Technological and psychological aspects of proctoring on-line tests from the participants' perspective

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Abstract

Privacy is often cited as a major issue in online testing using technological proctoring methods. In fact, this is perceived by test participants as the most significant aspect which has a major impact on the level of trust in the online testing environment. Even though the limitations related to the pandemic situation have already subsided, online testing has proven to be one of the ways to increase the efficiency of some important activities related to the agenda of higher education institutions. Although efficiency and flexibility of deployment is one of the undeniable advantages of online testing, it is necessary to emphasize that online testing using online proctoring systems raises some concerns among the participants, which may also have a negative impact on their results. For this reason, a research survey was conducted among the participants of the online admissions tests, in order to find out their readiness, but also the specific concerns and expectations that online proctoring brings from their perspective. Thus, although most respondents reported serious concerns about the use of online proctoring (e.g., concerns about privacy, psychological well-being, etc.), they did not fundamentally question the process per se and in many cases appreciated its benefits in enhancing protection against fraudulent behaviour.

Keywords: On-Line Testing, Proctoring Methods, Proctoring, Psychological Aspects, Technological Aspects.

1. Introduction

There is a long-held view that cheating is more prevalent in on-line tests than in traditional face-to-face tests [1]. This view is based primarily on the fact that although opportunities may be similar in both types of testing, the opportunity for

cheating may be greater in the on-line environment because videoconferencing and on-line testing environments do not provide as close supervision to the instructor [2].

Regardless of whether tests and testing are on-line or face-to-face, students report that proctoring is the main factor that prevents cheating on exams [3]. Despite the fact that some studies have reported more cheating in unproctored exams than in proctored exams, no difference was found between on-line and face-to-face courses in the case of proctored exams [4]. Students also reported that cheating is more common in unproctored on-line testing and exams (and less so in proctored on-line tests) and that they would be more likely to engage in cheating in such a context [5]. From this result, it can be inferred that students in online environments tend to perceive proctoring as a signal that the higher education institution considers cheating to be a serious problem, and this signal alone may cause students to change their behavior in their own testing and examination [6].

Research conducted also agrees that cheating becomes a serious problem when on-line tests are not (effectively) controlled [7]. It is therefore not surprising that these authors have shown that the average test performance of students who took the unproctored version of the test is significantly better than that of their counterparts who took the proctored version. One study also showed [8] that students performed significantly better on on-line tests randomly drawn from an item bank of test items than on on-line tests composed of fixed questions, without drawing lots and the ability to change individual distractors. The authors of the study also found that the performance gap between on-line tests drawn from the item bank and fixed-item items decreased when the tests were proctored, suggesting that proctored items go some way to reducing the frequency of cheating.

2. On-Line Proctoring Systems and Their Methods

On-line proctoring can be considered a form of digital assessment allowing an exam or test to be taken from any location using only digital devices [9]. An on-line proctoring system allows students and learners to take exams and tests anywhere (e.g., at home) in a relatively safe and secure manner. The different methods of "native" and "technology" proctoring should then prevent students or participants from committing fraudulent acts.

On-line proctoring systems, which first emerged in 2008, have become widespread in higher education institutions [10] especially since they have been forced to move teaching, and therefore testing, to the on-line space as part of pandemic measures [11]. While some on-line proctoring systems work by limiting the number of applications which a computer can run during an exam [12] other proctoring systems use artificial intelligence and machine learning algorithms to identify suspicious behavior when examining on-line exam and testing records [13]. While universities consider these benefits of on-line proctoring to be very effective, in some cases students complain of feeling uncomfortable for being tracked and their privacy being violated [14]. It is also important to note that as on-line proctoring systems improve, students are finding new ways to circumvent the protective methods of these platforms [15].

The methods of on-line proctoring vary among the producers of these systems, but we can distinguish two main categories: 'native' or natural proctoring (the features of the exam or test) and 'technological' proctoring (the conditions of the exam or test). Among the basic methods of natural proctoring we can include working with test variability, working with the type of test items and their distractors, working with time, i.e. methods relying on, i.e., open book [16, 17] and others. The basic types of technological proctoring methods are then based on the capabilities of modern recording technologies, analytical techniques and neural networks [18] such as the use of real-time camera proctoring, proctoring using footage and its post-review, and automated proctoring, where software, often in the form of a neural network, is responsible for part of the detection of fraudulent behaviour [19]. Thus, we next describe aspects of each method of natural and technological proctoring, including some of the advantages as well as pitfalls which must be considered.

2.1. Natural Proctoring

As already mentioned, one of the basic methods of this form of proctoring is the use of open-book [20]. However, using this method of testing in the on-line space means adapting the entire test agenda to this situation. Classical testing allows questions focused on the equipment of individual pieces of information, but when testing with an open-book, it means moving to higher levels of Bloom's taxonomy [21]. This involves creating questions and test situations which require students to apply their knowledge to new situations and use analytical and critical thinking [22]. To make this approach fair to students, it is recommended to have students practice these more advanced cognitive skills before they need them on an exam or test. Redesigning tests to an "open-book" format is extremely challenging. Practically, we need to abandon all knowledge-based test items and develop new ones at higher levels of Bloom's taxonomy which test understanding and skills [23]. Other aspects of using the open-book testing method in the on-line space include:

- The variability of the test is ensured by the so-called question bank, i.e., a sufficient number of questions drawn by lot, with a sufficient number of offered or made-up answers [24]. If we compare this technique (simplistically) to rolling a dice, then (suppose the test has 50 questions, each question has 4 offered answers, and we have three sets of tests with 50 questions each): we roll a dice which has not six, but fifty sides (variability in the number of questions); we roll not one dice, but four (variability in the number of 4 offered answers); and we roll not once, but three times (variability in the number of 3 sets of tests). According to the basic rules of probability, a simple calculation shows that the resulting probability of drawing two identical tests in this way is 1052, a value that corresponds to the diameter of the visible universe in kilometres.
- Working with the time of the test, is governed by the human capacity to process written information. The average reading speed, of an untrained human, is about 210 words per minute [25, 26] and others, which is also

a limit on the length of the written question and answer, which must correlate with the total test time, and the total number of questions. The possibility of using graphical assignments is offered, but here it is necessary to point out that if they are used they may limit students with visual difficulties.

2.2. Technological Proctoring

This method of proctoring is based on the use of modern recording technologies, analytical techniques and neural networks [18]. Proctoring implemented in this way has two main modalities [27]. First, large-scale testing, where economies of scale appear to be an advantage. The second modality is large-scale distance testing, which has higher security standards and is used, for example, for entrance and exit exams, for certifications, etc. Both types are also offered commercially as a service [28].

- Real-time camera proctoring is one of the oldest and best known forms of technological proctoring. It is the form which most closely resembles an actual exam hall, where the proctor watches the exam remotely [29]. The number of exams which can be observed by one proctor varies depending on the method chosen. The more screens a proctor has to watch, the fewer exams he or she can simultaneously watch [30]. The biggest disadvantage of this form is its limited scalability and the need to schedule the exam in advance. A student cannot simply log in and start working as soon as they feel ready; instead, they must schedule a time several days in advance so that the proctor is available. The capacity of the system is determined by the number of available proctors, but also by the bandwidth capacity of the system [29].

- Proctoring using the recording and its subsequent review. This commonly used form of technological proctoring stores camera footage and logs so that proctors can later review the (accelerated) video [31]. Based on this footage, they assess whether fraud occurred during the examination. The biggest advantage of this form is that students can take the exam whenever they are ready. They can log right in and start the exam without having to plan it in advance. Another advantage is that this form is easily scalable and can handle large concurrent exams [30]. A large number of students can take exams at the same time and proctors can then assess them over a longer period of time. This is not possible with live proctoring.

- Automated proctoring, which is becoming increasingly popular, proctors no longer watch (or control) the entire exam. Instead, a specialized computer program (usually based on a neural network) identifies moments where there is a possibility of cheating [32]. For example, whenever another program is opened, a student looks away or another person is detected in the room. The proctor is alerted to such events and can then review specific moments to assess whether fraud has indeed occurred. The automated proctoring process is much more efficient as it is not necessary to review all images and logs [33]. This also makes it a very scalable solution. One disadvantage is that if students know how the software works, they may be able to bypass the anti-fraud measures more easily. On the other hand, a human proctor remains unpredictable for the student because they cannot be sure what they are looking at any given time. Another disadvantage is that the software easily produces false positives (i.e., reports innocent events as potential fraudulent behavior).

3. Focus, Context and Methods of the Research Investigations

Privacy is often cited as a major issue in on-line testing using technological proctoring methods. In fact, this moment is perceived by test participants as the most significant aspect [34] which has a major impact on the level of trust in the on-line testing environment [35]. In addition to privacy concerns, another major issue is the ethical behavior of test takers [5]. Although on-line testing can be more challenging for participants, due to the strict control processes and technological requirements, yet some studies have found that participants believe it is easier to commit fraudulent behavior in on-line testing [1]. However, other studies have provided evidence that this type of fraudulent behavior does not lead to an advantage or improved test score [4].

During the pandemic, Palacký University and its Faculty of Education, as well as a number of higher education institutions, faced the problem of implementing mass on-line admission tests for study, as there was a risk that applicants would not be able to participate in person in these tests. One of the main components of the admission procedure to the Faculty of Education is the so-called study aptitude test, which is taken by approximately 2 500 applicants to Bachelor's degree programs each year. Since at that time there was no commercial system available on the market which would meet these requirements and at the same time would be acceptable in terms of financial costs, the Faculty started work on the development of the Testing System Unifor (TSU for short). This system was designed to be able to prevent cheating by using both natural and technological proctoring methods and thus enable massive on-line testing. The TSU has been used repeatedly at the Faculty of Education of UP, in the admissions process for 2020/2021, 2021/2022 (natural proctoring methods only), 2022/2023 and 2023/2024 (use of both natural and technological proctoring methods). Based on these facts and the real experience of implementing on-line admission tests within TSU, this study aimed to determine the readiness and attitudes of participants towards this form of admission tests. Therefore, our research work focused on answering the following research questions:

Q1: Were participants well prepared technologically for the on-line entrance exam?
Q2: What are students' concerns when using on-line proctoring?
Q3: Do students believe that using on-line proctoring prevents cheating attempts?

Based on the above research questions, I sought to determine the views of on-line admission test takers on this form of on-line testing using both natural and technological proctoring methods. These findings could provide feedback to system

designers, test question developers, as well as faculty leadership or the general professional community on how to use these proctoring tools and methods in different situations to increase test taker motivation and engagement.

Based on the study of the literature, and based on the findings from interactions with participants in the 2020 and 2021 on-line admissions tests, participants' attitudes and concerns about technological (on-line) proctoring were translated into key factors and indicators of interest. Subsequently, an on-line questionnaire was developed based on these findings. The developed questionnaire was submitted for approval to the Ethics Committee of the Faculty of Education, which by its recommendation No. 10/2023 enabled the collection of the necessary research data. Members of the author's team then proceeded to collect the necessary research data (Milan Klement), their statistical processing (Květoslav Bártek) and subsequent interpretation and discussion (Tomáš Dragon).

In addition to participants' overall readiness for on-line testing, their level of concern about on-line proctoring and their attitudes about the possibility of cheating were also measured. The research also included several demographic variables to identify any dependencies on significant characteristics of each participant group. Thus, the questionnaire consisted of two parts: the demographic questions included gender, age, previous implementation of college admissions, and experience and on-line proctoring, while the second part was divided into two subsections with a total of 12 questions which elicited participants' attitudes and opinions. The questions had a three-point Likert scale ranging from agreement (3) to disagreement (1) along with a neutral option (2).

4. Partial Research Results

The research sample included all participants in the on-line admissions test for the 2023/2024 academic year, i.e., 2,458 participants who were contacted by email immediately after the on-line testing ended. A total of 1,487 on-line admission participants responded to the mailed questionnaire, resulting in a return rate of 60.5%, which guaranteed the conclusiveness of the findings presented below. The robustness of the collected research data was calculated using Cronbach's alpha, which reached $\alpha = 0.79$. This result can be considered satisfactory and indicates a high level of internal consistency and reliability of the acquired research data.

The descriptive statistics, obtained from the first part of the questionnaire which focused on the demographic data of the respondents, showed that 48% (n = 562) of the sample were male and 52% (n = 922) were female, 87% (n = 1,294) of the respondents were under the age of 25, 83% (n = 1,234) of the students were applying to college for the first time, and 39% (n = 580) had previous experience with on-line testing.

In the second part of the questionnaire, respondents (n = 1,487) indicated their attitudes and experiences on four indicators related to their own on-line testing process using both natural and technological proctoring methods. In line with Binstein [35] a simple test was used, based on averaging the individual attitudes and experiences to extract statistically significant values using a t-test. One-sample t-tests compare the means of a single sample to a predetermined value to determine whether the sample mean is statistically greater or less than the significance level. As the research questions used a three-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (3), the mean value of the scale was set to 2. Thus, one-sample t-tests were conducted to determine whether the averaged responses of the respondents were significantly greater or less than the established significance level, i.e., $p > 0.05$.

Q1: Were participants well prepared technologically for the on-line entrance exam?

The first area examined was the respondents' readiness to implement on-line testing using technological proctoring methods, which assume not only appropriate technical equipment, but also the necessary digital competencies and all-round support of the examinees. The summary of the respondents' answers is presented in Table 1.

Table 1.
Analysis of respondents' answers on their readiness for on-line testing.

	Mean Score (M)	Standard Deviation (SD)	Signif. (P)	% Of Respon. Answers
Sufficient technical equipment	2.384	0.624	0.001	76.8
Sufficient digital competence	2.696	0.717	0.024	88.7
Sufficient connection speed	2.524	0.693	0.000	81.4
Sufficient level of support	2.942	0.828	0.004	94.6

The mean value of the responses to the area focusing on respondents' technical preparedness for on-line testing was 2.637 (SD = 0.716), which was relatively high, t(1,487) = 18.524, p = 0.007. 76.8% of respondents (n = 1,145) responded positively to the question "my technical equipment is sufficient/adequate" indicating that respondents believed they had sufficient technical equipment to conduct on-line testing. The vast majority of respondents (88.7%, n = 1,321) responded positively to the statement "my computer skills are good/excellent" (M = 2.696, SD = 0.717), declaring that they were prepared for on-line testing and had the necessary digital competencies to work with the testing environment, while 81.4% (n = 1,205) of respondents rated their "internet connection needed for on-line testing as good/excellent" (M = 2. 524, SD = 0.693). Furthermore, 94.6% (n = 1,412) of respondents reported that "getting support, advice and guidance provided before taking the on-line test was good/excellent" (M = 2.942, SD = 0.828). Thus, most respondents did not encounter technical problems and these problems did not negatively affect their performance in the on-line test.

Q2: What are students' concerns when using on-line proctoring?

To Address This Research Question, Four Types of Respondents' Concerns Were Analyzed (Fear of External Distractions, Fear of Influence on the Environment, Fear of Increased Psychological Pressure, Fear of Using the Webcam). A Summary of Respondents' Answers Is Presented in Table 2.

Table 2.
Analysis of respondents' answers focusing on their concerns about on-line testing.

	Mean Score (M)	Standard Deviation (SD)	Signif. (P)	% Of Respon. Answers
Fear of interference	1.254	0.481	0.052	38.7
Fear of impact on the environment	2.354	0.733	0.000	79.2
Fear of psychological pressure	2.305	0.708	0.015	77.4
Fear of webcams	2.546	0.739	0.002	85.8

Across all respondents who responded to questions in this area, 70.3% of students (n = 1,041) expressed concern about distractions or pressures in on-line testing using on-line proctoring (M = 2.115, SD = 0.665), t(1,487) = 5.271, p = 0.017. Thus, the above table shows that respondents on average had significant privacy concerns, increased psychological stress and influence on their environment. The mean responses of the respondents regarding concerns about the influence of the surrounding environment were 1.254 (SD = 0.481), which was the result at the established level of significance as t(1 487) = 4.018, p = 0.052; meaning that 61.3% of the respondents (n = 907) believed that the surrounding environment influenced their performance in the on-line testing. Furthermore, 79.2% (n = 1,175) of respondents reported that their small apartment prevented their family from moving around or bothered them with noise during on-line testing (M = 2.352, SD = 0.733). The majority of respondents (77.4%, n = 1,145) agreed with the statement that "the fear of on-line testing negatively reflected on my test performance", (M = 2.305, SD = 0.708). Furthermore, 85.8% (n = 1,279) of respondents agreed that "watching via webcam causes anxiety in me and causes poor performance", (M = 2.873, SD = 0.782).

Q3: Do students believe that using on-line proctoring prevents attempted cheating?

The final area explored focused on respondents' opinions regarding their general attitudes toward the issue of the permissibility of cheating behavior in on-line testing and the ability of on-line proctoring to prevent such behavior. It also explored whether they were generally satisfied with the possibility of on-line proctoring and whether they would voluntarily undergo it to maintain equality of opportunity. A summary of respondents' answers is presented in Table 3.

Table 3.
Analysis of respondents' answers on the possibility of cheating in on-line proctoring.

	Mean Score (M)	Standard Deviation (SD)	Signif. (P)	% of Respon. Answers
Admissibility of cheating	2.941	0.737	0.002	97.6
Prevention of cheating	2.804	0.643	0.034	90.4
Satisfaction with on-line proctoring	1.102	0.584	0.931	21.7
Mandatory use of on-line proctoring	1.954	0.702	0.008	77.3

The mean of respondents' answers to this area of the questionnaire was 2.220 (SD = 0.667), which was significant as t(1 487) = 6.55, p = 0.224; this indicates that 71.8% of respondents (n = 1 071) believed in the importance of on-line proctoring in ensuring equality of opportunity and eliminating cheating in on-line testing.

Almost 98% of students (n = 1,457) then agreed on the importance of eliminating cheating behavior (M = 2.941, SD = 0.737). More than 90% of respondents (n = 1,139) also agreed that using on-line proctoring can prevent cheating behavior in on-line testing (M = 2.804, SD = 0.643). Overall respondent satisfaction did not show a significantly positive attitude towards on-line proctoring (M = 1.102, SD = 0.584), t(1 487) = 0.083, p = 0.931, as only 21.7% of respondents (n = 328) agreed that they were satisfied, while 78.3% of respondents (n = 1 159) disagreed with this statement. Regarding the statement "if using on-line proctoring were optional, I would still choose to use it", respondents showed similarly strong reluctance (77.3%, n = 1,145), (M = 1.954, SD = 0.702).

5. Discussion

The findings of this study were obtained through the use of pedagogical research methods to gain a deeper understanding of the factors associated with on-line proctoring in the context of massive forms of on-line testing using both natural and technological forms of proctoring. This wide range of protective elements (technological proctoring), along with appropriate test question and test condition design (natural proctoring) and the analytic procedures used, provide practical insights whixh can lead to a better understanding and resolution of these important issues.

Respondents' answers indicated that they were well prepared technologically for on-line testing in the admissions process, and that they also possessed the necessary digital competencies. This fact is not so surprising, since in the context of the pandemic state, many learning situations, and at all levels of education, were implemented on-line. However, technical difficulties can occur regardless of the quality of the equipment, for example, problems with Wi-Fi connectivity or the state of the equipment used, as described in the study by Milone, et al. [15].

In relation to the second research question, respondents expressed several concerns about their experiences with on-line proctoring. Students were particularly concerned about environmental and psychological factors, which is in line with previous findings by other authors, for example Day, et al. [36] and Harmon, et al. [37]. Feelings of stress and anxiety during on-line proctoring, particularly in relation to the surrounding environment, can be attributed to the overall situation at the time of the pandemic measures, as it was necessary to conduct this testing in their home environment. Again, this finding is consistent with previous research, with Williams and Williams [38] stating that the "more comfortable students feel with their environment and the learning process, the easier it is for them to focus and perform well". Respondents' concerns also centered on being monitored via webcam during the exam. These concerns are compounded given that on-line proctoring tools can take control of the computer and can not only look into respondents' homes, but also observe and interpret movements during the exam. The corresponding psychological fears of webcam surveillance ultimately contribute to feelings of fear and stress.

Previous studies have also reported that students' cheating may be related to beliefs and values rather than situational factors [39]. As the use of on-line proctoring has been shown to discourage cheating [34] respondents' answers were consistent with existing literature. The results also showed that respondents' overall satisfaction with on-line proctoring was lower than expected. Given that the pandemic itself disrupted many aspects of people's lives, this finding is not so surprising. Mandatory choice can negatively affect student satisfaction [35] leading to involuntary switching to on-line proctoring being met with resistance. This is consistent with reactivity theory [40] which states that people resist what is perceived as the elimination of their choice/freedom, even when what they are reacting against is for their own benefit.

6. Conclusions

One of the major challenges faced by educational institutions is the integrity of on-line assessment and testing [41] i.e. the need to conduct on-line testing using appropriate tools and methods [15]. With the sudden increase in on-line distance education due to the Covid-19 pandemic and the associated need to ensure a level playing field in examination, universities have adopted various proctoring technologies to monitor on-line examinations and testing. These technologies are able, based on both natural and technological proctoring methods, to identify and respond to suspicious activity during on-line examinations. Even though the limitations associated with the pandemic situation have already subsided, on-line testing has proven to be one way to increase the efficiency of some important activities related to the agenda of higher education institutions. Although efficiency and flexibility of deployment is one of the undeniable advantages of on-line testing, it is necessary to emphasize that on-line testing using on-line proctoring systems raises some concerns among participants which may also have a negative impact on their results.

For this reason, a research survey was conducted among participants of on-line admissions tests, in order to determine their readiness, but also the specific concerns and expectations that on-line proctoring brings from their perspective. Thus, while most respondents reported serious concerns about the use of on-line proctoring (e.g., concerns about privacy, psychological well-being, etc.), they did not question the process per se and appreciated its benefits in enhancing protection against unethical behavior. The findings therefore revealed the importance respondents attached to the protection of equal opportunities and the need to prevent efforts to engage in fraudulent behaviour, even at the expense of their own wellbeing. However, the majority of respondents were not satisfied with on-line testing and would not continue with it if they had the opportunity.

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