SRTRIN - A Framework of Remote Online Invigilation

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Abstract

Every field of life has passed through the effects of COVID-19, particularly, millions of learners were affected from the educational sector, and moved towards remote learning. Assessment is a major element to assess the knowledge and expertise of learners, and invigilation is a process to monitor the examinees during the process of examination; during COVID-19, mostly, invigilation was done remotely, through online monitoring. E-learning industry is also doing its assessments through remote online proctoring. There is a famous quotation that there is no need for any ammunition to destroy a nation because it only needs to pull down the standard of education and permit the learners to cheat in the examinations. Literature reveals that remote online assessments are facing the challenges of undetected cheating that is harmfully disturbing the evaluating levels of learners' knowledge and skills. Most of the educational institutions are requesting the examinees to use a single camera during the exams that is insufficient and results in unseen cheating. Automated online proctoring is one of the solutions that allows a third party to get involved in the process of remote online proctoring; however, there are chances of hacking that may compromise the exam data. Moreover, these proctoring software can be tricked, leading towards cheating, and are expensive solutions. Educational institutions need best solutions to their problems at low monetary costs, with minimum risks. Existing literature discloses that there is a shortage of research towards remote online proctoring. This paper offers a framework, SRTRIN (Self Real-Time Recorded Invigilation). Twelve hypothesis were formulated, based on independent variables, and tested on dependent variable 'remote online invigilation', through the quantitative questionnaire feedback of teachers, those had performed remote online invigilation during COVID-19. Statistical analyses were done using One Sample t-Test. Outcomes revealed that all the independent variables acted as catalysts on remote online invigilation to prevent cheating. Therefore, this framework is extremely effective for remote online invigilation, to provide a solution towards the control of cheating, without putting the exam data on risk with lowest financial investment, enhancement of the quality of remote online invigilation that is applicable for the current scenario and after the COVID-19 pandemic at international levels.

Key words: *Academic Misconduct, Cheating, Framework, Online Assessment, Pandemic Pedagogy, Remote Online Invigilation.*

1. Introduction

Education is a significant asset for nations. It is an essential mode of attaining skills and knowledge that improves the expertise and understanding of learners. An important rule of a successful life is based on; never stop learning.

COVID-19 (pandemic) has affected the entire world in different fields of life. Education is one of the sectors that was under impact in different ways. Pandemic has disturbed the process of education and affected more than three hundred million learners around the world

[1]. Consequently, educational practices of teaching, learning and examinations have moved to online modes with experimental and piloting scales [2]. Therefore, educational institutions are piloting their teaching, learning and assessment practices. Appropriate digital monitoring helps in increasing the performance [41].

Assessment is a vital tool in education that is used to test the knowledge and skills, and after stepwise assessments, successful learners are awarded the licenses, certificates, diplomas and degrees, with the confirmation that they are capable of taking over the work related to their special skills depending on their areas of expertise, like doctors, pilots, engineers, teachers; conversely, the outcomes of assessment for unsuccessful learners tell that they still need to grasp a standard level of understanding, skills and expertise. A famous saying of Nelson Mandela points out that “Destroying any nation does not require the use of atomic bombs or the use of long range missiles. It only requires lowering the quality of education and allowing cheating in the examinations by the students." [3]; because graduated doctors through this type of educational system will not be able to handle sick people, consequently, victims will get expired, engineers will destroy the infrastructure, justice will be vanished and many more.

As per common knowledge, core activities and benefits through face to face invigilation are based on the following: (a). an invigilator gets a clear view of all the surroundings of examinees. (b). Examinees movements can be monitored by walking and watching the rear and front areas in the exam room. (c). All the examinees remain under surveillance through a single glance. (d). Any misconduct during exam gets noticed and recorded on the paper. (e) All the faces appear under similar level of illumination. (f). Eye movement of examinees remain clear even if they put on spectacles. (g). Identities of examinees are verified before the start of exam. (h). Examinees are prohibited to attend the toilet, in general, and in case of an emergency an examinee gets accompanied by an administrative staff until the entrance area of rest room. (i). In case of computer based exams, direct electric connections are given to the computers and stable internet connections are provided, generally with wired internet connections in computer labs. (j). Examinees are requested to leave all the resources, away from the exam place. (k). Examinees might get permission to use calculators, depending on the subject material. (l). Examinees can clarify their doubts about the questions of examination by enquiring the subject invigilators, or place a request to call their subject instructor for the clarification of their queries. When face-to-face invigilation moves to remote online invigilation then above mentioned fundamental activities in this paragraph from points (a) through (l) are required to be ensured and implemented online for the successful execution of remote online invigilation.

Literature reveals that appropriate assessment of examination is a crucial stage of an educational cycle. Assessment is a significant and central part of education [4]. Assessment of e-learning courses is based on online proctoring [6]. Overall, face to face mode of assessment is shifted to online mode of assessment, during COVID-19 [5]. Remote online proctoring is required to perform online assessments [6]. Online assessments are getting affected because of unnoticed cheating that adversely affects the examination outcomes; online proctoring software is a solution [7]. Automated online proctoring involves a third party that gets connected with the computers of learners which could be harmful from many aspects related with examination [8]. Third party software can be cheated through hiding the eye movements through using spectacles and projection of dim lights [34]. Laptop has an issue of battery life that could be exhausted during the examination [30]. Identity theft of examinees is a challenge during online proctoring [6]. Examinees need to be restricted to leave the exam place during

remote online examination [30] Most of the former research has concentrated on learners' feedbacks and capabilities towards remote assessments [9, 10]. There is a deficiency in research area towards remote online proctoring of assessments and a lot of work needs to be done [11]. Division of Wi-fi router's bandwidth and its position affect the speed of internet [12]. A suitable structure would be a solution to minimize online cheating for online assessments [13]. Overall, educational institutions look for best solutions of their problems at a minimum budget [14, 15, 16, 17, 18, 19].

On the basis of existing literature, the main question is; how the cheating in exams can be controlled for remote online invigilation without harming the exam data, with minimum cost effects? The offered framework endeavors to find out the solution of this question. Next sections are going to discuss about literature review, hypotheses, methodology, results, conclusions, recommendations, and references. It is believed that this framework will help in successful implementation of practices towards remote online invigilation to prevent cheating, and to accommodate the requirements of online e-learning examinations and post pandemic needs of remote online invigilation.

2. Literature Review

2.1. Assessment of examination, Online Assessment, Remote Online Invigilation and Challenges

Assessment is a major, significant and fundamental component of the pedagogical process because it gives evident indication about gaining the knowledge, skills and expertise towards the development and advancement of a leaner, and delivers the level of understanding [20].

COVID-19 has transferred formal assessment to online assessment [5]. An online assessment is a test of an individual's skills and expertise concerning a specific subject or area, and web based technologies are used to conduct these assessments through internet, where online assessment is based on remote online invigilation [6]. Major challenges in online assessment are academic dishonesty, like cheating, chances of hacking the examinations, infrastructure and high costs to keep it online [6]. Summative online assessments are facing a major challenge of cheating in examinations that is the most important issue which needs to be solved; moreover, there are risks of identity deception, and one of the solution is proctoring through video conferencing using the camera [6]. Overall, educational organizations are conducting the remote online proctoring through requesting the students to use a single camera of laptop, desktop or mobile that is not enough to prevent the exams from cheating. Examinees use a single camera during exam, therefore, they could be requested to reposition it multiple times to have a look of the surroundings [21]. As most of the examinees are using laptops for taking the exams, therefore, it is difficult to move the camera during the examination; moreover, several movements of camera connected with desktop or mobile is very difficult, while taking the online examination. One of the key debatable issues in online assessment is the security of exam data [22]. Online assessment is based on internet based examinations, therefore, extra care needs to be given to the safety and confidentiality of exam data, remote online invigilation, and identification of examinees [23].

Researchers [24] have offered a prototype for remote online invigilation using RIVA method. They have used a log file that was recording the cheating attempts through the web camera, and at later stages the examination committee was checking the log file for academic dishonesty and penalizing the examinees; however, they have not addressed the matters related with exam issues, those could be unnoticed and lead to cheating.

Quasi experiment is used by researchers [25] to settle the discussion of cheating in online exams, conducted through the use of remote online invigilation recordings, using Respondus Monitor, and a webcam recording software; nevertheless, the issue of unobserved academic conduct was not discussed. A research is conducted by [26] towards the improvement and provision of remotely invigilated online exams (RIOEs), focusing on the reduction of learners' cognitive load or working memory; however, researchers have not focused on the issues of avoiding unnoticed cheating during remotely proctored exams. A research conducted through a survey questionnaire by [27] on the students of 61 universities states that learners reported their concern regarding undeveloped methods of remote assessment, focusing on remote proctoring as a major issue.

An organized structure for the process of reliable assessment is significantly required [28]. A proper structure would be an answer to the problem of online cheating for remote online assessments [13].

2.2. Online Proctoring and automated AI based Online Proctoring Software

Academic reliability gets affected when the examinations are taken online because of unnoticed cheating that falsely increases the marks; automated remote online proctoring software is the solution of these issues, to avoid cheating in examinations [7].
Online proctoring is a process to monitor the online assessment of exam-takers using web based tools [29]. There are many artificial intelligence (AI) based proctoring software available in the market to monitor online exams, such as Proctorio, ProctorExam, Proctortrack and Examity. These companies offer the online proctoring services and charge the amount on the basis of purchased licenses.

Overall, the types of online proctoring offered by these companies can be summarized as follows [29]:

i). Live proctoring: human invigilators monitor the exams through web cameras.

ii). Auto proctoring: an artificial intelligence (AI) based software monitors live web cameras of exam-takers with AI based features.

iii). Recorded proctoring: there are no live proctors connected with the monitoring of online exams. The live audios and screen feeds of exam-takers are recorded and reviewed later.

Following are the price quotations of Prcotorio and Proctor Exam:

a). Proctorio:

Figure 1 displays the prices from Proctorio (A. Shadid, personal communication, October 18, 2020). The price of $18 per user, per year is for more than 4000 licenses of users. If the number of users are less than 4000 then this price gets increased to 20$ per user, per year with unlimited usage. Another option is 5$, per user, per exam. The price of live proctoring is $45 per user (A. Shadid, personal communication, October 17, 2020). These prices include all the features, like Proctorio's integration with learning management system (Moodle). Figure 2 illustrates the extension of Proctorio. Users have to install the extension of Proctorio for taking the exam and online monitoring.

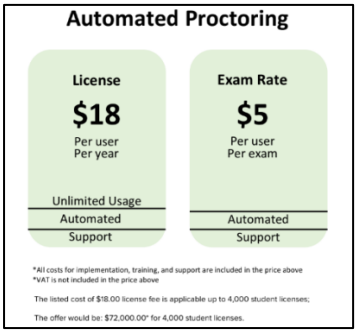

Figure 1. Price of Proctorio

Figure 2. Extension of Proctorio

b). ProctorExam

Figure 3 displays the price of ProctorExam (J. Ambrosio, personal communication, 2021). Figure 4 illustrates the required extension.

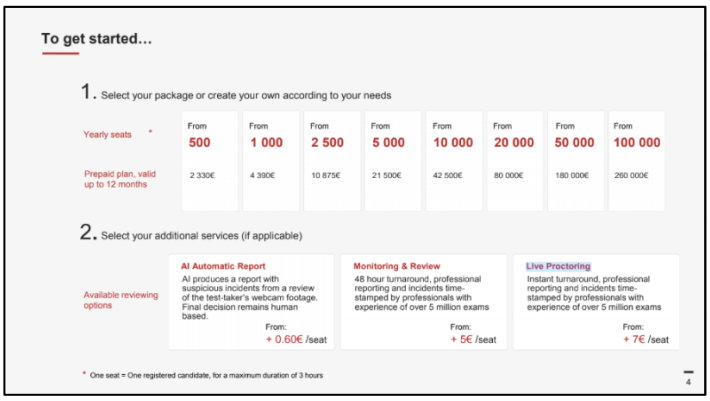

Figure 3. Price of ProctorExam

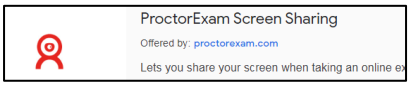

Figure 4. ProctorExam extension

and strategies of Proctorexam include: identity verification, no breaks during examinations, permitting the use of any material, such as pen, pencil and papers, based on the decision of institution, reconnection in case of disconnection, such as network connection and depletion of laptop's battery [30]. Automated proctoring software informs the students that leaving the exam place during exam is counted as suspicious activity, therefore, they are not allowed to leave the exam place; moreover, mobiles are not allowed to be carried during examination. However, concerned institution could inform the proctoring company and allow the students to use particular resources, as per requirements of the course [30].

2.3. Claimed Features of Security by Online Proctoring Software

Proctorio and other online proctoring software claim that they have a high level of security, such as ***Zero-knowledge or Military-grade encryption*** that ensures the safety of exam data [31]. However, Military-grade encryption is a marketing terminology because it is based on a standard of encryption, termed as AES-256 that is a default standard of encryption for Internet Explorer (IE8) for Windows Vista (AES-256 encryption), moreover, latest browsers have the same level of encryption, such as Chrome or Firefox [32]. Fox-IT is a security firm of Netherlands that had claimed the successful decryption (hacking) of AES-256 encrypted keys from a short distance [33].

2.4. Cost and Risks

The cost of these online proctoring software, as given above is very high. Additionally, if an educational institution avails the services of any online proctoring software, one of a potential risks is the recording of each and every activity (including exam questions), on and

off the screen. Moreover, the exams would be online through a third party. Hence, there are possibilities of hackers' attacks on the exam data. In addition, the data of online proctoring would be saved on the servers of a third party. One of a main challenges in remote online assessment is the risk of exam hacking [6]. Online proctoring is a method of observation where a third party is authorized to run the examinations through their software, and to establish the links with the electronic devices of learners, headphones and web cameras, to record and certify that directions of remote online proctoring are in place; organizations and learners should follow all the instructions given by the third party, and they are not allowed to ask questions, in case of difficulty in understanding; overall this could be potentially harmful [8].

2.5. Cheating in Automated or AI based Online Proctored Exams

Cheating could be done in AI based online proctored exams. There are different ways of cheating in online exams. Two of the following practices cannot be detected by AI software of online proctoring, and lend a helping hand in cheating during online exams [34]:

i). Dim the lights of room before the start of exam, turn up the brightness of laptop or computer to maximum and wear the glasses; as a result, movement of eyes would be difficult to detect by the AI proctoring software. A sample is presented in figure 5. *(Note: facial features in all the figures of this paper are purposely blurred to hide the pictorial identity of individuals).*

ii). Use a smartphone, turn off its WiFi and turn on mobile data on the smartphone. Place the phone at the blind spot that would be difficult for AI proctoring software to discover. An example is presented in figure 6.

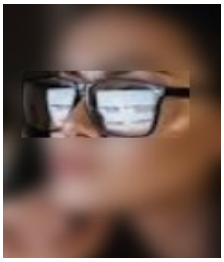

Figure 5. Difficult to sense the movement of eyes by AI based proctoring software

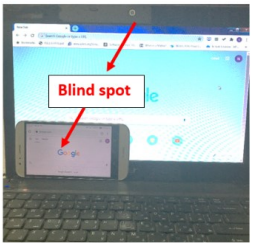

Figure 6. Blind spot, unnoticed by AI based proctoring software

2.6. Calculator and Electric Extension Cord

Calculator is a device to perform arithmetic operations. The similarity of a calculator is like a mobile phone [35]. Computer is an electronic machine that works on electricity; therefore, computers and laptops need continuous electric power. The use of electric extension cord for connecting a laptop with direct electric power gives uninterrupted electric supply to the laptop [36]. Therefore, battery of the laptop will not be in use and switching-off issue during the work in progress will be resolved.

2.7. Multiple-Camera Mode of Production in Filmmaking

Filmmaking companies and television shows are using multiple-camera mode of production or multicam where more than one cameras are used to capture different views of a human and surroundings from different angles that gives a clear view of surroundings to the viewer [37].

2.8. Google Meet as Meeting Room for Invigilation, Recording, and Grid View Extension

Google meet is a tool of video conferencing that links participants through sharing and joining a retrieved link from Google meet, where they can work together; it allows 49 participants, all together, to appear on as a single view [38]. Google meet has the recording feature, using which all the on-screen activities can be recorded and these recordings are forwarded to the "My Drive" folder of the originator, accompanied with an email; moreover, host control option of Google meet can allow or restrict the participants to share their screens and sending the messages during remote online video conferencing [39]. Grid View is an

extension from "Google Chrome Web Store" that simultaneously shows all the persons those have joined the meeting through "Google Meet's" link [40]. However, currently, all the "Grid View" extensions are blocked by Google for "Google Meet".

2.9. Wi-Fi Speed and Position of Router

During COVID-19, societies are heavily depending on the internet for teleworking, related to pedagogical needs, official assignments and amusements that affect the speed of internet because the bandwidth of internet for every user gets reduced, resulting in slow speed of internet; maximum number of users are inversely proportional to the lowest speed of internet [12]. In addition, [12] recommended the way to strengthen the Wi-Fi signals on electronic gadgets through sitting nearby the Wi-Fi router because it transmits strong signals to nearby areas.

3. Hypotheses

Keeping in view the literature review following hypotheses were formulated:

H_0: The use of double camera view has no effect on the process of remote online invigilation to prevent cheating.
H_1: The use of double camera view has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: The real time self-invigilation by the subject instructor has no effect on the process of remote online invigilation.
H_1: The real time self-invigilation by the subject instructor has a positive effect on the process of remote online invigilation.
H_0: Recording the online exam invigilation activity has no effect on the process of remote online invigilation to prevent cheating.
H_1: Recording the online exam invigilation activity has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Appearance of all the examinees in a single view during online examination session has no effect on the process of remote online invigilation to prevent cheating.
H_1: Appearance of all the examinees in a single view during online examination session has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Attending the rest room by the examinees, prior to the start of exam has no effect on the process of remote online invigilation to prevent cheating.
H_1: Attending the rest room by the examinees, prior to the start of exam has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Provision of direct electric supply to the electronic gadgets (like laptop) has no effect on the process of remote online invigilation to prevent cheating.
H_1: Provision of direct electric supply to the electronic gadgets (like laptop) has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Illumination of examinees surroundings for clear appearance of faces on the cameras has no effect on the process of remote online invigilation to prevent cheating.
H_1: Illumination of examinees surroundings for clear appearances of faces on the cameras has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Preventing the use of manual calculator (as it looks like a mobile phone, and forcing the use of electronic calculator from computer) has no effect on the process of remote online invigilation to prevent cheating.
H_1: Preventing the use of manual calculator (as it looks like a mobile phone, and forcing the use of electronic calculator from computer) has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Removal of subsequent items from examinees desks and surroundings of exam areas (like calculators, smart phones and smart watches) has no effect on the process of remote online invigilation to prevent cheating.
H_1: Removal of subsequent items from examinees desks and surroundings of exam areas (like calculators, smart phones and smart watches) has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Proving the identities of examinees in front of cameras using ID cards has no effect on the process of remote online invigilation to prevent cheating.

H_1: Proving the identities of examinees in front of cameras using ID cards has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Sitting nearby the Wi-Fi router to fully utilize the bandwidth (for uninterrupted connection) during exam has no effect on the process of remote online invigilation to prevent cheating.
H_1: Sitting nearby the Wi-Fi router to fully utilize the bandwidth (for uninterrupted connection) during exam has a positive effect on the process of remote online invigilation to prevent cheating.
H_0: Overall, all the independent variables used in this framework (given above) have no effects on remote online invigilation to prevent cheating.
H_1: Overall, all the independent variables used in this framework (given above) have positive effects on remote online invigilation to prevent cheating.

4. SRTRIN - A Framework of Remote Online Invigilation

Keeping in view the existing literature, available in the previous sections, automated proctoring software uses three modes, and the offered framework SRTRIN (Self Real-Time Recorded Invigilation), given below, is a mixture of these proctoring modes with an addition of self (by the instructor) invigilation. The multiple views of surroundings, during online examination is one of the independent variables that may affect the outcomes of remote online invigilation. Moreover, real time self-invigilation is another independent variable that may regulates the process of remote online invigilation because examinees may convey exam related issues with the teacher. Recording of exam session comes next to it because recording could be referred back at later stages for any suspicious activity, and examinees could keep in mind that all the activities during the exam are getting recorded. This framework allows to invigilate number of examinees in a single video conference, therefore, layout of the remote online invigilation session needs to show all the examinees together, on a single view; hence, layout is another independent variable, might control the outcomes of remote online invigilation. Finally, a few number of strategies, recommended by literature, those are offered in the previous sections of this paper are required to be added to the practice of remote online invigilation, those might act as moderating variables to affect the outcomes of remote online invigilation to prevent cheating, including: 1). Restriction on leaving the exam places. 2). Use of direct electric supplies to laptops/electronic gadgets. 3). Clear appearances of faces with illuminated surroundings. 5). Prohibition of the use of manual calculators. 4). Restrictions on using mobiles, smartphones, smart watches and other resources (instructors may allow some items as per the requirements of the courses). 6). Proof of examinees identities. 7). Sitting nearby Wi-Fi routers and avoiding the sharing of routers signals during exam timings.

Following figure 6.1. shows the overall design for the proposed framework of remote online invigilation – SRTRIN (Self Real-Time Recorded Invigilation):

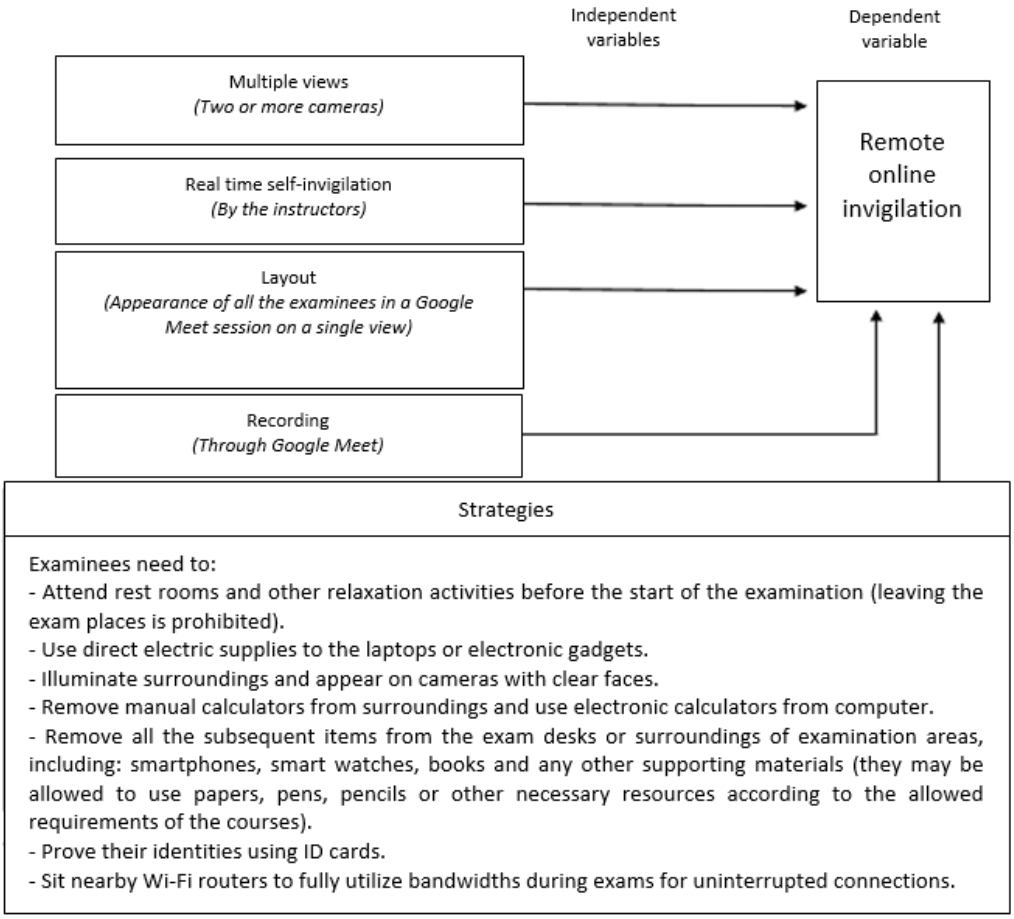

Figure 6.1. SRTRIN – A framework of remote online invigilation

Figure 6.1. shows SRTRIN (Self Real-Time Recorded Invigilation) framework - for the dependent variable "Remote Online Invigilation"; this framework has independent variables, including: multiple views of camera, real-time self-invigilation, layout (appearance of all the examinees), recoding of exam sessions, and a set of strategies.

5. Methodology

The hypotheses of this framework were tested through the quantitative data questionnaire feedback, taken from teachers of four different countries, those were having the experience of conducting remote online invigilation during COVID-19. Total number of respondents were 33. Respondents were requested to furnish their feedback on the level of effectiveness towards independent variables used for SRTRIN framework regarding remote online invigilation to prevent cheating in online examinations. Ten point (10-point) Likert scale was used to receive the feedback through their opinions for (i) Multiple (two) camera views. (ii) Real-time self-invigilation by instructors. (iii) Layout of invigilation (appearance of all the examinees in a single view). (iv). Recording of exam session. (v). Attending rest rooms (toilets) by the examinees prior to the start of examination. (vi) Direct electric supplies to laptops/electronic gadgets. (vii) Illumination of examinees surroundings to appear with clear faces on cameras. (viii). Prohibition of the use of manual calculators. (ix) Removing of all the subsequent items from exam desks and surroundings. (x). Proving the identities of examinees on cameras using ID cards. (xi). Sitting nearby Wi-Fi routers to fully utilize bandwidths during examination. (xii). Overall evaluation of effectives about all the above mentioned (11)

independent variables on the process of remote online invigilation (dependent variable) to prevent cheating.

Concerning the questionnaire, mid value is 5 and 'μ' is the representative symbol for mean; hence, overall representation of hypotheses was as follows:
Null hypothesis H_0: $\mu <= 5$ and *Alternative hypothesis* H_1: $\mu > 5$

After the collection of data, analysis was done on the basis of One Sample t-Test, using MS Excel.

6. Results

6.1. One Sample t-Test on SRTRIN Framework of Remote Online Invigilation

Table. 1 shows the outcomes of quantitative data, collected through the questionnaire from teachers, towards testing the effects of following eleven independent variables on remote online invigilation to prevent cheating. Statistically, One Sample t-Test is used to analyze the data for the SRTRIN framework. The P-values indicate that all the null hypothesis are rejected and all independent variables have positive effects on remote online invigilation to prevent cheating; and overall, this framework of independent variables is verified as an extremely effective method for remote online invigilation to prevent cheating.

Table.1: Outcomes of independent variables of SRTRIN through One Sample t-Test

Independent variable	P-Value	Outcome	Comments		Effect
Multiple (double) camera view	4.86E-12	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Real time self-invigilation by subject instructor	7.86E-13	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Recording of exam session	3.59E-12	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Appearance of all examinees in a single online view	7.72E-13	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Attending rest room by the examinees prior to the start of exam	2.06E-17	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Provision of direct electric supply to laptops/electronic gadgets	4.25E-17	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Illumination of examinees surroundings for clear appearances of faces	1.05E-18	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Prohibiting the use of manual calculators	9.76E-09	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Removal of subsequent items from examinees surroundings	3.74E-20	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Proving the identities through ID cards	2.17E-13	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
Sitting nearby Wi-Fi router to utilize full bandwidths	3.99E-20	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive
`Overall, all the independent variables given above are effective on remote online invigilation to prevent cheating	2.96E-14	<0.05 (Significant)	Reject H_0	H_1: $\mu > 5$	Positive

7. Conclusions

Pandemic (COVID-19) has changed the entire world, and education sector is one of the largest segments, under impact. Consequently, teaching and learning was moved online. Assessment is the key component to test the learners' knowledge and skills that was conducted through remote online invigilation. In general, E-learning industry also practices remote online invigilation techniques. Current practices of online assessments through remote online invigilation have gaps; automated proctoring software can be deceived.

This paper offers an appropriate picture for understanding the technicalities of remote online invigilation for conducing the online assessments, and SRTRIN (Self Real-Time Recorded Invigilation) framework identifies central independent variables, those have operated as moderating variables, including; 1). Multiple (two) views of cameras. 2). Real time self-invigilation. 3). Layout of appearances for all the examinees in google meet's conference on a single view. 4). Recording of remote online invigilation sessions. 5). Application of key strategies (attending toilets before exam, provision of direct electric supplies to the laptops/electronic gadgets, illumination of exam's surroundings for clear appearances of faces, prohibiting the use of manual calculators, removal of subsequent items from examinees surroundings, proving their identities using ID cards, and sitting nearby Wi-Fi routers to fully utilize the bandwidths). Results of this study indicate that all these independent variables act as catalysts and help to regulate the process of remote online invigilation towards successful testing of learners' knowledge and skills, and prove that SRTRIN fulfills the requirements of successful online assessments through remote online invigilation to prevent cheating during online examinations. This framework is equally applicable for post pandemic online educational assessment scenarios and for the e-learning industry, to avoid cheating in online exams that also provides security of data, along with zero monetary input because all the activities are based on internal arrangements of an educational institution, without any involvement of a third party, and the required software, resources and their application are free of any charge, as compared to the outsourced proctoring, done by a third party. The emerged image of this framework points to the practicality and sustainability, as a tool for the better implementation of remote online proctoring that clearly gives the answer, how to control the issue of cheating in remote online exams, successfully, through remote online invigilation without placing the exam data at risk, with zero financial investment. Dear field specialists and educational experts at national and international levels, SRTRIN framework is in your hands; what are your waiting for? Integrate the SRTRIN framework as a remote online proctoring method for your e-learning assessments, during and after COVID-19 scenarios and test the knowledge of learners at flawless levels; without the fear of cheating.

8. Recommendations

8.1. Details of SRTRIN (Self Real-Time Recorded Invigilation) Framework for Implementation

The results of this study reveal that all eleven independent variables are effective on remote online invigilation to protect from cheating. Following are the recommended strategies, based on the research outcomes of SRTRIN framework of remote online invigilation for detailed understanding and implementation:

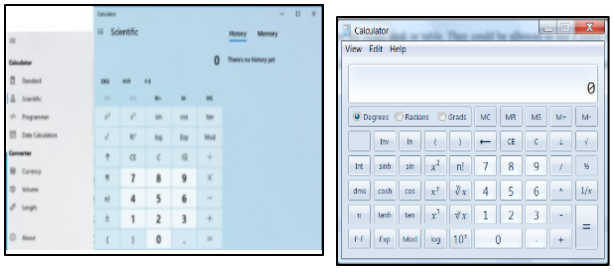

Figure 7. Scientific calculators of MS Windows

Keeping in view the study outcomes of SRTRIN framework, Do's and Don'ts of remote online invigilation Don'ts: a). Smartphones, tablets, books, smart watches or any other supporting materials on the exam desks and within the surroundings are not allowed. Scientific calculators are available in the start menu of MS Windows (figure 7), those can be used during examinations. The use of manual calculators is prohibited because; resemblance of a calculator is like a smart phone [35].

b). Family members of examinees should not use Wi-Fi during examination timings.

Do's: a). Examinees should complete all activities before the start of examinations (leaving the exam places after the start of exam is a suspicious activity).

b). Use of electric power sockets or electric extension cords for laptops/electronic gadgets during examinations. Figures 8 and 9 display samples of these two items.

c). Places of examinations must be illuminated (lightened and brightened up) properly, examinees faces must be seen clearly through the webcams.

d). Identity verification is must; examinees should prove their identities, as presented in figure 10.

Figure 8. Electric extension cord

Figure 9. Electric power socket

Figure 10. Prove the identity

e). Sitting nearby the Wi-Fi router gives strong signals.

f). Multiple (two) Views of Cameras:

The front views are available through the cameras of laptops or personal computers; however, for receiving the rear views of surroundings, examinees have to place their smartphones at the backsides of their exam places with a distance of around 1.5 meter, as displayed in figure 11. Distance could be reduced to 1 meter for a closer look.

There are two samples of rear and right views, including: i) view number 1 (figures 11, 12 and 13). ii) View number 2 (figure 14). View number 2 is strongly recommended.

If examinees switch to any other screen, it could be noticed, as displayed in figure 12.

View number 1

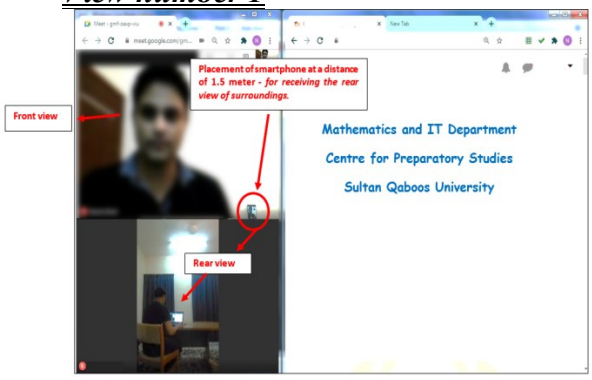

Figure 11. Front and rear view (view number 1

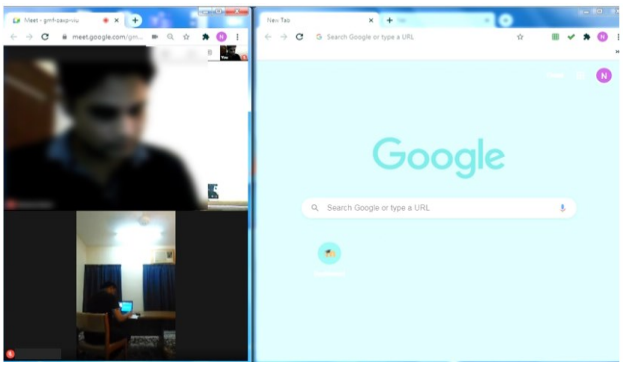

Figure 12. Switching of screen (view number 1)

Direction of face (example in figure 13) and movement of eyes can be noticed from front camera while examinee is working on the paper.

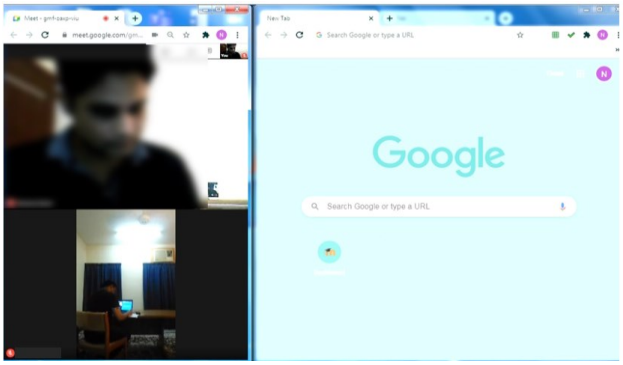

Figure 13. Direction of face (view number 1)

View number 2

View number 2: smartphone is placed at the right side with a distance of 1 meter, as presented in figure 14.

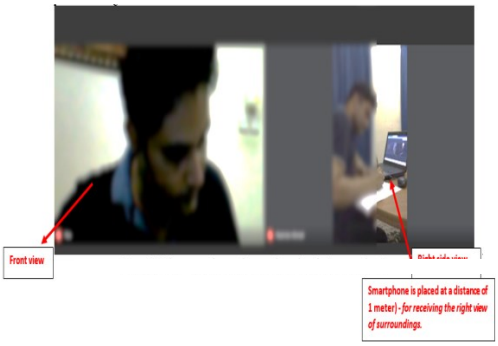

Figure 14. Placement of smartphone at the right side (view number 2)

Any view can be selected for online proctoring (*view number 1* or *viewer number 2*).

g). Real Time Self-Invigilation (By the Instructors) Real time self-invigilation, led by the instructors play a vital role in smooth online invigilation because instructors know all the examinees, may resolve their issues based on the examinees backgrounds and profiles. Instructors must wear headphones and use cameras during remote online invigilation.

h). Layout (Appearance of all the Examinees in Google Meet's Sessions on a Single View)

As "Google Meet" is globally in practice for online instruction and invigilation (with webcams [front views]), used by most of the educational institutions, and there is no doubt that it is a power tool that is used for teaching and conducting the remote online invigilation. Presently, maximum number of allowed participants to be viewed in the Google Meet is 49, as displayed in figure 15. Therefore, if there are 20 examinees in a video conference of Google Meet, used as the online room of remote exam invigilation, then 40 views will be available using two cameras.

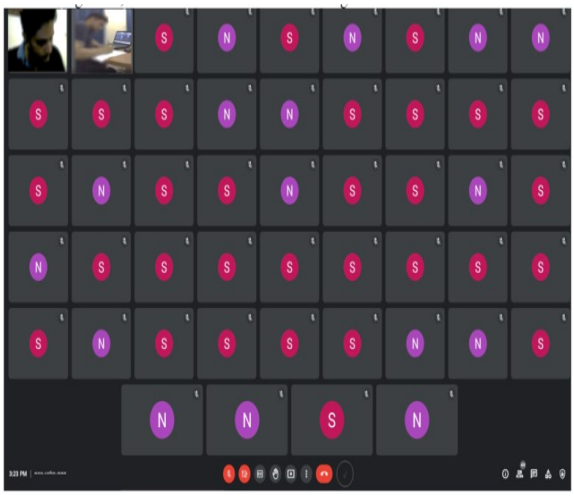

Figure 15. Layout of all the examinees on a single view

It is recommended to allow 20 to 24 participants for an exam session that become 48 views (including front webcam views plus rear views of mobiles); more than 24 participants result in hidden views (participants), those would be overlooked during invigilation, as shown in figure 16, section 'A' (3 others). In addition, to make the invi gilation more reliable, change the settings and turn off 'Host Controls' => 'Share their Screen' and 'Send Chat Messages' (figure 16, section 'B'); change the layout settings and move to 49 participants (figure 16, section 'C').

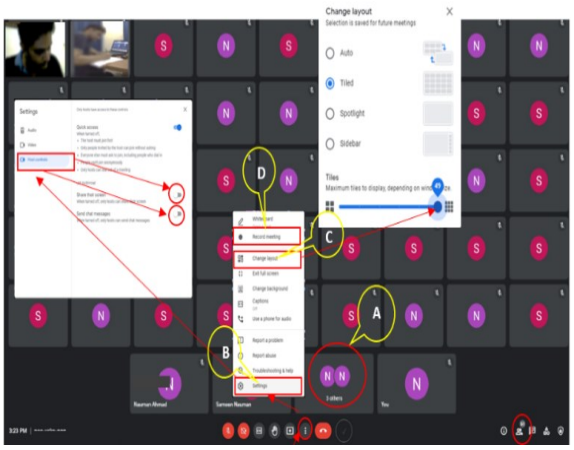

Figure 16. Hidden views (3 others), Layout (49 participants), Settings (Host Controls)

Before moving towards recording feature of Google Meet, click on 'Your entire screen' (figure 17), else, only the participants those talk during the invigilation get recorded, then click the 'Record meeting' option (figure 16, section 'D'). Finally, after terminating the recording option, a copy of recorded invigilation comes to 'My Drive' folder of the instructor's user account (creator of the Google Meet's link), followed by an email.

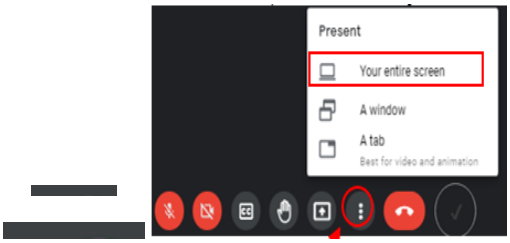

Figure 17. Present → your entire screen

Same rules could be applied for other programs, available in the market for remote online invigilation to prevent cheating, such as Zoom or Microsoft Teams. Two or more computer machines can be used by the invigilator, to divide exam sections in two groups, or invigilation can be done for two sections, together. Second or third machine can also be used as a backup of any emergency (such as network disconnection); invigilator can switch to the backup machine for trouble-free monitoring. This Framework can be tested using other online conferencing software tools, such as Zoom and Microsoft Teams as the future work.

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