution incorporated most of the features of standard online proctored examinations as documented by previous research studies (Northcutt et al., 2016; Drew, 2020; D’Souza & Siegfeldt, 2017; Nie et al., 2020; Kharbat & Daabes, 2021; Raman et al., 2021). However, the institution experienced challenges regarding additional costs, a lack of compatible devices among students, low bandwidth in rural areas, and students' technical inability to implement the OPE. The financial condition of government higher education institutions across India in general and in the state of Assam has been awful for the last decade. The government of India's budget allocation for digital learning was decreased from 6.04 billion in 2019–20 to 4.69 billion in 2020–21 (Banerjee, 2020). Jha (2020) stated that only 28.9 per cent of students in higher education in India had computers at home in the year 2017–18. Only 24 percent of Indian households had internet facilities in 2017–18 (National Statistical Office [NSO], 2019). Overall, 76 percent of students in India in the age range 5–35 years did not know how to use a computer (Jha, 2020). Under these circumstances, the present study's findings that financial burden, inadequate access to compatible gadgets, low bandwidth and insufficient technical know-how among students are major challenges in implementing OPE successfully seems quite justified.

RQ-2: How do the students perceive Online Proctored Examination (OPE)?

To answer RQ-2, item-wise analysis of the students' responses (n=209) in 12 closed-ended items, presented in the first subsection of the survey, was primarily done using frequency and simple percentage. Moreover, a one-sample t-test was employed to analyse the sample mean of overall perception. One-sample t-tests compare a sample mean with a hypothesized mean to ascertain if it is significantly greater or less. The present survey items adopted a five-point Likert response mode ranging from Strongly Agree to Strongly Disagree, indicated by scores 5 to 1, respectively. Thus, the average score for each item is 3. As 12 items were included to assess students' perceptions, the predetermined value (mean) of students' perceptions was 36 (Kharbat & Daabes, 2021). Hence, a one-sample t-test was conducted to determine if the average perception of the students was significantly higher or less than 36 with $p < 0.05$. The results are presented in Table 1.

Perusal of the result depicted in Table 1 indicates that the majority of the respondents, i.e., 51.2 percent (n=209), agreed that OPE is credible (16.27 percent strongly agree and 34.93 percent agree). Regarding the statement “*Online Proctored Examination (OPE) is more valid and reliable than other forms of e-assessment*”, 49.28 percent of students recorded a positive response (11.49 percent strongly agree and 37.79 percent agree). Again, 49.28 percent of respondents agreed that academic honesty is maintained in OPE (15.31 percent strongly agree and 33.97 percent agree), whereas 34.93 percent responded in a negative direction (12.44 percent strongly disagree and 22.49 percent disagree), and 15.79 percent of respondents were neutral in this regard. Overall, 44.49 percent of respondents

agreed (8.61 percent strongly agree and 35.88 percent agree) that OPE increases student engagement in online learning, while 60.29 percent rated OPE as helping in improving technical know-how (19.14 percent strongly agree and 41.15 percent agree). Thus, with regard to the attribute *relative advantage* as per Rogers' DOI (Rogers, 2003), it is evident that students perceived OPE to be relatively advantageous in terms of the proportion of positive responses regarding its credibility, validity & reliability, ability to maintain academic honesty, increase student engagement and improve technical know-how is higher than the proportion of negative responses.

Table 1: Students' Perception of Online Proctored Examination (OPE)

Items	Responses in frequency (n=209)					
	SA	A	NC	D	SD	
Online Proctored Examination (OPE) is credible as students are being monitored during examinations.	34 (16.27)	73 (34.93)	31 (14.83)	47 (22.49)	24 (11.48)	
Online Proctored Examination (OPE) is more valid and reliable than other forms of e-assessment.	24 (11.49)	79 (37.79)	46 (22.01)	49 (23.44)	11 (5.26)	
Academic honesty is maintained in Online Proctored Examination (OPE).	32 (15.31)	71 (33.97)	33 (15.79)	47 (22.49)	26 (12.44)	
Student engagement in online learning increases because of attending Online Proctored Examination (OPE).	18 (8.61)	75 (35.88)	37 (17.70)	62 (29.67)	17 (8.13)	
Attending Online Proctored Examination (OPE) helps in improving technical know-how.	40 (19.14)	86 (41.15)	21 (10.05)	44 (21.05)	18 (8.61)	M= 38.54 sd = 11.957 t = 3.071 p = .0024
Online Proctored Examination (OPE) is easy to be compatible with.	30 (14.35)	74 (35.41)	30 (14.35)	57 (27.27)	18 (8.61)	
There is nothing objectionable to continuous audio-video surveillance in Online Proctored Examination (OPE).	23 (11.01)	99 (47.37)	31 (14.83)	39 (18.66)	17 (8.13)	
It is not difficult to understand and handle technical aspects related to Online Proctored Examination (OPE).	23 (11.01)	78 (37.32)	32 (15.31)	58 (27.75)	18 (8.61)	
Getting prior instructions, SOPs and training make Online Proctored Examination (OPE) easy to participate in.	23 (11.01)	78 (37.32)	43 (20.57)	49 (23.45)	16 (7.66)	
Online Proctored Examination (OPE) is more fun and interesting.	17 (8.13)	64 (30.62)	46 (22.01)	56 (26.79)	26 (12.44)	

There is no loss in trying Online Proctored Examination (OPE), even if one does not like it.	38 (18.18)	82 (39.23)	24 (11.48)	45 (21.53)	20 (9.57)	
Participating in OPE motivates other students to use it.	29 (13.88)	67 (32.06)	51 (24.40)	42 (20.10)	20 (9.57)	

**Note: Figures in the parentheses indicate each item's percentage of total responses SA- Strongly Agree, A-Agree, NC- No Comment, D- Disagree, SD-Strongly disagree
Source: the author**

Approximately half of the respondents were compatible with OPE as 49.76 percent students responded positively to the statement “*Online Proctored Examination (OPE) is easy to be compatible with*” (14.35 percent strongly agree and 35.41 percent agree), whereas one third of responses were in a negative direction (27.27 percent disagree and 8.61 percent strongly disagree), and another 14.35 percent were neutral. The majority of the respondents, i.e., 58.38 percent, stated that there is nothing objectionable in continuous audio-video surveillance in OPE (11.01 percent strongly agree and 47.37 percent agree). Thus, more students had a positive perception towards the statements reflecting *compatibility* with OPE, than those who perceived OPE to be incompatible.

In statements representing *ease of use* of OPE, almost half of the respondents recorded their response positively. Overall, 48.33 percent (n=209) of students perceived that it is not difficult to understand and handle technical aspects related to OPE and pointed out that prior instructions, SOPs and training make OPE easy to participate in (11.01 percent strongly agree and 37.32 percent agree). However, only one third (38.75 percent, n=209) of respondents felt that OPE is more fun and interesting (8.13 percent strongly agree and 30.62 percent agree). As far as *trialability* and *observability* of OPE were concerned, again a higher proportion of students responded in a positive direction. In total, 57.41 percent of students agreed that there is no loss in trying OPE, even if one does not like it (18.18 percent strongly agree and 39.23 percent agree). To the statement “*Participating in OPE motivates other students to use it*”, 45.94 percent of responses were in a positive direction (13.88 strongly agree and 32.06 percent agree).

The *t-analysis* showed that the average score for perception of the students towards OPE was 38.54 (*sd*=11.957), in comparison to the predetermined average of student perception (36), which was significant, $t = 3.071$, $p = 0.0024$; indicating that students were significantly positive in their perception towards OPE.

The findings relating to RQ-2 showed that the perception of the majority of the students was inclined in a positive direction regarding all the attributes as per Rogers' DOI Theory (Rogers, 2003). *Relative advantage, compatibility, complexity/ease of use, trialability* and *observability* were previously been discovered to be favorably associated to OPE acceptance (Raman et al., 2021). Approximately 50 percent of respondents perceived that OPE is credible, valid and reliable and has the ability to maintain academic integrity, which is backed by the findings of Kharbat and Daabes (2021). Regarding *compatibility* and *ease of use* of OPE, the respondents

showed a positive attitude as evident in Table 1. Moreover, 57.41 percent of students agreed that there is no loss in trying OPE. Previously, Raman et al. (2021) highlighted that before and during COVID-19, students had adapted to the online examination environment very well. With regard to the overall perception, the t-analysis showed that students were significantly positive in their perception towards OPE, which is also corroborated with the findings of Igaz and Adanır, (2020) and Raman et al. (2021).

RQ-3: Are the students satisfied with the overall experience in Online Proctored Examination (OPE) and do they prefer it for future?

Kotler and Keller (2006) elaborated that, to become effective and successful, the satisfaction of its beneficiaries is primarily important for any system. Besides perception, students' satisfaction with the overall experience as well as their future preferences relating to OPE were identified. The responses of students (n=209) were analyzed through frequency and simple percentage. In line with the analysis undertaken to answer RQ-2, here also a one-sample t-test was employed to ascertain whether the students are significantly satisfied or not with their overall experiences in OPE and whether they significantly prefer OPE for the future or not. Both the items used a five-point Likert scale, representing scores 5 to 1, with 5 being strongly agree and 1 being strongly disagree; as such, the predetermined means for both the items were 3 (Kharbat & Daabes, 2021). To test the significance, a .05 level of significance was used. The results are presented in Table 2.

As depicted in Table 2, the overall experience of 56.94 percent of students was satisfactory for OPE, as 20.10 percent and 36.84 percent of students strongly agreed and agreed respectively with the statement "My overall experience with OPE is satisfactory". The average satisfaction score for respondents regarding OPE was 3.31 ($sd=1.34$), compared to the predetermined average of 3, which was significant, $t = 3.408$, $p = .0008$, indicating that students were significantly satisfied with their overall experience with OPE.

Table 2: Students' Satisfaction Level with the Overall Experience with Online Proctored Examination (OPE) and Their Future Preferences

Items	Responses in frequency (n=209)					Mean	sd	t	p
	SA	A	NC	D	SD				
My overall experience with OPE is satisfactory.	42 (20.10)	77 (36.84)	22 (10.53)	41 (19.62)	27 (12.92)	3.31	1.34	3.408 (Sig.)	.0008
I will choose OPE in the future, even if it is optional.	29 (13.88)	39 (18.66)	23 (11.01)	77 (36.84)	41 (19.62)	2.70	1.35	3.183 (Sig.)	.0017

**Note: Figures in the parentheses indicate each item's percentage of total responses SA- Strongly Agree, A-Agree, NC- No Comment, D- Disagree, SD-Strongly disagree
Source: the author**

If participation in OPE is optional, the majority of students would not choose OPE in the future as only one third of students responded positively to the statement “I will choose OPE in future, even if it is optional” (13.88 strongly agree and 18.66 percent agree), while 56.46 percent of students responded negatively to the statement (36.84 percent disagree and 19.62 percent strongly disagree). The average score for students’ responses relating to future preference for OPE was 2.70 ($sd = 1.35$), which was significantly less than the predetermined score of 3, $t = 3.183$, $p = .0017$, indicating that students were significantly negative about or reluctant to choose OPE in the future.

Thus, the present finding yields an interesting picture. The students were significantly satisfied with the overall experience with OPE. However, they were significantly reluctant to use it in the future. This finding is supported by Kharbat and Daabes (2021), who revealed, in their study, that students indicated a very strong reluctance to use OPE in the future. The contradictory finding, revealing significant satisfaction but significant reluctance to use OPE in the future, can be attributed to several issues and concerns that students experienced while participating in OPE, like poor internet connectivity, high-cost involvement, lack of compatible devices, a disruptive home environment and psychological concerns as evident in Table 3.

RQ-4: What are the perceived issues and concerns of students with regard to Online Proctored Examination (OPE)?

To answer RQ-4, the responses of participants ($n=209$) in the checklist containing six possible issues and four concerns, selected based on local socio-economic, geographical and digital infrastructure scenarios, inputs from interviews with the exam controlling body and previous research studies, were analysed using frequency and percentage.

Table 3: Perceived Issues and Concerns of Students with Online Proctored Examination (OPE)

	Problems Faced	Frequency	Percentage to total N
Perceived Issues	Incompatible device	70	33.49
	Poor Internet Connectivity	142	67.94
	High-Cost Involvement	75	35.89
	Irregular Electricity	68	32.54
	Difficulty in Handling Tools	72	34.45
	Unknown Accessibility Issues	27	12.92
Perceived Concerns	Distractions in the Physical Environment	67	32.06
	Feel Tense, Anxious and Nervous	124	59.33
	Breaches in Personal Privacy	55	26.31
	Unacceptable for My Culture and Family as Webcam Remains Open	32	15.31

Source: the author

The results presented in Table 3 reveal that 67.94 percent of students experienced poor internet connectivity, while 34.45.24 percent faced difficulty in handling tools. Again, 35.89 percent of students were concerned about the high-cost involvement, while 33.49 percent experienced incompatible device issues. The problem of irregular electricity was faced by 32.54 percent of students, while 12.92 percent were confronted with unknown accessibility issues. Previously, Cahapay (2021) pointed out that browser incompatibility, anxiety over tracking tools, poor internet connection, power cuts, and unknown accessibility issues are the major challenges for online assessment. According to the Internet and Mobile Association of India (IAMAI, 2019), the internet users in India vary widely in terms of socio-economic and geographic classes. The internet penetration for the 12-plus age population is only 27 percent in rural areas and 51 percent in urban areas. Thus, the issue of poor internet connectivity, experienced by the highest percentage (67.94 percent) of students, is not surprising.

With regard to the concerns of students about their participation in OPE, psychological concerns were the most prevalent with 59.33 percent of students reporting that they felt tense, anxious and nervous, followed by concerns about the physical environment, privacy concerns and cultural & family concerns, with 32.06, 26.31 and 15.31 percent of responses, respectively. Kharbat and Daabes (2021) previously reported that the predominant concerns of students in OPE were privacy, various environmental and psychological factors. Psychological and privacy concerns were also reported by Karim et al. (2014), who revealed that, in remote proctored examinations, the examinees tend to perceive slightly more pressure and tension, and expressed some elevated concerns over privacy. Concerns about the physical environment at home were also reported by Das (2020), Cahapay (2021) and Rahman (2021). According to Das (2020), with only 37% of Indian homes having one living space, it would be a luxury for many students to be able to take online classes in a quiet setting. Rahman (2021) revealed that the lack of a proper environment at home is one of the leading problems in online learning in Assam.

8. Conclusion

The need for online examinations during COVID-19 lockdowns presented an unprecedented challenge to the global academics. However, the results of the present study indicated a satisfactory picture regarding the efficacy of the OPE adopted by the case institution. It incorporated most of the security features to ensure an objective, reliable, transparent, secure and flexible online assessment. The students were significantly positive in their perception of OPE and significantly satisfied with their overall OPE experiences. Nevertheless, they were significantly negative about or reluctant to endorse future use of OPE. Poor internet connectivity, high-cost involvement, difficulty in handling tools, incompatible devices, and power cuts turned out to be the major issues; while psychological factors followed by physical and privacy factors were among the leading concerns of students. An additional financial burden in designing and adopting an artificial intelligence-based OPE was another concern at the institutional level. Thus, the findings yield significant implications for the academic body by highlighting institutional challenges as well as the prominent

issues and concerns of students. Wide installation of IT infrastructure regardless of geographical area is the precondition for ensuring all classes of people can access internet connectivity. Students belonging to a poor class require support from the educational institution, government and at societal level at large to ensure access to compatible devices as well as data plans (Rahman, 2021). There is a need to execute a well-thought-through series of training programmes on technical know-how for tool handling to build up the confidence level of both teachers and students. The government should review and enhance the budgetary allocation to higher education institutions to boost their digital infrastructure potential. Institutions in India at large should work to align with the global scenario of digital developments and embrace the new norm of online learning and assessment.

9. References

- Apampa, K. M., Wills, G., & Argles, D. (2011). Towards a blob-based presence verification system in summative e-assessments. *International Journal of E-Assessment*, 1(1), 1–16. <https://ijea.org.uk/index.php/journal/article/view/9>
- Ashri, D., & Sahoo, B. P. (2021). Open book examination and higher education during COVID-19: Case of University of Delhi. *Journal of Educational Technology Systems*, 50(1), 73–86. <https://doi.org/10.1177/0047239521013783>
- Attia, M. A. (2014). Postgraduate students' perceptions toward online assessment: The case of the faculty of education, Umm Al-Qura University. *Education for a Knowledge Society in Arabian Gulf Countries (International Perspectives on Education and Society)*, 24, 151–173. <https://doi.org/10.1108/S1479-367920140000024015>
- Banerjee, A. (2020, June 12). The perils of online education in India. *Frontier-An Independent Weekly Since 1968*. <https://www.frontierweekly.com/views/jun-20/12-6-20-The%20perils%20of%20online%20education%20in%20India.html>
- Bartley, J. M. (2005). Assessment is as assessment does: A conceptual framework for understanding online assessment and measurement. In S. Howell, & M. Hricko (Eds.), *Online Assessment and Measurement: Foundations and Challenges* (pp. 1–45). IGI Global. <https://doi.org/10.4018/978-1-59140-720-1.ch001>
- Berkey, D., & Halfond, J. (2015, July 20). *Cheating, student authentication and proctoring in online programs*. New England Board of Higher Education. <http://nebhe.org/journal/cheating-student-authentication-and-proctoring-in-online-programs/>
- Boitshwarelo, B., Reedy, A. K., & Billany, T. (2017). Envisioning the use of online tests in assessing twenty-first century learning: A literature review. *Research and Practice in Technology Enhanced Learning*, 12(16), 1–16. <https://doi.org/10.1186/s41039-017-0055-7>
- Bowen, G (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2), 27–40. <https://doi.org/10.3316/QRJ0902027>
- Brady, A. M. (2005). Assessment of learning with multiple-choice questions. *Nurse Education in Practice*, 5(4), 238–242. <https://doi.org/10.1016/j.nepr.2004.12.005>
- Cahapay, M. B. (2020). Reshaping assessment practices in a Philippine teacher education institution during the Coronavirus disease 2019 crisis. *Pedagogical Research*, 5(4), em0079. <https://doi.org/10.29333/pr/8535>
- Corrigan-Gibbs, H., Gupta, N., Northcutt, C., Cutrell, E., & Thies, W. (2015). Deterring cheating in online environments. *ACM Transactions on Computer-Human Interaction*, 22(6), 1–23. <https://doi.org/10.1145/2810239>
- Crisp, G., Guardia, L., & Hilier, M. (2016). Using e-Assessment to enhance student learning and evidence learning outcomes. *International Journal of Educational Technology in Higher Education*, 13(18) 1–3. <https://doi.org/10.1186/s41239-016-0020-3>

- Das, S. (2020, August 6). Digital divide biggest scourge in online study. *The Pioneer*. <https://www.dailypioneer.com/2020/state-editions/digital-divide-biggest-scourge-in-online-study.html>
- De Villiers, R., Scott-Kennel, J., & Larke, R. (2016). Principles of effective e-assessment: A proposed framework. *Journal of International Business Education*, 11(2016), 65–92. <https://neilsonjournals.com/JIBE/abstractjibe11devilliersetal.html>
- Donovan, J., Mader, C., & Shinsky, J. (2007). Online vs. traditional course evaluation formats: Student perceptions. *The Journal of Interactive Online Learning*, 6(3), 158–180. <https://ncolr.org/issues/jiol/v6/n3/online-vs-traditional-course-evaluation-formats-student-perceptions.html>
- Drew, H. (2020, April 1). Mass school closures in the wake of the coronavirus are driving a new wave of student surveillance. *The Washington Post*. <https://washingtonpost.com/technology/2020/04/01/online-proctoring-college-exams-coronavirus/>
- D'Souza, K. A., & Siegfeldt, D. V. (2017). A conceptual framework for detecting cheating in online and take-home exams: Conceptual framework for detecting cheating in exams. *Decision Sciences Journal of Innovative Education*, 15(4), 370–391. <https://doi.org/10.1111/dsji.12140>
- Elsalem, L., Al-Azzam, N., Jum'ah, A. A., & Obeidat, N. (2021). Remote E-exams during Covid-19 pandemic: A cross-sectional study of students' preferences and academic dishonesty in faculties of medical sciences. *Annals of Medicine and Surgery*, 62(February), 326–333. <https://doi.org/10.1016/j.amsu.2021.01.054>
- Gathuri, J. W., Luvanda, A., Matende, S., & Kamundi, S. (2014). Impersonation challenges associated with e-assessment of university students. *Journal of Information Engineering and Applications*, 4(7), 60–68. <https://iiste.org/Journals/index.php/JIEA/article/view/14289>
- Gilbert, L., Whitelock, D., & Gale, V. (2011). *Synthesis report on assessment and feedback with technology enhancement*. *Electronics and Computer Science*. University of Southampton. <https://eprints.soton.ac.uk/273221/1/Synthesis%2520report%2520on%2520assessment%2520and%2520feedback%2520Final%2520Report%2520July%25202011.pdf>
- Gipps, C. V. (2005). What is the role for ICT-based assessment in universities? *Studies in Higher Education*, 30(2), 171–180. <https://doi.org/10.1080/03075070500043176>
- Hillier, M. (2014). The very idea of e-Exams: student (pre)conceptions. In B. Hegarty, J. McDonald, & S. K. Loke (Eds.), *Rhetoric and Reality: Critical perspectives on educational technology*, *Proceedings ascilite Dunedin* (pp. 77–88). <https://core.ac.uk/download/pdf/43365108.pdf>
- Ilgaz, H., & Adanır, G. A. (2020). Providing Online exams for online learners: Does it really matter for them? *Education and Information Technologies*, 25(March 2020), 1255–1269. <https://doi.org/10.1007/s10639-019-10020-6>
- IMAI (2019). *India Internet 2019*. Internet and Mobile Association of India. <https://cms.iamai.in/Content/ResearchPapers/d3654bcc-002f-4fc7-ab39-e1fbeb00005d.pdf>
- Isaias, P., & Issa, T. (2013). E-learning and sustainability in higher education: an international case study. *The International Journal of Learning in Higher Education*, 20(4), 77–90. https://espace.curtin.edu.au/bitstream/handle/20.500.11937/13152/194083_99461_E-Learning__Sustainability_in_Higher_Education.pdf?sequence=2&isAllowed=y
- Jha, A. (2020, August 17). Issues facing online education. *Hindustan Times*. <https://hindustantimes.com/india-news/issues-facing-online-education/story-SaG9rbmlRjRnALWqPspjII.html>

- Karim, M. N., Kaminsky, S. E., & Behrend, T. S. (2014). Cheating, reactions, and performance in remotely proctored testing: An exploratory experimental study. *Journal of Business and Psychology*, 29(December), 555–572. <https://doi.org/10.1007/s10869-014-9343-z>
- Khan, R. A., & Jawaid, M. (2020). Technology Enhanced Assessment (TEA) in COVID 19 Pandemic. *Pakistan Journal of Medical Sciences*, 36(COVID19-S4), COVID19-S108-S110 <https://doi.org/10.12669/pjms.36.COVID19-S4.2795>
- Kharbat, F. F., & Daabes, A. S. A. (2021). E-proctored exams during the COVID-19 pandemic: A close understanding. *Education and Information Technologies*, 26, 6589–6605. <https://doi.org/10.1007/s10639-021-10458-7>
- Kocdar, S., Karadeniz, A., Peytcheva-Forsyth, R., & Stoeva, V. (2018). Cheating and plagiarism in e-assessment: Students' perspectives. *Open Praxis*, 10(3), 221–235. <https://doaj.org/article/3e05e6677c834657b3069ed455427e64>
- Kotler, P., & Keller, K. L. (2006). *Marketing Management*. Prentice Hall.
- Kubiatko, M. (2020). Are ICT being used correctly? Small reflection about correct using of ICT in education. *Problems of Education in the 21st Century*, 75(1), 4–5. <https://doi.org/10.33225/pec/17.75.04>
- Kundu, A., & Bej, T. (2020). Experiencing e-assessment during COVID-19: An analysis of Indian students' perception. *Higher Education Evaluation and Development*, 15(2), 114–134. <https://doi.org/10.1108/HEED-03-2021-0032>
- Mellar, H., Peytcheva-Forsyth, R., Kocdar, S., Karadeniz, A., & Yovkova, B. (2018). Addressing cheating in e-assessment using student authentication and authorship checking systems: Teachers' perspectives. *International Journal for Educational Integrity*, 14(2), 1–21. <https://doi.org/10.1007/s40979-018-0025-x>
- Milone, A. S., Cortese, A. M., Balestrieri, R. L., & Pittenger, A. L. (2017). The impact of proctored online exams on the educational experience. *Currents in Pharmacy Teaching & Learning*, 9(1), 108–114. <https://doi.org/10.1016/j.cptl.2016.08.037>
- National Statistical Office (NSO) (2019, November). *Key indicators of household social consumption on education in India, NSS 75th round (July 2017 to June 2018)*. Ministry of Statistics and Programme Implementation, Govt. of India. <https://ruralindiaonline.org/en/library/resource/key-indicators-of-household-social-consumption-on-education-in-india-nss-75th-round-july-2017-june-2018/>
- Nicol, D. (2007). E-assessment by design: using multiple-choice tests to good effect. *Journal of Further and Higher Education*, 31 (1), 53–64. <https://doi.org/10.1080/03098770601167922>
- Nie, D., Panfilova, E., Samusenkov, V., & Mikhaylov, A. (2020). E-learning financing models in Russia for sustainable development. *Sustainability*, 12(11), 2–14. <https://doi.org/10.3390/su12114412>
- Northcutt, C. G., Ho, A. D., & Chuang, I. L. (2016). Detecting and preventing 'multiple-account' cheating in massive open online courses. *Computers & Education*, 100(September), 71–80. <https://doi.org/10.1016/j.compedu.2016.04.008>
- Pedersen, C., White, R., & Smith, D. (2012). Usefulness and reliability of online assessments: A Business Faculty's experience. *International Journal of Organisational Behaviour*, 17(3), 33–45. https://eprints.usq.edu.au/22439/5/Pedersen_White_Smith_IJOB_v17n3_PV.pdf
- Rahman, A. (2021). Using students' experience to derive effectiveness of COVID-19-lockdown-induced emergency online learning at undergraduate level: Evidence from Assam, India. *Higher Education for the Future*, 8(1), 71–89. <https://doi.org/10.1177/2347631120980549>
- Raman, R., B, S., G, V., Vachharajani, H., & Nedungadi, P. (2021). Adoption of online proctored examinations by university students during COVID-19: Innovation

- diffusion study. *Education and Information Technologies*, 26, 7339–7358.
<https://doi.org/10.1007/s10639-021-10581-5>
- Ridgway, J., Mccusker, S., & Pead, D. (2004). *Literature Review of E-Assessment*. Futurelab Series Report 10. <https://telearn.archives-ouvertes.fr/hal-00190440>
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.
- Rowe, N. C. (2004). Cheating in online student assessment: Beyond plagiarism. *Online Journal of Distance Learning Administration*, 7 (2), 1–10.
<https://westga.edu/~distance/ojdla/summer72/rowe72.html>
- Sorensen, E. (2013). Implementation and student perceptions of e-assessment in a Chemical Engineering module. *European Journal of Engineering Education*, 38(2), 172–185. <https://doi.org/10.1080/03043797.2012.760533>
- Stone, D. E., & Zheng, G. (2014). Learning management systems in a changing environment. In V. C. X. Wang (Ed.), *Handbook of research on education and technology in a changing society* (pp. 756–767). IGI Global.
<https://doi.org/10.4018/978-1-4666-6046-5>
- Weiner, J. A., & Hurtz, G. M. (2017). A Comparative study of online remote proctored versus onsite proctored high-stakes exams. *Journal of Applied Testing Technology*, 18(1), 13–20.
<https://jattjournal.com/index.php/atp/article/view/113061/79315>
- Whitelock, D. M., & Brasher, A (2006). Developing a Roadmap for e-Assessment: Which Way Now? In M. Danson (Ed.), *Proceedings of the 10th CAA International Computer Assisted Assessment Conference* (pp. 487–501). Loughborough, UK: Professional Development.
http://oro.open.ac.uk/11950/1/CAA_Conf_06_roadmap_paperfv.pdf