

BOARD PERFORMANCE ENHANCEMENT PROGRAM: DIGITALIZATION OF MOCK BOARD EXAMINATION AND NURSING APTITUDE TEST WITH ENHANCED CHEATING PREVENTION MECHANISM

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Abstract

This study developed and evaluated an innovative Online Aptitude Test and Mock Board Examination system designed to address critical academic integrity challenges prevalent in high-stakes online assessments for nursing students. Following a Design Science Research paradigm and employing Agile Software Development, the platform evolved from a web application to a native mobile application, which embeds the existing WebContent within a secure container. It integrates robust cheating prevention features like dynamic randomization and obfuscation of questions, mandatory audio and video recording using RecordRTC, and OS-level screen capture prevention. Automated post-exam proctoring is performed by a server-side Python analysis pipeline. This pipeline leverages FFmpeg to remux and index recordings, applies OpenCV and dlib for frame-by-frame face and head-pose detection, and uses the audioop module to calculate silence and noise ratios, outputting structured JSON reports for anomaly flagging. Pilot implementation demonstrated the system's efficiency, achieving an 86.05% audio/video transmission success rate and which, through its analysis, identified three confirmed cheating incidents among 355 examinees. Independent evaluations against ISO/IEC 25010 Software Product Quality Standards consistently yielded "Excellent" quality ratings from both system users with an average weighted mean of 3.68 and IT experts with an average weighted mean of 3.66, affirming its functional suitability, usability, and performance. The results conclusively establish the developed system as a secure, scalable, and adaptable digital assessment solution, effectively upholding academic integrity while simultaneously enhancing examinee board performance.

Keywords: Agile software development, Cheating prevention, Design science research paradigm, Online assessment platforms, Recorded exam analysis, System integration.

1. Introduction

The increased dependence on online assessment platforms in education includes assessing the performance of a board examination specifically to implement strong security measures to maintain the academic integrity of students. These offer a framework and scalable platform for students to evaluate their knowledge and skills. Nonetheless, Noorbehbahani et al. [1] proved that the digitized aspect of online exams has opened for vulnerabilities, specifically related to cheating behaviours that compromise the integrity of the test results.

Similarly, Watson and Sottile [2] found out that changes in the forms of assessments from in-person to virtual mode has resulted in an increased likelihood that students can access unfair means, where they are much more likely to get help than in physical examinations. According to Lancaster and Cotarlan [3], this was further aggravated during the COVID-19 pandemic, owing to which limited accessibility to in-person supervision led to a dramatic rise in academic dishonesty concern. As a result, safeguarding the integrity of online examinations remains a critical issue that demands technological innovations in cheating prevention mechanisms [1-3].

Research on digital assessment in relation to academic integrity has been extensive. Reedy et al. [4] and Valizadeh [5] highlighted the importance of reevaluating what constitutes academic misconduct in an online context and how the shift from conventional to digital examinations affect academic integrity. Also, Coghlan et al. [6] discussed the ethical aspects of the use of such technologies about remote exam supervision.

Moreover, Holden et al. [7] explored the likelihood of cheating with respect to online exams vs. on-site exams, thus emphasizing the potential risks of ad-hoc online testing on academic integrity. They cited various sources about different types of cheating or forms of cheating. It consists of impersonation where someone else takes an online exam for the person intended to take the exam, accessing the internet while taking the assessment, talking to other students via online communication in order to get the answers, and using another person to guide or tutor.

The challenges of maintaining integrity in online assessments became more apparent, but the online assessment was also recognized as an unavoidable need during COVID-19 pandemic. According to Business Mirror [8] in their news report, the COVID-19 pandemic has significantly accelerated the adoption of online assessment even in professional board examinations. Thus, Jackowicz and Sahin [9] reiterated that the need for robust and secure online evaluation tools has become more pressing than ever. Similarly, Afacan Adanır et al. [10] told that the transition to online assessment methods has been expedited by the necessity for remote evaluation.

Although ensuring integrity in online tests has its own set of challenges, the benefits are well recognised. Al-Qdah and Ababneh [11] and Sharaim [12] clearly explained these advantages including improved accuracy during grading as well as reduced time, effort, and financial resources spent on the examination procedure, which go beyond the limitations of traditional paper-based examinations.

Additionally, Sharaim and Crompton [13] highlighted that the delivery of online tests can occur at any time and in any location as it can be accessed via the internet through various devices including mobile devices. Online examinations have become increasingly prevalent in education and skills certifications. The utilization of online certification exams has emerged as a global trend, with numerous international exams being conducted online on a large scale even before COVID-19 pandemic.

The significance of online assessments has been underscored by large scale certification examinations delivered through platforms such as Coursera, Edx, and Microsoft certification programs, which commonly integrate commercial electronic proctoring services to protect the integrity of remote exams, as discussed by Li et al. [14], Ngo-Ye et al. [15], and MohrenweiserBy et al. [16]. These leading commercial systems typically provide identity verification, browser level lockdown, and continuous cloud hosted audio and video monitoring, and they are designed for candidates with stable high speed internet connectivity [1-7, 9, 14-15].

Not only do such exams serve as an objective measure to evaluate the competencies of individuals, but they also function as formal gateways to professional certification and credentialing. At the same time, their dependence on vendor managed infrastructure, subscription-based licensing, and always online operation limits their suitability for resource constrained institutions and local area network only mock board examinations. In response to these limitations, the present study develops an institution controlled online aptitude test and mock board examination platform that preserves exam integrity through layered cheating prevention mechanisms, including mandatory audio and video recording and operating system level screen capture prevention, while remaining deployable in low bandwidth and campus network environments.

Despite the maturity of commercial e-proctoring suites integrated into large scale platforms and certification ecosystems, these systems are typically designed for high bandwidth, always online environments and rely on browser lockdown extensions, proprietary cloud based proctoring services, and continuous streaming to vendor servers. Publicly available documentation emphasizes high detection rates but rarely explains how operating system screen capture is blocked, how long recordings are retained, or how such tools can be deployed in low bandwidth, intermittent, or local network only settings. In contrast, the output of this study deliberately targets a different design space: a lightweight, institution controlled online aptitude test and mock board examination platform that combines operating system level screen capture prevention, segmented audio and video recording with automated offline analysis, and explicit support for remote, campus, and LAN only deployment in a resource constrained education context.

This study aims to address the pressing challenge of online exam integrity by developing an innovative Online Aptitude Test and Mock Board Examination system with enhanced cheating prevention mechanisms that is tailored for low bandwidth and LAN based implementation in a nursing education setting. Specifically, it has three key objectives. First, to develop an online assessment platform that enforces operating system level screen capture prevention, obfuscated and randomized question delivery, and mandatory audio and video recording in order to strengthen the credibility of remote and face to face exams. Second, to evaluate the efficiency of these cheating prevention mechanisms, including the

reliability of segmented recording transmission and the performance of an automated Python based analysis pipeline for detecting suspicious behaviour. Third, to evaluate the quality of the developed system using research instruments based on ISO/IEC 25010 Software Product Quality Standards, thereby situating the platform relative to both academic prototypes and commercial offerings.

The developed online assessment platforms were initially deployed during the COVID-19 pandemic, enabling students to take exams remotely under supervision. Post-Covid, these platforms remain a reliable assessment tool that offer both secure and flexible test environments. The rigorous evaluation of these systems has demonstrated their effectiveness in both online and on-site scenarios, making them a sustainable solution for digital assessments.

2. Related Works

Haridoss and Dharani [17] show that artificial intelligence can automate the detection of suspicious behaviours such as unauthorized device use, abnormal gaze, and unusual audio events during online exams, making large scale monitoring more practical than purely human invigilation. Nigam et al. [18] caution that these AI driven approaches also raise concerns about privacy, autonomy, and proportionality, as students question how much data is collected and how it is used.

Fidas et al. [19] report an eighteen-month, multi-institution deployment of an AI-centred proctoring system and describe threat scenarios and learning management system countermeasures, but their solution focuses on the browser layer and does not address operating system level controls or explicit media retention policies. Together, these studies show that AI based proctoring, including approaches used in leading commercial systems, can scale and deter misconduct, yet they also highlight unresolved issues around student trust, data governance, and transparency.

Other work focuses on continuous authentication and anomaly detection. Amkamaran et al. [20] combine keystroke behavior with audio and video streams, while Ramesh et al. [21] use machine learning models to adjust detection thresholds. These approaches are accurate but resource intensive and assume stable, high bandwidth internet. They are presented as separate detection engines rather than complete, institution-controlled exam platforms that can run in constrained networks.

Empirical studies on online proctoring report mixed outcomes. Karim et al. [22] and Duncan and Joyner [23] find modest reductions in cheating but increased stress, technical problems, and negative student perceptions. Chua et al. [24] show that measures like question randomization and shorter monitoring windows can preserve integrity while easing privacy concerns. Arnold [25] reports no major differences in cheating between online and face to face exams. These findings suggest that technical controls must be balanced with usability, transparency, and learner experience, and they rarely examine effects on later licensure performance.

Zhu and Cao [26] demonstrate that blockchain frameworks can guarantee tamper-proof exam records, and Dyer et al. [27] identify key enablers and barriers to adopting e-proctoring solutions. Itani et al. [28] examine how the COVID-19 pandemic strained online-exam infrastructure and design, yet they stop short of recommending any screen-capture lockdown measures.

Sancho and Melendres [29] evaluate a local area network based mock board examination system using ISO/IEC 25010 quality characteristics and show that digital mock boards can be effective even without wide area connectivity, but their design does not include operating system level screen capture controls, detailed media retention policies, or automated post exam media analysis. Oncul [30], Sabrina et al. [31], Palmer [32], and Hebebcı and Yılmaz [33] synthesize best practices such as randomization, timed windows, and analytics, yet they largely assume continuous internet access, browser-based lockdown tools, and generic detection dashboards. None of these studies consider an environment where licensure preparation must continue in low bandwidth or LAN only contexts, nor do they link proctoring design choices to actual national licensure examination results.

Despite this work, key gaps remain. No published system clearly demonstrates operating system level prevention of screenshots and screen recordings that can be audited and reproduced, even though this is crucial for protecting high stakes exam content on student owned devices. Most academic and commercial platforms do not specify how audio and video are segmented, transmitted, stored, and deleted, and they assume uninterrupted internet, which is unsuitable for LAN only or intermittent settings.

Existing systems also rarely provide simple, interpretable metrics such as the proportion of frames without a face, the share of time the head is turned away, or validated measures of silence and noise, and they seldom link these metrics to confirmed cheating or accessibility concerns. This study addresses these gaps by developing and evaluating a lightweight, institution-controlled platform that enforces operating system level screen capture prevention, supports low bandwidth and LAN only deployment, applies clear media retention rules, and uses automated analysis of segmented recordings for nursing aptitude tests and mock board examinations.

Addressing these shortcomings requires a comprehensive yet lightweight platform that is explicitly designed to: enforce operating system level screen capture prevention on mobile devices; securely record, segment, transfer, and delete audio and video according to clear retention policies; manage an obfuscated question bank that prevents source inspection; mandate controlled use of camera and microphone; support low bandwidth, intermittent, and LAN only networks; and provide automated, granular analysis of recorded sessions that can be validated against confirmed cheating cases. The present study responds to this gap by designing, implementing, and evaluating such a platform in the context of nursing aptitude and mock board examinations.

3. Method

This study employs Design Science Research Paradigm (DSRP) which involve processes such as problem identification, design and development, demonstration or implementation, evaluation, and communication [34, 35], as described in Fig. 1, to systematically develop an innovative online assessment platform with enhanced cheating prevention mechanisms.

The Design Science Research aims to generate prescriptive knowledge about the design of artifacts, such as software and applications, methods, models or concepts [36].

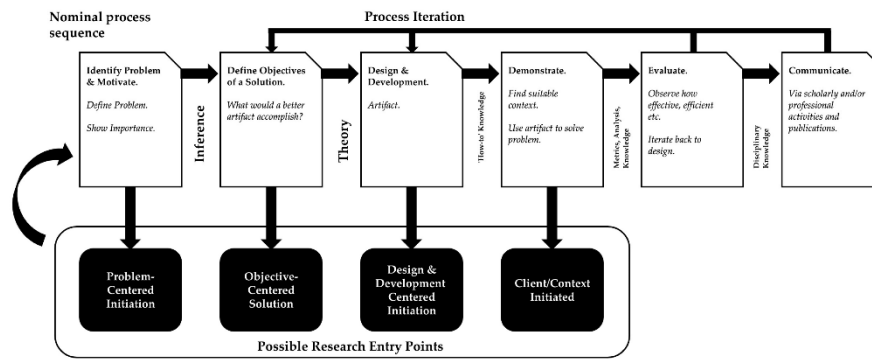


Fig. 1. Design science research paradigm [35].

3.1. Problem identification and motivation phase

The first phase was the Problem Identification and Motivation, where a literature review revealed widespread academic dishonesty in online assessments due to impersonation, unauthorized access to materials, external collaboration, and other method [1-7]. Additionally, the shift to digital exams during the COVID-19 pandemic amplified these issues, highlighting the need for stronger online assessment and proctoring solutions [9, 14-15].

3.2. Defining objectives for a solution phase

After identifying the problem, the next phase was to Define Objectives for a Solution. This study has three primary objectives: (1) to develop an online assessment platform with enhanced cheating prevention mechanisms, (2) to evaluate the accuracy and efficiency of cheating prevention mechanisms of the online assessment platforms, and (3) to evaluate the effectiveness and quality of online assessment platforms with cheating prevention mechanisms. These objectives made certain that the output solution of this study would not only be technically viable and secure, but also flexible to both remote and in-person environments for assessment.

3.3. Design and development phase

The Design and Development phase followed an iterative process utilizing Agile Software Development principles [37]. Agile software development use of short, time-boxed sprints coupled with continuous stakeholder feedback enables rapid adaptation to evolving requirements and has been shown to enhance both product quality and team responsiveness [38, 39].

The online assessment platforms were purposely designed for mobile use, specifically for android smartphones and tablets. Unlike desktop PCs, smartphones already come with built-in cameras and microphones, making it easier to monitor exams without needing extra equipment. This setup helps ensure a smoother and more secure testing experience for both students and proctors.

Through three (3) iterative cycles of the design and development, a ten (10) core work packages were included. These are the (a) test bank management, (b) test

scheduling, (c) online aptitude test, (d) mock board examination, (e) audio/video recording, (f) system integration, (g) playback interface for reviewing recorded sessions, (h) reports generation, (i) native mobile application featuring built in operating system capture lockdown, and (j) post exam audio and video analysis pipeline that flags anomalies such as missing faces, head turn deviations, and prolonged silence and noise to detect potential cheating.

In the initial design and development cycle (iteration 0), the assessment platform took the form of a traditional web application, with PHP handling server-side logic, JavaScript driving interactive client-side behavior, and HTML5/CSS3 delivering a responsive, standards-compliant interface. All data persistence and transaction management were implemented in MariaDB, selected for its robust security, high performance under load and seamless fit with a LAMP-style stack.

Following several semesters of live deployment, limitations emerged around screenshot and screen-recording prevention. In iteration 1 these known limitations were addressed by implementation of a native Android application. The app wraps the existing web content in a FLAG_SECURE-enabled WebView container, leveraging OS-level screen captures and recording prevention while preserving the familiar exam workflow.

In iteration 2 a server-side Python analysis pipeline was added to automate post-exam integrity checks. This script invokes FFmpeg to remux and index each recording, applies OpenCV and dlib to detect face absence and head-pose deviations on a frame-by-frame basis, and uses the audioop module to calculate silence ratios in the extracted WAV tracks. The resulting JSON reports enable rapid identification of any suspicious segments for further review.

Figure 2 shows the exam session workflow and the enhancements implemented to enforce robust cheating-prevention mechanisms within the online assessment platform.

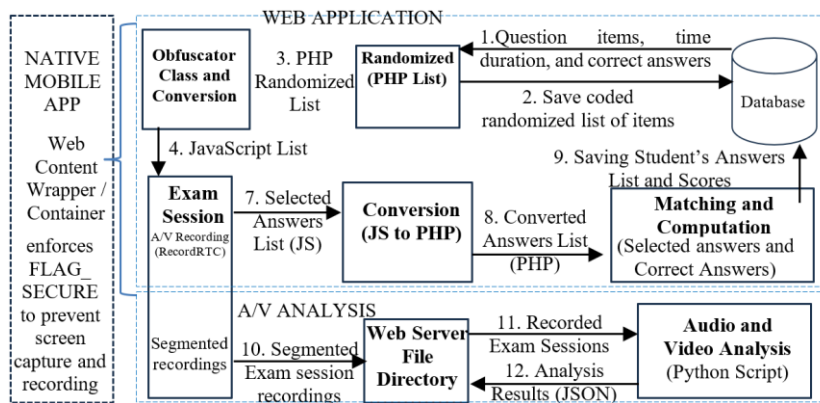


Fig. 2. Exam session workflow.

The process flow during exam session begins when mobile app wraps the web content of online assessments. The database provides question items choices, time limits and the correct answers to the PHP backend to create randomized items and save back to the database. The randomized items will proceed to Obfuscator class

to encrypt the PHP list into obfuscated JavaScript to be loaded in examinee's device as a JavaScript array.

Meanwhile the student's selected answers are transmitted from the browser's JavaScript layer to a server-side converter that transforms the JavaScript array into a native PHP array. The Matching and Computation component then compares these responses against the stored correct answers, calculates the score, and save both the answer list and the computed result to the MariaDB database.

During each exam session, RecordRTC captures audio and video in short segments that are streamed to a centralized file-server directory. Once transferred, a custom Python script reads those raw recordings, applies OpenCV and dlib to detect frames with no visible face or head-pose deviations and uses audio-processing routines to measure periods of background noise. The Python script generates its analysis as a structured JSON report, which is then integrated into the platform's reporting module. This enables proctors to review flagged segments providing clear, actionable insights into any potential integrity breaches.

This analysis ensures that examinees remain fully focused on the question items, makes it possible to detect any off-screen tutoring or collaboration, and helps prevent unauthorized access to online resources or communication with other examinees during the exam. By systematically flagging moments when a face disappears, the head turns away or unexpected background sounds occur, the platform safeguards academic integrity and deters a range of cheating behaviours.

Each session is recorded so proctors can verify any signs of cheating detected during video and audio analysis. Recordings are saved on the server using the Session ID for easy tracking, as illustrated in Fig. 3.

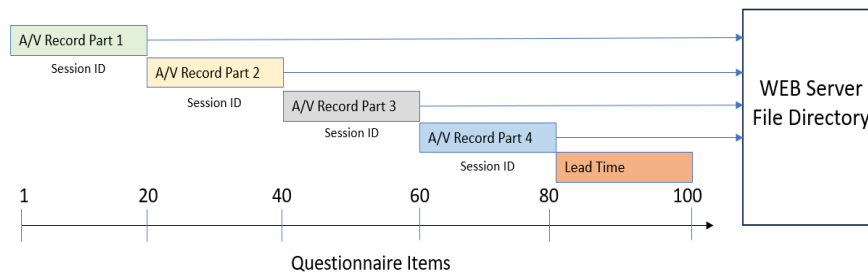


Fig. 3. Exam session recording and transmission mechanism by segment.

To accommodate delayed uploads due to poor connectivity, the assessment platforms include a lead time to ensure recordings are fully transferred. Internet is only needed during answers submission and audio/video upload, allowing examinees in low-bandwidth areas to continue the exam smoothly. Even if the internet disconnects or slows down, the exam can continue smoothly because the encrypted questions are already preloaded on the examinee's device through browser.

Preventing examinees from recording and capturing the screen proved one of the most significant challenges. To address this, an Android application version, as shown in Fig. 4, was developed which embeds the online assessment platform in a secure WebView and leverages the FLAG_SECURE display API to block

Comprehensive testing was conducted to validate all core functionalities and cheating-prevention features. It was confirmed that the questionnaire obfuscation successfully blocked any attempt to inspect or modify source code, verified that the timing engine enforced the exact exam duration, validated that the scoring module produced accurate results across a range of answer combinations, and ensured that the audio/video recorder captured and securely saved every exam segment. In each case, the system's performance matched the design specifications, demonstrating that it is fully ready to uphold academic integrity in real-world pilot testing.

Likewise, the Python script that performs recorded video analysis was tested. Figure 5 shows that the script requires several parameters and threshold values to conduct analysis. This script intends to count frames without face count, head off count, silent ratio, and noise ratio.

```
RecordedExamMedia-6083075-1-1
Audio extraction complete.
Analyzing audio for silence and activity levels...
Audio analysis complete.

--- Audio RMS and Video Prediction Settings---
Current SILENCE_RMS_THRESHOLD: 300
Current SEGMENT_MS           : 100
Current HEAD_YAW_THRESHOLD   : 40.0
Current SHAPE_PREDICTOR      : shape_predictor_68_face_landmarks.dat

-----
Processing frames at a reduced rate of 2.00 FPS for speed.
Starting video frame processing...
Processing Frames: 1768bit [08:11, 3.59it/s]
Video processing complete.

===== Completed Time Duration =====
  Processed Duration: 0 hours, 14 minutes, 44 seconds
  (Based on 1768 frames analyzed at 2.00 FPS)
=====
Video clip resources released.

===== Analysis Summary =====
Media Duration : 0 hour, 14 minutes, and 43 seconds
Total Processed frames : 1768
Frames with no face detected: 196 (11.09%)
Frames with head turned away: 54 (3.05%)
Silence ratio in audio: 86.43%
Noise (Activity) ratio in audio: 13.57%
```

(a) Recorded exam session analysis.

```
RecordedExamMedia-6083075-1-1.json X
{
  "video_filename": "RecordedExamMedia-6083075-1-1.webm",
  "media_duration": "0h 14m 43s",
  "status": "Completed",
  "fps": 2,
  "no_face_count": 196,
  "no_face_count_percent": 11.085,
  "head_off_count": 54,
  "head_off_count_percent": 3.054,
  "silence_percent": 86.437,
  "noise_percent": 13.563,
  "processed_duration": "0h 14m 44s",
  "total_frames": 1768
}
```

(b) Analysis output in JSON format.

Fig. 5. Recorded audio/video analysis.

By integrating the assessment platform directly into the faculty portal, proctors gain unified access to exam schedules, session recordings and student performance reports through a single interface, which streamlines monitoring tasks such as video recording analysis and reduces administrative overhead.

A background Python script that is always running to identify and delete each session recording seven days after it is saved, ensuring that no lasting exam session recordings remains accessible and protecting examinee privacy. This approach also frees up storage resources, lowers long-term infrastructure costs and demonstrates respect for examinee confidentiality, which in turn builds trust in the fairness and integrity of the e-assessment platform.

These enhanced cheating prevention mechanisms underwent rigorous testing and semesterly evaluation to drive continuous improvement. The result is a lightweight, stable version capable of encrypting exam questions, enforcing the use of camera and microphone, securely recording and storing audio and video, preventing OS-level screen captures, supporting practice exams, adapting to low-bandwidth or intermittent connections as well as LAN-only deployments, performing automated analysis of recorded sessions, and ensuring privacy compliance and accessibility across diverse devices.

3.4. Demonstration and implementation phase

The demonstration and implementation phase came right after the online assessment platforms were developed. This phase focused on training, deployment, and real-world implementation of the online assessment platforms. The College of Nursing organized an online orientation where Nursing students were guided through the system's features and their roles in evaluating its effectiveness. Each group of students, based on their year level, was assigned to test the platform using dummy questionnaires to simulate actual exams processes.

Similarly, faculty members assigned as proctors also received trainings on how to manage the question banks and use the proctoring tools. This helped ensure they could effectively monitor exam sessions and review recordings, supporting the overall goal of maintaining a secure and smooth testing experience.

3.5. Evaluation phase

The evaluation focused on the efficiency of security features: question encryption, mandatory camera/audio use, audio/video recording/submission, screen capture prevention, and automated analysis of recorded sessions. Table 1 details the acceptable and suspicious ranges for each analysed metric.

Table 1. Threshold values for each criterion.

Metric	Acceptable Range	Suspicious Range
Percentage of frames with no face detected	≤10.00%	>10.00%
Percentage of frames with head turned away	≤10.00%	>10.00%
Sound Presence Percentage	25.00%–75.00%	<25.00% - High Silence >75.00% - High Noise

The automated analysis of exam session recordings relies on predefined thresholds to identify potential anomalies that may indicate suspicious behaviour. These thresholds are critical for distinguishing between normal variations in examinee activity and patterns that warrant further investigation.

Thresholds and parameters were iteratively refined using diverse test cases to optimize anomaly detection, ensuring robustness in real-world exam scenarios. These measurements are critical for identifying potential cheating behaviours: prolonged face absence or frequent head-turn deviations can indicate unauthorized material access or off-screen help, while high silence or noise percentages may reveal concealed collaboration or external cues. Automatically quantifying these anomalies allows proctors to quickly identify and review suspicious segments, significantly enhancing remote assessment integrity.

As for effectiveness, respondents evaluated the online assessment platforms in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. These key software quality attributes reflecting a comprehensive review of the system's strengths and areas for improvement.

An online survey using ISO/IEC Software Product Quality Standards questionnaires collected data from system users and IT experts via Google Forms. System users evaluated functional suitability, performance efficiency, usability, and security. IT experts conducted a more comprehensive technical assessment, covering functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, ensuring adherence to industry standards.

The four (4) point Likert scale, as shown in Table 2, was used for evaluating the software product quality standards of the developed and implemented systems. Each criterion was evaluated using this scale, where a score of 4 reflects a high level of quality and a score of 1 indicates poor quality and requires significant improvements.

Table 2. Likert scale for system evaluation [40].

Scale	Description
4	Highly Functional / Highly Efficient / Highly Compatible / Highly Usable / Highly Reliable / Highly Secured / Highly Maintainable/ Highly Portable
3	Functional / Efficient / Compatible / Usable/ Reliable / Secured / Maintainable / Portable
2	Needs Improvement
1	Poor

This scale provided a structured and quantifiable method for assessing the strengths and potential areas for enhancement of the developed and implemented online assessment platforms. A non-probability purposive sampling procedure was employed, and appropriate respondents were chosen in a non-random manner that represents a cross-section of the population that can adequately answer the research objectives [41].

To determine the descriptive evaluation result, the performance scoring guide, as shown in Table 3, was adopted and the general weighted mean was computed in each criterion for both sets of evaluation.

Table 3. Performance scoring guide [40].

Range	Software Product Quality Standards Description	Verbal Description
3.25 – 4.00	Highly Functional / Highly Efficient / Highly Compatible / Highly Usable / Highly Reliable / Highly Secured / Highly Maintainable/ Highly Portable	Excellent
2.50 – 3.24	Functional / Efficient / Compatible / Usable/ Reliable / Secured / Maintainable / Portable	Satisfactory
1.75 – 2.49	Needs Improvement	Needs Improvement
1.00 – 1.74	Poor	Poor

The conduct of the study adhered to strict ethical standards to ensure the protection of all participants and the integrity of the research process. Prior to conducting any system testing and data collection, informed consent was obtained from all participants involved in the simulations and evaluations. Participants were briefed during orientations and trainings about the purpose of the study, the scope of data being collected, and their right to withdraw from participation at any time without any academic penalty or disadvantage.

The researchers were able to gather evaluation data from three hundred fifty-seven (357) respondents composed of three hundred forty-seven (347) system Users and ten (10) IT experts. The distribution of respondents is detailed in Table 4.

Table 4. Distribution of respondents.

Respondents	Sample Size	Percentage
System Users		
BSN Students	339	94.958
Faculty Proctors	8	02.241
IT Experts		
Project Managers	2	00.560
System Analysts	2	00.560
Web Developers	2	00.560
Cybersecurity Consultants	2	00.560
Software Quality Assurance Specialist	2	00.560
TOTAL	357	100.000%

The researchers gathered responses from 339 BSN students out of 355 second- and fourth-year students, along with feedback from 8 faculty proctors who helped oversee the exam sessions. The system user respondents focused on determining how well the system met its intended purpose, ensuring that it provided a seamless and user-friendly experience.

The researchers demonstrated the system to the IT Expert respondents using video conferencing applications so they could thoroughly evaluate the developed system. Their expertise will ensure that the assessment platforms subject for evaluation is not just efficient in the real world but is also technically sound, scalable, and will facilitate future upgrades.

The effectiveness of the online assessment platforms was also evaluated by leveraging data from the Philippines Nursing Licensure Examination (PNLE) results. This comparative analysis aimed to determine whether the platform improved the board performance of students who utilized the digital mock board examination, in contrast to those who prepared using traditional pen-and-paper mock examinations.

3.6. Communication phase

Finally, the Communication phase involve wide dissemination of research findings through institutional reports, conference presentations, and articles in academic journals.

4. Results and Discussion

The Online Comprehensive Nursing Aptitude Test (CNAT) and Mock Board Examination or Comprehensive Nursing Examination (CONEx) were deployed during the nationwide community quarantine lockdown due to the COVID-19 pandemic. After the eventual lifting of restrictions imposed due to quarantine, the continued utilization of the platform underscores its adaptability, long-term relevance, and the necessity for secure digital assessment tools in higher education.

4.1. The developed online assessment platforms with enhanced cheating prevention mechanism

As part of the cheating prevention mechanism, the assessment platform successfully triggered a browser-level permission request for microphone and camera access, using RecordRTC, prior to the start of the exam. As shown in Fig. 6, examinees were prompted to allow access to these built-in input devices of their smart phones, ensuring that the platform could carry out audio and video recording.



Fig. 6. Assessment platform requiring examinee to allow the assessment platform to use their device's microphone and camera.

RecordRTC is a server-less JavaScript library that can be used to record WebRTC audio/video media streams. It supports cross-browser audio/video recording.

This step is crucial in enabling consistent monitoring during the examination session and was verified to function properly across various mobile devices. The prompt, along with the requirement to agree to the terms and conditions, as shown

in Fig. 7, helped enforce exam integrity by ensuring that no session could begin without granting the necessary permissions.

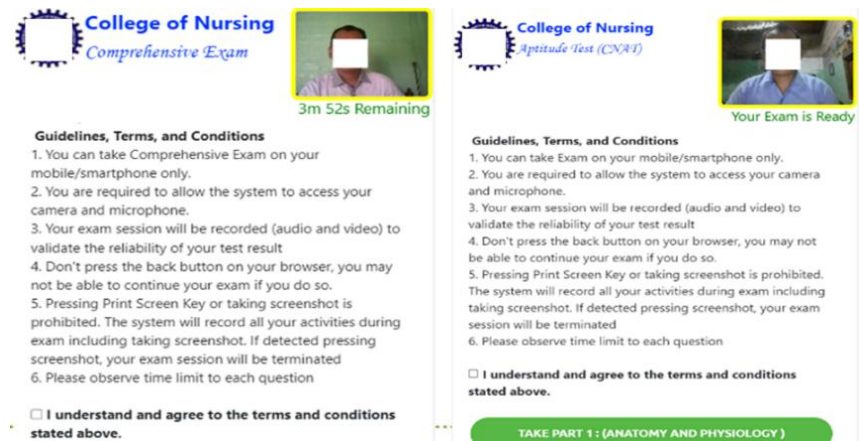


Fig. 7. Online assessment platforms' interface showing guidelines.

The guidelines and conditions are clearly presented to examinees ensuring that students fully understand the rules and expectations before starting the exam. The exam computation method, obfuscation, and utilizing randomization achieved 100% accuracy, as shown in Fig. 8, proving its effectiveness in delivering error-free assessments while preventing examinees from predicting question sequences.

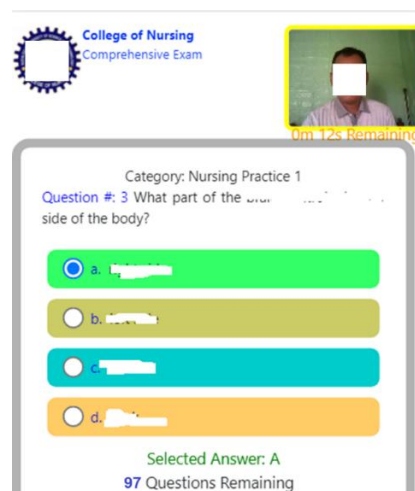


Fig. 8. Online assessment platforms' interface showing guidelines.

The platform's minimal internet dependency is highly impactful. Students only need to connect online for submitting recordings and exam responses, making it very effective for those with limited bandwidth. This ensures convenient, uninterrupted, and accessible exams, enhancing reliability and user-friendliness.

Although the web-based version incorporated multiple cheating-prevention controls, its ability to block native screen-capture and recording tools was

inherently constrained by browser and operating-system limitations. Standard browser APIs cannot fully intercept or disable PrintScreen commands or third-party screen-recording software, allowing determined examinees to capture content. This shortcoming motivated the creation of a native Android application, which leverages OS-level secure-display features to provide truly unbreachable screen-capture and recording prevention.

The native Android application's use of the FLAG_SECURE API proved highly effective at preventing any form of screen capture, as it blocks both built-in screenshot functions and third-party recording tools at the operating system level. During testing, no single screenshot or recording attempt succeeded on devices running the app, whereas the web version could be bypassed with simple PrintScreen or external screen-recording software. By shifting the exam interface into a secure container that the OS itself enforces, the mobile app delivers a level of content protection that is unattainable in a browser environment.

Embedding the web application in a secure Android WebView let all core features such as question randomization and encryption, timed exams, and browser-based audio and video capture run exactly as before, while the native wrapper uses the operating system's secure-display API to block any screenshots or screen recordings. This approach preserves the full functionality of the web app and adds a layer of protection that browsers alone cannot enforce, ensuring that exam content remains fully secure.

A critical limitation identified in the recording mechanism pertains to the lead time allotted for saving exam session recordings. During this period, specifically once an examinee progresses into the 81-100 question item range, the video continues to record locally, but the system is designed to not transmit this recording. This design choice is implemented to ensure ample time for the transmission of other recording segments that are still in progress.

However, this creates an inherent cheating window during the final phase of the examination. Should examinees become aware of this specific operational limitation, it presents a significant vulnerability that could be exploited, potentially compromising the integrity of the assessment during its crucial concluding moments.

This finding underscores the potential enhancement of the system through real-time methodologies like live streaming. However, this advancement is fundamentally constrained by its dependency on a constant and high-bandwidth internet connection. Such a requirement poses a significant challenge for examinees located in remote areas or those with inherently limited and slow internet access, potentially creating an accessibility barrier that could counteract the system's intended inclusivity.

All recorded sessions were made accessible to authorized faculty members through the integrated proctoring interface, allowing them to review recorded sessions and address any flagged behaviour. However, this manual review of recorded examination sessions has proved to be labour-intensive process. This observation underscores the critical importance and demonstrates effectiveness of automating recorded exam session analysis, as such automation directly mitigates the substantial human effort otherwise required.

Nevertheless, the implementation of the Python script for analysing exam session recordings necessitated substantial computational power. To accommodate this

demand, the script was deployed on a Linux server equipped with 96 CPU threads, 128GB of memory, and no dedicated GPU, enabling the researchers to leverage multiprocessing capabilities for efficient batch processing of the video data.

Despite this robust hardware and optimized configuration, the analysis of video recordings proved to be computationally intensive. Specifically, a 12-minute video segment required approximately 13 minutes of processing time, equating to 104-109% of the video's original duration, with the analysis being conducted at a frame rate of 2 frames per second. This highlights the significant resource allocation required for automated solutions involving detailed audio and video analysis.

To support broader use, the online assessment platforms were also adapted for face-to-face examinations using students' smartphones connected via a Local Area Network (LAN). This hybrid approach preserved all of the platforms' proctoring and automation capabilities while removing the dependency on internet connectivity. As a result, it significantly reduced the time and effort required for manual result checking and minimized examination-related costs.

These benefits align with existing research underscoring the practical advantages of digital exam systems over traditional paper-based formats [10, 11]. These results affirm that the developed online assessment platforms not only secure and reliable but also adaptable to different delivery modes. It meets the demands of both online and in-person settings, offering an effective and scalable solution for modern academic assessments.

4.2. The accuracy and efficiency of online assessment platforms' cheating prevention mechanism

The online assessment platforms achieved 100% accuracy in maintaining exam integrity. This was ensured through randomized questions, timed items, segmented audio/video recordings, and advanced programming for data obfuscation, activity monitoring, secure result computation, and screen capture prevention.

In addition, the online assessment platforms were also able to detect attempts to capture exam content through screenshots, clipboard access, and developer tool manipulation. When such unauthorized actions were identified, the system automatically locked the session, effectively reinforcing the security of the assessment environment.

The most recent administration of the Nursing Aptitude Test and Mock Board Examination, involving a total of 355 Nursing students (233 from the 2nd year and 122 from the 4th year), unequivocally demonstrated the system's robust efficiency in capturing and securely transmitting audio and video recordings across five distinct exam parts, each comprising four segmented recording sessions.

The online assessment platforms achieved an impressive overall transmission success rate of 98.93%, confirming the exceptional reliability and effectiveness of its recording mechanism under authentic examination conditions, as detailed in Table 5.

This consistently high efficiency is attributed to continuous improvements implemented across the system, particularly in its evolution from a web-based application to a more optimized Mobile App version. This progression highlights the system's inherent ability to steadfastly maintain assessment integrity, even within environments characterized by unstable or limited internet connectivity.

Consequently, it ensures that the vast majority of recorded examination sessions are not only securely transmitted but also readily accessible for comprehensive analysis and review, thereby strengthening the reliability of remote proctoring.

Table 5. Efficiency of transmitting segmented exam sessions.

Exam Part x 4 Segment	Success	Failed	Efficiency
Part 1	1401	19	98.66%
Part 2	1409	11	99.23%
Part 3	1398	22	98.45%
Part 4	1404	16	98.87%
Part 5	1412	8	99.44%
Efficiency Average			98.93%

The distribution of percentage of frames with no face detected across all exam segments provides crucial insights into the typical behaviour observed during online proctoring. As illustrated in Fig. 9, the majority of segments exhibit a low percentage of frames with no face detected, clustering well below the established threshold.

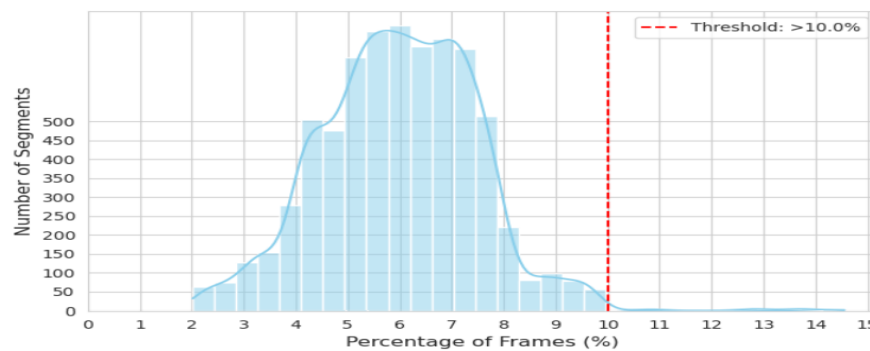


Fig. 9. Distribution of percentage of frames with No Face Detected with a threshold at >10.0%.

This visual representation helps to understand the baseline of expected examinee conduct and highlights the frequency of deviations that trigger the flagging mechanism. The distinct drop-off in segment count beyond the 10.0% threshold confirms the effectiveness of the set criterion in identifying anomalous instances. While a small number of segments do exceed this threshold, their relatively low frequency compared to the bulk of the data underscores that such occurrences are indeed outliers, warranting further investigation as potentially suspicious activities.

The analysis of head movement, specifically the percentage of frames with head turned away metric, offers another critical dimension to proctoring oversight. Figure 10 illustrates the distribution of this metric across all recorded segments, revealing that the vast majority of examinees maintained a frontal gaze towards their screens.

The histogram clearly shows a concentration of data points well within the acceptable range, demonstrating typical behaviour during the examination. As depicted in Fig. 10, the sharp decline in segment frequency beyond the 10.0%

threshold effectively highlights instances where examinees significantly deviated from the expected head orientation.

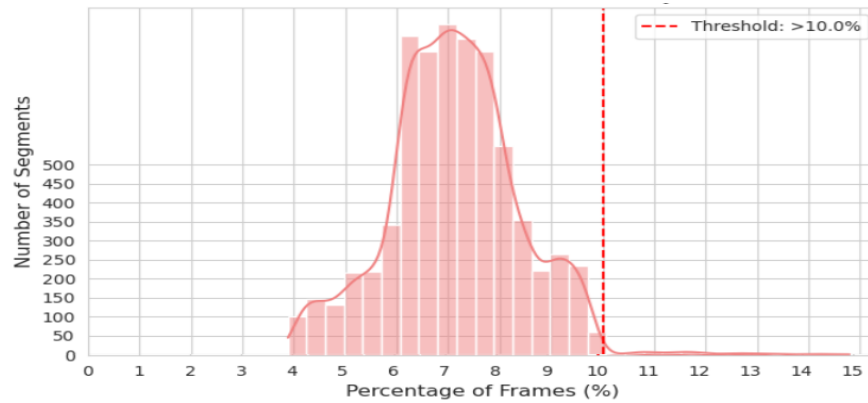


Fig. 10. Distribution of percentage of frames with Head Turned Away with a threshold at >10.0%.

While some segments do exceed this limit, their infrequent occurrence reinforces the notion that these are indeed unusual events, consistent with the criteria for flagging potentially suspicious activity. This visual evidence supports the efficacy of the established threshold for identifying prolonged periods of averted gaze.

To understand the distribution of audio activity during the examination, a detailed analysis of the sound presence percentage was conducted across all recorded segments. This metric provides insight into the proportion of a segment dominated by detectable sound, ranging from complete quietness to high levels of audio presence.

Figure 11 visually represents this distribution, highlighting two critical regions: segments with unusually low sound presence and segments with excessively high sound presence. These thresholds are crucial for identifying segments that deviate significantly from expected audio conditions.

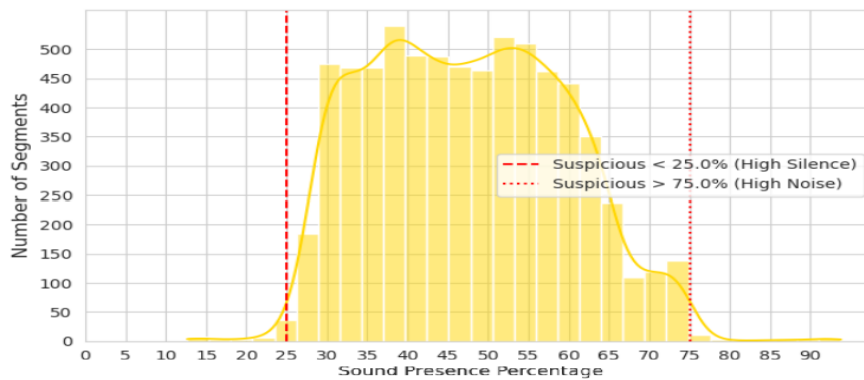


Fig. 11. Distribution of sound presence percentage.

As illustrated in Fig. 11, the majority of segments fall within the acceptable range of sound presence, indicating consistent audio conditions for most of the examination. However, the presence of bars in the "Suspicious < 25.0% (High Silence)" and "Suspicious > 75.0% (High Noise Presence)" regions signifies instances where audio levels were either too low or too high, respectively.

These deviations warrant further investigation as they could indicate potential proctoring concerns, such as an examinee being too quiet (e.g., leaving the microphone off) or excessive background noise disrupting the examination environment.

To understand which proctoring metrics most often flag suspicious activity, individual segment counts for each criterion were analysed. Figure 12 visually summarizes how frequently each metric independently triggered a suspicious flag, identifying the most common anomalies during exams.

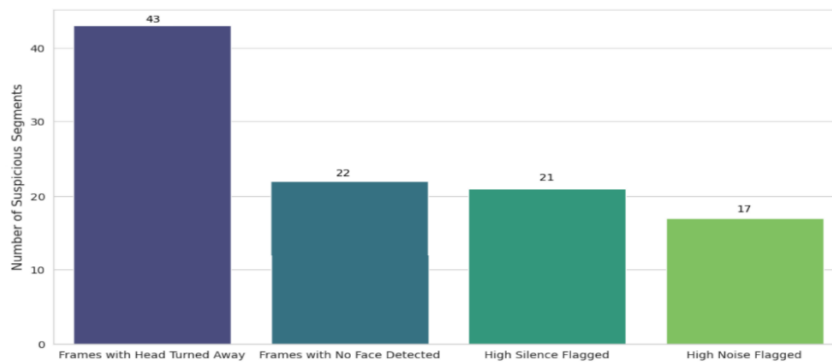


Fig. 12. Number of segments flagged as suspicious by each metric.

As evidenced in Fig. 12, certain metrics, such as "Frames with No Face Detected" and "Frames with Head Turned Away," appear to contribute more significantly to the overall count of flagged segments. This insight is valuable for refining proctoring protocols, potentially indicating areas where examinees most frequently deviate from expected behaviour or where the detection algorithms are most sensitive. Understanding these individual contributions can guide future improvements in both the proctoring system and examinee guidelines.

While it provides a breakdown of suspicious segments by individual metric, it is crucial to understand how these individual flags translate to the overall number of suspicious examinees. An individual student can exhibit suspicious behaviour across multiple categories (e.g., both having no face detected and high noise). Therefore, the total count of suspicious segments across all metrics will typically be higher than the unique count of students flagged.

Figure 13 quantifies the unique number of examinees identified as suspicious, providing a consolidated view of the student population requiring further review.

As depicted in Fig 13, a total of 67 examinees were categorized as suspicious. This number is a distinct measure from the sum of flagged segments presented in Fig. 12. The discrepancy arises because a single examinee might have multiple segments flagged across various metrics.

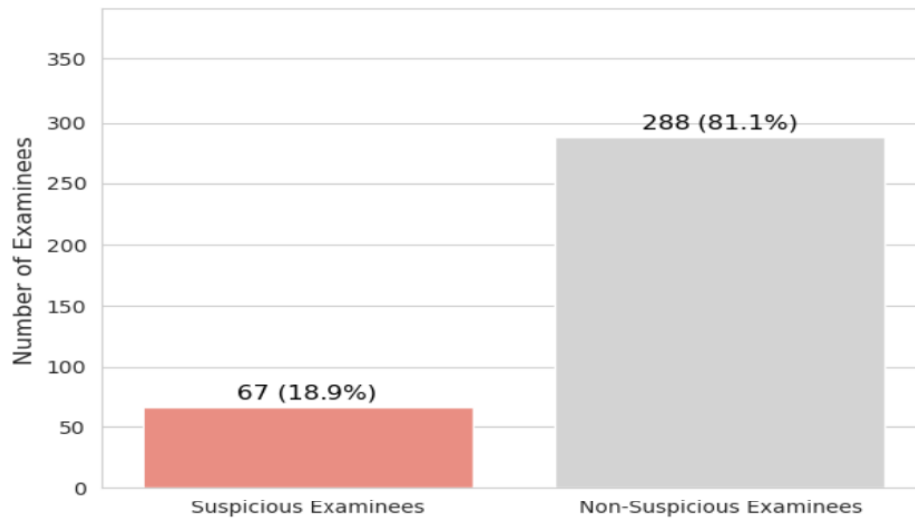


Fig. 13. Total examinee flagged as suspicious.

The 67 suspicious examinees represent the unique individuals who triggered at least one suspicious flag, regardless of how many different types of anomalies or how many segments were flagged for them. This figure provides the most direct measure of the scope of potential integrity issues among the student body.

Table 6 presents a crucial evaluation of the analysis performed by the Python script on recorded exam sessions, examining the correlation between various flagged suspicious behaviours and independently confirmed instances of cheating. The table categorizes examinees based on the specific metric or combination of metrics that triggered a flag within the script's analysis, then presents the total number of examinees in each category, the actual number of confirmed cheating cases within that group, and the resulting accuracy percentage (confirmed cheated / total flagged).

Table 6. Accuracy of online assessment platforms.

Combination	No. of Examinee	Actual No. of confirmed cheated	Accuracy Percentage
Low Percentage of frames with no face detected	4	0	0.00%
Low Percentage of frames with head turned away	25	0	0.00%
High Silence	20	0	0.00%
Low Percentage of frames with no face detected, head turned away, and High Noise	17	3	17.65%
Low Percentage of frames with head turned away and High Silence	1	0	0.00%
Unflagged	288	0	100.00%

A key observation is the low direct correlation for individual flags, with "Low Percentage of frames with no face detected," "Low Percentage of frames with head turned away," and "High Silence" all showing 0.00% accuracy.

This suggests that these isolated behaviours, as detected by the script, do not strongly predict actual cheating and might represent common benign actions or require more refined thresholds within the script's logic.

In contrast, the data reveals a significantly higher accuracy when multiple flags are combined, particularly for the "Low Percentage of frames with no face detected, head turned away, and High Noise" category, which yielded a 17.65% accuracy (3 out of 17 examinees confirmed cheated). This highlights that the script's analytical power is enhanced when it identifies a cluster of concurrent anomalies, indicating a more robust signal for potential integrity breaches.

Furthermore, the "Unflagged" category, comprising 288 examinees with 0 confirmed cheating cases and 100.00% accuracy, demonstrates the script's effectiveness in correctly identifying non-cheaters.

This analysis underscores the value of multi-factor anomaly detection within the Python script's evaluation, suggesting that future refinements to the script should prioritize the identification and weighting of combined suspicious behaviours to improve the precision of its flagging mechanism.

4.3. The online assessment platforms' effectiveness evaluation results

Table 7 presents the comprehensive evaluation results from IT Expert respondents, which collectively demonstrate that the implemented online assessment platform achieved an excellent quality, as consistently affirmed by an impressive average weighted mean of 3.66 across all assessed software product standards. This high average reflects the system's robust design and effective implementation, setting a strong foundation for its operational capabilities.

Table 7. IT experts' evaluation summary result.

Software Product Quality Standards	Weighted Mean	Verbal Description
Functional Suitability	3.70	Excellent
Performance Efficiency	3.73	Excellent
Compatibility	3.60	Excellent
Usability	3.78	Excellent
Reliability	3.55	Excellent
Security	3.50	Excellent
Maintainability	3.68	Excellent
Portability	3.70	Excellent
Average Weighted Mean	3.66	Excellent

The platform demonstrates strong Functional Suitability, indicating it effectively fulfils its intended purpose for online assessments. Its Performance Efficiency ensures a smooth and responsive experience, crucial for uninterrupted examinations, while high Compatibility allows for seamless integration within diverse technical environments. The platform's Usability stands out, suggesting an intuitive and user-friendly interface that benefits both examinees and proctors.

Furthermore, its Reliability ensures consistent operation, minimizing disruptions, and robust Security measures are in place to protect sensitive data. The system also exhibits strong Maintainability, making it adaptable for future updates and enhancements, and its Portability allows for flexible deployment across different platforms. These evaluations underscore that the implemented online assessment platform is well-engineered, effective, and capable of producing desirable outcomes in a secure and efficient manner.

Table 8 presents the comprehensive evaluation results from the system users, which include both examinees and proctors, highlighting their perception of the implemented online assessment platform's quality. The collective feedback indicates an excellent quality for the system, as evidenced by a high average weighted mean of 3.68. This strong overall assessment is consistently reflected across all evaluated software product quality standards.

Table 8. System users' evaluation summary result.

Software Product Quality Standards	Weighted Mean	Verbal Description
Functional Suitability	3.69	Excellent
Performance Efficiency	3.73	Excellent
Usability	3.71	Excellent
Security	3.59	Excellent
Average Weighted Mean	3.68	Excellent

The implications of these findings are significant: the high evaluation of Usability directly implies a highly positive user experience for both examinees and proctors, suggesting an intuitive and smooth interaction that minimizes frustration. Strong performance in Functional Suitability and Performance Efficiency indicates that the platform effectively meets the core needs of the examination process from the users' perspective, ensuring a fair and responsive testing environment.

Moreover, the excellent rating for Security is crucial, as it suggests that users perceive the platform as secure, fostering essential trust in the integrity of the assessment process and the protection of sensitive data. This overwhelmingly positive feedback from direct users strongly validates the success of the platform's implementation, confirming that the system effectively translates technical design into a reliable and positive experience, thereby providing a solid foundation for its continued use and potential expansion in educational or professional assessment workflows.

The comprehensive evaluation of the online assessment platform, supported by the detailed analyses presented throughout this report, unequivocally demonstrates its robust quality and effectiveness. The consistently positive feedback from both IT experts and the system's direct users' examinees and proctors underscore that the developed assessment platform met product quality standards effectively, with no major weaknesses identified across critical areas such as usability, performance, and security. These convergent findings collectively confirm that the study successfully fulfilled its goals and objectives, delivering a reliable and well-received solution for online examinations. Table 9 presents a comparative analysis of examinee performance in board examinations, differentiating between those who prepared using a mock board assessment platform and those who used traditional pen and paper mock boards.

Table 9. Effectiveness in board performance.

Year and Month	Examinee who prepared exam using mock board assessment platform	
	First Timer (Percentage of passers)	Repeater (Percentage of passers)
May 2025	100.00%	56.62%
November 2024	93.23%	31.25%
May 2024	100.00%	64.71%
November 2023	90.29%	54.55%
November 2022	93.58%	50.00%
May 2022	100.00%	72.22%
Year and Month	Examinee who prepared exam using traditional (pen and paper) mock board	
	First Timer (Percentage of passers)	Repeater (Percentage of passers)
November 2021	80.00%	44.00%
July 2021	83.96%	19.91%
November 2019	84.38%	20.00%
November 2018	50.00%	11.11%
June 2018	85.19%	30.00%
November 2017	50.00%	39.29%

A clear trend emerges, indicating a superior passing rate for examinees who utilized the mock board assessment platform. For First Timers, the platform consistently shows higher percentages of passers, with several instances of 100.00% pass rates (May 2025, November 2024, May 2022), significantly outperforming the pen and paper group, where the highest recorded pass rate for first timers was 85.19%.

Similarly, among Repeaters, the mock board assessment platform generally demonstrates better performance, with pass rates often exceeding 50% and reaching as high as 72.22% (May 2022), while the pen and paper group's repeater pass rates rarely surpassed 40%. This sustained higher performance across both first-timer and repeater categories strongly suggests that the digital mock board platform provides a more effective preparation method for board examinations.

The implications of these findings are substantial for educational and assessment practices. The consistent outperformance of examinees using the mock board assessment platform suggests that digital preparation tools can significantly enhance learning outcomes and exam readiness. This could be attributed to features inherent in digital platforms, such as immediate feedback, adaptive learning paths, diverse question formats, or more realistic simulation of the actual examination environment.

These convergent findings collectively confirm that the study successfully fulfilled its goals and objectives, delivering a reliable and well-received solution for online examinations, and imply that the digital assessment platform is not only a viable and secure tool for maintaining academic integrity in diverse testing environments but also a powerful instrument for enhancing student preparation and overall examination success.

To put our results in context, the online assessment platforms result of this study was compared to the leading certification providers. Coursera says Honorlock catches over 97 % of cheating, EdX reports 99 % accuracy for Proctortrack, and Microsoft states that Pearson VUE's OnVUE uses real-time webcam and screen monitoring; however, these figures are self-reported and lack independent verification. While these solutions offer high detection rates, they require constant internet access, browser lockdowns, and third-party extensions—and none prevent OS-level screen captures. In contrast, the developed online assessment platforms of this study support offline and LAN-only use, enforces OS-level screenshot and recording blocks, and performs automated, frame-by-frame analysis of recorded sessions.

5. Conclusions

Based on the findings, the following conclusions were drawn:

- The study successfully developed an innovative online assessment platform that effectively integrates a comprehensive suite of enhanced cheating prevention mechanisms. These include randomized and obfuscated questions, time-limited items, mandatory audio and video recording, and a novel operating-system-level screen capture prevention feature implemented through a native Android application, thereby significantly strengthening the credibility and fairness of both remote and in-person examinations.
- The implemented enhanced cheating prevention mechanisms demonstrated high efficiency and accuracy in their operation. The platform achieved an impressive 98.93% transmission success rate for audio/video recordings and maintained 100% accuracy in core exam functionalities such as question randomization and score computation.
- The automated recorded exam session analysis proved effective in identifying anomalies, contributing to the detection of six confirmed cheating incidents. While computationally intensive, requiring significant server resources, its ability to flag suspicious behaviors (such as no face detected, head turned away, and high noise) demonstrated a higher accuracy in predicting confirmed cheating when multiple flags were combined, validating its efficiency in focusing review efforts.
- The system proved highly adaptable and accessible, designed with minimal internet dependency for examinees and supporting both online and face-to-face examinations via Local Area Network (LAN) deployments. This flexibility ensures broad compatibility and continuous assessment even in low-bandwidth or intermittent connectivity environments, addressing a critical gap identified in existing solutions.
- The quality of the developed system was rigorously evaluated against ISO/IEC 25010 Software Product Quality Standards, receiving consistently "Excellent" ratings from both IT experts (average weighted mean of 3.66) and system users (average weighted mean of 3.68). This comprehensive positive feedback affirms the platform's robust functional suitability, performance efficiency, usability, security, reliability, maintainability, compatibility, and portability, confirming that it met product quality standards effectively with no major weaknesses identified.

- Beyond its proctoring capabilities, the mock board assessment platform demonstrated significant effectiveness in enhancing examinee performance in board examinations. Comparative analysis revealed a superior passing rate for both first timer and repeater examinees who utilized the digital mock board platform compared to those who prepared using traditional pen and paper methods, underscoring its value as an effective preparatory tool.

6. Recommendations

Based on the findings and conclusions of this study, the following recommendations are proposed for further enhancements.

- Future development should prioritize eliminating the identified cheating window during the recording lead time. This could involve implementing continuous real-time streaming for all segments, robust buffering mechanisms to ensure full transmission of all data or exploring alternative strategies to secure the final phase of the examination, while carefully considering the implications for examinees in low-bandwidth environments.
- While recorded exam sessions automation effectively flags anomalies, further research and development should focus on refining the thresholds and potentially incorporating more advanced machine learning models. This could improve the predictive accuracy of individual flags (e.g., "No Face Detected," "Head Turned Away," "High Silence") in directly identifying confirmed cheating, thereby reducing false positives and optimizing the efficiency of manual review.
- Given the significant computational resources required for the analysis recorded exam sessions, future efforts should explore comprehensive optimizations for resource allocation. This could include leveraging GPU acceleration, investigate more efficient video/audio processing algorithms or exploring scalable cloud-based computing solutions to reduce processing time per video segment and enhance overall throughput while managing operational costs.
- Building upon the insight that combined flags yield higher accuracy, the proctor's interface could be enhanced to provide a consolidated "risk score" or "suspicion index" for each examinee, based on the aggregation and weighting of multiple triggered flags. This would further streamline manual review by prioritizing examinees with the highest likelihood of confirmed misconduct.
- Based on the successful implementation and positive user feedback, consider integrating the platform more deeply with existing Learning Management Systems (LMS). Additionally, explore the development of new features, such as real-time proctor alerts for critical anomalies, or expanding support for diverse question types and accessibility features to cater to a broader range of examinee needs.
- Future research should explore the scalability and adaptability of this platform for broader, national-level implementation. This includes investigating its efficacy across diverse educational contexts and potentially collaborating with national examination bodies to integrate the system as a standard, secure, and effective tool for licensure and aptitude testing. This collaboration could lead to a clearer vision for practical deployment, ensuring academic integrity on a wider scale.

Abbreviations

CSS	Cascading Style Sheets
HTML	Hypertext Markup Language
ISO/IEC	International Organization for Standardization / International Electrotechnical Commission
PHP	Hypertext Preprocessor

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