

Reliable and secure online exams during the COVID-19 pandemic

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Abstract

The paper aims to present the authors' experience in choosing software tools and suitable methods for reliable and secure online exams in organizing and conducting entrance, final and state exams at the Trakia University - Stara Zagora during the COVID-19 pandemic. To achieve this goal, literature sources related to the topic are analyzed, the prerequisites are presented and the conditions in Trakia University for conducting online exams are clarified. A comparison of existing secure browsers is made, from which Safe Exam Browser and LockDown Browser are selected and used. Emphasis is placed on the planning, organization and conduct of online exams and how reliability and security are achieved. There is a separate place for the problems that have arisen and the possible solutions for overcoming them.

Keywords: online exams, Safe Exam Browsers, LockDown Browser, student assessment,

1 Introduction

The spread of the new coronavirus COVID-19 has led to profound changes in social interaction and the organization of the education sector. In just a few days, universities switched to e-learning. This required a rapid adaptation of lecturers and students. One of the main problems of online learning was conducting exams. It had to ensure the reliability, security and fairness of the assessments. Many lecturers and students thought that distance exams were not suitable for higher education. The coronavirus pandemic became a major factor that helped “everyone to better understand that all the attributes of higher education such as online defenses, online entrance and final exams, as well as online academic jobs are as good as those conducted “in real life”. (Strielkowski, 2020) Immediately after arising of the emergency, the management of the Trakia University - Stara Zagora decided to conduct all exams (entrance, final and state) online. The examination process for each of the listed types of exams includes - organization of exams, preparation of exam materials, conducting exams and assessment. This paper focuses on conducting entrance online exams and, in particular, the measures taken to make them reliable and secure.

2 Related work

COVID-19 pandemic and the rapid development of the Internet and information technologies are making the questions, related to the online exams an important problem for a growing number

of researchers. Most often, researches relate to methods for detecting cheating during the exam and identifying students. „Academic dishonesty is nothing new, but an online testing environment requires different strategies and tactics from what we have had to consider in the past“ (Michael and Williams, 2013). According to (Grünigen et al, 2018) “One of the most important aspects is to prevent access of students to unallowed external help (humans) or resources (teaching material, internet) during the exam (cheating prevention)” “since access to the Internet allows for new ways of dishonest behavior in comparison to pen-and-paper exams. Preventing cheating requires extensive technical and organizational measures”. A basic measure of protection is indicated “combining a lock-down browser with recordings by physical cameras. The lock-down browser drastically raises the amount of effort a student must exert in order to cheat, while the cameras are a strong threat that cheating might even be detected after the exam.” In (Grajek, 2020) four most commonly used ways of proctoring are listed: “Passive monitoring of software on students' computers (by tracking application[s] students are running on their computers and whether they switch to another application while taking an exam); Active restriction of software on students' computers (by using a "lockdown browser" application that blocks access to other applications during exams or course activities); Passive video surveillance of students (by using software that accesses a student's webcam to directly monitor them) and Active video surveillance of students (by using a method similar to passive video surveillance software but adding real-time monitoring by live proctors)”; Results of a survey among institutions from the US, Australia, Canada and others show that “Active restriction of software and passive video surveillance is the most widespread. Most institutions that adopt online proctoring use more than one type.” Most institutions use Respondus Monitor products and / or the LockDown browser. ProctorU is the next preferred online tracking tool. Some institutions use Zoom to actively conduct video exams.

Some studies examine the attitude of both parties (evaluated and evaluators) to electronic evaluation. In (Kocdar et al, 2018) a study is presented that aims “to identify students' perceptions on cheating and plagiarism and trust in e-assessment according to their assessment experience and mode of learning as well as exploring their concerns in e-assessment”. It is concluded that although “most of the students are willing to accept e-assessment practices, some have concerns about cheating and plagiarism and a low degree of trust in e-assessment, which should not be ignored”. (Mellar et al, 2018) examines the “higher education teachers' perceptions of the prevalence and types of cheating in their courses with a focus on the possible changes that might come about as a result of increased use of e-assessment, ways of addressing cheating, and how the use of student authentication and authorship checking systems might impact on assessment practice”. Most lecturers expected cheating to become a greater problem with the increased use of e-assessment. Student authentication was not seen as a major problem. The paper aims to present the authors' experience in choosing software tools and suitable methods for reliable and secure online exams in organizing and conducting entrance, final, and state exams at the Trakia University - Stara Zagora during the COVID-19 pandemic.

3 Prerequisites for secure and successful conduction of online exams

To be held successfully online exams some several prerequisites and conditions must be met in advance. First of all, must be selected a software application or online exam platform that must meet certain requirements. They relate to both the security and the reliability of the tools and technologies used. At Trakia University (TrU) we accent the following basic requirements for online exam platform: To allow administration and service of a sufficiently large number of students simultaneously; to be web-based, work in cloud to allow conducting exams remotely for students who do not have the opportunity to participate in person or do not participate in person due to various circumstances (for example COVID-19); The user should not install additional applications besides the secure browser; To allow personalization of the choice for conducting the

exam; To work in different languages, for which is expected to be needed, but obligatorily in Bulgarian and English; To allow constant updating by the server part; Easy to be configured and integrated with other applications as needed; To maintain a high level of security of the environment by allowing a level of security depending on the functions of the staff - only authorized staff to have access to the tests before, during and after the exam, incl. and for the results; To allow tracking and reporting of all attempts to access the e-learning environment.

Conducting online exams implies that a platform or environment for e-learning and distance learning has already been created. It maintains materials and resources for the courses. To conduct online exams, we must have a rich library of questions based on the theoretical knowledge or skills that students need to demonstrate. The paper does not discuss the topic of creating test questions, their types, etc., but considers them only as a prerequisite for online exams. Part of the requirements for the libraries with questions and the functionalities of the virtual learning environment (VLE) are as follows: The questions should be distributed thematically with the possibility to choose a certain number at random from each topic for the individual courses; They should be well thought out, formulated in an understandable way, with different levels of complexity and weight of the assessment; In case of more than one correct answer, points should be formulated for each correct answer to the question; To allow the possibility of fixing the time for performing the test; To allow the possibility of penalty points for incorrect answers; To allow the possibility to change the operating modes - adaptive with review of errors in self-preparation; or a test mode in which only the final result of solving the test is shown; To offer additional help and instructions through the menus that could be useful before the start of the test. It is especially important in online tests to predict all possible situations to prevent cheating during the exam.

The second prerequisite for secure and successful conduction of online exams is the provision of a secure browser. The secure browser ensures: Prevention of Question Copying; Prevention of screen sharing programs; Prevention from opening any other window of applications; Live Streaming of remote candidate; Unable to use shortcuts or function keys to access some applications; Student couldn't quit browser during online test; The time for the exam is limited. "SEB quits (and/or unlock the device) automatically after the exam was submitted." (ETH Zurich, 2020)

4 Conditions for the realization of the online exams in TrU

The conditions offered by TrU for the realization of the online exams comply with the above-mentioned prerequisites. Trakia University has a VLE, which is called Trakia Electronic University (TrEU), available at <http://edu.uni-sz.bg>. The electronic platform of the Trakia University is based on Moodle 3.6.5. It offers functionalities and features that are required for online exams, namely: it is user-friendly; It is familiar to students from previous exams or pre-test using; has a responsive design - can be applied to various devices - desktop, laptops, tablets, mobile devices; Offers 16 types of questions (multiple-choice, calculation, true/false, embedded answers, drag and drop into text, essay, matching, etc.), incl. use of mathematical formulas and graphical objects in the questions, as well as the addition of new third-party question types; offers quiz analysis, feedback analysis, question analysis, log analysis, etc.

Electronic courses have been created in the platform of TrU, which contain multimedia teaching materials (multimedia textbooks, presentations, lectures in various formats, video lectures, audio recordings, etc.), assignments for students with opportunities for collective work and tests for the courses in which online exams are taken. There are modern technological tools introduced through Moodle plugins such as Virtual Programming Laboratory, a flowchart of programming algorithms, plugins for games and gamification, visualizations of program code created with www.pythontutor.com modern forms of training with simulations in engineering and some natural sciences and others.

The second basic requirement for conducting secure and reliable exams is the use of secure browsers. TrU uses two browsers: Safe Exam Browser 2.4.6 (SEB) and LockDown Browser (LDB) with Respondus Monitor (RM). The first browser is free, and the second has a paid one-year TrU license. They allow easy and quick incorporation into TrEU. When conducting online exams, both browsers are applied depending on the nature of the exam: whether it has to be conducted with quaestors or with auto-proctoring. SEB and LDB require the installation of a secure browser on the user's device. They run on Windows and Mac (LDB also works on iOS for iPad). Both browsers are integrated into the learning management systems of TrU.

The features of the browsers are the following:

SEB: "SEB consists of three components: a kiosk-application, a portable firefox with the seb-plugin and extensions to divers learning-management-system" (ETH Zurich, 2020); Requires test setup by entering code generated by SEB; A key-file can be generated and sent to the user to run the test – it can be encrypted; It does not allow active processes for video sharing and remote intervention on the client computer; Allows to add other restrictions using a configuration tool. Another form of protection is to implement a checksum in the key-file which would be changed if the file was manipulated by the user in an attempt to overcome some of the imposed restrictions. If the checksum is not correct the SEB browser wouldn't start.

LDB: Automatically triggers stop of the process for applications that allow screen sharing or messaging - Skype, Viber, Facebook, etc. Add-on application Respondus Monitor (RM) provides live automated proctoring and video archiving; Possibility to observe and conduct the exam without the presence of a quaestor; Requires the student to record a video of the environment in which the exam is conducted; Verifies students' Identification; Keeps a video of the exam; Allows based on the recorded video to make an assessment and analysis of the problems encountered during the exam.

Online exams save money and time for students and lecturers, do not require the use of paper, create greater security. As a disadvantage can be reported that an online exam system is a little bit more susceptible to fraud.

When using both browsers, additional protection from simultaneous sessions to the e-university server was used via a Moodle module called Onessionion.

For observation, during the exams, web conferencing with students is used via Google Meet. It is mainly used for online exams due to the following advantages: Unlimited hardware resources in terms of CPU load, session recording functionality. Google Meet supports access to a variety of hardware and software configurations used by prospective students; It does not interfere with the work of SEB and allows video surveillance of participants. LockDown Browser requires Google Meet to be stopped, but Respondus Monitor supports video recording of the exam.

5 Organizing and conducting online exams

The overall organization and conduct of entrance examinations include submission of documents, development of examination materials, preliminary work with the applicants (acquaintance with the rules for conducting the examination, the type of questions and the grading system) and conducting the examination. Only issues related to ensuring the security and reliability of online exams are discussed here.

Before the beginning of the entrance exams, the following main activities are performed in TrU: Training and instructing of the quaestors - lecturers and employees; Development of detailed written and video instructions for applicants and quaestors; Creating virtual rooms in Google Meet; Creating e-mails for each applicant and quaestor with domain trakia-uni.bg; Registration of the applicants in TrEU with a username and password; Sending names and passwords to the already created e-mails; Conducting preliminary online meetings of the quaestors with the

applicants, divided into groups at different hours on the day before the exam; Execution of a trial test in the presence and after instructions from the quaestor. The first version of online entrance exams conducted at TrU was using Safe Exam Browser and video surveillance via Google Meet. The groups were small, 5-6 people with one quaestor for each group. The following steps were performed sequentially during the exam: Informed consent of the persons that a video is being recorded; Starting a video recording of the exam; Identification of the person by a copy of his / her identity card, which was sent by him / her and shared with the quaestor; Inspection by the quaestor of each computer of the participants in the exam for shared monitors and unauthorized software - all installed programs on the computer are inspected by name, regardless of the OS - Windows or Mac; Video inspection of the environment / space around the desk and in the room - there should be no other persons and unauthorized materials that may tempt the applicant for cheating; Instructing the applicants on the manner of conducting the test, on the permitted and impermissible actions; Selection of the variant of the test by a random applicant in a randomly selected virtual room - online with video surveillance of the selection of the variant by several or all groups of applicants; Sending by e-mail a key for the test to the applicants - separately for each exam because many exams are held at the same time; Sending the test password by e-mail to the quaestors; Beginning of the exam; Video surveillance of the prospective students with camera and microphone on; Instructions if the camera stops. The exam does not count if the camera is turned off. A backup option is for the person to join the virtual room via a mobile device; At the end of the exam, the candidate turns off the secure browser and this returns it to the place from where it was started, ie. his e-mail; When all the applicants are finished, the video is stopped. It is available for viewing if necessary. More than 3000 entrance exams were held at TrU with over 2100 candidates for the academic year 2020-2021. For all the applicants who study in Bulgarian, they were conducted in the described way. Some of the lecturers used SEB to conduct their mid-term and final exams also.

The second option for conducting exams is with the application of LockDown Browser. Thus, the final exams at the Faculty Technics and Technologies-Yambol were held, as well as some of the exams at other faculties. LockDown Browser with Respondus Monitor was applied during the entrance exams with the students who will study in English. In this case, the day before the exam, the applicants are instructed and they take a trial test using LockDown Browser with Respondus Monitor to install the software and get acquainted with the VLE of TrU. During the entrance exams and final exams, the conservators and technical specialists remain online for support and consultation in case of problems. „Respondus Monitor® builds upon the power of the LockDown Browser, using a student’s webcam and industry-leading video analytics to prevent cheating during non-proctored exams.“ (Respondus, Inc. 2020) Respondus Monitor offers a fully automated proctoring solution that enables students to take online exams. It is integrated into Moodle, the platform on which TrEU is based. „At the heart of Respondus Monitor is a powerful artificial intelligence engine (AI), Monitor AI TM that performs a second-by-second analysis of the exam session. The first layer of Monitor AI includes advanced algorithms for facial detection, motion, and lighting to analyze the student and examination environment. The next layer uses data from the computing device (keyboard activity, mouse movements, hardware changes, etc.) to identify patterns and anomalies associated with cheating.“ (Respondus, Inc. 2020) The third option for conducting exams at TrU was in a virtual room of Google Meet scheduled through Google Calendar, through which all participants are invited. Thus, some final exams, State exams for students from certain programs of Faculty of Technics and Technologies and thesis defenses were held. The State Examination Commissions are also included in the invitations for the virtual meetings for these examinations.

6 Identified problems from the exams and ways to overcome them

During the exams, some difficulties arose due to technical problems and insufficient technical literacy of the applicants. The technical difficulties are caused mainly by computer hardware problems or power outages. In case of disconnection of the Internet connection on the computer, if the applicant fails to turn on the web conferencing software via mobile device in time, then for objective reasons for these applicants the examination session is considered unsuccessful. Another common problem is the use of a camera with low resolution and low lighting, which does not allow the quaestor to assess whether there is an attempt for cheating. Difficulties also arose from insufficient technical literacy of the applicants and insufficient preparation for the day of the exam. Many of the applicants had not been acquainted with the training materials for passing the exam. Some of them did not understand basic things like the terms "Static IP" and constant uninterrupted "Internet connectivity". Subsequently, the ability to check the IP and whether it changes over time was added, which was useful for those who were not sure if they met this condition.

Conclusions

A very good preliminary preparation and organization was created for conducting the online exams during COVID-19 at TrU. Therefore, the level of security and reliability was high enough because of the level of technical literacy of the applicants. The possibility of using another person to solve the test was prevented by adding a password to access the test, which is told to the applicants through an audio channel immediately before the start of the exam and only if they are present in the video chat connection. The possibility of using unauthorized materials was prevented by using security browsers. To achieve an even higher level of reliability and security, the following recommendations can be made:

- ✓ To be imposed stricter requirements regarding the quality of webcams and the lighting of the premises, which due to the extreme conditions could not be met;
- ✓ To be added a step before the exam in which the candidate visits a web page to be recorded his IP and to be prevented the possibility of another person to take the test while the candidate is present only in the video chat;
- ✓ It would be good if each applicant was present with more than one camera in the chat - one that captures him and a second that captures the environment around him.
- ✓ To be conducted more training for quaestructors to be prepared for any challenges;
- ✓ To be done a separate video of each applicant instead of a total video for 5 applicants or to be used LockDown Browser with Respondus Monitor, which records each applicant individually.

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