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Online assessment solution without in-person proctoring

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Abstract

Online assessment became an important part of the assessment of students after March 2020 in the COVID-Time. Traditional face-to-face evaluations were no more possible, therefore the use of solutions like Google Suite Educational became mandatory. In this paper we explore the strengths and weaknesses of some applications for student evaluation. Also, we will present a Web-based evaluation software that we have developed and which allows to schedule questions at random with a given time for students to answer the question and without the possibility to come back to a previous question.

Keywords: online evaluation, avoid cheating, answering restrictions

1. Introduction. Problem description

After March 2020 teachers and students from the "Lucian Blaga" University of Sibiu (LBUS) had to face new challenges regarding the on-line teaching and on-line evaluation. Even though on-line teaching resources like the e-learning platform from our university or the Google-Classroom Suite were available before the pandemic outbreak, these options weren't often used for disseminating course information and almost never for testing. The teaching activities and the testing were presence-based with all the good and the bad.

The new pandemic situation forced the teacher to change their teaching and evaluation styles to use the online medium. Obviously, this came with pros and cons. The pros came with the integration of more diverse multimedia content and sources, the breakout rooms give the opportunity to use student-centered teaching. The cons are mainly about testing and especially the evaluation of students.

2. Theoretical aspects

Being forced by the pandemic outbreak to switch to on-line teaching (here we were reasonably prepared to) but also to on-line evaluation we first made a research of scientific literature and Web about solutions regarding on-line testing, in order to validate our ideas and to find an optimum solution.

In [1] the authors propose 8 Online Exam Control Procedures (OECP) as following:

"**I. Limiting exam time**

OECP-1. An exam should be scheduled for a specific date and time.

OECP-5. The exam should close when the allotted time period for work expires.

II. Limiting student access

OECP-2. An exam should be open to Internet access for only a 15 minute time period.

OECP-4. Students can work only one question at a time and cannot access completed questions.

OECP-6. Students can access the online exam only one time.

OECP-7. Online exam access should use Repondus Lockdown Browser or its equivalent.

III. Changing test characteristics

OECP-3. An exam should randomize (scramble) question sequence and answer choices.

OECP-8. About one-third of objective type questions should be rotated/modified on each exam every term."

The OECP are further detailed in the very popular resource from the George Washington University [2].

According to [3] the solutions for proctoring online examinations are:

1. **Proctoring in-person.** Students take the test in a classroom or at a testing center under supervision of human proctors;
2. **Real-Time/Live Remote Proctoring**. The exam is taken anywhere the student chooses by using a remote human proctor;
3. **Record and Review Proctoring**. A human proctor reviews the recorded exam;
4. **Automated proctoring**. Use a specialized software based on machine learning and advanced artificial intelligence techniques. The use of automatic proctoring raises ethic and legal issues, as described in [4].

3. State-of-the-art solutions

The Google Workspace for Education [5] is used by our university as the main online platform since 2016. The functionality for grading and testing is adapted for most of the teacher's needs. The most used online testing method is applying tests with the Google-Forms application, where tests and quizzes are relatively easy to create and to manage. One quiz can contain single and multiple-choice questions, short answers or paragraphs areas for longer answers, checkboxes and dropdown-lists. Also, the respondents can upload files which are stored in a folder attached to the teachers google-drive account. These files might have a required filetype and size. The quiz can be organized into sections.

The main weakness is the poor control of the test. Even though the questions can be arranged randomly into the test there is no easy way to control the student's actions like after answering a question to block the given answer. Otherwise, the students will try to collaborate mostly using the social-media applications to send the correct answers to the questions in the quiz. Also, the timing of such a quiz is crucial. If there is enough time the students will try to find the right answers on the web or other resources. To counteract these problems, Google Workspace Marketplace contains Add-ons designed to improve the efficiency of the tests. But these Add-ons are generally created by third-party developers and involve installation actions and costs.

A solution that we have also tested is *exam.net* [6]. Even if the solution was designed mainly to be used in classroom to eliminate the paper, it is a good solution also for online testing. It allows the teacher to prepare the test from 6 different types of questions. The application allows the students to use some tools like a synonyms dictionary, a drawing tool, a calculator, a mathematics tool with graph-drawing capabilities and with algebra capabilities and also a chat to discuss with the professor.

The main advantage of this platform is that the student that is evaluated can't get out from the questionnaire without the professor to be announced. If the student gets out, the paper is blocked, and he can reenter only with professor's permission. This facility is offered on Chromebook-app and into a lot of browsers on Mac or Windows. In order to take a specific exam, the students need to use a unique identifier and an exam code (both offered by the professor). We have used the application for some exams, but unfortunately only in periods when it was available for free/testing.

A complete solution for online assessment is the one provided by *Respondus® (Assesment Tools for Learning Systems)* [7]. It consists of 5 different modules: *LockDown Browser®* ("Prevent cheating during online exams"), *Respondus Monitor®* ("Fully-automated proctoring for online exams"), *StudyMate® Campus* ("The smarter way to make flash cards and learning games"), *Respondus 4.0®* ("Easily create and manage online assessments") and *Respondus Test Bank Network®* ("Thousands of ready-to-use publisher test banks"). The first 2 modules are of maximum interest for us, therefore we present their short description, as given by their authors.

LockDown Browser [8]: "Assessments are displayed full-screen and cannot be minimized; Browser menu and toolbar options are removed, except for

Back, Forward, Refresh and Stop; Prevents access to other applications including messaging, screen-sharing, virtual machines, and remote desktops; Printing and screen capture functions are disabled; Copying and pasting anything to or from an assessment is prevented; Right-click menu options, function keys, keyboard shortcuts and task switching are disabled; An assessment cannot be exited until the student submits it for grading; Assessments that are set up for use with LockDown Browser cannot be accessed with other browsers."

Respondus Monitor [9] is "a fully-automated proctoring solution. Students use a webcam to record themselves during an online exam. Afterward, flagged events and proctoring results are available to the instructor for further review". "After a quick one-time installation, Respondus Monitor launches from the student's preferred browser (Chrome, Firefox, Safari, Edge) whenever the exam settings require it". "Respondus Monitor isn't just a browser plugin. It offers a native, feature-rich experience for Windows, Mac, Chromebook and iPad devices."

Unfortunately, none of the many free solutions tested provides the features that we consider strictly required (timeout for each question and restrict returning to previous questions) and the decision to purchase assessment solutions must be taken at the university level (decision not taken yet, at least for the time being), so we have decided to develop our own solution.

4. The proposed approach

Because of the drawbacks of the previous solutions we chose to develop our own web-based testing application that has to fulfill the following requirements:

- individual **timeout** for **each question**;
- **restrict navigation** through questions;
- **reduced load on server**, in order to accept all (about 200) students simultaneously (to reduce the risk to be helped/replaced by a colleague);
- **update in real-time** each answer on the server;
- accept (for now) both **single-choice** questions and **open** questions;
- **no restrictions in evaluating** answers;

The flowchart of the assessment process from a student point of view is presented in Figure 1. A short description of the steps is:

1. **Login with ID**. The students login to the application based only on an ID obtained previously by email (specific for a student and an exam).
2. **Validate ID and wait to start.** The software verifies if the ID exists in the database and verifies if, for that ID, an opened question is available. If the ID is incorrect it displays a message and leaves the application. If none of the questions is opened it retests this periodically after 10

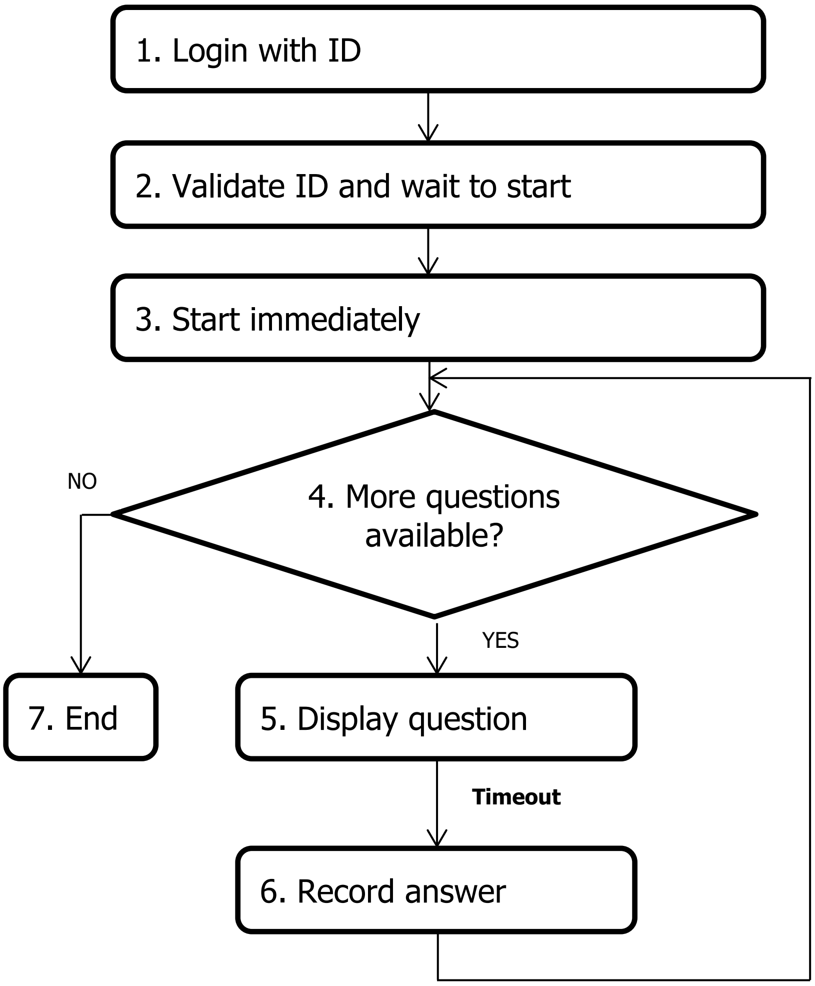

Figure 1 The flowchart of the assessment process

seconds… (this exit path and the loop are not presented in the flowchart).

3. Start immediately. Display such a message and a countdown timer starting from a random value between 20 and 30 seconds. This random delay is done for two reasons: to allow the students to be fully prepared for the first question and to delay the start of the questions in order to spread the load of the server.

4. More questions available? In this phase the software tests if there are more opened and unanswered questions available for that ID.

5. Display question. Display the question to the user. Also start a countdown timer to know how much time you still have until the question is automatically closed.

6. Record answer. Records the answer in the database together with the server time of the moment.

7. End. Informs the student that the assessment is over.

Beside the student part of the web application (presented above) we have also a **web admin dashboard** where the admin can do actions like:

- Load the database with questions for each ID (questions marked initially not opened)

- Change the state of questions (individually or for all) between not opened, opened or closed.
- Save the answers to a local file in order to evaluate the answers.

Preparing of the questions for each ID (including randomizing questions and answers) and evaluating the answers are done locally, with a **desktop application**. We chose to do web-based only the testing for security reasons (mainly) and for maximum flexibility in configuring the test-bank and evaluation of answers.

The single choice questions have always a last choice "I do not respond" which gives the student 0 points. If the student chooses a bad answer he loses half of the points assigned of the question. We have done this to discourage "blind" (random) answering.

The web solution that we have developed was based on php and mysql services, available from the university datacenter. We used this approach both for legal reasons and for simplifying our task. On the client side we rely on Javascript, mainly for countdown timers. Even if the Javascript code can easily be modified from the developer console, by recording the server time for each answer any unexpected delay is detected (and a "cheating flag" raised). Also window and tab switching is detected and logged. In order to validate our implementation, we have successfully done a penetration test using Burp Suite Professional [11].

The developed assessment solution was used together with a Real-Time/Live Remote Proctoring approach, done by the teacher with the Meet solution provided by Google [10].

5. Results… and dangers

The solution we have implemented has been used (successfully, from our point of view) for exams taken starting Summer of 2020 until now…

In Table 1 we present the results for one of our exams taken by 3rd year Computer Science students. The results were obtained in Summer 2019 (face-to-face, on paper) and in Summer 2020 (web-based, online). Even if there are big differences between exams (first is only classic, with topics that should be explained in detail, the second contains also questions with single-choice answers), the distribution of the results is significant and presented in Figure 2. In both cases we present the number of students for each bin (containing (0-10%], (10-20%], …,(90-100%] of the result of the best student).

Table 1. Results obtained using face-to-face and online methods

Bin	Percentage from the best student result	No of students in Summer 2019 (face-to-face)	No of students in Summer 2020 (online)
1	(0- 10%]	9	5
2	(10- 20%]	7	9
3	(20- 30%]	13	12
4	(30- 40%]	27	15
5	(40- 50%]	22	13
6	(50- 60%]	23	29
7	(60- 70%]	17	25
8	(70- 80%]	6	28
9	(80- 90%]	2	12
10	(90-100%]	1	4
	total	127	152

From Figure 2 we notice that the shape approximately reflects a Gaussian distribution. For the online assessment the results are better, because for (engineering) students it was easier to answer to some single choice questions than to respond with details to theoretical subjects. The results are also influenced by the fact that in the 2019 class the best student result was much better than usual.

A problem that we faced on one examination was a classical DDOS attack, done from worldwide machines. The internet provider detected the massive attack, but unfortunately isolated the destination of the attack (!!!), therefore helping the attacker. Luckily, we had a backup of the application on a different cloud-based machine, so the assessment was not jeopardized. Based on this experience, the university services improved to avoid such a behavior.

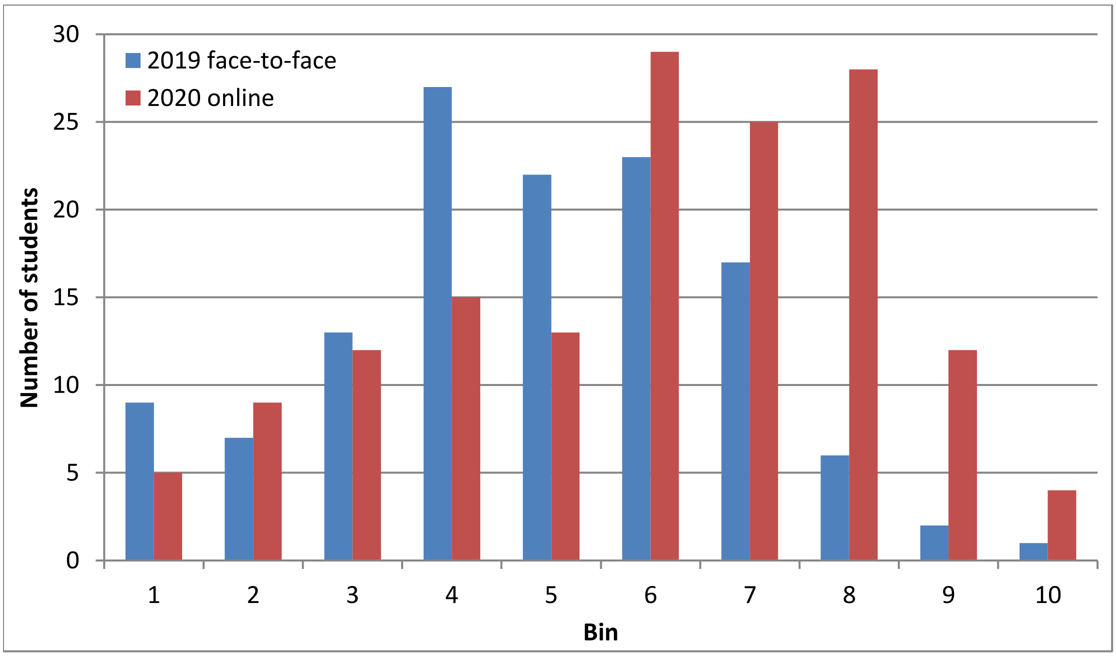

Figure 2 Results obtained for face-to-face and online examinations

6. Conclusions and future work

When forced to switching to online examination we realized that the free solutions are not completely satisfactory, and the non-free solutions are expensive. Therefore, to build your own web-based assessment solution is to be taken into consideration.

In the future we plan to develop the solution to accept also multiple-choice questions and to improve the interface to better adapt to different screen resolutions.

But, for the future, we mainly hope the pandemic to be over, and to return to in-person proctoring exams (for both on paper and computer-based examination).

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