Re-Examining the Examiners: Changes in Privacy and Security Perceptions of Exam Proctoring

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Abstract

With the shift to remote learning during the COVID-19 pandemic, educators turned to remote exam proctoring software to support integrity for online tests. However, due to the mechanisms used to surveil test-takers, these systems come with significant privacy and security tradeoffs. At the height of the pandemic, Balash et al. (SOUPS '21) found that test-takers had privacy concerns with remote proctoring but acquiesced due to a number of factors. We investigate how perceptions have changed four years later. To gain a fuller perspective on how users experience these tools now, we replicate Balash et al.'s study with 127 participants who have experienced exam proctoring. We found a significant shift in favor of proctoring software, with greater acceptance of all monitoring methods compared to 2020. This is likely due to the convenience of remote exams and a growing resignation to privacy trade-offs. We discuss these implications and suggest future directions.

CCS Concepts

• **Human-centered computing** → **User studies**; **Human computer interaction (HCI)**.

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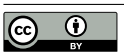
1 Introduction

There has been a steady uptick in the use of remote exam proctoring software [8] that enables students and other test-takers to complete exams remotely under supervision to ensure academic integrity. This trend accelerated during the COVID-19 pandemic when schools moved to remote learning; one poll in 2020 noted that 77% of institutions were already using or planning to use these software solutions [29]. Remote proctoring is also applied beyond educational settings [9], including in conducting driving and/or certification exams. Remote exam proctoring software come in various forms: browser extensions, standalone applications, and integrations within learning management systems. To ensure academic integrity, these tools can be highly intrusive, often requiring test-takers to perform a manual room scan, give access to their network, and allow microphone and camera access [13, 57]. While studies have found that students cheat less on online proctored exams compared to in-person exams [6, 24], research is inconclusive as to whether online proctored exams affect the overall performance during exams, with some studies showing that it stays the same [17, 39] and others showing otherwise [35, 88]. Additionally, studies have shown that students are more stressed when taking online proctored exams [8, 79, 88].

At the height of the COVID-19 pandemic in 2020, Balash et al. [8] investigated students' perceptions of the privacy of exam proctoring systems and their comfort level with various observation methods deployed by these systems, such as lock-down browsers, screen sharing, and eye tracking. Balash et al. found that students were uncomfortable with the privacy invasive nature of these tools but felt they were a reasonable tradeoff for balancing their personal safety with the ability to take exams. With the pandemic abated and the return to regular, in-class learning, we seek to understand if test-taker perceptions have changed regarding online proctored exams. To further enrich our insights on user perspectives, as exam proctoring software has been adopted in many different contexts, this study considers both students and the general population of test-takers, which could include those taking professional exams, like the BAR exam under remote proctoring. As such, we ask the following research questions:

RQ1 How has the exam proctoring ecosystem changed relative to Balash et al.'s results in 2020?
RQ2 How have test-takers' privacy perceptions of exam proctoring tools changed since the return to in-person learning following the COVID-19 pandemic?
RQ3 What are the proctoring method trends of exam proctoring software?



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To answer these questions, we replicated the methodology of Balash et al. [8]. Their work involved analyzing exam proctoring browser extensions and their reviews, as well as surveying students about their experiences with online exam proctoring. As such, we first evaluated the current exam proctoring software posted in the Google Chrome Web Store [28]. We find that extensions still request and access many of the same permissions found in prior work and, in some instances, request additional permissions. We also find that some proctoring software extensions are only available through private download or have moved away from extensions entirely to using full custom browsers, perhaps to exert even more control on the test-takers' environment.

Next, we also replicated Balash et al.'s [8] survey protocol, with minor updates. This included asking participants about their exposure to online proctored exams and their privacy concerns, mimicking Balash et al, but we also included a new section about their usage post-2022. To reflect the broader trends of online proctored exam adoption, we recruited $n = 127$ test-takers who have completed an exam with remote proctoring software in some capacity, not just in the student context. Notably, we found no difference in the privacy perceptions of the student and non-student population within our dataset. We observe increased preferences for online exams over traditional exams (53%), a significant departure from prior work [8, 47, 92]. We also find that the majority of test-takers (77%) believe there is a sensible privacy and integrity trade-off when taking online proctored exams, compared to the (41%) in prior work [8]. Additionally, we see more comfort regarding proctoring software among participants, with over 70% of participants in our study reporting they are at least neutral with the software. Participants prefer to use proctoring software mainly for convenience, but some also chose to because they had good past experiences with proctors. We hypothesize that these attitude changes are due to a combination of changes within the educational ecosystem brought on by the pandemic and normalcy biases.

Due to their limited efficacy, our findings highlight the need to rethink the use of exam proctoring for remote test taking, including the use of alternative methods of evaluation where possible. Several participants indicated they can circumvent these tools to cheat on proctored tests. We discuss our results, and present promising directions for future research. For example, more work should investigate institutional factors regarding why users may feel more comfortable using proctoring software. There is also a need for data assurance methods and safety frameworks for inclusive decision making among test-takers and instructors.

2 Background and Related Work

2.1 Online Proctoring Software

Online exam proctoring software is an example of educational technology (edtech), and is designed to ensure academic integrity while taking remote exams. As the COVID-19 pandemic unraveled and many schools switched to online classes, exam proctoring software were increasingly adopted. Common exam proctoring software, such as Examsoft [27], Proctorio [67], and ProctorU [69], among others [21, 25, 26, 37, 40, 52, 66, 68, 71–73], have various mechanisms to prevent access to unauthorized resources, including using live proctors to administer an exam, preventing actions on a user's browser, full room scans, and eye movement detection. This software is often installed on a user's personal device and has access to their camera, file system, and network traffic. An online proctored exam can also refer to conference call (Zoom, Microsoft Teams) test-taking solutions; however, in this work, online proctored exams refer to specific software (both browser extensions and independent software) that is designed for proctoring exams.

2.2 Security and Privacy of Exam Proctoring Software

Edtech software has seen significant research interest within the usable security and privacy community. Work done by Chanenson et al. [15] found a lack of both privacy and data breach protocol among K-12 schools, with significant limitations in terms of resources for educators and professionals. Relatedly, Kelso et al.'s work [46] reveals that complex security and privacy interplays between education institutes and edtech vendors makes establishing a data protection baseline among edtech challenging. Hasan's analysis found that online discussion centered on edtech rarely discussed security and privacy harms [34]. In comparison, exam proctoring systems' security and privacy implications have drawn significant media scrutiny [33, 36, 38, 43, 48, 63, 83] and academic research [8, 9, 22, 47, 53, 54, 78, 84, 88, 92] since their widespread adoption during the COVID-19 pandemic. Research by Kharbat and Abu Daabes [47], Balash et al. [8], and Yang and Hasan [92] show a wide range of privacy concerns with proctoring software. By using the Contextual Integrity [58] framework, Terpstra et al. [84] found that students accepted data sharing with their instructors but expressed significant concerns about third-party vendors accessing sensitive information.

Other studies have highlighted the security risks associated with online proctoring tools [20, 78, 81]. Slusky [81] find many proctoring software to contain vulnerabilities that can expose sensitive student data if compromised, while Cohney et al. [20] find that many proctoring platforms fail to adhere to robust security standards, leaving students vulnerable to breaches. Shioji et al. [78] further find that universities often lack sufficient technical expertise or oversight during procurement of proctoring software, resulting in systems with weak encryption, poor access controls, and insufficient transparency regarding data retention policies.

These works underline the tension between maintaining academic integrity and safeguarding student privacy and security. Our study builds on this foundation by examining how these perspectives have evolved, revisiting student perspectives on privacy and security in online proctoring systems four years after Balash et al.'s [8] initial findings.

2.3 Exam Proctoring Bias

Advanced automated proctoring tools rely on AI technologies such as facial recognition, gaze tracking, and behavioral analysis to ensure academic integrity during remote exams. However, a growing body of research [13, 14, 19, 49, 55, 77, 93] highlights the inherent biases in these systems, which disproportionately impact students based on race, skin tone, gender, and other demographic factors. These biases raise ethical and practical concerns, particularly about fairness, equity, and the exacerbation of systemic

inequalities. Through a study in four courses involving 357 students, Yoder-Himes et al. [93] found that students with darker skin tones and Black students were flagged significantly more frequently for cheating compared to their lighter-skinned peers. Similarly, Burgess et al. [13] found that proctoring software were more likely to incorrectly flag students with darker skins tones for cheating, leading to false cheating accusations. These findings align with broader concerns about algorithmic fairness in AI systems [7, 12, 31, 51, 59, 76, 87, 89].

The ethical implications of these biases are compounded when proctoring systems rely heavily on algorithmic decisions without sufficient human oversight. Brown [11] shares concerns about how the exam proctor software discriminates against disabled students. For instance, AI-generated flags for suspicious behavior, such as gaze deviations or atypical movements, often lead to unfair accusations against students with disabilities. The use of automated systems to track test-takers, such as facial and keystroke analysis to detect anomalous behavior, have also been criticized for lack of accuracy and potential privacy infringement [57, 79]. In addition, recording can unintentionally amplify biases by capturing elements of a student's environment not intended to be documented for example, a personal care attendant or an emotional support animal, leading to false accusations of cheating [14]. The cumulative effects of these biases also create a chilling effect on student performance and educational outcomes [22].

2.4 Exam Proctoring Effectiveness

Researchers have explored online exam proctoring effectiveness in enforcing academic integrity [3–5, 24, 32, 39, 94], the prevalence and patterns of cheating in different formats [23, 24, 30, 42, 79, 85], and the psychological and performance-related effects on students [16, 22, 62, 65, 74, 88, 91]. The effectiveness of proctoring tools has yielded mixed results. A recent study by Alessio et al. [5] of 150 faculty and 78 students found that 42% of students and 23% of faculty doubted the effectiveness of preventing dishonest behavior during assessments. While Hylton et al. [39] found that exam scores in proctored and non-proctored exams were not significantly different, Dendir et al. [24] found that the introduction of the Respondus lockdown browser led to a decrease in average exam scores.

Cheating behaviors in online exams vary based on the exam's stakes, enforcement mechanisms, and context. Rios et al. [74] observed that while proctoring tools had little impact on low-stakes exams, cheating behaviors were more prevalent in higher-stakes settings. At the same time, the presence of online proctoring can impact students' experiences during exams. Patael et al. [62] found that students reported heightened stress levels during remotely proctored exams, with Conijn et al. [22] and Pokorny et al. [65] finding that students often felt scrutinized, diminishing their focus and comfort. Collectively, these studies illustrate the unintended psychological burden of proctoring technologies.

The use of large-language models (LLMs) during exams has seen wide-spread media [86] and research coverage. In the context of online exams, LLM output has been shown to pass multiple-choice and multi-modal exams [56, 82]. While our study does not directly inquire about the usage of LLMs during online proctored exams, their use will no doubt influence the adoption of more advanced exam proctoring tools [82].

2.5 The Original Study

The COVID-19 pandemic and social distancing measures that were subsequently enforced in 2019 forced many instructors and institutions to hurriedly adopt online learning, with many turning to exam proctoring software to administer tests. While these proctoring tools can ensure exam integrity, they also collect a lot of personal and sensitive information from test takers (including scanning rooms and tracking eye movement), leading to security and privacy concerns among test-takers. In 2020, Balash et al. analyzed common exam proctoring software, followed by a survey (n = 102) to assess users' perceptions and attitudes toward the proctoring software [8]. They found that proctoring services request many permissions from users, including desktop recording, tab control, and geolocation. Additionally, they found that participants had significant concerns regarding exam proctoring software. While participants recognized the necessity of some methods to ensure integrity, many found the tools largely invasive. The study recommended better institutional support for assessing the necessity of proctoring methods, including informing students of online proctored exams via syllabi and involving students in choosing proctoring software. Our study replicates Balash et. [8] to show how student perceptions and attitudes toward exam proctoring software have changed over the last four years as the pandemic measures are lifted and classes return to in-person.

3 Methodology

To explore how exam proctoring perceptions have changed over the last four years, we conducted a replication of study Balash et al.'s work [8]. First, we re-administered their survey on Prolific, followed by analyzing the proctor extensions available via the Chrome extension store. In this section, we first briefly highlight our replication motivation. Then, we describe our approach to the analysis of exam proctoring extensions, followed by our survey methodology including the survey structure, recruitment, data analysis, and limitations of the study.

Importantly, this paper closely replicates the original study, only asking additional questions related to post-COVID experiences. We chose not to perform analysis beyond what was conducted in Balash et al. for a fair comparison, both in terms of the survey and the browser extension analysis. This is common practice for other recent replication research in usable security and privacy [60, 64]. Through the replication we are able to address underlying trends in perceptions towards exam proctoring as the pandemic abated.

3.1 Our Replication

Balash et al.'s [8] study was conducted during a time where security and privacy norms had to adjust during an emergency period. Now that the pandemic has abated, measuring how security and privacy perceptions have reshaped is pertinent. We hypothesize that there have been significant changes with both the use of exam proctoring software as well as security and privacy attitudes toward proctoring

tools by test-takers. To investigate this, we replicated the work of Balash et al. seeking to specifically understand (1) whether exam proctoring techniques have changed now compared to during the pandemic (2) the extent to which participants still encounter exam proctoring after the pandemic, and (3) whether user attitudes toward online exam proctoring have changed after the pandemic.

3.2 Browser Extensions & Privacy Policies

To understand the evolution of the exam proctoring browser extension ecosystem, we re-conducted an investigation of extensions present in the Google Chrome webstore. At the time of measurement, there were fewer browser extensions compared to prior work, but we still completed the same measurement on those available, including measuring the number of reviews, ratings, and privacy policies of the existing available extensions, including Examod [26], Edusynch [25], Proctorexam [66], Proctortrack [68], Proview [71], PSI Online Proctoring [72], Proctorio [67], ProctorU [69], and Respondus [73]. Notably, ConductExam [21], and Examsoft [27] do not have extensions available and instead provide custom software solutions, which we further discuss in Section 5.1.

3.3 Survey

Similar to the original study [8], we conducted an online survey to understand the current security and privacy attitudes toward exam proctoring. In this section, we review our survey and recruitment protocol. Both the screener and main survey questions can be found in Appendix A.1 and A.2.

Screening Survey. To ensure participants had prior experience with remote proctored exams, we administered a screener on Prolific that also collected demographic information, including age, gender, technical background, and educational background; we additionally asked if participants participated in Balash et al's [8] prior study (no participant indicated so). We further required participants to complete the Internet Users' Information Privacy Concerns (IUIPC) questionnaire [50], a validated scale to assess their privacy perceptions.

Main Survey. Qualified participants who had prior experience with remote exam proctoring were invited to complete to the main survey via Prolific. They were then asked to read our informed consent, which explained that they would be sharing their experiences with previous exam proctoring. Participants were asked the following:

(1) **Awareness and Exposure**: We asked participants to report, to the best of their recollection, their experiences with online exam proctoring, including the services used, the number of exams they took, the nature of the exam (school, work-related, etc.), and if they were required to take the exam by their institution. We additionally asked if they took the exam with accommodations or if they experienced any technical difficulties while taking the exam. Questions **Q1** through **Q17**.
(2) **Methods Used**: We then asked participants to describe the procotoring methods that were used in their exam. This included the kinds of personal information they were required to show, monitoring methods used, and how comfortable they felt about each method used. Questions **Q18** through **Q28**.
(3) **Understanding of Functionality & Privacy Concerns**: Next, we asked participants to report their understanding and feelings on what the exam proctoring did; this included whether they thought exam proctoring software prevented cheating. We also asked questions related to their overall privacy concerns with exam proctoring software. Questions **Q34** through **Q39**.
(4) **Exam Proctoring Software**: Depending on whether test-takers used a web browser extension or standalone software, we asked participants about their experience with installing their selected software. We also asked test-takers the name of the software they downloaded, what device they downloaded it on, and any technical issues uninstalling the software. Questions **Q40** through **Q50**.
(5) **Post-Covid Changes**: Finally, we asked test-takers about their experience using exam proctoring software after the uplifting of COVID 19 restrictions. If participants did not take a proctored exam post-2022, we asked if they would have preferred to; separately, we asked test-takers who took a proctored exam post-2022 how their 2020-2021 exams were

Table 1: Demographics, the year of the last test the participant took, and IUIPC data collected at the end of the screening survey. Demographics from the prior study (2021) is also presented.

		Screening (*n* = 347)		Main Study (*n* = 134)		Balash et al. [8] (*n* = 102)	
		n	**%**	**n**	**%**	**n**	**%**
Gender	Woman	185	53	64	47	47	46
	Man	139	40	65	48	52	51
	Non-binary	5	1.4	2	1	2	2
	No answer	18	5	1	.75	1	1
Age	18–24	23	6	12	8	73	72
	25–34	120	34	61	45	22	22
	35–44	98	28	38	28	5	5
	45–54	55	15	15	11	2	2
	55+	33	9	6	4	0	0
	Prefer not to disclose	1	.2	0	0		
	No Data	17	4	2	1		
Student?	Yes	45	12	28	20		
	No	279	4	100	74		
	Prefer not to disclose	6	4	4	1		
	No Data	17	4	2	1		
Last Test Taken	2024			38	28		
	2023			27	20		
	2022			15	11		
	2021			14	10		
	2020			7	5		
	2019-2014			21	15		
	Earlier			9	6		
	No Data			3	2		
		Avg.	**SD**	**Avg.**	**SD**		
IUIPC	Control	5.83	0.89	5.85	0.89		
	Awareness	6.42	0.66	6.45	0.68		
	Collection	5.69	1.16	5.60	1.16		
	IUIPC Combined	5.93	0.90	5.96	0.91		

conducted and their experiences with those exams. In closing, we asked all participants whether they felt exam proctoring was a good solution for monitoring remote exams. Questions **Q51** through **Q55**.

Quantitative and Qualitative Analysis. Balash et al.'s original dataset was provided to us upon request. To quantitatively measure the distribution differences between Balash et al.'s [8] dataset and our own, we use pair-wise Mann-Whitney U tests for ordinal (Likert-scale) questions, and χ^2 tests on nominal (yes/no) questions. Due to the high numbers of significance tests which could lead to false-positive significances, we corrected p-values across *all* tests to reduce this likelihood. All reported p-values are already corrected based on the number of tests (46 in total), with Holm–Bonferroni correction. Nominally, this reduces the α value to determine significance below the 0.05 threshold, providing higher confidence that the observed differences are likely significant and not false-positive. A post-hoc power analysis was performed, and our analysis is well powered. Comparing two groups with more than 100 participants allows for $> .95$ power, which is sufficient for the statistical test we perform, particularly with p-value correction.

For qualitative analysis, the lead author inductively developed two primary codebooks for both the open text responses and extension reviews, which combined codes from Balash et al. [8] and new codes from this study. In both processes, researchers came together to discuss disagreements or adding additional codes. We report counts for context, but do not imply generalizability.

Open text responses (Section 5.2) were double-coded by two researchers, resulting in high inter-coder agreement (Cohen's $\kappa > 0.8$) [61]. For the extension reviews (Section 5.1), a subset of 159 reviews was double-coded by two researchers over several rounds. Upon completion, an inter-coder agreement of Cohen's $\kappa > 0.7$ was achieved.

3.4 Recruitment

We recruited from August 29th, 2024 to September 9th, 2024 via Prolific [70]. Participants were paid .50 USD for the screening survey, and 4.00 USD for the main survey. On average, the presurvey took 4 minutes to complete, and the main survey took 16 minutes to complete. Demographic data can be found in Table 1; we had $n = 347$ participants take the presurvey, from which we invited $n = 134$ eligible participants back for the main survey. Participants were eligible for the main survey if they have taken an online proctored exam. Participants that did not complete either the main survey or screener had their responses filtered out of the study.

Additionally, we also filtered out participants that did not answer open-text responses in a consistent manner that demonstrated attention, such as answering with multi-paragraph responses that appeared LLM-generated. Since there is no reliable way to definitively detect synthetic text [18], we used our best judgment and group consensus to ensure data quality. Fifteen participants in the screener did not complete the survey, while an additional 5 did not answer open-text responses appropriately. The 7 participants filtered in the main survey did not complete it. In summary, we had 347 initial presurvey participants, with 134 invited back to the main survey. After filtering, we had $n = 327$ valid responses for the presurvey, and $n = 127$ for the main survey.

4 Limitations and Ethical Considerations

4.1 Limitations

Our study has several limitations. First, we limited our study participation to those residing in the United States, so our study may not be generalizable to broader populations. Second, we cannot verify the truthfulness of respondents' answers to our survey questions. We note that we ask potentially sensitive questions, especially regarding cheating, so participants may feel it necessary to answer in a morally acceptable way; we tried to prevent this by allowing participants to not answer any question they were not comfortable answering. Additionally, like all studies that rely on information recall, recall bias may play a role in how users may perceive their past experiences with exam proctoring. We did not find anything to suggest that participants could not recall their experiences with sufficient context to answer survey questions. However, asking users to recall their past experiences is a commonly used method in the usable security and privacy field [16, 84, 90].

Third, we did not control for type-2 errors during our analysis, and so we cannot definitely say that items that did not have a significant difference were truly unchanged (a false-negative). Controlling for false negatives is very difficult and would have required increasing the number of participants well beyond what was practical. However, given the high number of significant differences observed (even under conservative p-value corrections), we argue it is appropriate to offer insights to unobserved changes and consider them meaningful in context.

Fourth, when comparing reviews of browser extensions, we recognize that those who write online reviews do not represent the majority of users of exam-proctoring software. However, other researchers have similarly used online reviews [2, 92] to get insightful perspectives into user concerns and preferences. We further note that when comparing our results to those of Balash et al., the prior findings have the same bias built in, which provides a reasonable basis for comparison.

Finally, our survey looks at broader user experience with exam proctoring software compared to Balash et al.'s focus on then **current** students. This is to reflect the continued adoption of these tools across various contexts and to encourage participants to recall their past experiences as students. Indeed, many of our participants are not current students (Table 1). The context in which an online proctored exam is used (for example, taking a college exam vs. a driver's test) may impact participants' sense of privacy-invasiveness and acceptance of these tools. To be certain, we ran the same quantitative analysis outlined in Section 3.3 on student and non-student perceptions of these tools and found no significant difference in privacy perceptions. Furthermore, some participants in our sample did not take proctored exams during or after the pandemic (pre-2020). While this population was the minority, we note that Balash et al. also had participants whose last proctored exam was pre-2020. This underlines an overall shift in the privacy perceptions of these tools.

4.2 Ethical Considerations

All data collected used only Prolific's random identifiers for identification, with open-text responses scrubbed of potentially identifiable

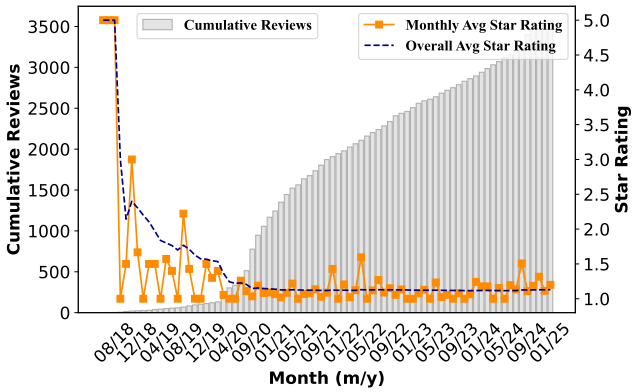


Figure 1: The count, star rating, and average star rating of every extension review we collected, from 2017 to 2024.

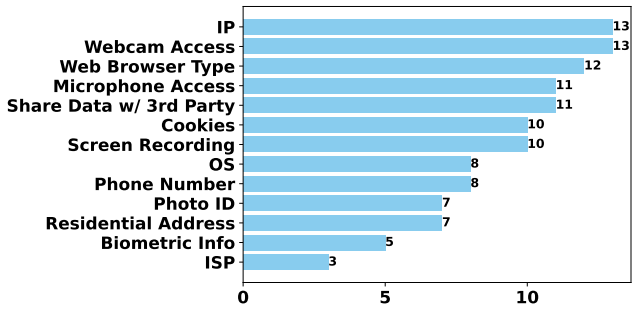


Figure 2: Disclosed data collection practices by (n = 13) exam proctoring software present in privacy policies.

information. Our study protocol was approved by our Institutional Review Board, with approval number NCR235283.

5 Results

In this section, we first detail changes in the exam proctoring extension ecosystem (**RQ1**) followed by analyzing participants' privacy perceptions of online proctoring software (**RQ2**). Lastly, we discuss the continued and broader perceptions of exam proctoring software (**RQ3**).

5.1 RQ1: Extension Analysis

To understand how exam proctoring extensions have evolved, as well as their potential security vulnerabilities, we analyzed popular extensions available on the Google Chrome extension store. We found that, out of the (n = 13) extensions we gathered reviews from, there was a steady uptick of reviews from 2021 to 2024 (Figure 1). In total, there were 1,172 reviews before and during 2020, and 2,412 from 2021 to 2024 (a 105% total increase).

Though the gradual rise in reviews suggests that browser extensions are still in use for exam proctoring, they continue to be unpopular among many test-takers. While the popularity of browser-based exam proctoring surged after July 2020, the monthly average rating for these extensions has consistently hovered around the overall average of 1.5 stars (Figure 1), which is similar to previous findings by Balash et al. [8]. With approximately 3,500 reviews collected across the 13 extensions analyzed, this low rating highlights significant dissatisfaction levels among test-takers who are proctored via browser extensions.

Many exam proctoring browser extension reviews are still negative. We analyzed a total of 363 reviews written from 2015 to 2024. Because some of the popular proctoring software have moved away from browser extensions, we were only able to analyze a small number of reviews compared to Balash et al.'s 2020 study [8]. Additionally, Proctorio [67] re-uploaded their extension to the webstore, removing all reviews prior to 2024.

We found that many reviews were solely negative (n = 154 ; 42.4%), with test-takers having sentiments such as "*systems like these make me wish one could give a zero-star review*"; only a small percentage (n = 6) of users reported liking exam proctoring extensions. Over a third of test-takers directly mention privacy and security concerns (n = 147) with sentiments such as "*this exam is complete spyware*" and "*terrible invasion of privacy.*" Technical difficulties (n = 112) were also heavily featured in reviews: "*... at some point during the exam the software is unable to recognize my face and kicks me out, claiming face not visible ... I have to restart, re-certify myself with photo and ID card, and attempt to reload the exam where I left off. Sometimes, this process crashes my browser entirely and I have to repeat again.*" Other issues reviewers mentioned included the stress associated with taking the exam (n = 12), as well as issues with the human exam proctor (n = 25) and product support (n = 35). Not only can this be inconvenient to test-takers, but some reviewers also noted that they sometimes had to pay to retake tests due to technical errors.

Shifts from browser extensions to custom software. Some of the proctoring services that do not have browser extensions have fully custom software, including custom browsers. For example, Examsoft [27] uses its own application that test-takers are required to download to take exams. While it is unclear why many proctoring services shifted to software solutions, the reviews within our dataset suggest that extension functionality was inconsistent and buggy. We hypothesize that proctoring companies have moved toward using software applications to overcome the constraints within the browser extension ecosystem.

We also found that proctoring software can be integrated into existing learning management systems (LMS), such as Blackboard [10] or Moodle. Honorlock [37], which also has a browser extension [8], can now integrate entirely into LMS software. This could influence test-takers' acceptance of proctoring software, which we discuss further in Section 6.

Privacy policy and manifest permissions remain largely unchanged. We analyzed the privacy policies of the 11 extensions we found on the Google Chrome extension store and their accessed permissions from the extensions' *manifest* files. As shown in Table 2, **Tab** control is the most common permission requested; this is likely to monitor the opening and closing of browser tabs. Proctortrack requests the most permissions out of the extensions in our dataset.

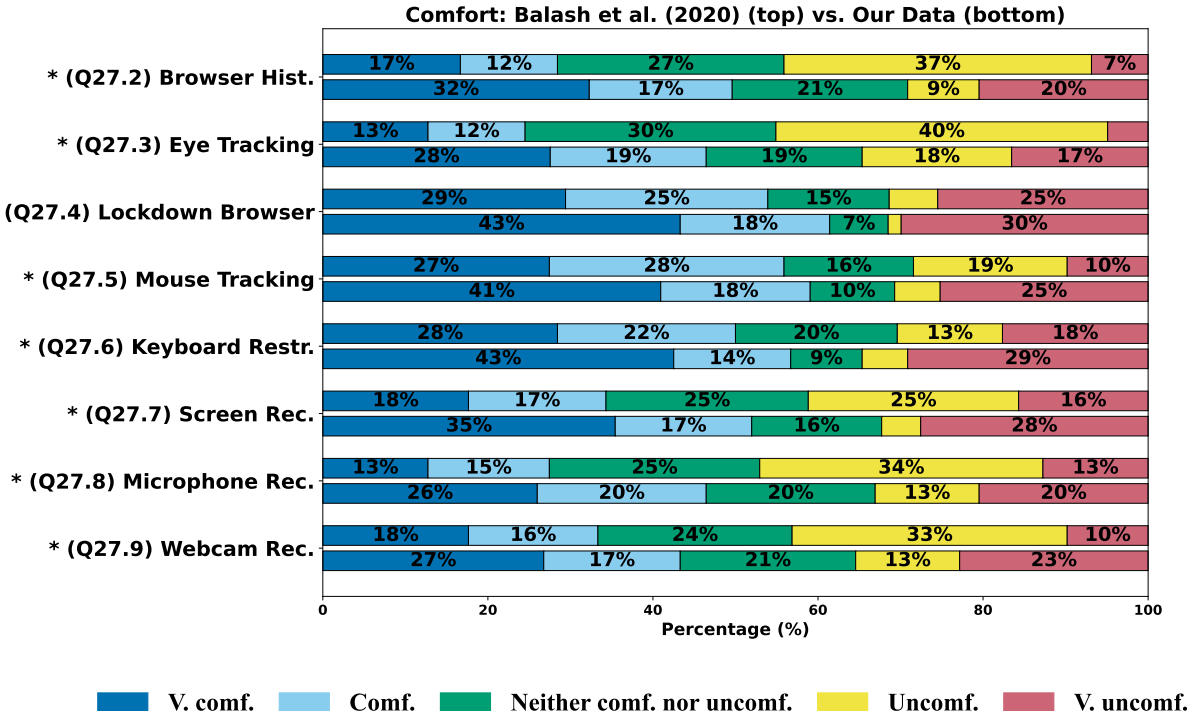
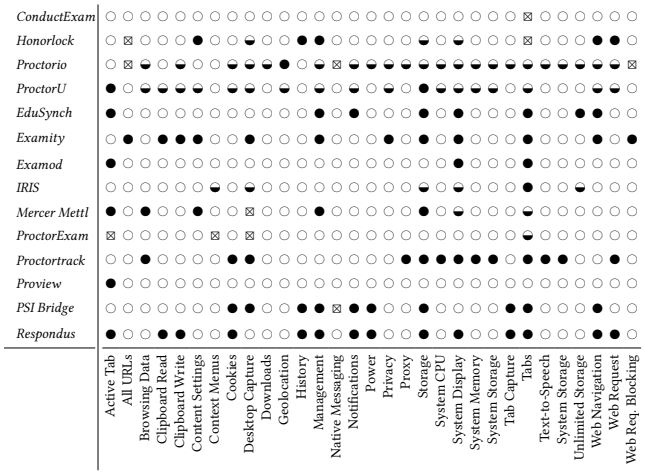


Figure 3: Shifts in comfort of proctoring methods, compared to Balash et al. [8]. Bars notched with a * indicate significance. Note that the graph percentage values indicators below 6% are omitted for the sake of visual clarity.

Table 2: Permission access of browser extensions via the manifest files, and comparison with Balash et al. [8].



Legend:
●: Permission granted in 2024.
⊠: Permission granted in Balash et al.
◒: Permissions are granted in both studies (permissions unchanged).
○: Permission not granted in 2024 or Balash et al. (or the extension was not part of original study).

We also measured the disclosed data collection practice each extension states in their privacy policies. Webcam and IP address access are the most requested (Figure 2), which aligns with the findings by Balash et al [8].

Summary. We find that proctor extension software has remained largely unchanged since Balash et al.'s study [8], with apps still requesting many of the same permissions from test-takers. Reviews have stayed consistently low, with reviews in our dataset averaging a 1.5 out of 5 stars. Reviewers believe that exam proctoring software is security and privacy invasive, with technical issues notably prominent. This is in contrast to participant sentiment in our survey.

5.2 RQ2: Privacy Perception Changes

Participants are less concerned about exam proctoring software compared to previous work. Questions **Q34** through **Q39** assessed participants' privacy perceptions of exam proctoring software, such as concerns with data collection and the privacy invasiveness of the software. We find significant shifts in preference in almost every likert-scale question. Over 70% of respondents believed that proctoring software provides an acceptable balance between privacy and academic integrity ($U = 8713.5; p < .001$; Figure 8, **Q37**), a substantial increase from the 41% observed in prior work by Balash et al. [8]. There was less concern about sharing information with proctoring companies ($U = 4929.0; p < .1$),

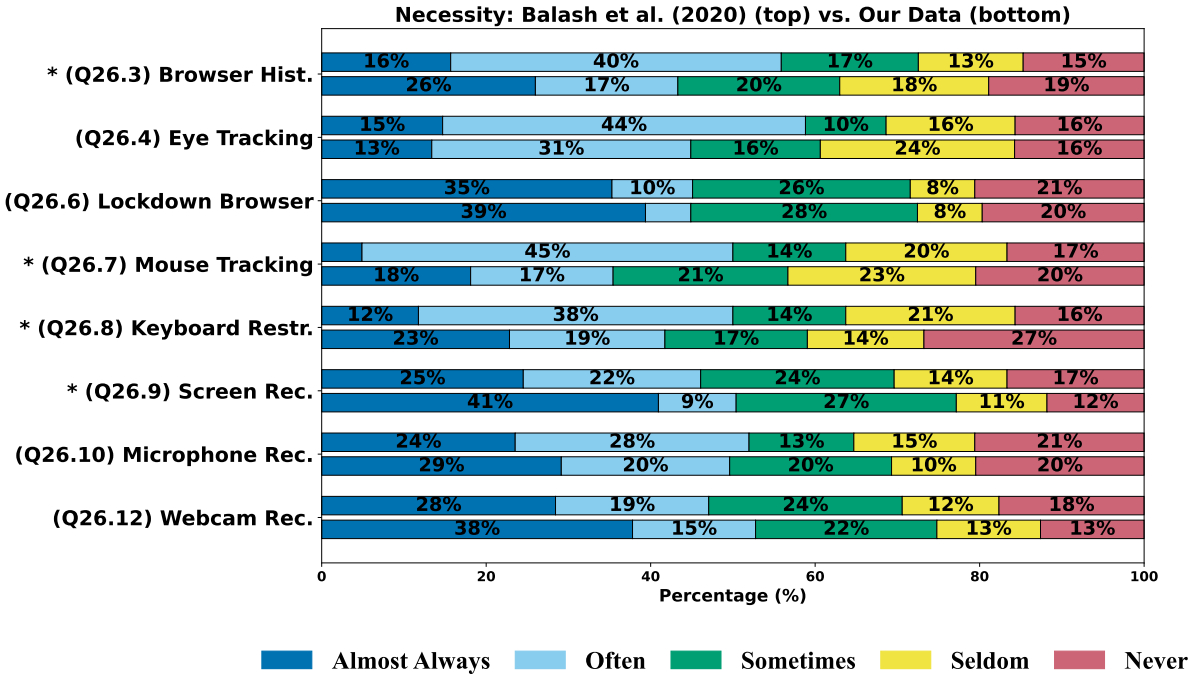


Figure 4: Shifts in perceptions of necessity of proctoring methods, compared to Balash et al. [8]. Bars notched with a * indicate significance. Note that values below 6% are omitted for the sake of visual clarity.

more faith in proctoring services not being privacy invasive ($U = 4631.5; p < .01$), and less concern about privacy risks when using proctoring software ($U = 4762.0; p < .01$). Additionally, exam proctoring garnered significantly more support, with over 75% of participants in our study agreeing that exam proctoring software is suitable for remote exams; this is an increase from the 50% reported by Balash et al. [8].

When asked to elaborate on how they felt about giving information to proctoring companies (**Q35**), those who were open to sharing stated that they simply felt comfortable doing it ($n = 34$; 25%), trusted in the company ($n = 11$; 8%), or felt that their data is necessary for the software to function ($n = 9$; 6%). Most participants that were apprehensive mention data integrity concerns ($n = 55$; 42%), especially regarding the possibility of their data being leaked. For example, one participant stated that they are "*concerned with providing personal information to any company as it has been proven many times this data can be leaked or hacked*" (P60). Indeed, prior work has found exam proctoring software to be vulnerable [13], and some exam proctoring companies have faced breaches in the past [1].

Participants are more comfortable with proctoring methods compared to previous work. We assessed participant comfort with proctoring methods by asking them to rate their comfort level of each proctoring method on a 5-point likert scale, from the most to the least comfortable (Figure 3). All methods, except lockdown browsers ($U = 5319.0; p = 0.198$), showed increased participant comfort compared to Balash et al.'s [8] study (Figure 3). This included browser history ($U = 3649.5; p < .001$), eye ($U = 3997.5; p < .001$), and mouse tracking ($U = 4238.0; p < .001$), as well as keyboard restrictions ($U = 4669.5; p < .01$), and finally screen ($U = 4101.5; p < .001$), webcam ($U = 4419.0; p < .001$), and microphone recording ($U = 4439.5; p < .001$). Notably, every method **except** keyboard restrictions saw a significant increase in comfort level compared to Balash et al. [8], even the most privacy-invasive methods such as eye tracking and browser history monitoring.

We additionally assessed participant's comfort with exam proctoring methods broadly (**Q22**), where we observed only a slight increase in comfort ($U = 5663.0; p < .1$; Figure 5). Overall concern with installing proctoring software on personal devices was also assessed, where we saw a marginal increase in concern ($U = 5419.0; p < .1$; Figure 6).

To explore the factors affecting monitoring comfort, Balash et al. [8] performed an ordinal logistic regression and found that comfort with live proctoring and webcam recordings significantly increased the likelihood of being more comfortable with exam proctoring generally. We replicated the ordinal logistic regression (see Table 3 in Appendix B) and found that these methods were **no longer** significant factors affecting overall monitoring comfort. One possibility for this change is that as people began to use applications such as Zoom more often for online courses and other interactions during the pandemic, they became comfortable with having others view them through their computer's web camera in a classroom.

Participants have mixed perceptions of the necessity of different proctoring methods. Next, we gauged how participants

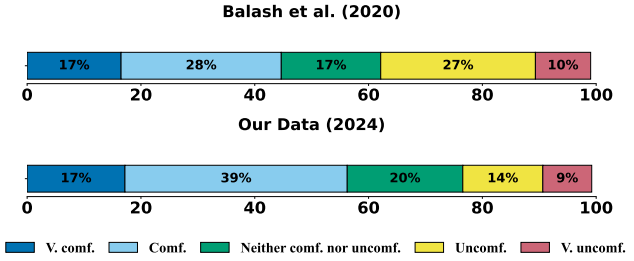


Figure 5: The general comfort with proctoring methods among participants (Q22), compared to Balash et al. [8].

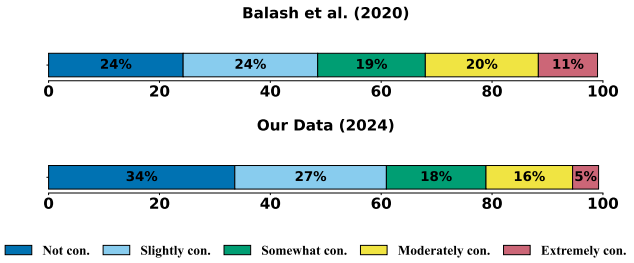


Figure 6: The general concern with downloading proctoring software onto personal computers among participants (Q49), compared to Balash et al. [8]. Note that values below 5% are omitted for the sake of graph clarity.

felt about the necessity of each proctoring method (Figure 4). Similar to assessing their comfort (Figure 3), we asked participants to rate the necessity of each surveillance method on a likert scale from most to least necessary. We found that participants' views were highly polarized; browser history tracking ($U = 4895.0$; $p < .1$), mouse tracking ($U = 4168.5$; $p < .001$), and keyboard restriction ($U = 4673.0$; $p < .01$) all saw increases in both extremes ("Almost Always" and "Never"). Screen recording ($U = 4884.5$; $p < .1$), in particular, saw an increase in being perceived as always necessary. This difference in perceived necessity may stem from the growing sophistication (and usage) of these tools after the pandemic, which we further discuss in Section 6.

All other methods saw no significant changes in user perception, including eye tracking ($U = 5837.5$; $p = 1$), lockdown browsers ($U = 6029.0$; $p = 1$), microphone recording ($U = 5568.0$; $p = .53$), and webcam recording ($U = 5825.5$; $p = 1$).

Summary. We observe a significant shift in favor of exam proctoring software in our study. Participants feel that exam proctoring software maintain an acceptable amount of privacy and are more comfortable sharing data with proctoring companies. One reason for this is the convenience of taking exams without having to travel in-person. Participants are also more comfortable with proctoring methods, even though they may have mixed feelings about their necessity.

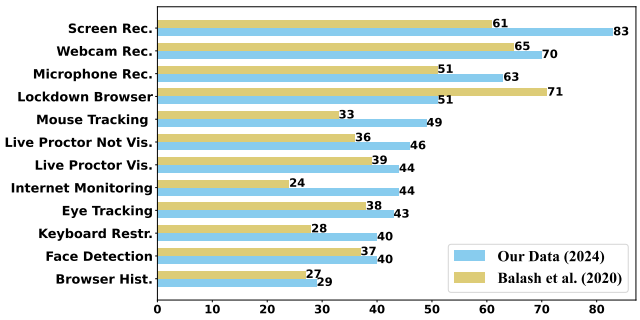


Figure 7: The number of encountered proctoring methods reported by participants, compared to Balash et. al [8].

5.3 RQ3: Exam Proctoring Usage Trends

Finally, we detail the continued use and broader perceptions of proctoring software. We examine how proctoring software has evolved since 2020, its usage, and user experiences.

Proctoring methods have not shifted. From χ^2 tests, none of the exam proctoring methods saw significant statistical changes compared to 2020 (Figure 7). This suggests that proctoring software still remains as invasive as it has in the past [8, 79], or that instructors are still willing to use invasive settings. While not statistically significant, we see less participants reporting the use of lockdown browsers, but more in every other category. This may be due to the growing resistance of this method by students, as outlined in Simko et al. [79]. The complexity of implementing lockdown features compared to others may also be the reason for this shift, including potential security risks associated with lockdown browsers [20]. We hypothesize that increased exposure to monitoring methods leads to increased acceptance by test-takers (Figure 3, detailed in Section 5.2.)

Participants believe they can cheat even when using proctoring software. We found no statistically significant changes in people's belief that exam proctoring makes it less likely to cheat ($U = 7577.0; p < .05$; **Q29**). We also found no significant difference in how test-takers perceive their ability to cheat ($U = 4964.5$; $p < .05$; **Q30**). This suggests that, despite the growing sophistication of these technologies [13], test-takers still believe cheating is possible (Figure 8); for example, P113 stated that: "*without somebody directly watching you and your environment it is easy to cheat.*"

Proctoring software is still plagued with technical difficulties. Some participants mentioned technical difficulties during their proctoring experience ($n = 17$; **Q16**). Sometimes services did not work on test-takers' devices: "*The software wouldn't load the first time I was scheduled to take [the exam] ...*" (P127). Sometimes proctoring agents flagged test-takers' environment in a seemingly random way, as one participant described, "*I was getting flagged for noise disturbances like the garbage truck and kids screaming on the street*" (P115) and "*at one point the software couldn't see me well enough for a split second and paused the exam*" (P89). Other issues included long loading times (P135), and unstable internet

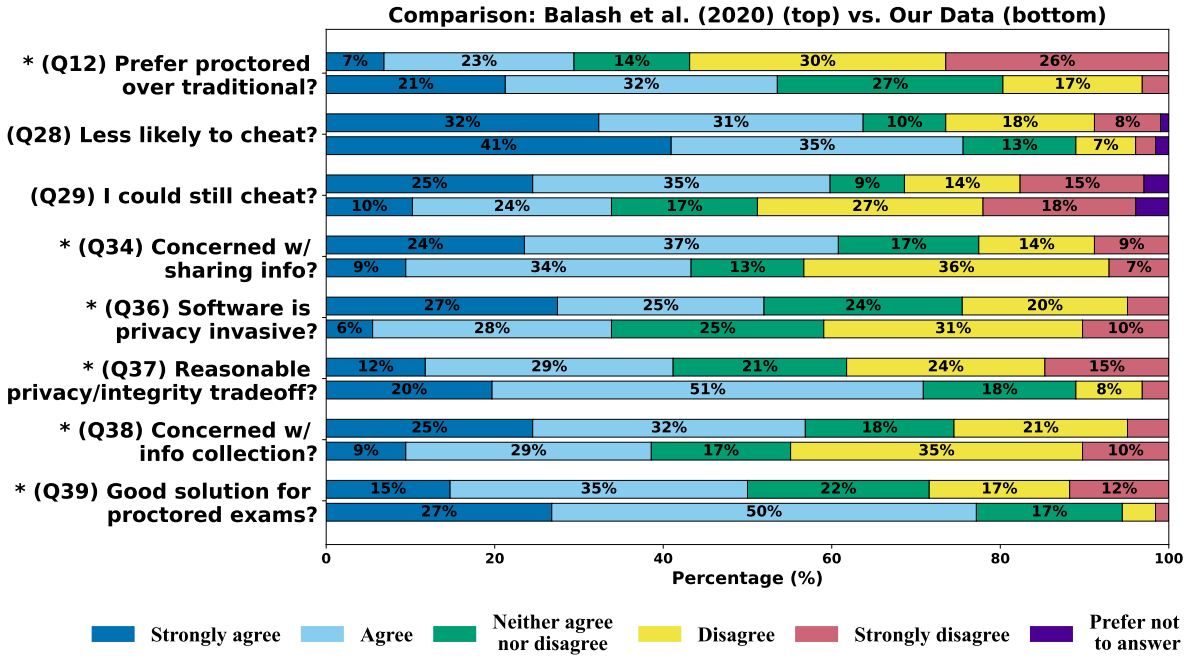


Figure 8: Shifts in privacy perceptions among participants compared to 2020, questions Q12, Q29, Q30, Q34, Q36, Q37, Q38, Q39. Bars notched with a * indicate significance. Note that values below 5% are omitted for the sake of visual clarity.

causing participants to disconnect without a way to reconnect to their exam (P122). This aligns with both our review analysis 3.2 and prior work [79].

Several participants appreciate the convenience of taking exams remotely. Some participants preferred online proctored exams due to convenience, citing the ability to take the exam at home as a key factor ($n = 18$; **Q7**); "*... I had two choices, and the one I chose seemed the easier way to go about it, otherwise I had to go through a testing center. So basically, my choices were go through a testing center, or go through MonitorEDU. I was more comfortable with the later [sic] option*" (P124).

However, some mentioned that the convenience of online proctoring was not a choice, but a necessity due to limited access to physical testing centers. For example, one participant stated: "*Primarily it was challenging for me to reach the closet [sic] in person exam center. It was either an hour long bus ride or a $30 dollar Uber ride ...*" (P57). Limitations due to the pandemic (P21, P48) were also cited.

More participants indicated a preference for proctoring software compared to previous work. We saw a significant increase in the number of participants who prefer online proctored exams over traditional exams ($U = 9239.5$; $p < 0.001$; **Q12**). When asked to describe the overall experience of being monitored, over half ($n = 68$) mentioned having a good experience using the software. For example, one participant commented on how they liked how the proctoring service forced them to be more disciplined during their studies: "*I actually enjoy proctored exams. It forces me to be disciplined and careful and I like that*" (P54). Others commented on how they liked the service because it preserved academic integrity, "*It was solid. I liked that I was on camera. I preferred showing my professor I knew the course material and did not cheat on the test*" (P50). While there are many contextual factors that play a role in whether remote proctoring prevents cheating [23, 74, 85], these comments suggest that the surveillance techniques are effective at convincing test-takers that the services are able to preserve integrity. Other factors participants mentioned included ease of use (P14), the unobtrusiveness of the software (P102), and convenience (P72), with many answers expressing generic approval of their experience ("*it was good*" (P71)).

Some participants in our dataset disliked proctored exams. While this sentiment was uncommon ($n = 29$), reasons included distracting surveillance methods, negative proctoring experiences, and more anxiety throughout the exam. For example, one participant notes that they were more focused on making sure they didn't look suspicious than taking the exam itself; " *... The online proctored exams were stressful and I felt I was spending the majority of the time concerned with making sure my face was on the webcam and that I wasn't doing anything that could be misconstrued as suspicious*" (P46). This sentiment is also heavily reflected in prior work [22, 65, 79].

To explore the factors that may drive a preference for or against taking an online proctored exam, Balash et al. [8] performed an ordinal logistic regression and found that test-takers who were more concerned about the amount of information collected by the proctoring services were significantly less likely to prefer online proctored exams over traditional exams. We replicated the ordinal logistic regression (see Table 4 in Appendix B) and found that concern about information collection was **not** a significant factor.

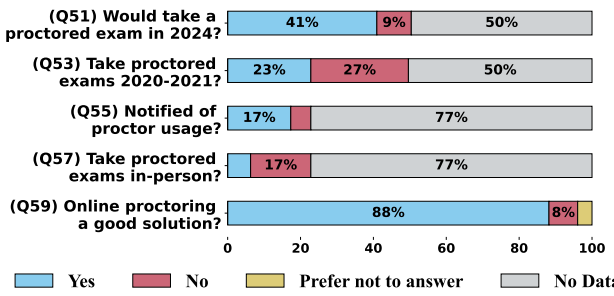


Figure 9: Percentage of participants that answered either yes, no, or prefer not to answer regarding their post-COVID perspectives. Values below 7% are omitted for visual clarity. Questions Q51, Q53, Q55, Q57, Q59.

This may show that test-takers perceptions of exam proctoring is now less influenced by the data collection requirements of these tools. However, we did find that participants who reported being *Moderately* or *Extremely* aware of the methods used to proctor online exams (**Q21**) were significantly **less likely** ($\eta = 2.1, OR = 8.2, p < 0.001$) to prefer online proctored exams (**Q12**).

Participants are willing to take proctored exams post-pandemic. Questions **Q51** through **Q60** explore participants' post-COVID testing experiences following the lifting of COVID-19 restrictions. An overview of the responses can be found in Figure 9. Note that participants were either able to answer **Q51 or Q53** based on their responses to previous sections. Then, participants who answered yes to **Q51** were then further allowed to answer **Q55** and **Q57**.

Q51 asked participants who did not take a proctored exam post-COVID (after 2022) if they would have chosen to take an online proctored exam during the 2024 school year. A majority of ($n = 63$) participants said they would if given the option ($n = 53$ of 63). Participants who took proctored exams both during the COVID-19 pandemic and afterward (**Q51**) were asked if they preferred to take exams in-person – over half ($n = 21$ of 29) reported they would not. When asked why, participants once again mentioned convenience being an important factor. One user, for example, discusses the financial difficulty of taking in-person exams, "*I have a busy life. I have a wife and kids to take care of. Gas is expensive. Car maintenance is expensive. I can't really think of any reason why I would want to take the exam in person*" (P98). We further discuss the trade-off between privacy and convenience in Section 6. Some participants also felt less anxious taking proctored exams or had good experiences with proctored exams; P19, for example states that "since I have good experience with this format, I would have no issue doing it again" (P19). Other motivators included less distractions when taking the test and personal comfort. For example, P32 comments: "*It's easier to take it at home. I can stay in my comfortable clothes and don't have to drive*".

Summary. Usage trends and participants' beliefs have significantly changed in comparison to Balash et al.'s work [8]. Despite the increase in the use of invasive monitoring methods, test-takers are more likely to prefer proctoring software compared to four years ago, widely because of the convenience they provide. While some participants did not like online proctored exams, they were a minority in our dataset. A majority of participants said they would take an exam with proctoring software again if given the option.

6 Discussion

In this paper, we replicated Balash et al's [8] study to investigate how attitudes toward exam proctoring software have changed over the last four years, with many pandemic measures now lifted and classes mostly back in-person. We find that participants have seemingly become comfortable with these tools due to their convenience affordances despite their privacy invasive proctoring practices.

In this section, we reflect on our findings and the potential differences with the earlier study by Balash et al. [8], then offer recommendations to various stakeholders.

6.1 Reflections from Prior Work

In our study, we find that test-takers are significantly more receptive toward online exam proctoring in almost every regard. Key differences compared to prior work [8] include participant's preference for proctored exams over in-person exams, less concern with information sharing and collection practices, and a greater belief that proctoring software was both a good solution during the pandemic, and offers a reasonable privacy/integrity trade-off.

In their study, Balash et al. [8] recommended better avenues for students and educators to deliberate over the usage of exam proctoring tools. From our replication study, we observe that there has only been marginal improvements in this regard; the vast majority of exam proctoring test-takers were still **required** to use proctored exams in our dataset (**Q7**, Figure 10), though more test-takers that did take proctored exams were notified in advance that they were going to be used (**Q55**, Figure 9).

Furthermore, we found that fewer of our participants installed browser extensions, instead using more standalone software (Figure 10). While the difference is minimal, this suggests that more proctoring companies are moving away from browser extensions (Section 6.3). We hypothesize that the proliferation of exam proctoring technology during the pandemic has lead to more sophisticated solutions – as such, software can either be their own application outside the browser ecosystem, or integrated directly in existing solutions (LMS), which we discuss in Section 6.3.

Still, the majority of test-takers who could recall their uninstall decision did not uninstall proctoring software from their devices (Figure 10), both standalone and extensions, despite the risk of vulnerabilities being significant [13, 48]. We hypothesize that this is due to both privacy resignation and the ubiquity of this software, which we discuss next.

6.2 Privacy Resignation and Acceptance of Proctoring Software

Seberger et al. describes a sense of privacy fatalism among test-takers overwhelmed by applications that request, store, and use their personal data [75]. This leads to users feeling that privacy violations are an inevitable compromise to engage in the digital

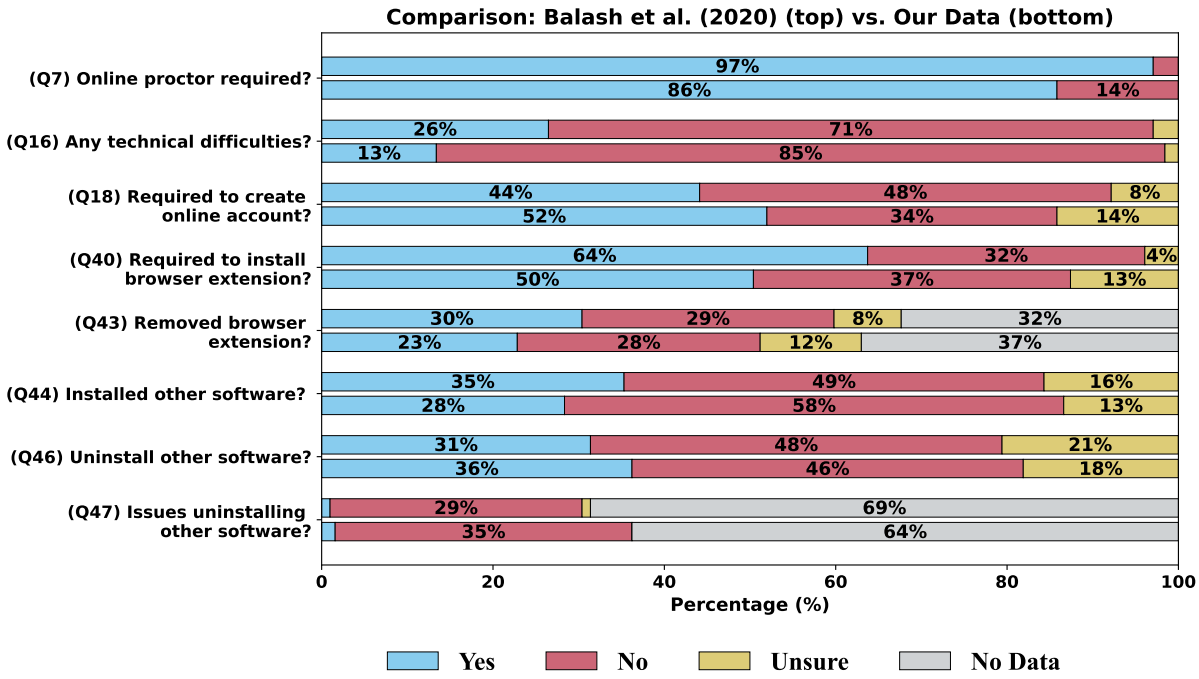


Figure 10: Assessments in exam proctoring usage, compared to Balash et al. [8]. Values below 4% are omitted for visual clarity. Questions Q7, Q16, Q18, Q40, Q43, Q44, Q46, Q47.

landscape. We find evidence in both extension reviews and open-text responses that users of exam proctoring software (test-takers) **are** aware of the security and privacy risks posed by online exam proctoring tools, but feel they have no choice but to use the software anyway. Specifically, we saw that participants are more comfortable with the majority of surveillance mechanisms, even the most privacy-invasive kind, such as browser history monitoring and eye tracking (Figure 3). This comfort can be attributed to many things; for one example, during the pandemic, Zoom experienced a 1900% increase in activity, becoming a tool that millions of users used to navigate work, school, and social activities [41]. Having been conditioned to expect webcam access during the pandemic, test-takers likely feel more comfortable with monitoring of any kind when using online proctored exams.

Both privacy resignation [75] and power dynamics likely play a significant role in this belief. Indeed, prior work examining the relationship between institutions and test-takers find that test-takers' consent to using specific kinds of technology is questionable [8, 78, 79, 84]. Shioji et al. points out that decentralized decision-making is difficult to implement among institutional settings, and is thus rarely considered [78].

Paradoxically, normalcy bias may also play a role in perception changes. Participants in our dataset expressed a willingness to retake proctoring exams in the future due to having good experiences in the past. This may cause test-takers to underestimate (or not consider) the risks that proctoring software pose, such as information breaches [1, 13, 48].

6.3 Exam Proctoring Improvements and Edtech Integration

We further hypothesize that the growing sophistication of proctoring software has changed users' security and privacy perceptions. With the pandemic having accelerated the adoption of these tools [29], it followed that direct integration into existing edtech software such as Blackboard [10] became a priority for many vendors. From both prior work [8, 79] and our data, initial trials with proctor extensions were fraught with challenges that left test-takers both frustrated and (at times) unable to take their exams. A departure from extensions toward software-based (and integrated) solutions meant greater control over the exam ecosystem by institutions – this shift is supported by our replication results.

However, this may come as a consequence of test-takers unable to discern what systems they **can** abstain from (exam proctoring software) and what systems are necessary (such as assignment submission systems). This may also drive the perception that these services are more convenient to participants; if test-takers are already engaging with one part of the system, they may be more inclined to utilize the services within the same platform without realizing the privacy risks. Beyond convenience, attitudes toward surveillance are changing among the general population. Wu et al.'s analysis on harms of online behavioral advertisement demonstrate that participants often feel powerless in the face of mass-surveillance [90]; indeed, some of our participants indicated that abstaining from surveillance methods wouldn't matter, since they've already shared so much personal information to the proctoring companies. Longitudinally, this has disturbing implications for

subtle surveillance within edtech (and broader) tech apparatuses as a whole. It is possible the attitudes we captured in this study reflect broader reservations of privacy attitudes as a whole, in the name of convenience, within the US population [75, 90], suggesting a need for better mechanisms (regulatory or otherwise) that provide holistic protection to citizens, especially those most at risk of privacy harms [80].

6.4 A Need for Alternative Testing Methods and Decentralized Decision-Making

While we find that most participants in our study were more comfortable with exam proctoring software compared to Balash et al's [8] study conducted four years ago, their efficacy in ensuring exam integrity drew mixed reactions from participants. While some participants indicated that these tools are effective, several others pointed out that they can effectively circumvent these tools to cheat on proctored tests. In fact, work by Simko et al. [79] highlights the diverse techniques that students can use to circumvent proctoring techniques. This inefficacy in stopping cheating, coupled with privacy discomfort and distraction posed by proctoring tools as well as their biases based on test takers' race, skin tone, and gender [13, 14, 19, 49, 55, 77, 93] raise questions whether the use of these tools is even worthwhile. Perhaps, there might be opportunities for examiners to rethink how they evaluate students all together, including using open-note exams and effort-based grading for certain courses to encourage more active learning. Alternatively, if exam proctoring is necessary, institutions should provide test-takers with alternative resources, such as posting notice of available testing centers or allowing test-takers to rent hardware with proctoring software pre-installed.

We also found that most test-takers fail to remove proctoring software from their computers after taking an exam. Either software or instructors should provide un-installation reminders to students after the exams are completed. Alternatively, browser extensions could auto-delete after a certain amount of time. Lastly, the privacy of test-takers must be considered in equal weight when deciding to adopt exam proctoring software. We recommend more avenues for negotiation between test-takers and institutions regarding the usage of proctoring software. This can be in the form of explicit privacy policies and explanation of security and privacy implications of proctoring software, including notice of potential vulnerabilities. It is especially critical to inform test-takers when the software is already integrated into LMS. We encourage Shioji et al.'s recommendations of developing frameworks that highlight the security, privacy, and safety dimensions of these tools [78].

6.5 A Need for Privacy-Preserving Proctoring Services

From our results, we find that test-takers are significantly more receptive to exam proctoring software and their surveillance techniques. This suggests that there **is** a niche for this software, and test-takers will continue to use them in the near future. However, proctoring software remains largely the same in the permissions they access and their privacy-invasiveness.

As such, our recommendations are two-fold: first, we recommend more work investigating ways to make proctoring services both integrity-preserving **without** increasing surveillance needs. For example, by measuring test-takers' responses to different surveillance conditions to pinpoint which are most effective can remove unnecessary methods. Participants in our dataset frequently expressed concerns regarding how proctoring companies use their data. While expanding the Family Educational Rights and Privacy Act (FERPA) to include protocols for specific kinds of datum edtech software collects can offer some protection, as prior work has highlighted [15, 34, 46], FERPA is often not robust enough to account for the growing market of invasive edtech software. As such, we recommend stronger policy guidelines that go beyond just FERPA protections, such as California's Student Test Taker Privacy Protection Act [44], to protect users' privacy.

Regarding proctoring software itself, we recommend investigating data assurance measures, including verifiable audits and clear data ownership policies (e.g., privacy nutrition labels [45]). Mukherjee et al. [55] advocates for privacy-preserving measures like selective obfuscation, which can hide non-essential visual cues while maintaining effective cheating detection. Second, understanding how security and privacy perceptions change when integrating proctoring software into existing systems – LMS and other Edtech settings – should be investigated. Vulnerability testing should also be a priority [13].

7 Conclusion

In this paper, we replicated a study by Balash et al. [8] that looked at the security and privacy perceptions of test takers toward exam proctoring tools. Our work shows that user acceptance of proctoring services has increased, despite the software's privacy invasiveness having remained relatively the same since 2020. We also find that users are more willing to give up their private information in order to take tests from home, and are less concerned with data collection. We recommend that the security and privacy risks of proctoring software are articulated to test-takers before they take exams using these tools. More research is crucially needed to evaluate the necessity of the most invasive surveillance methods.

Acknowledgments

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A Survey Instruments

A.1 Screening Survey

S1 I have taken this survey previously.
- ◯ Yes
- ◯ Unsure
- ◯ No

S2 How familiar are you with online exam proctoring?
- ◯ Not at all familiar
- ◯ Moderately familiar
- ◯ Slightly familiar
- ◯ Extremely familiar
- ◯ Somewhat familiar

S3 I have taken an online proctored exam.
- ◯ Yes
- ◯ Unsure
- ◯ No
- ◯ Prefer not to answer

S4 Please describe your overall online proctored exam experience.
Answer: _____

These questions were followed by the 10 IUIPC items as described by Malhotra et al. [50]

D1 What is your gender?
- ◯ Woman
- ◯ Prefer not to disclose
- ◯ Man
- ◯ Prefer to self-describe
- ◯ Non-binary

D2 What is your age?
- ◯ 18 – 24
- ◯ 55 – 64
- ◯ 25 – 34
- ◯ 65 or older
- ◯ 35 – 44
- ◯ Prefer not to disclose
- ◯ 45 – 54

D3 Are you currently a student?
- ◯ Yes
- ◯ Prefer not to disclose
- ◯ No

D4 What is the highest degree or level of school you have completed?
- ◯ No schooling completed
- ◯ Some high school, no diploma
- ◯ High school graduate, diploma, or equivalent (e. g., GED, Abitur, baccalaureat)
- ◯ Some college credit, no degree
- ◯ Trade / technical / vocational training
- ◯ Associate degree
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Professional degree (e. g., J.D., M.D.)
- ◯ Doctorate degree
- ◯ Prefer not to disclose

D5 Which of the following best describes your educational background or job field?
- ◯ I have an education in, or work in, the field of computer science, computer engineering or IT.
- ◯ I do not have an education in, nor do I work in, the field of computer science, computer engineering or IT.
- ◯ Prefer not to disclose

A.2 Main Study

Thank you for participating in the second part of our survey. You have been invited to our main study because of your direct experience taking an online proctored exam.

Your answers based on your online exam proctoring experiences are important to us!

Please read the following instructions carefully:
- Take your time in reading and answering the questions.
- Answer the questions as accurately as possible.
- It is okay to say that you don't know an answer.

Q1 How many online proctored exams have you taken?
- ◯ 1
- ◯ 3
- ◯ 5+
- ◯ 2
- ◯ 4

Q2 What was the nature of the exam(s) you took using an online proctoring service? Select all that apply.
- ◯ Course Quiz
- ◯ Course Exam (E.g. test, midterm exam, final exam)
- ◯ Standardized Test (E.g. GRE, GMAT, bar exam)
- ◯ I have not taken an exam with online proctoring
- ◯ Other: _____

Q3 Of those ones you chose, which is the most recent?
- ◯ Course Quiz
- ◯ Course Exam (E.g. test, midterm exam, final exam)
- ◯ Standardized Test (E.g. GRE, GMAT, bar exam)
- ◯ I have not taken an exam with online proctoring
- ◯ *[Other value entered in **Q2**]*

Q4 As best as you can remember, when was the month, date, and year when you last took an online exam with a proctoring service?
- ◯ Month: _____
- ◯ Day: _____
- ◯ Year: _____

Q5 What was the subject matter of the last examination you took using an online proctoring service?
Answer: _____

Q6 What was the name of the online proctoring service used during your last examination?
- ◯ ConductExam
- ◯ Respondus
- ◯ Kryterion
- ◯ Pearson OnVUE
- ◯ Honorlock
- ◯ ProctorU
- ◯ PSI Online Proctoring
- ◯ Proctorio
- ◯ Talview
- ◯ Examity
- ◯ Smowl
- ◯ Mercer Mettl
- ◯ ProctorExam
- ◯ YouTestMe
- ◯ Proview
- ◯ Questionmark
- ◯ IRIS Invigilation
- ◯ TestReach
- ◯ ExamSoft
- ◯ Proctortrack
- ◯ Other: _____
- ◯ ProctorFree
- ◯ Surpass
- ◯ Unsure

Q7 Were you required to take that exam using an online exam proctoring service?
- ◯ Yes, I was required to use an online exam proctoring service.
- ◯ No, there were other forms of assessment available to me but I opted to use an online exam proctoring service

Q8 Who required you to take an online proctored exam?
Answer: _____

Q9 What were the deciding factors in your choice to take your exam with an online proctoring service instead of other forms of assessment?
Answer: _____

Q10 In your experience, what are some benefits of using online exam proctoring?
Answer: _____

Q11 Please explain your views on the privacy of online exam proctoring.
Answer: _____

Q12 I prefer online exam proctoring services over traditional exam formats.
- ◯ Strongly disagree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly agree
- ◯ Neither agree nor disagree

Q13 Did the online proctoring service make any necessary exam accommodations or other modifications based on your needs as an exam taker?
- ◯ Yes, I request and was provided adequate accommodations
- ◯ No, I requested and was not provided adequate accommodations
- ◯ I did not request nor require exam accommodations
- ◯ Unsure
- ◯ Prefer not to answer

Q14 Please describe the accommodations provided to you. You may indicate N/A if you prefer not to answer. *[Shown only if answer to **Q13** was "Yes"]*
Answer: _____

Q15 Please describe how accommodations were not provided for you despite your request. You may indicate N/A if your prefer not to answer. *[Shown only if answer to **Q13** was "No"]*
Answer: _____

Q16 Did you experience any technical difficulties when taking your exam as it relates to the online proctored service?
- ◯ Yes
- ◯ No
- ◯ Unsure

Q17 Please explain any technical difficulties you may have experienced during your exam with the online proctored service. *[Shown only if answer to **Q15** was "Yes"]*
Answer: _____

Online Exam Proctoring Methods. In this part of the survey you will be asked about the methods employed by online exam proctoring services.

Q18 When preparing to take an online proctored exam were you required to create an account with the online proctoring service?

◯ Yes ◯ No ◯ Unsure

Q19 When registering for an online proctored exam what, if any, personal information where you required to enter in online forms? Select all that apply.
◯ Residential Address ◯ Driver's License Number
◯ Educational institution affiliation ◯ Phone Number
◯ Email Address ◯ No information was required
◯ Student ID Number ◯ Unsure
◯ Full Name ◯ Other: _____
◯ Social Security Number

Q20 When taking an online proctored exam what kinds of physical documentation, if any, were you required to provide? Select all that apply.
◯ Driver's License
◯ Student ID
◯ Passport
◯ No physical documentation was required
◯ Unsure
◯ Other: _____

Q21 How aware are you of the methods used by online exam proctoring services to monitor exam takers?
◯ Not at all aware ◯ Moderately aware
◯ Slightly aware ◯ Extremely aware
◯ Somewhat aware

Q22 How comfortable were you with the methods used to proctor the exam(s) that was proctored online?
◯ Very comfortable
◯ Comfortable
◯ Neither comfortable nor uncomfortable
◯ Uncomfortable
◯ Very uncomfortable

Q23 Please select all methods that were used to proctor the exam(s) that was proctored online. Select all that apply.
◯ Live proctor visible to me
◯ Live proctor not visible to me
◯ Web browser history monitoring
◯ Eye movement tracking
◯ Facial detection
◯ Lockdown browser
◯ Mouse movement tracking
◯ Keyboard restrictions (E.g. no copy and paste)
◯ Screen recording
◯ Microphone recording
◯ Internet activity monitoring (E.g. interaction with a web site)
◯ Webcam recording

Q24 Please describe any methods not listed above, or indicate "none" if there are no more methods.
Answer: _____

Q25 Please describe your overall experience being monitored during your online proctored exam.
Answer: _____

Q26 Previously you indicated that your most recent online proctored exam was a *[Answer from **Q3**]*. Please refer to that experience in answering the following questions. Considering your most recent online proctored exam, what kind of monitoring (if any) was necessary to proctor that exam online?
Answer: _____

Q27 Previously you indicated that your most recent online proctored exam was a *[Answer from **Q3**]*. Again considering your most recent exam from the question above. For each exam monitoring type please select how often they are necessary for online proctoring.

	Always	Often	Sometimes	Rarely	Never
Live proctor	◯	◯	◯	◯	◯
Web browser history monitoring	◯	◯	◯	◯	◯
Eye movement tracking	◯	◯	◯	◯	◯
Lockdown browser	◯	◯	◯	◯	◯
Mouse movement tracking	◯	◯	◯	◯	◯
Keyboard restrictions (E.g. no copy/paste)	◯	◯	◯	◯	◯
Screen recording	◯	◯	◯	◯	◯
Microphone recording	◯	◯	◯	◯	◯
Webcam recording	◯	◯	◯	◯	◯

Q28 Again considering your most recent online proctored exam of *[Answer from **Q3**]*. For each exam monitoring type please select how comfortable you feel about them.

	Very Comfortable	Comfortable	Neither comfortable nor uncomfortable	Uncomfortable	Very Uncomfortable
*[Types from **Q27**]*	◯	◯	◯	◯	◯

Online Exam Proctoring Functionality. In this part of the survey you will be asked about the functionality of online exam proctoring services. If you feel uncomfortable answering any question below, you may select "Prefer not to answer."

Q29 The use of online exam proctoring tools makes it less likely that my classmates or I will cheat on an exam.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree ◯ Prefer not to answer

Q30 If I wanted to, I believe I would still be able to cheat even with online exam proctoring.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree ◯ Prefer not to answer

Q31 Please explain your belief about the ability to cheat (or not cheat) with online proctored exams. Or write N/A if you prefer not to answer.
Answer: _____

Q32 Have you been accused of cheating by exam proctoring software?
◯ Yes ◯ Prefer not to answer
◯ No

Q33 Which of the following methods employed by the online exam proctoring software was used to accuse you of cheating? Select all that apply. *[Shown only if answer to **Q32** was "Yes"]*
◯ Live proctor visible to me
◯ Live proctor not visible to me
◯ Web browser history monitoring
◯ Eye movement tracking
◯ Facial detection
◯ Lockdown browser
◯ Mouse movement tracking
◯ Keyboard restrictions (E.g. no copy and paste)
◯ Screen recording
◯ Microphone recording
◯ Internet activity monitoring (E.g. interaction with a web site)
◯ Webcam recording
◯ Unsure
◯ Other: _____
◯ Prefer not to answer

Privacy Concerns. In this part of the survey you will be asked about the benefits and potential risks you associate with online exam proctoring.

Q34 I am concerned about sharing information with online exam proctoring companies.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree

Q35 Please explain your answer to the previous question regarding the consequences of sharing information.
Answer: _____

Q36 I think online exam proctoring services are too privacy invasive.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree

Q37 I think online exam proctoring offers a reasonable tradeoff between my privacy and the integrity of the exam.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree

Q38 I am concerned about the amount of information that online proctoring services collect during the exam.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree

Q39 I think online exam proctoring is a good solution for monitoring remote examinations.
◯ Strongly disagree ◯ Agree
◯ Disagree ◯ Strongly agree
◯ Neither agree nor disagree

Exam Proctoring Web Browser Extensions. A web browser extension is a small software module that is used to extend the functionality of your web browser

with additional features. Some online proctoring services require exam takers to install a web browser extension in order to take an exam. In this part of the survey you will be asked questions about your experience using web browser extensions to take online proctored exams.

Q40 To the best of your recollection, were you required to install and use a web browser extension in order to participate in a proctored online exam?
◯ Yes ◯ No ◯ Unsure

Q41 What do you think the browser extension did? *[Shown only if answer to **Q40** was "Yes"]*
Answer: _____

Q42 What was the most recent web browser extension you installed in order to participate in a proctored online exam? *[Shown only if answer to **Q40** was "Yes"]*
◯ ConductExam ◯ ProctorExam ◯ No browser extension was installed
◯ Examity ◯ Proctorio
◯ Honorlock ◯ ProctorU ◯ Other: _____
◯ IRIS Invigilation ◯ PSI Online Proctoring
◯ Mercer Mettl ◯ Unsure

Q43 Did you remove or disable any browser extensions that you were required to install to take an online proctored exam? *[Shown only if answer to **Q40** was "Yes"]*
◯ Yes ◯ No ◯ Unsure

Exam Proctoring Software. Some online proctoring services require exam takers to install standalone application software on a computer, like your PC or Mac, in order to take an exam. In this part of the survey you will be asked questions about your experience installing and using exam application software to take online proctored exams. Please note this may be in addition to the requirement to install a browser extension.

Q44 Did you have to install other types of exam proctoring software (not including a browser extension)?
◯ Yes ◯ No ◯ Unsure

Q45 What do you think this exam proctoring software did? *[Shown only if answer to **Q44** was "Yes"]*
Answer: _____

Q46 Did you uninstall the exam proctoring software? *[Shown only if answer to **Q44** was "Yes"]*
◯ Yes ◯ No ◯ Unsure

Q47 Did you have any issues uninstalling the exam proctoring software? *[Shown only if answer to **Q46** was "Yes"]*
◯ Yes ◯ No ◯ Unsure

Q48 From the computing devices listed below, please select the device you used to take your most recent online proctored exam.
◯ Personal Computer ◯ Mobile Device (Smartphone, Tablet, etc)
◯ Shared Home Computer
◯ School Issued Computer ◯ Unsure
◯ Public Computer (E.g. Library) ◯ Other: _____

Q49 How concerned are you about installing online exam proctoring software on the computer you used to take the exam?
◯ Not at all concerned ◯ Moderately concerned
◯ Slightly concerned ◯ Extremely concerned
◯ Somewhat concerned

Q50 Please explain your answer to the previous question regarding your concern about installing online exam proctoring software.
Answer: _____

Post-Covid Changes. In this next section, we will ask you questions regarding your test usage after 2020 and the uplifting of COVID 19 restrictions.

Q51 If you were given the option to take a proctored exam during the Fall 2024 school year, would you? *[Shown only if answer to **Q4** was "2022 or less"]*
◯ Yes ◯ No ◯ Unsure

Q52 Why/why not?
Answer: _____

Q53 Did you take online proctored exams during the 2020-2021 academic year? *[Shown only if answer to **Q4** was "2023 or greater"]*
◯ Yes ◯ No

Q54 How were your exams administered during the 2020-2021 academic year? *[Shown only if answer to **Q53** was "No"]*
Answer: _____

Q55 Were you notified that exam proctoring tools would be used in your class prior to taking your exam? *[Shown only if answer to **Q53** was "Yes"]*
◯ Yes ◯ No

Q56 What factors do you believe motivate your institution's continued use of exam proctoring tools? *[Shown only if answer to **Q53** was "Yes"]*
Answer: _____

Q57 Would you have preferred to take proctored exams in-person? *[Shown only if answer to **Q53** was "Yes"]*
◯ Yes ◯ No

Q58 Why/why not?
Answer: _____

Q59 In retrospect, do you think online exam proctoring was a good solution for monitoring remote examinations?
◯ Yes ◯ No ◯ Prefer not to answer

Q60 Why so?
Answer: _____

B Regression Tables

Table 3: Ordinal regression model to describe the level of comfort with proctoring methods responses to Question Q22. The model uses an ascending comfort scale (i. e., from *Very uncomfortable* to *Very comfortable*). The Aldrich-Nelson pseudo R^2 of the model is 0.32**.**

Factor	Estimate	Odds ratio	Error	t value	Pr(>|z|)	
Live Proctor ∈ {*Comfortable, Very Comfortable*}	−0.50	0.61	0.38	−1.30	0.19	
Browser History ∈ {*Comfortable, Very Comfortable*}	−0.76	0.47	0.45	−1.69	0.09	.
Eye Tracking ∈ {*Comfortable, Very Comfortable*}	−0.18	0.84	0.43	−0.41	0.69	
Lockdown Browser ∈ {*Comfortable, Very Comfortable*}	−0.60	0.55	0.42	−1.44	0.15	
Mouse Tracking ∈ {*Comfortable, Very Comfortable*}	0.03	1.03	0.45	0.07	0.94	
Keyboard Restr. ∈ {*Comfortable, Very Comfortable*}	0.23	1.25	0.62	0.36	0.72	
Screen Recording ∈ {*Comfortable, Very Comfortable*}	−0.87	0.42	0.68	−1.28	0.20	
Mic Recording ∈ {*Comfortable, Very Comfortable*}	−0.18	0.83	0.57	−0.32	0.75	
Webcam Recording ∈ {*Comfortable, Very Comfortable*}	−0.73	0.48	0.45	−1.63	0.10	
Intercepts						
Very uncomfortable | *Uncomfortable*	−3.77	0.02	0.46	−8.27	<0.001	***
Uncomfortable | *Neither comfortable nor uncomfortable*	−2.34	0.10	0.34	−6.94	<0.001	***
Neither comfortable nor uncomfortable | *Comfortable*	−1.15	0.32	0.27	−4.20	<0.001	***
Comfortable | *Very comfortable*	0.93	2.52	0.27	3.44	<0.001	***

Signif. codes: '***' ≅ < 0.001; '**' ≅ < 0.01;'*' ≅ < 0.05; '.' ≅ < 0.1

Table 4: Ordinal regression model to describe the preference for online proctored exams based on responses to Question Q12. The model uses an ascending agreement scale (i. e., from *Strongly disagree* to *Strongly agree*). The Aldrich-Nelson pseudo R^2 of the model is 0.34**.**

Factor	Estimate	Odds ratio	Error	t value	Pr(>|z|)	
Exams taken > 3	−0.15	0.86	0.34	−0.45	0.65	
Aware methods ∈ {*Moderately aware, Extremely aware*}	2.11	8.22	0.57	3.72	<0.001	***
Concern amount ∈ {*Disagree, Strongly disagree*}	−0.85	0.43	0.52	−1.62	0.11	
Privacy invasive ∈ {*Disagree, Strongly disagree*}	0.95	2.59	0.50	1.90	0.06	.
Reasonable tradeoff ∈ {*Agree, Strongly agree*}	0.43	1.53	0.42	1.02	0.31	
Good solution ∈ {*Agree, Strongly agree*}	0.41	1.50	0.44	0.92	0.36	
Comfort methods ∈ {*Uncomfortable, Very uncomfortable*}	−0.94	0.39	0.42	−2.23	0.03	*
Concern sharing ∈ {*Disagree, Strongly disagree*}	−0.12	0.89	0.49	−0.24	0.81	
Intercepts						
Strongly disagree | *Disagree*	−3.36	0.03	0.66	−5.08	<0.001	***
Disagree | *Neither agree nor disagree*	−1.14	0.32	0.48	−2.38	0.02	*
Neither agree nor disagree | *Agree*	0.35	1.41	0.47	0.74	0.46	
Agree | *Strongly agree*	2.05	7.79	0.50	4.12	<0.001	***

Signif. codes: '***' ≅ < 0.001; '**' ≅ < 0.01;'*' ≅ < 0.05; '.' ≅ < 0.1