

Secured E-Examination System with Continuous Authentication to Prevent Cheating

Keerrthanam Amkamaran¹, Intan Farahana Binti Kamsin², Zety Marlia Zainal Abidin³, Hemalata Vasudavan⁴

^{1,2,3,4}Asia Pacific University of Technology and Innovation, Technology Park Malaysia, Bukit Jalil, Kuala Lumpur, Malaysia.

¹keerrthanamkumaran@yahoo.com, ²intan.farahana@staffemail.apu.edu.my, ³zety@staffemail.apu.edu.my,
⁴hemalata@staffemail.apu.edu.my

Abstract— The growth of technologies over the years has been tremendous as it is significant to improve and adapt the education system based on the new norm. Besides, EExamination is getting popular among higher-education institutes in new norm. As a result, standard cheating detection approaches will no longer be completely effective in preventing cheating during exams. Therefore, this research proposes a solution to prevent students from cheating in their examination through the help of Artificial Intelligence and Continuous Authentication. To provide scientifically sound results, a sampling size of 200 respondents which consist of Lecturers and Proctors will be taking part in a survey. They will be sorted out by using the stratified sampling method. As a conclusion, this research could convince many higher education institutes to switch their physical examination to E-Examination which also avoid the possibility of spreading the infection of COVID-19.

Index Terms

Continuous Authentication, Cheating, E-Examination, FaceRecognition, Proctor

1. Introduction

Online Examinations or also known as “E-Examinations” are a type of computer-based assessment where it is conducted entirely online [1]. An internet-electronic device, such as PC, Smartphones, or Tablets, is required to start an E-Exam. It is a remote learning approach, allowing students to take their examination anywhere and anyplace they feel comfortable. Since the COVID-19 has created a new norm all over the world, the daily lives of human being had to adapt to it. As a result, education system in higher education institutes had been adapted. For instance, E-Exams are widely used in higher institutes as an alternative of face-to-face examination where it is conducted mostly in the campus. It is because, conducting face-to-face examination could increase the possibility of

students to being affected by COVID-19 infection as the students will be taking their examination in a closed hall/room. On the other hand, E-Examination does not require students to be gathered in a room to take their examinations.

As the usage of E-Exam system is increasing among higher education institutions, the security of the system needs to be advanced. The reason of enhancing the security of the EExamination system is because, higher education institutes does not “trust” E-Examination where the possibility of students to cheating during examination is high. Administrators/Proctor are unable to monitor the students during E-Examination which is a drawback of E-Examination. Thus, all students do not receive a fairness in results. In addition, the enhance security feature will convince more higher education institutions to switch the physical examination to E-Examination.

This research paper will propose the suitable approaches to increase the security of the E-Examination system to prevent students from cheating during examination. The proposed solution helps proctors to detect the students that are cheating by implementing features that includes continuous authentication and etc. Besides, live proctoring will be enhanced in this proposed solution.

This research paper is structured as follow: Literature Review where Domain and Similar System of the E-Examination system, problem statement that explain about the gaps of the previous research paper, Aim, Objectives, Questions, and Significance of this research, Methodology that include the sampling method and data collection method, Proposed system of this research and Conclusion.

2. Literature Review

2.1 Domain Research

Continuous Authentication to Secure E-Examination

Considering authentication is a fundamental aspect of online identity security, validating an examinee before and during the

E-Examination is a crucial component [2]. Authentication can be classified into three categories such as, knowledge-based and possession-based which are known as a traditional way of authentication. The third authentication is category is biometric-based. According to [3], even though knowledgebased authentication is most common method of authenticating people, this category gives only low levels of security. It is because of the strong reliance on knowledge, which is vulnerable to collaboration and impersonation. Based on Hastings and Dodson (2004, as cited in [3]), possession-based authentication is dependent on private items held by the students. For instance, memory cards, keys and adapters. Furthermore, biometric-based authentication identifies the examinee/student based on some characteristics where it can create an secured one-to-one relationship between the examinee/student and set of data [4].

Biometric authentication is carried out in E-Examinations before the student login. Because of this one-time authentication, the system/proctor could not be able to detect any cheating during the E-Exam, [5]. Once the student/examinee starts his/her E-Examination, Continuous Authentication begins where the student will be continually authenticated [6]. Several research has mentioned that Continuous Authentication has various techniques such as fingerprint, eye tracking, voice authentication, face recognition and etc. [7], [8], [6]. The automatic process of validating a human fingerprint is referred to as fingerprint authentication [7]. Besides, a student's eye gazing point when he or she moves his or her glance around is known as eye tracking. Voice recognition is based on student's vocal features.

According to [9], proposed combining facial recognition with keyboard dynamics, however, there has been lack of research on the viability of continuous user verification during EExamination conditions and data fusion for decision making.

Although there have been studies that suggest combining facial and keyboard dynamics for continuous authentication, it has been only a little research on its usefulness in real-world deployment. Therefore, in this research, only face recognition will be used as continuous authentication.

Cheating during E-Examination

Preventing cheating during E-Examination becomes a key issue for proctors, lecturers, and teachers. [10] recommended the use of 8 techniques for proxy monitoring. This technique claims to reduce total expenses by minimizing the time and cost spent by the institution and examinee [10]. In addition, these techniques would prevent the possibilities of students to cheating in EExamination. The techniques are E-Examination are set on a specific time, the E-Examination will be provided with certain duration, randomizing the E-Examination questions for each

student/examinee, the questions to be answered one by one by the students/examinee, the E-Examination system to be open for certain duration of time, examinee to attend the E-Examination on specific time, provide Blackboard's Respondus Lockdown Browser (RLB) for students during the E-Examination, provide multiple set of question in a EExamination. A research study has discussed how university students believe their E-Examinations to be evaluated [11]. The students mentioned their difficulties on the exam questions, timelines.

Based on [12], the communications between professors and students served as a foundation for more research into the individuals' potential to cheat. Watson & Sottile (2010 as cited in [13]) mentioned that students have high possibility to get assist in answering the question during E-Examination compare to face-to-face examination. As a result, maintaining the integrity of E-Examination is quite difficult. In order to increase the integrity of E-Examination, [14] suggested video proctoring in order to identify possible cheating students. Implementing this strategy, it requires to collect images of the students' webcam and needed to be examined and monitored on a frequent basis, similar to standard processes for face-to-face examinations. Another strategy was implemented by [15], which was fingerprint detection for biometric authentication. The researcher explained several problems relating to lack input uniformity, fake inputs, and database modification. Furthermore, technology like identification, keystroke recognition, and camera proctoring have been implemented to secure E-Examination by [16].

In recent years, several strategies for E-Examination have been deployed as discussed above. Several research suggest that as technologies and internet services to reduce cheating, academic dishonesty rises. Several institutions have stated certain websites offer services to help students to prevent them to get caught in E-Examinations, [17]. There are even certain students that utilize tiny earbuds to cheat in E-Examination which is accessible in any e-commerce sites. With a large size of firms producing advanced technologies, a big barrier for institutes to conduct E-Examination.

Based on the explanation above, we can conclude that this study will be implementing the use of technologies such as camera proctoring to reduce the percentage of students to cheat in their E-Examination. Those questions given by the lecturers will be randomize and each examination will have multiple sets of question. These techniques are highly achievable since each student could not discuss their answers with other students and they will be monitoring by the proctor to prevent students to cheat in E-Examination.

Secured E-Examination System for Students

Since the pandemic has create a new norm, education system has to adapt to it. As a result of it, digital education apps are being quickly introduced all around the world, [18]. In addition, the physical examination even has been shifted online (EExamination). According to [19], they mentioned institutes uses Soft Tutor E-Examination system to conduct the EExamination.

The advantage of utilizing E-Examination is it saves time, cost, flexibility and accessibility of lecturers and students. [20, 21], [22] mentioned that it is because students are allowed to use their own device “Bring Your Own Device” (BYOD) during exam. In addition. BYOD techniques allow universities to supply examinee’s devices without paying prohibitively high fees. For instance, the government of Uruguay funded countrywide the “one laptop per child” scheme. The idea was then implemented in Australia (Crook & Sharma, 2013 as cited in [20]). Furthermore, in Lebanese French University, since October 2015, the E-Examination system has been utilized to replace the face-to-face examinations. In addition, almost 180 E-Examinations were completed at the year 2016 to 2017 which involved students in IT Field [23].

However, due to security issues, E-Examination is not generally utilized because the system does not count on examinee’s honesty [24], [18]. Besides, BYOD is controlled and accessed by the student anywhere he/she wants. As a result, preventing cheating in E-Examination is quite difficult [21], [25]. Based on [26], [27] research study, several research gaps have been discussed in order to improve the secure E-Examination system. The gaps are the E-Examination systems were designed with certain security like authentication restricting its completeness when used in a real-world examination setting. Besides, another gap is the E-Examination system have typically concentrated on technological features while ignoring instructional factor as well as teaching and assessment principles.

As a result of the aforementioned challenges, this research presents a general design for creating a secured E-Examination system. The implementation of continuous authentication, live proctoring and face-recognition identification will be implemented in this proposed system. This is to ensure that students could not able to cheat during the E-Examination.

2.2 Similar System

FlexiQuiz

This is a cloud-based application. Its main function is to create E-Exam that allows instructors to easily design, distribute, and evaluate personalized exams. FlexQuiz develop professional tests that involve students and evaluate their learning on certain course with hundreds of adjustable features. This system contains functions such as time limitations for each exam,

provide question banks, randomization of questions, send notifications via email, multiple set of questions and ability to insert photos, audio and video [28]. It is mainly recommended to high level institute lecturers, online tutors, government and so on. This application is supported by Web-Based and Desktop platform. Besides, this application uses SSL encryption which makes the system to be secured [29].

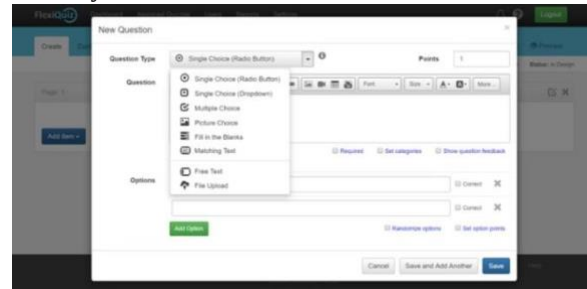


Figure 1 shows the interface of FlexiQuiz [29]

Classtime

Classtime is a versatile E-Examination system that enables institutes and organization to construct examinations with nine distinct question kinds, a vast public library, time limitations, complex scheduling, analysis, quick, data-driven feedback, and anti-cheating capabilities [30]. This application is only webbased. This application has extra features such as attendance management system, blocking websites and application during examination, mobile learning, classroom management, proctoring and etc. In security features, students could not be able to attend the exam as anonymously. This is to prevent students from cheating. Besides, the students have a authentication process before entering the class [31].

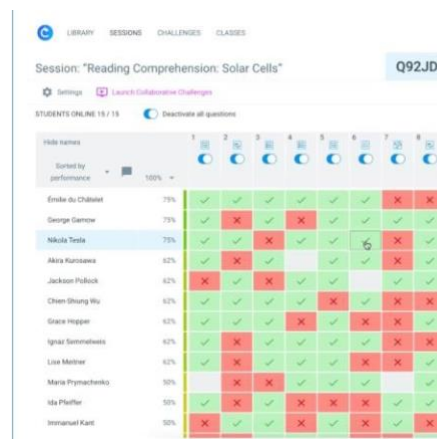


Figure 2 shows the Interface of Classtime [30]

	FlexiQuiz	Classtime
--	-----------	-----------

Features		
Platform	Web-Based, Desktop (Mac/Windows/Linux/Chromebook)	Web-Based
Authentication	✗	✓
Randomization	✓	✓
Time Limit	✓	✓
E-Examinations	✓	✓
Continuous Authentication	✗	✗
Live Proctoring	✗	✓
For Higher Education Institution	Yes	Yes
Free Systems	No	No
Free Version	Yes	Yes

Table 1 shows the comparison of similar system

The Table 1 above shows the comparison of the two similar systems to this research. The main features that need have in this system is E-Examination, Continuous Authentication, Authentication, and Live Proctoring. Besides, each system provides web-based application and both systems are a monthly paid software. However, both systems provide a free version but with less features.

2.3 Conclusion

Based on the both similar systems, the proposed system will be developed with features of E-Examination, Continuous Authentication, Live Proctoring and Time Limit. This is to ensure that the E-Examination system is secured and prevent students to cheat during exams.

3. Problem Statement

In these few years, the development of information technology and communication have advanced rapidly which provide a strong influence on human beings and their daily lives. The sphere of education has a high level of impact of these

technologies. Since the declaration by World Health Organization (WHO) on COVID-19 pandemic [32], almost 100 over nations declared either complete or partial lockdown which affect billions of people [33]. This has causes universities and colleges to switch to online learning mode. Electronic/Online examination were also proposed as a technique of evaluation instead of physical examination which are conducted in campus [34]. According to [35], by conducting online/electronic examination (E-Exam), it gives advantage where it saves money by eliminating the production and delivery of question papers. Besides, another advantage of E- Exam is that institution don't have to provide large number of PC and laboratories for the examinations as students can use their owned devices which is known as "Bring Your Own Device" (BYOD) (Hillier & Fluck, 2015, as cited in [36]).

Based on [37], E-assessments are widely praised for educational improvements in assessment, such as rapid feedback, the ability to provide various set of question papers, and the enhanced ability to utilize auto-scored questions, resulting in greater accuracy and equality by grading.

When it comes for examination, cheating is a source of issue that occur (Cizek, 1999, as cited in [36]). Cheating during examination is truly dishonest act and it is quite tough to mitigate, specifically with online examination carried on student-owned devices (BYOD). Keresztury and Cser (2013, as cited in [7]) mention the various possibilities of reasons that students tend to cheat in their examination such as parental pressure, fear, ambiguous learning goals, desire of scoring higher marks, less chance of getting caught, less time to study and availability of online information. Students are given the accessibility to attend the E-examination any location that is comfortable for them. But even so, since proctors (the person that monitor the students during examination) are not monitoring the exam, the possibilities of students tend to cheat in their examination is high. Besides, E-Exam has other few challenges where someone else takes the examination for the student, using application that provides answers for students and so on [7].

Therefore, one of the procedures to reduce the E-Exam Security is Authentication. In addition, this procedure is critical for verifying the presence of the student because they play a vital role in security (Ullah et al., 2012, as cited in [7]). According to [38], by applying the continuous authentication, the verification of the students can be confirmed. Authentication can be carried out by assist of Artificial Intelligence to implement the face recognition in the E-Examination System [7]. It recognizes the student based on the database of the Institute Management System.

4. Research Aim

Based on the problem statement explained above, the aim of this project is to propose a solution to prevent students from cheating in their examination through the help of Artificial Intelligence and Continuous Authentication (Cyber Security). As the pandemic has created a new norm, e-examination will be introduced in most of the academics in the future. Providing a secured e-examination environment for institutes/schools, would improve the efficiency and effectiveness of EExamination (E-Exam). Besides, this will also increase the consistency and reliability, thus institutes/schools are able to switch to E-Exam.

5. Research Objectives

The Objective of this project are stated below.

- i. To develop a Secured E-Examination Web Application
- ii. To implement Face-Recognition to identify the students
- iii. To implement Continuous Authentication with Face-Recognition where proctor can monitor the students

6. Research Significance

By conducting this research, it would help to convince many institutes to conduct their exams through E-Examination as this research is about developing a secured E-Examination System. As the Covid-19 has created a new norm, E-Examination contributes a lot to the education field. It is because, conducting E-Examination will avoid a huge gathering of students, the accessibility for students, reduce the cost and time and so on. The main challenge of E-Examination is that lecturers/teachers could not be able to find whether the students are referring to other sources during examination. Therefore, to avoid students from cheating in their examination, this research is crucial where a secured system will be developed. This research will gain the trust of institutes, teachers, lecturers, and tutors to conduct E-Examination. Besides, it also reduces the possibility of students to get Covid-19 infections. In addition, all students will be fairly treated as this proposed system will reduce the percentage of students to cheating in their examination. As many institutes conduct this proposed system, there will be a lot of future research conducted by other researchers to enhance the security of the E-Examination system.

7. Methodology

7.1 Sampling method and Respondents

For this research paper, stratified sampling is used for sampling method. It is because using stratified sampling, the sample will be divided into subgroups which have similar characteristics. Besides, this research needs a large number of samplings,

therefore quantitative approach is suitable for this research. For this research study, the target users will be lecturers and students. Therefore, stratified sampling is best suited as it gives wider coverage of the population [39]. By using stratified sampling, it guarantees that each subgroup will be appropriately represented in that sample.

The respondents of this research study are lecturers and administrators. In addition, the data collection method will be carried out with 200 respondents. This is because, the EExamination system will be developed more secured to ensure students to not cheat in their exam. Therefore, lecturers and institutes would replace face-to-face exams to E-Examinations. As the usage of E-Examinations in higher institutes increase, there will be more research study carried out to enhance the security of E-Examination. Through stratified sampling, the sample of lecturers will be divided based on their course and area of study. In addition, the administrator will be divide based on their Course Department.

7.2 Data Collection Method

For this research study, survey will be carried out as data collection method. It is because, conducting survey will be costeffective and remote administration is possible via websites, email, phone and etc. Besides, conducting survey for this research paper because multiple questions regarding the EExamination and its security can be answered, providing significant flexibility in data processing. In addition, using online software to conduct survey could help to analyze the data more advanced techniques such as data visualization to establish validity and reliability.

In developing the questions for the survey, there will be 4 multiple choice questions, 1 rating scale question, 1 matrix question, 1 dropdown questions, 1 open-ended question, and 2 ranking questions. Before sending the survey to the 200 respondents, the survey will be tested to get feedback on those questions. Besides, it will assist in identifying any possible issues with the survey. Once the survey is ready to be distributed, they survey will be send out on optimal time. Therefore, the data analysis would result in more reliable and valid. Based on the data collected, the analysis will be carried out to ensure the feasibility of the proposed system.

8. Overview of the Proposed System

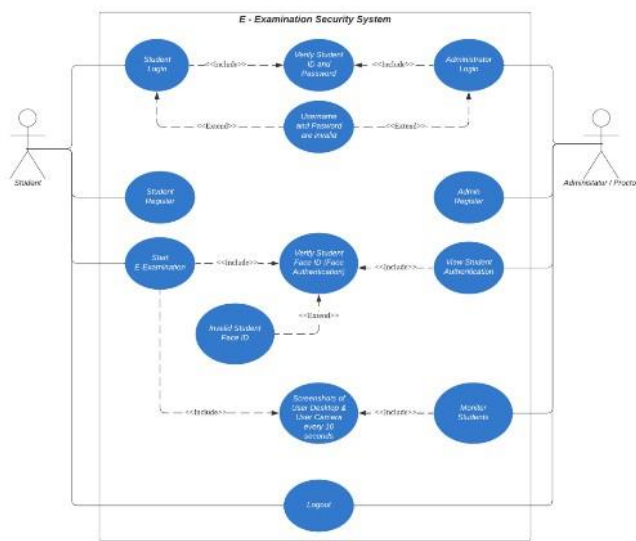


Figure 3 shows the use -case diagram of the E-Examination Security System

Based on the Use Case Diagram shown in Figure 3, The EExamination Security System will be consisting of two types of users such as “Student” and “Administrator/Proctor”. If there is any new user willing to access the system, they will need to register their information for the first time. During the registration process, the system will be requiring the user to turn on their camera and the system will capture their face. It will be stored in the database. The purpose of using requiring the user’s Face ID is to strengthen the security of the E-Examination.

The students who will be attending the E-Examination will need to login to his/her account with their username and password. The database will validate the username and password of the user. Once the validation is successfully completed, the system will be accessible to the user. The main function of this system is performing the E-Examination. Thus, when a student is ready to start his/her E-Examination, the students need to pass through Face Recognition Authentication. The Face ID will be validated by the database of the student. Besides, the Face ID will be stored in database during the registration phase of student. Once the Face ID is validated successfully, the student will be able to access the E-Examination and start answering the questions. Before the E-Examination starts, the Proctor must be logged in to the system to enable the E-Examination to students.

During the E-Examination, the user needs to turn on their camera until they submit their answers. Proctor will ensure that all the students have turned on their camera. In addition, the proctor will be continuously authenticating the students by their Face Detection. The system will be taking the user’s interface screenshot for every 10 seconds to ensure that the student is not

browsing the internet or viewing any notes. Once the student submits their answers, they are able to logout the system.

The proctor/administrator are the users that will be monitoring the students before and during the E-Examination. They are able to view the Student’s Face Authentication before they start their E-Examination. During the E-Examination, the proctor will be monitoring the students through their camera. If there is any unusual scenario detected, the proctor will mark the student. Besides, the proctor will access the student’s system to view the user interface screenshots. If there is any notes or web browser found, the student is considered to be cheating in exam.

9. Conclusion

In a nutshell, this research proposal discusses about EExaminations system for higher-education institutes, its drawbacks which is Cheating, and the solution to prevent it to happen during the examination. To be more precise, this proposal covered the ideas of previous studies and how to enhance it to increase the security of the E-Examination system to prevent cheating. By implementing continuous authentication and online proctoring, it provides a method for identifying and deterring students to cheating during EExamination. In addition, Face Recognition is also implemented to authenticate the student before starting the EExam. The proctors will be monitoring it through the Secured E-Examination System. During the E-Exam, the system will capture the screenshot of the student device and camera which will be stored in the database where proctors will be monitoring it to identify any students are cheating. By implementing these securities, it could convince many higher education institutes to switch their physical examination to E-Examination.

In in the future, there will be research studies conducted to enhance the security of the E-Examination system as the usage of it is increasing because of the new norm. In order to enhance it further, more Artificial Intelligence (AI) can be implemented. Such as, replacing the proctors with AI to monitor students during the exam. In addition, keystrokes authentication could be implemented which will use an algorithm to identify the students those cheats during examination. Furthermore, another features can be implemented is eye and voice tracking system where the AI will monitor the students eye movement and detect if the students are talking to someone else.

References

- [1] Khan, M. A., Vivek, V., Khojah, M., Nabi, M. K., Paul, M., & Minhaj, S. Mohd. (2021). Learners’ Perspective towards E-Exams during COVID-19 Outbreak: Evidence from Higher Educational Institutions of India and Saudi Arabia. *International Journal of Environmental Research and Public Health*, 18(12), 6534. <https://doi.org/10.3390/ijerph18126534>
- [2] Ryu, R., Yeom, S., & Kim, S.-H. (2020). Continuous multibiometric authentication for online exam with machine learning. *Australasian Conference on Information Systems 2020, Wellington*, 1–7.

- <https://eprints.utas.edu.au/36155/1/143519%20-%20Continuous%20multibiometric%20authentication%20for%20online%20exam%20with%20machine%20learning.pdf>
- [3] Okada, A., Whitelock, D., Holmes, W., & Edwards, C. (2018). eAuthentication for online assessment: A mixed-method study. *British Journal of Educational Technology*, 50(2), 861–875. <https://doi.org/10.1111/bjet.12608>
 - [4] Bhattacharyya, D., Ranjan, R., Farkhod, A., & Choi, M. (2009). Biometric Authentication: A Review. *International Journal of Uand E-Service*, 2(3), 13–28. <https://www.biometrie-online.net/images/stories/dossiers/generalites/International-Journal-of-u-and-e-Service-Science-and-Technology.pdf>
 - [5] Ghizlane, M., Hicham, B., & Reda, F. H. (2019). A New Model of Automatic and Continuous Online Exam Monitoring. 2019 *International Conference on Systems of Collaboration Big Data, Internet of Things & Security (SysCoBloTS)*, 1–5. <https://doi.org/10.1109/syscobiots48768.2019.9028027>
 - [6] Annamalai, P., Raju, K., & Ranganayakulu, D. (2018). Soft Biometrics Traits for Continuous Authentication in Online Exam Using ICA Based Facial Recognition. *International Journal of Network Security*, 20(3), 423–432. [https://doi.org/10.6633/IJNS.201805.20\(3\).03](https://doi.org/10.6633/IJNS.201805.20(3).03)
 - [7] Bawarith, R., Basuhail, Dr. A., Fattouh, Dr. A., & Gamalel-Din, Prof. Dr. S. (2017). E-exam Cheating Detection System. *International Journal of Advanced Computer Science and Applications*, 8(4), 176–181. <https://doi.org/10.14569/ijacsa.2017.080425>
 - [8] Feng, H., Fawaz, K., & Shin, K. G. (2017). Continuous Authentication for Voice Assistants. *Proceedings of the 23rd Annual International Conference on Mobile Computing and Networking - MobiCom '17*, 343–355. <https://doi.org/10.1145/3117811.3117823>
 - [9] Gupta, A., Khanna, A., Jagetia, A., Sharma, D., Alekh, S., & Choudhary, V. (2015). Combining Keystroke Dynamics and Face Recognition for User Verification. *IEEE Xplore*, 294–299. <https://doi.org/10.1109/CSE.2015.37>
 - [10] Cluskey Jr., G. R., Ehlen, C. R., & Raiborn, M. H. (n.d.). Thwarting online exam cheating without proctor supervision. *Journal of Academic and Business Ethics*, 1–7. Retrieved April 28, 2022, from <https://gato-docs.its.txstate.edu/jcr:ef57dbda-35ac-45c7-86d4-4a41a3580c58/Integrity%20of%20Online%20exams.pdf>
 - [11] Umar, M. A., & Wilson, F. (2019). Perception of Electronic Examination among Undergraduate Students of University of Maiduguri. *International Journal of Humanities and Education Development (IJHED)*, 1(5), 211–221. <https://theshillonga.com/index.php/ijhed/article/view/47/27>
 - [12] Kalhori, Z. (2014). The Relationship between Teacher-student Rapport and Student's Willingness to Cheat. *Procedia - Social and Behavioral Sciences*, 136, 153–158. <https://doi.org/10.1016/j.sbspro.2014.05.306>
 - [13] Noorbehhahani, F., Mohammadi, A., & Aminazadeh, M. (2022). A systematic review of research on cheating in online exams from 2010 to 2021. *Education and Information Technologies*, 1–48. <https://doi.org/10.1007/s10639-022-10927-7>
 - [14] Hylton, K., Levy, Y., & Dringus, L. P. (2016). Utilizing webcambased proctoring to deter misconduct in online exams. *Computers & Education*, 92–93, 53–63. <https://doi.org/10.1016/j.compedu.2015.10.002>
 - [15] Alotaibi, S. J. (2010). Using Biometrics Authentication via Fingerprint Recognition in E-exams in E-Learning Environment. *The 4th Saudi International Conference, the University of Manchester*. https://eprints.soton.ac.uk/271453/1/USING_BIOMETRICS_AUTHENTICATION_VIA_FINGERPRINT_RECOGNITION_IN_E-EXAMS_IN_E-LEARNING_ENVIRONMENT.pdf
 - [16] Xiong, Y., & Suen, H. K. (2018). Assessment approaches in massive open online courses: Possibilities, challenges and future directions. *International Review of Education*, 64(2), 241–263. <https://doi.org/10.1007/s11159-018-9710-5>
 - [17] Kanchan, R. (2021, November 26). *How to Prevent Cheating in Online Exams with 7 Proctoring Technologies*. Mettl; Examination and Proctoring. <https://blog.mettl.com/prevent-cheating-in-onlineexams/>
 - [18] Ocak, G., & Karakus, G. (2021). Undergraduate students' views of and difficulties in online exams during the COVID-19 pandemic. *Themes in ELearning*, 14(14), 13–30. <http://earthlab.uoi.gr/tel/index.php/themeselearn/article/view/31/16>
 - [19] Rytönen, A., & Myrsky, L. (2014). Student experiences on taking electronic exams at the University of Helsinki. *Conference: World Conference on Educational Multimedia, Hypermedia and Telecommunications*. https://www.researchgate.net/publication/285576390_Student_experiences_on_taking_electronic_exams_at_the_University_of_Helsinki
 - [20] Fluck, A., & Hillier, M. (2018). eExams: Strength in Diversity. *Tomorrow's Learning: Involving Everyone. Learning with and about Technologies and Computing*, 409–417. https://doi.org/10.1007/978-3-319-74310-3_42
 - [21] Fluck, A., Adebayo, O. S., & Abdulhamid, S. M. (2017). SECURE E-EXAMINATION SYSTEMS COMPARED: CASE STUDIES FROM TWO COUNTRIES. *Journal of Information Technology Education: Innovations in Practice*, 16, 107–125. <http://repository.futminna.edu.ng:8080/jspui/bitstream/123456789/8804/1/25.pdf>
 - [22] Fitzharris, R., & Kent, S. (2020). Adoption of Bring-Your-Own-Device Examinations and Data Analytics. *Adoption of Data Analytics in Higher Education Learning and Teaching*, 327–348. https://doi.org/10.1007/978-3-030-47392-1_17
 - [23] Al-Hakeem, M. S., & Abdulrahman, M. S. (2017). Developing a New e-Exam Platform to Enhance the University Academic Examinations: the Case of Lebanese French University. *International Journal of Modern Education and Computer Science*, 9(5), 9–16. <https://doi.org/10.5815/ijmecs.2017.05.02>
 - [24] Sarayrih, M. A., & Ilyas, M. (2013). Challenges of Online Exam, Performances and problems for Online University Exam. *IJCSE International Journal of Computer Science Issues*, 10(1), 439–443. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.698.304&rep=rep1&type=pdf>
 - [25] Dawson, P. (2015). Five ways to hack and cheat with bring-your-own-device electronic examinations. *British Journal of Educational Technology*, 47(4), 592–600. <https://doi.org/10.1111/bjet.12246>
 - [26] Kuikka, M., Kitola, M., & Laakso, M.-J. (2014). Challenges when introducing electronic exam. *Research in Learning Technology*, 22, 1–17. <https://doi.org/10.3402/rlt.v22.22817>
 - [27] Fluck, A. E. (2019). An international review of eExam technologies and impact. *Computers & Education*, 132, 1–15. <https://doi.org/10.1016/j.compedu.2018.12.008>
 - [28] nextSpark. (2022). *FlexiQuiz Pricing, Alternatives & More 2022 - Capterra*. [www.capterra.com; nextSpark. https://www.capterra.com/p/184132/FlexiQuiz/](https://www.capterra.com/p/184132/FlexiQuiz/)
 - [29] FlexiQuiz. (2022). *Free Test Generator - easily create an online quiz*. [www.flexiquiz.com. https://www.flexiquiz.com/](https://www.flexiquiz.com/)
 - [30] CAPTERRA. (2022). *Classtime Pricing, Alternatives & More 2022 - Capterra*. [www.capterra.com. https://www.capterra.com/p/183552/Classtime/#features](https://www.capterra.com/p/183552/Classtime/#features)
 - [31] Classtime Blog. (2020, August 10). *Help Prevent Student Cheating in Online Assessments*. Classtime. <https://www.classtime.com/blog/help-prevent-student-cheating-in-online-assessments/>
 - [32] World Health Organization. (2020, April 27). *Archived: WHO Timeline - COVID-19*. World Health Organization; World Health

- Organization. <https://www.who.int/news/item/27-04-2020-whotimeline---covid-19>
- [33] Dunford, D., Dale, B., Stylianou, N., Lowther, E., Ahmed, M., & de la Torre Arenas, I. (2020, April 6). Coronavirus: A visual guide to the world in lockdown. *BBC News*.
<https://www.bbc.com/news/world-52103747>
- [34] Elsalem, L., Al-Azzam, N., Jum'ah, A. A., Obeidat, N., Sindiani, A. M., & Kheirallah, K. A. (2020). Stress and behavioral changes with remote E-exams during the Covid-19 pandemic: A cross-sectional study among undergraduates of medical sciences. *Annals of Medicine and Surgery*, 60, 271–279.
<https://doi.org/10.1016/j.amsu.2020.10.058>
- [35] James, R. (2016). Tertiary student attitudes to invigilated, online summative examinations. *International Journal of Educational Technology in Higher Education*, 13(1), 1–13.
<https://doi.org/10.1186/s41239-016-0015-0>
- [36] Chirumamilla, A. (2021). Analysis of security threats, requirements, and technologies in e-exam systems. Norway. *Norwegian University of Science and Technology*.
<https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2778909>
- [37] Appiah, Dr. M., & Tonder, Dr. F. van. (2018). E-Assessment in Higher Education: A Review. *International Journal of Business Management and Economic Research(IJBMER)*, Vol 9(6), 1454–1460. https://www.researchgate.net/profile/Martin-Appiah/publication/329775612_E-Assessment_in_Higher_Education_A_Review/links/5c1a2f61458515a4c7e90a08/E-Assessment-in-Higher-Education-A-Review.pdf
- [38] Al-Shalout, M. I., Rasmi, M., & Hassan, M. A. (2021). Evaluation of E-exam during Covid-19. *PSYCHOLOGY and EDUCATION*, 58(1), 4604–4612.
<https://pdfs.semanticscholar.org/b83e/4344c84b97757a44c1c53e18d674325dac5d.pdf>
- [39] Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *SSRN Electronic Journal*, 5(2), 18–27.
https://www.researchgate.net/publication/319998246_Sampling_Methods_in_Research_Methodology_How_to_Choose_a_Sampling_Technique_for_Research
- [40] Grewenig, E., Lergetporer, P., Werner, K., Woessmann, L., & Zierow, L. (2021). COVID-19 and Educational Inequality: How School Closures Affect Low- and High-Achieving Students. *European Economic Review*, 140, 103920.
<https://doi.org/10.1016/j.euroecorev.2021.103920>
- [41] Khelifi, Y. (2020). An Advanced Authentication Scheme for Eevaluation Using Students Behaviors Over E-learning Platform. *International Journal of Emerging Technologies in Learning (IJET)*, 15(04), 90–111. <https://doi.org/10.3991/ijet.v15i04.11571>