

Co-funded by the  
Erasmus+ Programme  
of the European Union



# WP3 – Development of techniques for the implementation of the remote teaching and training process with the use of support tools

## IO.9 Development of evaluation methodology

### Part II: Ensuring academic integrity

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## 1 INTRODUCTION

The COVID-19 pandemic has forced a departure from the current functioning of society in many aspects of the economy, travel, work and education, not excluding higher education. The necessity of remote education is one of the ways to maintain social distancing and protect our health and life.

A preliminary assessment of the situation at universities in European countries indicates that academic staff were not sufficiently prepared to conduct attractive and practical classes in a remote format.

The necessity to conduct classes remotely involves developing a dedicated didactic and training process project, considering the specific requirements of interdisciplinary engineering knowledge. Transferring this knowledge in remote education, due to its large scope, requires various didactic tools (lectures, fieldwork, design, practicals, laboratories, student assignments and assessment of the progress and knowledge of students and trainees).

The measurable expected final results are:

- Development of a remote learning methodology for Road Infrastructure Management (RIM) as a model solution to provide a basis for extending the methodology to include further aspects of civil engineering and transport.
- Developing an e-handbook for academic staff supporting the remote learning process.
- Development of model digital teaching and training materials dedicated to technical colleges and training for road management staff on RIM:
  - Road safety audit,
  - Roadside safety management,
  - Safety management of vulnerable road users,
  - Road pavement management.
- Developing an e-learning platform with access to project products.
- Appointment of a panel of experts in road infrastructure management.

The InfRO@D project targets the following groups:

- 1) Students, researchers, and academic teachers at universities.
- 2) Road authority staff at national, regional and local levels.
- 3) Experts, specialists, and practitioners involved in RIM activities, including staff who conduct training in various RIM courses.
- 4) All users of road infrastructure, as an indirect target group, for whom the risk of road accidents will ultimately be reduced by increasing the effectiveness and efficiency of RIM activities.

The project is also supported by a group of associates who will cooperate with project partners to consult and evaluate the results. They will implement final products and promote the dissemination and accessibility of the project results.

### ABOUT OUTPUT IO.9

- **Objective:** Development of evaluation methodology.

- **Work package:** The task falls under WP3 – Development of techniques for the implementation of the remote teaching and training process with the use of support tools.
- **Target Groups:**  
Research and teaching staff from the project and other European institutions involved.

## 2 ENSURING ACADEMIC INTEGRITY

### 2.1 What is academic integrity?

The educational system's foundational value of academic integrity emphasizes responsibility, honesty, and ethical conduct in all facets of academic life. It entails a dedication to preserving the strictest moral principles of justice and honesty in one's academic endeavours. This principle covers a wide range of actions, such as refraining from plagiarism, using exam cheating techniques, and submitting someone else's work as one's own. It also includes using sources sensibly and following the rules of citation to properly acknowledge the thoughts and contributions of others. Maintaining academic integrity promotes a culture of trust and respect within educational institutions and guarantees that all students have an equal opportunity to succeed.

When it comes to maintaining academic integrity, online learning provides a special set of challenges because it calls for different communication, engagement, and assessment strategies than traditional face-to-face learning. Lack of direct supervision and physical presence can lead to a feeling of detachment and anonymity, which heightens the urge to plagiarize or cheat. Additionally, it is simpler to acquire and use information thanks to the availability and abundance of internet resources, but it is more challenging to properly credit and acknowledge the sources. Additionally, the complexity and diversity of online learners—who may come from various backgrounds, speak a variety of languages, have varying expectations and motivations – can result in a variety of obstacles and pressures that affect their academic behaviour. Finally, the inconsistent and variable nature of online standards, procedures, and regulations may be confusing.

#### 2.1.1 Importance of academic integrity

Academic integrity is the foundation for both the academic community's credibility and the quality of education it provides. In the quest of knowledge, it embodies the values of integrity, responsibility, and moral behaviour. For educational institutions to remain credible and reputable as well as to maintain the worth of the degrees they award, it is imperative that academic integrity be upheld. It encourages students to engage in real learning, critical thinking, and the production of original material. By establishing moral principles like ethics and honesty, it also gets people ready for their future careers. Ensuring academic integrity is necessary for several compelling reasons:

- **Trust in research and scholarship:** Academic integrity extends beyond the classroom and into the realm of research and scholarship. Faith in the integrity of research results is essential to scientific progress and the advancement of knowledge. Ethical research practices ensure that the information produced is trustworthy and can be used to make decisions and innovate.
- **Institutional credibility:** Maintaining academic integrity is vital to the credibility and reputation of educational institutions. When organizations adhere to high ethical standards, they are seen as trustworthy and reputable places to learn. Conversely, a lack of academic integrity can tarnish an institution's reputation and reduce the value of its credentials.

- **Fairness and equality:** Academic integrity ensures a level playing field for all students. When all individuals adhere to the same ethical standards, it ensures that success is based on achievement, hard work, and a true understanding of the subject, rather than unethical behaviour. honest or unethical. This fairness promotes a sense of equality and trust among students, which in turn promotes a healthy learning environment.
- **Intellectual growth:** Academic integrity promotes true intellectual growth and development. When students engage honestly in their courses, they are more likely to absorb knowledge, develop critical thinking skills, and gain a deeper understanding of the subject. This learning experience is valuable not only for academic success but also for personal and professional development.
- **Ethical preparation:** Adhering to academic integrity prepares students for the ethical challenges they may face in their future careers and in life beyond academia. It instils values such as honesty, responsibility, and ethical behaviour, which are essential for the success and prestige of professional and personal endeavours.

In short, academic integrity is necessary to ensure equity, promote authentic learning, prepare individuals for ethical challenges, and maintain the reputation of educational institutions. and maintain faith in research and scholarship. It is the foundation of a fair and ethical education system that benefits both individuals and society at large.

### 2.1.2 Specifics of the ensuring academic integrity by remote assessment

Ensuring academic integrity in online exams can be difficult because the remote environment creates opportunities for cheating and dishonesty. However, some specific strategies and practices can be used to promote academic integrity in online exams:

- **Proctoring:**  
Implementation of a remote proctoring solutions that use webcams and AI to monitor students during the exam. Proctors can detect suspicious behaviour, such as looking away from the screen or having multiple people in the room.
- **Safe online exam platform:**  
Using secure online testing platforms that offer features like randomized questions, locked browsers, and webcam monitoring. These platforms can help prevent cheating and ensure that students cannot access unauthorized materials during exams.
- **Timed exams:**  
Setting strict time limits for online exams to reduce opportunities for students to research answers or collaborate with others. Randomizing the order of questions and limit the time spent on each question to prevent real-time sharing of answers.
- **Random question bank:**  
Creating a question bank with a variety of questions for each topic or exam section. Using the testing platform to randomize questions for each student, making it difficult to share specific questions or answers.
- **Unique evaluation method:**

Design of tests requires critical thinking and application of knowledge rather than simple recall. Open-ended questions, essays, and problem-solving exercises are less susceptible to cheating than multiple-choice questions.

- **Communicate expectations:**

Clearly communication of your expectations of academic integrity to students. Providing guidance on what constitutes fraud and the consequences of a violation.

- **Student authentication:**

Verification of the identity of students taking the exam. This could involve using multi-factor authentication or requiring students to log in using their university credentials.

- **Randomly arranging exam time:**

Scheduling exams at different times for different students to avoid collaboration. This approach can make it more difficult for students to share information in real time.

- **Online monitoring:**

Encouragement of students to report any suspicious behaviour they observe during the online exam. Implementation a reporting system for students to confidentially report concerns about academic misconduct.

- **Post-exam assessment:**

After the exam, review of the results for any forms of cheating or suspicious behaviour. Analyse of data to identify potential instances of academic dishonesty and take appropriate action.

- **Educational Approach:**

Emphasizing the importance of academic integrity and ethical behaviour throughout the course. Teaching students about the consequences of cheating and the value of honest learning.

This section has been inspired by the references [1]-[4].



### 3 PROCTORING SYSTEMS

A **proctoring system**, commonly known as an online exam proctoring system, is a software or technology solution designed to track and monitor online exams to ensure academic integrity and prevent fraud. It uses a variety of tools, techniques, and technologies to proctor candidates remotely, replicating the proctoring process provided during traditional in-person exams.

Key features of the surveillance system include identity verification, real-time monitoring of inspection activities using webcam, microphone, and screen sharing, behavioural analysis, and detection of possible abnormalities. may indicate potential fraud or misconduct. The system can also use AI algorithms to identify behavioural patterns, such as excessive movement or multiple faces in the frame, that may suggest inappropriate behaviour during the inspection.

Some proctoring systems offer live proctoring, with human proctors monitoring exam sessions in real time, while others use AI to analyse and report potential violations, prompting the instructor to consider more deeply. Additionally, proctoring systems can integrate with learning management systems (LMS) and test platforms, allowing for seamless test setup, administration, and post-test analysis.

The primary goal of the proctoring system is to ensure academic integrity and maintain a fair and safe testing environment in an online context, ensuring that test results accurately reflect knowledge and students' understanding of the subject. However, it is essential to balance the use of surveillance systems with privacy and ethical usage considerations, providing clear and transparent guidance to students on how to collect and use their data during monitoring.

#### 3.1 Features of proctoring systems

When implemented effectively and ethically, proctoring systems can help maintain academic integrity by preventing cheating and ensuring that exam results accurately reflect academic integrity of each student's knowledge and understanding of the subject. However, it is essential to balance the use of a monitoring system with considerations of privacy, accessibility, and the overall learning experience. It is also important to provide clear instructions to students regarding the use and purpose of the monitoring system.

The proctoring system provides a range of features designed to proctor online exams, ensure academic integrity, and prevent cheating. These features may vary depending on the specific monitoring solution, but common features include:

- **Real-time monitoring:** The monitoring system uses a webcam and microphone to monitor the test environment in real time. This includes video recording, audio monitoring and screen capture, allowing proctors to observe students throughout the exam.
- **Identity verification:** Proctoring systems often use biometric authentication methods, such as facial recognition or fingerprint scanning, to verify the candidate's identity at the start of the exam.

- **Behavioural analysis:** AI-based surveillance systems can analyse candidate behaviour and detect anomalies or suspicious actions, such as excessive movement, multiple faces in the frame, or attempts to use other devices.
- **Direct proctor supervision:** Some systems offer live proctoring, where a human proctor monitors multiple exam sessions in real time via a video feed. They intervene if they notice suspicious behaviour or potential violations.
- **Recording sessions for later review:** The proctoring system records exam sessions for later review. If misconduct is suspected, the instructor or designee may review the recordings to assess whether a violation has occurred.
- **Browser lockdown:** The proctoring system can enforce an exam browser lock, restricting access to other websites or applications during the exam to prevent cheating through external resources.
- **Test-taker attention detection:** AI algorithms can analyse eye movements and attention patterns to determine if students are constantly looking away from the screen, which could indicate potential cheating.
- **Post-test analysis:** Monitoring systems typically generate reports and analysis after review, highlighting any suspicious activity or patterns that may require further investigation.
- **Suspicious behaviour reporting:** The proctoring system can send real-time alerts to proctors or instructors if suspicious behaviour is detected during the exam, allowing for immediate action.
- **Integration with Learning Management System (LMS):** Seamless integration with LMS allows for a streamlined test setup and tracking process, making it easier and safer for instructors to take and manage online tests.

### 3.1.1 Realtime monitoring in proctoring systems

Real-time monitoring in a proctoring system involves direct and continuous observation of candidates during an online exam using a variety of technologies and tools. This method is intended to prevent cheating, maintain academic integrity, and ensure that students comply with established rules and guidelines throughout the exam period. The proctoring system provides a range of features designed to proctor online exams. These features may vary depending on the specific monitoring solution.

Real-time proctoring is an essential feature of a proctoring system. This live, continuous observation includes the use of webcams, microphones, and screen sharing to closely review test takers' actions and the testing environment throughout the test. Real-time monitoring is important in detecting and preventing various forms of fraud, including unauthorized collaboration, access to external resources, or use of prohibited material.

One of the key benefits of real-time monitoring is the ability to intervene immediately. If monitors or automated algorithms observe suspicious behaviour, such as unusual glances, excessive movement, or signs of communication with others, they can act quickly. This may include sending alerts to candidates, asking clarifying questions, or notifying instructors in real time to resolve any potential issues. This proactive monitoring approach helps maintain the security and fairness of the online testing environment.

Additionally, real-time monitoring helps create a solid record of the exam session. It not only allows for live monitoring but also records the entire test, including video, audio, and on-screen activity. These records provide valuable evidence in cases of suspected misconduct, allowing the instructor or designee to review the session after the exam to assess whether a violation occurred. In this way, real-time monitoring improves the reliability of online assessments and ensures that results accurately reflect candidates' personal knowledge and abilities.

### 3.1.2 Identity verification

Identity verification is an essential part of proctoring systems that helps to ensure that the test-taker is the authorized individual and stop impersonation and identity fraud. Before and during an online exam, the identity of the test-taker is verified using a variety of techniques and technologies. Identity verification in proctoring systems typically works as follows:

- Initial verification before the exam
- Authentication at the start of the exam
- Continuous authentication during the exam

Examinees may be asked to scan their government-issued photo ID, like a driver's license or passport, using the webcam on their computer. The ID document's legitimacy is subsequently confirmed by the proctoring system. During the first verification phase, the system takes several facial photographs of the test-taker. Using these pictures, a special facial recognition profile can be generated. To construct a biometric template for authentication, some systems may gather biometric information, such as the test-takers fingerprint or palm vein pattern. The test-taker is required to conduct a live facial recognition scan at the start of the exam. To assure a match, the proctoring system matches the current scan with the previously saved face recognition profile. Some systems include liveness detection technology, which looks for evidence of vitality, such as blinking or head movement, to confirm that the face is real and not a photograph, to prevent cheating using static images or movies.

At any time during the exam, the proctoring system may ask the test-taker to validate their identity by doing a live facial recognition scan. Some systems utilize voice recognition technology in addition to facial recognition to compare the test-taker's voice to a pre-recorded sample to verify identity further.

Although identity verification is a crucial part of proctoring systems, privacy concerns should always come first. The privacy of test takers must be protected, and institutions must have clear rules and processes in place to handle personal data properly. Additionally, depending on the jurisdiction and the kind of data gathered during identity verification, compliance with data protection laws like GDPR or HIPAA may be required.

### 3.1.3 Behavioural analysis

Behavioural analysis entails continuous observation and evaluation of a test-takers behaviour throughout an online exam to spot any anomalies or activities that would signal academic dishonesty or cheating. The system creates a baseline profile of the *test-takers* regular behaviours before to the exam, considering elements like gaze patterns, head motions, and typing tendencies. The system uses webcams, microphones, and screen sharing to record numerous aspects of the *test-taker's* behaviour throughout the exam. It evaluates this data in *real time* using AI and machine learning methods. Through the webcam feed, it watches eye

movement, observes head movement and posture, examines keystroke dynamics, response times, and the surrounding environment. Any odd or unforeseen variations from the established baseline.

During the exam, the system uses advanced technologies, including webcams, microphones, and screen sharing, to capture a complete picture of the candidate's actions and responses. Artificial intelligence (AI) and machine learning algorithms then come into play, scrutinizing the data for any deviations from the established baseline. For example, sudden shifts of gaze away from test content, unusual head movements, or changes in typing speed and rhythm should all be scrutinized. Even the time spent answering questions or interacting with the test interface is closely monitored.

Additionally, the system extends monitoring capabilities to the test taker's exam environment, using webcam feeds to analyse the environment. Several people in the frame, the presence of additional electronic devices or background noise are some factors that can arouse suspicion. If the system identifies behaviours or patterns that deviate significantly from the baseline or indicate possible misconduct, the system will quickly generate an alert or report to the proctor or instructor. It is designed to strike a balance between maintaining academic integrity and protecting applicant privacy, ensuring that the focus remains on detecting suspicious behaviour without intrusion unwarranted. In this way, behavioural analysis is an important tool to ensure the fairness and reliability of online reviews.

#### 3.1.4 Direct supervision

One of the important aspects of live proctoring is live proctoring, where one or more human proctors actively proctor the exam in real time. The proctor uses a video feed from the webcam, audio from the microphone, and screen sharing to closely observe the candidate's activities throughout the exam. This direct supervision allows proctors to intervene immediately if suspicious behaviour is detected, ensuring a safe and fair testing environment.

The in-person proctor plays an important role in ensuring the integrity of the exam. They can communicate with candidates, give instructions, clarify doubts, and apply exam rules. This real-time interaction adds an additional layer of control and helps prevent cheating, ensuring that the exam is conducted in a *standardised* and controlled manner.

Direct supervision also has the benefit of providing immediate feedback to candidates. Proctors can address any technical issues or concerns candidates may have in real time, reducing disruptions and anxiety that may occur during the exam. This one-on-one support helps improve the overall testing experience for candidates. Overall, direct supervision in the proctoring system ensures a high level of security, fairness, and reliability in online exams. It combines human vigilance and advanced technologies to closely monitor and supervise the testing process, thereby promoting academic integrity and building trust in the integrity of assessments.

### 3.1.5 Recording sessions for later review

During online tests, sessions recorded for review in proctoring systems are an essential tool for maintaining academic integrity. These recordings include video, audio, and screen activity to provide a complete record of the whole exam session. Recording these sessions serves as a tool for analysis and review, assisting in the identification and investigation of any possible violations or suspicious behaviours that might have taken place during the exam.

One of the main benefits of recording exam sessions is the ability to review candidate behaviour. In the event of suspected or reported suspicious activity, the instructor or designee may carefully review recorded sessions to assess the validity of concerns. This review process helps determine whether there has been test policy violations, academic dishonesty, or cheating.

Recorded study sessions also serve as evidence in cases of suspected academic misconduct. Institutions may use these records during academic integrity investigations to support their decisions and take appropriate disciplinary action if necessary. Documented evidence adds a layer of objectivity to the assessment process and ensures that actions are taken based on a thorough review of the facts.

Additionally, knowing that test sessions are recorded helps prevent the possibility of cheating. Candidates are aware that their actions are being monitored and recorded, increasing the likelihood of compliance with exam rules and regulations. This in turn promotes a fair and safe testing environment. In addition to being an academic integrity tool, the ability to review exam sessions can also provide valuable information about the effectiveness of exam structure and design. Tutors can analyse candidate experiences, identify areas for improvement, and optimize the review process for future assessments.

Overall, exam sessions recorded for review in a proctoring system contribute significantly to ensuring the integrity and reliability of online exams. They provide a valuable means of investigation, prevent potential misconduct, and pave the way for continuous improvement of the online exam administration process.

### 3.1.6 Browser lockdown

Another crucial component of proctoring systems created to protect the integrity of online tests is browser lockdown. To provide a regulated and secure testing environment, it limits the test-takers access to external websites, applications, or resources while they are taking the exam.

One of the main purposes of browser lockout is to stop test-takers from accessing unapproved resources or looking up answers online while taking the test. The test-takers web browser is set up to only enable access to the specific exam platform while the lockdown is in effect, blocking movement to other websites or resources. By removing the option to look up information or get help from outside sources, this lowers the chance of cheating.

Browser lockdown frequently inhibits capabilities like copy-paste functionality and the use of keyboard shortcuts that could be used to copy or paste responses from other sources in addition to limiting internet access. Thus, the test-taker can only engage with the exam's

content and cannot simply copy or transfer information from another source. It lessens the possibility of exam materials being distributed unlawfully by taking screenshots or duplicating exam content.

Although browser lockdown is a useful exam security feature, it's crucial to balance security with usability. The restrictions imposed by browser lockout should be explained to test-takers, and when necessary, exceptions should be granted to provide access to materials or tools needed for the exam. While reducing potential for academic misconduct, effective communication and clear standards guarantee that the exam process remains fair and transparent.

### 3.1.7 Direct proctor supervision

Direct supervision is a vital aspect of proctoring systems, serving to maintain the fairness and integrity of online exams. This approach aims to replicate the vigilance and control seen in traditional in-person exam settings. Key elements of direct supervision in proctoring systems include live proctoring, real-time intervention, identity verification, direct communication with test-takers, and the creation of comprehensive evidence.

A key element of direct supervision is live proctoring, which involves a human proctor actively overseeing an online exam from a distance or on-site. The test-takers behaviour is continuously observed by the proctor to make sure that all laws and regulations are being followed. A key component of direct supervision is identity verification, which makes sure that the person taking the exam is the authorized person. At the beginning of the exam, several techniques, including facial recognition, government-issued ID verification, and biometric authentication, may be used.

Direct supervision makes it easier for proctors and test-takers to communicate effectively. Through chat or voice contact, proctors can interact with test-takers and give directions, answer questions, and improve the exam experience overall.

Finally, direct supervision produces thorough documentation of the whole exam session, including audio and video records. These recordings enable post-exam assessments by instructors or other authorities and serve as vital proof in situations of suspected wrongdoing. In the end, direct supervision makes sure that online tests are administered honestly, openly, and in accordance with accepted academic norms.

### 3.1.8 Test-taker attention detection

The ability of a proctoring system to track and evaluate a test-taker's degree of focus and attention during an online exam is known as attention detection. To ascertain whether a test-taker is actively engaged with the exam content or if there are signs of distraction, disengagement, or even academic misconduct, this includes assessing several behavioural clues, such as eye movements and gaze patterns.

Webcams are used by proctoring systems to track test-takers eye movements and count how often they shift their gaze. The technology may determine a test-takers degree of involvement by analysing where they are looking on the screen and how frequently they interact with the

exam's questions and answer options. Active involvement is regarded as being demonstrated by sustained and concentrated attention to the exam material.

The system may activate alarms or notifications for further investigation if it notices extended periods of inattentiveness, where the test-taker repeatedly glances away from the screen or displays indicators of distractibility. This enables proctors or instructors to step in and look at any potential problems right away.

In proctoring systems, attention detection is a useful technique for ensuring that test-takers are focused on the exam and aren't cheating or indulging in academic misconduct. However, it is vital to strike a balance between respecting test-takers' privacy and comfort while also using attention detection to preserve exam integrity. Clear instructions and open communication can assist allay worries and guarantee this feature is used ethically.

### 3.1.9 Post-test analysis

Post-test analysis entails a careful evaluation and analysis of exam data and recorded sessions after the test has been finished. To find any abnormalities, probable violations, or suspicious behaviours that might have taken place during the exam, this analysis is essential. It offers the chance to evaluate the exam's overall integrity and, based on the results, to take the necessary action.

Reviewing the audio or video of the exam is one of the key goals of post-test analysis. These recordings of the test-takers conduct throughout the test contain video, audio, and screen activity. Instructors or other designated staff can look over these recordings to look for any indications of cheating, improper assistance, or other violations of exam guidelines. It offers priceless proof for looking into suspicions or taking care of problems that have been raised. Additionally, post-test analysis frequently includes statistical evaluation of the exam findings and data analytics. This involves looking for odd trends in test results, response times, or other performance data that might point to anomalies. Data anomalies may lead to further inquiry into possible exam fraud or cheating.

Future exam administrations will be improved as a result of the post-test analysis. Proctoring systems and exam procedures can be improved to improve security, fairness, and the exam experience in general by identifying trouble spots or flaws in the exam framework. By ensuring that test procedures are dependable and strong and that the integrity of online assessments is continually respected, it contributes to a continuous cycle of improvement.

### 3.1.10 Report suspicious behaviour

Reporting suspicious behaviour in the monitoring system is an important step in ensuring the integrity of online exams. When test administrators, such as instructors or proctors, observe actions or behaviours that raise concerns about possible cheating or academic misconduct, compliance is required.

Above all, recording behaviour is essential. This involves taking notes or recording details of what has been observed. It's essential to include specific information such as the incident timestamp, a clear description of the suspicious behaviour, and any relevant context that can

provide insight. Organizations often have their own procedures for reporting suspicious behaviour in monitoring systems. These procedures typically involve notifying a designated agency, such as the instructor, exam administrator, or academic integrity office, and providing them with written information.

Additionally, some monitoring systems provide built-in tools for reporting suspicious behaviour. These features allow proctors or instructors to flag specific moments during test recording or create real-time annotations of observed behaviour. If possible, evidence should be provided to support observations. This may include sharing video, audio, or screen recordings of activity to corroborate allegations of suspicious behaviour. These recordings constitute vital evidence for any subsequent investigation.

Maintaining confidentiality throughout the reporting and investigation process is essential to protect the privacy of all parties involved, including the person being tested. It is imperative to comply with organizational policies and legal requirements regarding security and data protection.

The designated agency must then thoroughly investigate the reported suspicious behaviour. This investigation may include reviewing the recorded testing session, interviewing the candidate, and collecting additional evidence if necessary. Based on the findings of the investigation, institutions should take appropriate action, which can range from issuing warnings and sanctions to implementing academic disciplinary measures. The severity of the misconduct will generally determine the nature of the response.

Some institutions may also choose to educate, provide resources, or provide training to help students understand and comply with the principles of academic integrity. Throughout this process, maintaining transparency is essential. Institutions should communicate survey results to all stakeholders, including applicants and instructors. This transparency underscores our commitment to maintaining academic integrity and fairness in online assessments.

### 3.1.11 Integration with Learning Management System

Integration with learning management system (LMS) is an essential aspect of the proctoring system, streamlining the online exam administration process and improving the instructor and student experience. This integration simplifies various aspects of test administration and data processing.

First, it typically starts with single sign-on (SSO), which allows users, including instructors and students, to access the monitoring system without the need for separate credentials. This reduces complexity and makes accessing monitoring features more convenient.

Exam planning becomes simpler thanks to LMS integration. Instructors can easily plan and manage proctored tests in the LMS, integrating them seamlessly with other course materials and assessments. Access control is improved through integration. Only authorized students can access proctored tests, and permissions and access links are managed within the LMS, ensuring a secure and controlled testing environment.



Data synchronization between the LMS and the monitoring system ensures that student registration and course information are accurately aligned. This ensures that the right students are registered in the right exams and that monitoring data is accurately linked to courses and individuals.

User management is simplified because the roles and permissions of users (such as instructor, proctor, or student) are synchronized between the two systems. This streamlines administrative tasks and ensures that individuals have access to essential features.

Seamless exam launch is made possible through integration. Students can launch proctored tests directly from the LMS interface, eliminating the need to navigate between multiple systems and improving usability.

Data integration allows monitoring data, including session recordings, reports, and analytics, to be linked to corresponding courses and students in the LMS. Instructors can access monitoring data in the same platform where they manage course content and assessments. Gradebook integration ensures that test results and scores are automatically synced with the LMS gradebook, providing students with quick feedback on their performance. Additionally, the integration supports the collection of data related to proctored exams, such as metrics on student participation and achievement, as well as incidents of academic misconduct practice. Instructors can access these analytics within the LMS for assessment and evaluation purposes.

Finally, support and training resources provided by monitoring system vendors can be integrated into the LMS, making it easier for instructors and students to access help and guidance when using it. This cohesive integration improves the performance and efficiency of the monitoring system within the broader context of the online learning environment.

### 3.2 Types of proctoring systems

Proctoring systems come in various types, each employing different methods and technologies to monitor and maintain academic integrity during online exams. Here are the main types of proctoring systems:

- **Live Online Proctoring**

Involves a human proctor who monitors the exam in real-time through video feeds. The proctor can intervene if they observe suspicious behaviour or potential violations. Provides immediate feedback and can address any issues during the exam.

- **Recorded Proctoring**

Records the entire exam session, including video, audio, and screen activity. The recording can be reviewed later by instructors or designated individuals to detect any irregularities or violations. Can be used in conjunction with automated alerts for suspicious behaviour.

- **Automated Proctoring**

Utilizes AI algorithms to monitor test-taker behaviour and exam conditions automatically. Analyses actions such as eye movement, facial expressions, and keyboard activity to detect potential cheating or misconduct. Flags and reports suspicious behaviour for further review. Advanced Automated Proctoring combines AI-based behaviour analysis with biometric authentication for enhanced security. Uses facial recognition and other biometric identifiers to verify the test-takers identity. Monitors behaviour patterns and compares them against known cheating behaviours.

- **Mobile App-based Proctoring**

Uses a mobile application to monitor the exam through the test-takers smartphone. Uses the phone's camera, microphone, and screen-sharing capabilities to monitor the test environment.

Institutions may choose the type of proctoring system based on factors such as the level of exam security required, budget constraints, privacy considerations, and the technology infrastructure available. It's important to carefully assess the needs of the exam and the preferences of both instructors and students when selecting a proctoring system.

### 3.2.1 Live Online Proctoring

A reliable and technologically advanced technique called "live online proctoring" was created to maintain the validity of online exams. It offers a secure setting for critical examinations by fusing cutting-edge monitoring technologies with on-the-spot human supervision. These systems provide a variety of capabilities that let organizations confidently administer exams even in distant and online learning settings.

These systems' core components are skilled human proctors who actively supervise tests in real time. Proctors make sure test-takers follow the examination's standards, stop cheating, and offer prompt assistance when necessary. Before the examination starts, identity verification procedures including face recognition and biometric authentication establish the test-taker's identity, guaranteeing that only authorized people are taking the exam.

Proctors can monitor test-takers actions using live video and audio streams to make sure they are paying attention and not engaging in any suspicious conduct. To keep an eye on test-takers' actions and ensure they don't access any unapproved materials or websites while taking the exam, proctors can watch the test-takers' screens in real-time. Through chat interfaces, test takers can contact proctors and ask questions or report technical concerns without leaving the test. The entire exam session is recorded, including video, audio, and screen activity. These recordings serve as valuable evidence in case of suspected misconduct or disputes.

Compared to automated proctoring techniques, live online proctoring provides a higher level of security, lowering the possibility of cheating or academic misconduct. These solutions improve the fairness and legitimacy of online exams by making sure that all test-takers follow the same guidelines and requirements. They support different exam forms, which makes them

appropriate for a variety of topics and disciplines. By establishing norms and policies that are consistent with their academic standards, institutions can customize the proctoring experience to meet their unique needs. Live online proctoring enables organizations to administer tests to distant and scattered students, hence increasing access to education.

Systems for Live Online Proctoring have many benefits, but they can have drawbacks. Institutions must consider balancing security with privacy, addressing issues with data processing, and maintaining a seamless user experience. Live online proctoring technologies are revolutionizing the field of online learning. They offer a solid response to the persistent problem of preserving exam security and integrity in virtual learning settings. These methods will become more and more important as online education develops in preserving the validity and reliability of academic evaluations, empowering both teachers and students in the digital era.

### 3.2.2 Recorded Proctoring

Another important technique used to maintain the integrity of online tests is recorded proctoring. Throughout the course of the exam, it continually records all audio, video, and screen activity. This thorough recording is a useful tool for preserving exam security because it can be afterwards reviewed for any signs of misconduct or anomalies.

Due to their automated nature, recorded proctoring systems are very versatile and effectively handle numerous test-takers at once. They are useful for educational institutions that conduct a lot of online exams because of their scalability. Recorded proctoring excels in recording every encounter, ensuring that any suspicious behaviour or efforts at cheating are documented despite the absence of real-time human assistance. Additionally, in cases of claims of academic misconduct, the recorded exam sessions are used as verifiable proof. These recordings can be used by instructors to assist inquiries and decision-making procedures, guaranteeing fairness and openness in handling such issues.

Test takers who are thinking about cheating or acting inappropriately may be discouraged by the awareness that their activities are being recorded. Even without real-time human proctoring, this psychological factor can help maintain the integrity of exams. Recorded Proctoring has many benefits for maintaining test security, however organizations using this technique should consider privacy issues, data security, and effective review procedures. For it to be implemented ethically, it must strike a balance between the requirement to preserve exam security and the privacy of test-takers.

The post-exam review procedure that recorded proctoring makes possible is one of its main benefits. The recorded sessions can be thoroughly examined by instructors or other specified personnel for indications of anomalies, such as unapproved items, suspicious behaviour, or contraventions of exam norms. This review procedure flexibility enables focused assessments, which improves the effectiveness of problem identification and resolution.

Recorded proctoring is a powerful technique for boosting the security and reliability of online exams. It offers a useful method for recognizing and dealing with academic dishonesty through thorough recording and subsequent post-exam review. When utilized carefully and ethically,

recorded proctoring helps to create fair and reliable online assessments, making sure that test results appropriately represent the candidates' knowledge and skills.

### 3.2.3 Automated Proctoring

Automated proctoring has emerged as an essential tool for maintaining the validity of online exams. This strategy uses sophisticated monitoring technologies, such as webcams, microphones, and screen capture, to record and continuously monitor test taker behaviour. Automated proctoring systems use artificial intelligence to evaluate the data gathered, spotting trends and irregularities in test-takers behaviour, such as gaze tracking, eye movements, and audio analysis. The technology sends real-time notifications to instructors or other designated people in the event of any suspicious conduct or potential violations, enabling prompt intervention.

An additional crucial component of automated proctoring is identity verification. Test-takers are needed to go through identity verification procedures before the exam starts, such as facial recognition, biometric authentication, or ID checks, to make sure that only authorized people take the exam. A thorough record of the entire exam is also provided via automated proctoring, which continually records video, audio, and screen activity throughout the exam session. In cases when misbehaviour is suspected, these recordings are an important source of evidence.

Scalability and efficiency are two of automated proctoring's key benefits. This technique enables institutions to administer exams to many test-takers at once, making it appropriate for online learning environments with diverse and distant student populations. When establishing automated proctoring systems, it's crucial to consider worries about privacy, algorithmic biases, and the necessity of human intervention in complex circumstances.

AI helps automated proctoring in several ways. To assess test-takers behaviour, AI-driven algorithms are trained to track eye movements, gaze direction, head motions, and facial expressions. AI can identify variations that might be signs of academic dishonesty by developing patterns of typical behaviour. Another use of AI in automated proctoring is voice analysis. AI can analyse audio data, including the test-takers voice, to find odd vocal tics or lurches in speech that might indicate shady behaviour or unlawful communication during the exam. AI is quite good at finding patterns in data. AI algorithms are used in automated proctoring to spot specific behaviours linked to cheating, like excessive mouse movements, repetitive screen captures, or a lot of tab switching throughout the exam. An important component of automated proctoring systems powered by AI is anomaly detection. When a second person enters the frame, for example, or when a test-taker tries to access prohibited materials or websites, AI can spot irregularities in the test-takers behaviour or the exam environment. AI can make it easier to detect plagiarism. Some automated proctoring systems include plagiarism detection techniques based on artificial intelligence that scan test-takers text responses against a sizable database of academic content to spot any instances of plagiarism or unauthorized content use. Beyond real-time monitoring, AI can perform a more thorough analysis of exam data, spotting trends and patterns that can point to bigger problems with exam integrity. The improvement of proctoring practices and policies is informed by this data-driven approach, thereby strengthening the overall fairness and integrity of online exams.

Automated Proctoring is a technological advancement that is essential to preserving the validity of online exams. It provides a reliable system for identifying and discouraging academic misconduct by fusing cutting-edge monitoring technology with AI-driven analysis and identity verification. Automated proctoring, when used responsibly and ethically, improves the validity and fairness of online exams, making sure that test takers knowledge and skills are appropriately reflected in exam outcomes in the current digital learning environment.

### 3.2.4 Mobile App-based Proctoring

Mobile app-based proctoring is an innovative approach to ensuring the integrity of remote exams in the digital age. It offers candidates a flexible way to use their smartphone or tablet to take the test, giving them the freedom to choose when and where they want to take the assessment. This accessibility is especially beneficial for students who do not have access to a computer or who prefer the convenience of a mobile device.

Test-takers have the option to utilize their phones or tablets for exams, giving them the freedom to decide when and when to take the exam. For students who might not have access to a computer or prefer the convenience of mobile devices, this accessibility is very advantageous.

An important element of mobile app-based surveillance is identity verification. The mobile app uses various methods such as facial recognition, biometric authentication or identity document scanning to confirm the candidate's identity before the exam begins. This step ensures that the person taking the test is an authorized person, which increases security.

Real-time monitoring is another indispensable aspect of mobile app-based monitoring. The mobile app actively monitors candidates throughout the exam using device features such as front camera, microphone, and screenshots. This real-time monitoring helps detect and prevent cheating, ensuring exam integrity.

To provide support during exams, mobile app-based proctoring often includes a live chat function. This feature allows candidates to communicate with proctors or support staff in real time, helping to clarify test instructions or resolve technical issues, contributing to a smoother testing experience.

Additionally, mobile app-based proctors can ask candidates to scan their surroundings using their mobile device's camera to ensure a safe testing environment, free of unauthorized devices or individuals. This step further improves the integrity of the review. In terms of security and data privacy, mobile app-based monitoring systems deploy strong encryption protocols to protect sensitive information, thereby addressing privacy concerns and data security.

While mobile app-based monitoring offers flexibility and accessibility, organizations must consider factors such as internet connectivity, device compatibility, and possible distractions, when deployed. Ensuring compliance with privacy regulations and maintaining a user-friendly interface is critical to successfully implementing this approach.

Mobile app-based proctoring is a modern solution to ensure the integrity of online exams. By leveraging mobile devices and advanced technology, institutions can provide a safe testing

environment that meets the needs of students and teachers. In the growing online education landscape, mobile app-based monitoring is a valuable tool to ensure assessments are trustworthy and fair, regardless of a person's location or device.

### 3.3 Most popular proctoring systems

Proctoring systems are a popular option for educational institutions, certification programs, and enterprises that depend on accurate and fair testing procedures because they effectively meet the growing demand for convenient and secure online assessments. There are several different proctoring systems available. Existing proctoring systems change or adapt as new ones are continually being created. Due to the rising need for online learning and remote exams, proctoring solutions have become much more common and widely used. A lot of colleges and universities have also created their own internal proctoring programs to cater to their requirements. The need for online education and remote assessment solutions has caused a considerable increase in the number of proctoring systems in recent years.

Some examples of well-known proctoring systems are:

- ProctorU (Meazure Learning)
- Honorlock
- Proctorio
- Examity (Meazure Learning)

#### 3.3.1 ProctorU

ProctorU is assessment management software that assists academic institutions in recording and reviewing exam sessions to detect suspicious activities. Multi-factor identity authentication, live proctor monitoring, end-to-end video recording, issue reporting, and time-stamped video events are among the platform's key features.

Administrators may use the solution to rewind movies while watching live sessions, preventing cheating or content theft in real time. Teachers can use ProctorU to authenticate participants' identities and screen backgrounds for prohibited stuff. To report issues, managers can also get screen and video recordings with timestamps, as well as other documented proof of problematic sessions.

Main features and benefits of ProctorU:

- Multifactor identity verification
- Professional proctor review of session to catch misconduct post-exam
- Live test-taker environment security checks to prevent unpermitted resources
- End-to-end video recording of each test-takers webcam & screen
- Enhanced exam process and proctor training customization
- Advanced technology – helps identify suspicious actions & behaviors

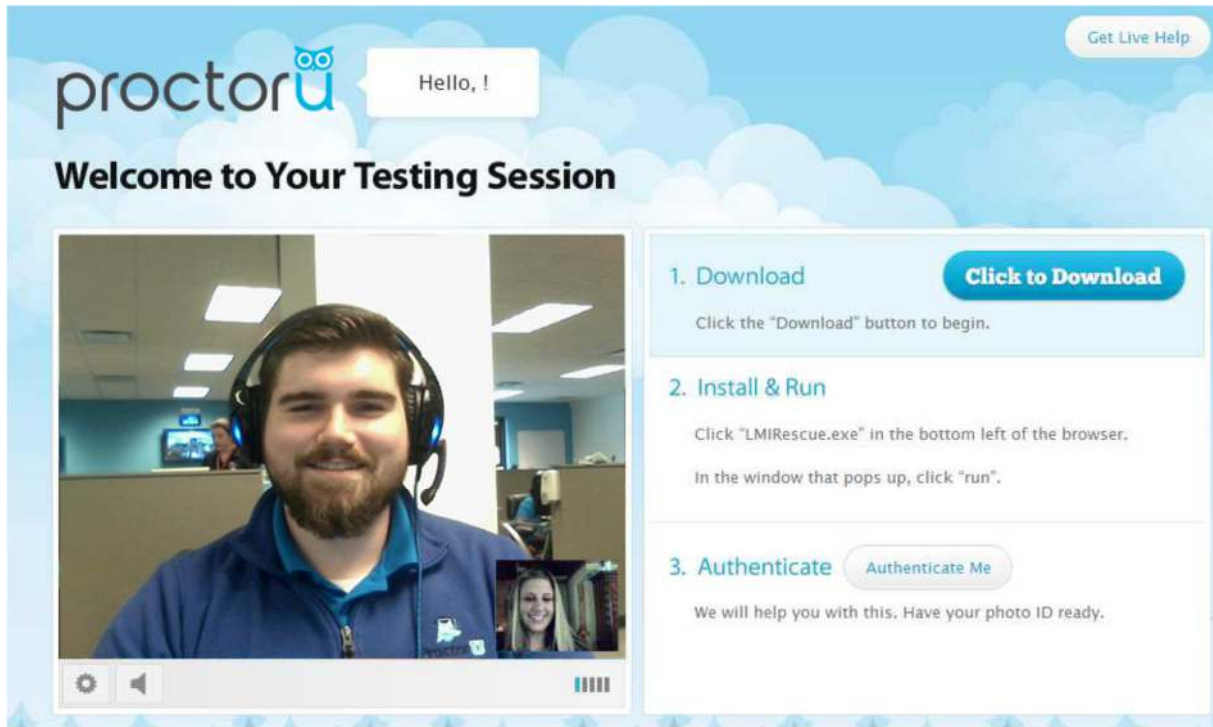


Figure 1. Screenshot of ProctorU proctoring system

ProctorU Proctoring Platform provides three service lines to choose from:

- Record+
- Review+
- Live+

Record+ uses live proctors who watch the video of students taking exams along with AI-based monitoring. The expense of using this choice for proctored tests is not borne by the students. Tests will be proctored on demand; advanced scheduling is not required. Review+ offers a live-proctored launch and post-session validation from our certified proctors. Through our protected browser, test-takers login to their proctoring session. By locking down each test-taker's PC in accordance with the settings provided by the exam administrators, Guardian safeguards the virtual environment. With Live+, a proctor actively keeps an eye on the students, records the sessions, and can act if anything seems fishy. Suspicious activity is automatically highlighted for proctors' review using Record+. Both services employ AI-based detection to identify on-screen activities, off-screen staring, changes in lighting, unexpected noises, and movement.

ProctorU capability is to observe test takers in real-time via webcams, microphones, and screen sharing is one of its primary advantages. Qualified proctors can monitor students while they finish their examinations, confirming their identities and assuring the security of the testing facility. ProctorU does this to assist organizations and educators in maintaining the validity of their online exams, which is essential in an era where online education is becoming more and more common.

ProctorU has received mixed reviews from students and educators. While it offers a convenient solution for monitoring online exams, some individuals find the process intrusive, as it requires

real-time monitoring of their activities during the test. However, ProctorU's commitment to student privacy and data security is a significant factor in its favour, as they have taken measures to protect students' personal information and ensure the security of the test environment.

### 3.3.2 Honorlock

Honorlock is a well-known online proctoring program in the realm of distant learning. It is a trustworthy response when it comes to upholding academic honesty while taking exams online. Honorlock employs several technologies and services to prevent plagiarism and ensure the validity of students' work even in the absence of on-site supervision.

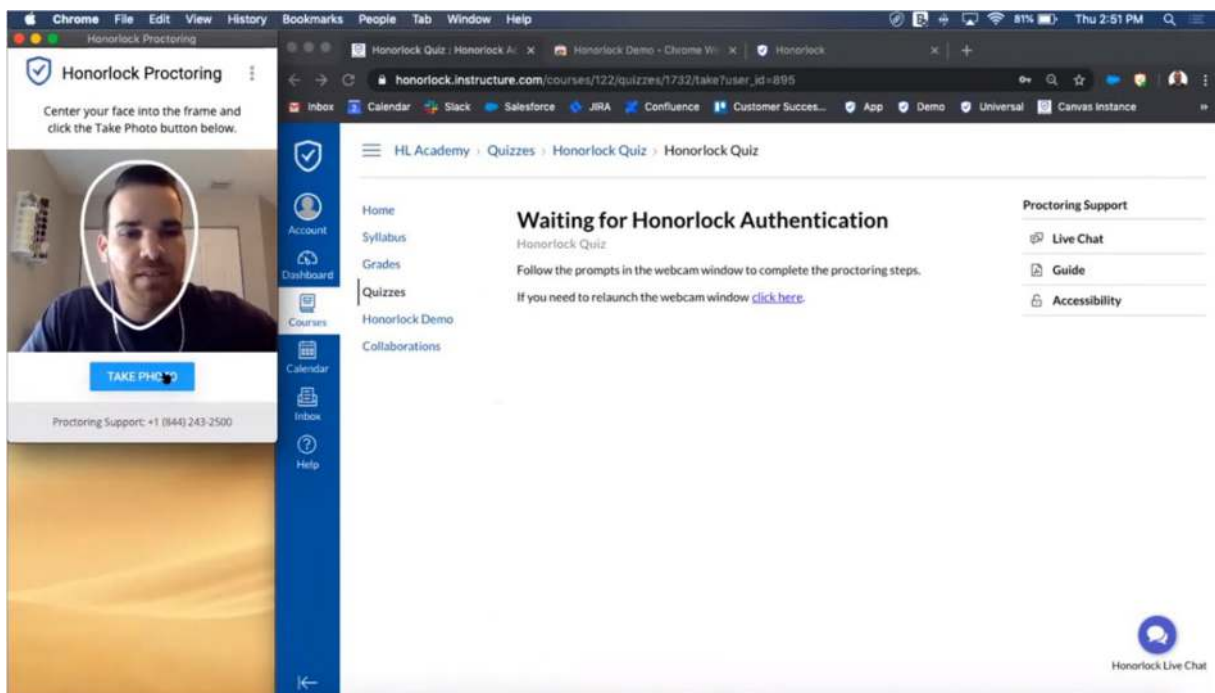


Figure 2. Screenshot of Honorlock proctoring system

One of Honorlock's key features is real-time proctoring, which makes use of the test-takers webcam, microphone, and screen-sharing to closely monitor them during the exam. With the help of this technology, proctors may intervene right away to maintain a fair testing environment in the case of any dubious behaviour. To prevent students from using unapproved resources while taking the test, Honorlock also offers browser lockout measures. Identity verification, one of the platform's security measures, regularly makes use of facial recognition.

This proctoring system places a strong emphasis on customization and accessibility. Remote exam administration is a beneficial service for educational institutions and online learners. Its 24/7 accessibility helps exam takers from all time zones. For universities that provide distance learning, this adaptability is a huge advantage.

Security and data privacy are major objectives for Honorlock. The platform employs encryption and secure data storage techniques to safeguard sensitive information. It ensures compliance with laws like FERPA and GDPR by enforcing stringent data privacy guidelines. The data of



students is treated with the highest care and meets with industry standards, so institutions can be confidence in this.

Honorlock growing popularity among educational institutions around the globe is evidence of its effectiveness. Academic dishonesty has greatly diminished thanks to the real-time human proctoring and technology-driven elements of this system. The overall integrity of assessments has improved in universities where Honorlock has been implemented into their online learning programs.

Honorlock is a complete solution for upholding academic integrity in online learning through real-time proctoring, providing a secure and reliable approach to supervise online exams. Webcam and microphone monitoring, screen sharing, browser lockdown, and identity verification are some of its features that make it possible to stop cheating and ensure the validity of students' work. Honorlock also gives flexibility and accessibility a high priority, enabling students to take tests at any time and from numerous locations, and it heavily emphasizes security and data protection by adhering to tight guidelines. Numerous educational institutions have implemented Honorlock with success because of its superior proctoring, practicality, and data privacy. Due to this, academic dishonesty has significantly diminished, and online exam integrity has generally been maintained.

### 3.3.3 Proctorio

The popular online proctoring software Proctorio provides several features to guarantee the reliability of online tests and exams. Proctorio offers a complete solution for academic institutions, instructors, and students looking for safe and impartial online testing settings with its collection of products.

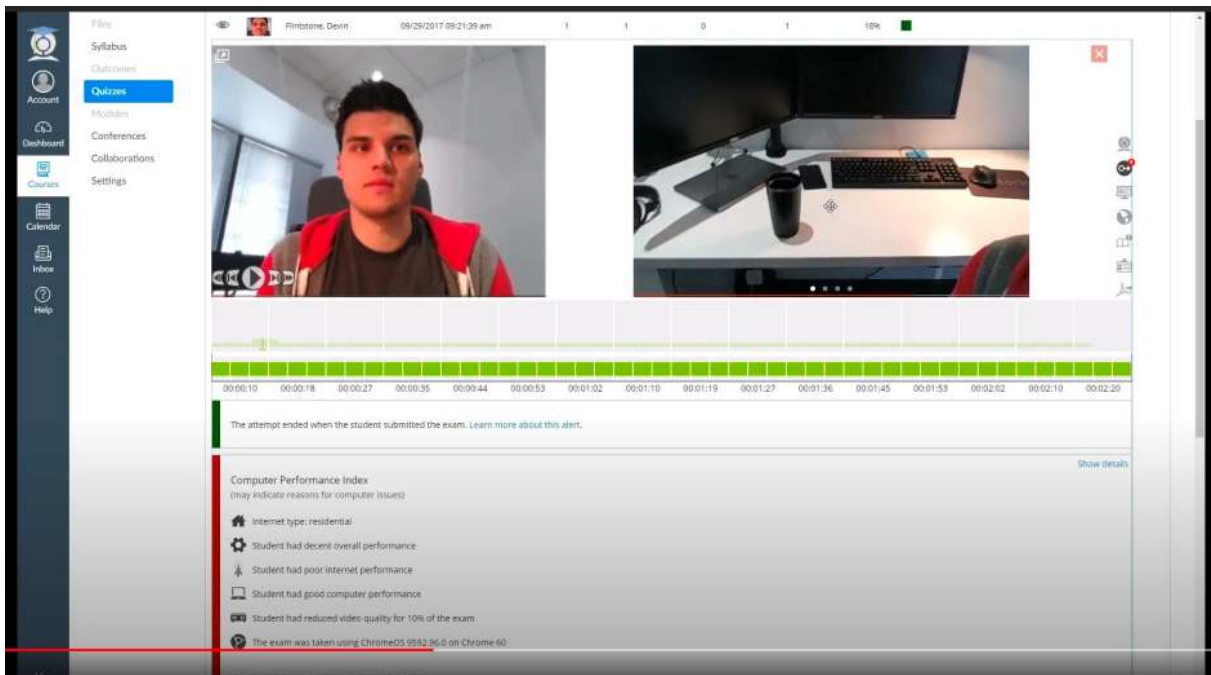


Figure 3. Screenshot of Proctorio proctoring system

Real-time proctoring capabilities are one of Proctorio key features. During tests, this includes keeping an eye on students using their webcam, microphone, and screen sharing. If any suspect conduct is noticed, proctors can step in right away to provide a controlled and fair testing environment. For organizations that provide high-stakes exams, when exam security is crucial, this capability is especially helpful.

Flexibility and accessibility are key concepts of Proctorio. Exams can be taken from any place, making it a practical choice for online students. Exam timing is also flexible, allowing students to pick the most convenient time to take their exams. This flexibility is a big benefit for organizations who provide remote or distant education.

Proctorio key priorities are security and data privacy. Sensitive information is safeguarded by the platform via encryption and secure data storage, ensuring that student data is handled carefully and in accordance with data protection laws like FERPA and GDPR. Proctorio offers universities with trust in the protection of student data by upholding strict privacy standards. Additionally, Proctorio allows teachers configurable settings so they can select the level of proctoring and security precautions that work best for their tests. The limits for exam behaviour, the security levels, and the rules for online exams can all be defined by the instructor. This versatility is especially helpful for customising the proctoring process to meet the individual requirements of various courses and assessments.

In conclusion, Proctorio is an extensive online proctoring platform that combines real-time proctoring, adaptability, and strong security measures to guarantee the integrity of online exams. It is a dependable option for educational institutions looking to hold safe and impartial online exams, and its adjustable features meet the individual requirements of teachers and students.

### 3.3.4 Eximity

Eximity provides a full range of tools that are intended to improve the security and reliability of online tests. With the help of camera feeds, microphone audio, and screen sharing, it is possible to actively monitor test-takers in real time and intervene as soon as any suspicious conduct is noticed. The platform places a strong emphasis on accessibility by enabling students to take tests at any time and from any location. With the help of customisation tools, instructors can adjust exam conditions and security settings to suit the requirements of their courses. Eximity prioritises data privacy and compliance, abiding by stringent rules to safeguard private student data. Strong reporting and analytics tools let instructors track student achievement and enhance their evaluation methods.

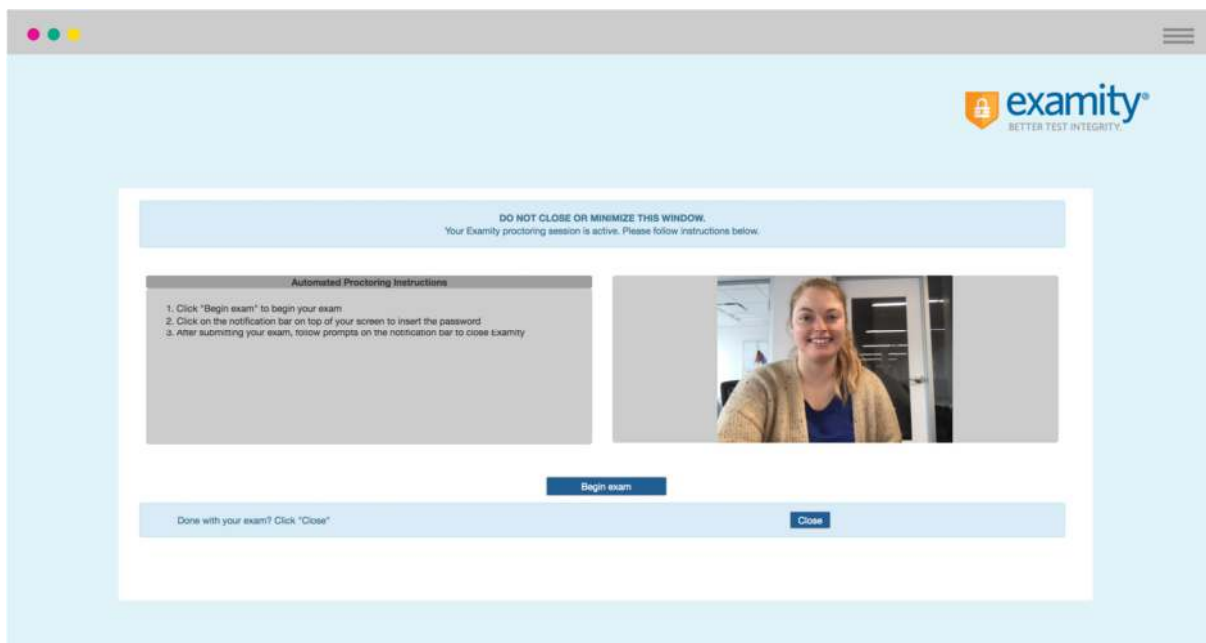


Figure 4. Screenshot of Examity proctoring system

Examity's real-time, live proctoring is one of its key features. This comprises the use of a live proctor who actively observes test takers via webcam feeds, microphone audio, and screen sharing while the exam is being administered. This human presence makes it possible for proctors to act swiftly in the event of suspicious conduct, maintaining a fair and regulated testing environment, particularly during high-stakes exams.

Examity provides convenient and open access to online learning. Exams can be taken remotely by students, negating the requirement for travel to testing facilities. For distance learners, this flexibility is especially useful because it enables them to finish exams at their own leisure and in a relaxing environment.

For Examity, security and data privacy are top priorities. The platform conforms with data protection laws like FERPA and GDPR and uses strong encryption and safe data storage techniques to protect sensitive information. This dedication to data security guarantees that universities can trust Examity to protect student information.

Another important aspect of Examity is customization. The degree of proctoring and security controls can be customized by instructors to fit their tests. This includes establishing standards for online tests, modifying security settings, and specifying test behaviour parameters. This flexibility gives educators the freedom to customise the proctoring process to match the needs of their courses and tests.

Examity is a complete online proctoring platform that combines flexibility, real-time proctoring, and strong security features to guarantee the integrity of online examinations. It provides for the changing requirements of academic institutions as well as students, making it a reliable option for holding secure and fair online exams.

### 3.4 Choosing a good proctoring system

When choosing a proctoring system, it's important to consider features like security and integrity, adaptability to meet various student needs, customization options, data privacy and compliance adherence, accessibility for students with disabilities, cost-effectiveness, scalability, compatibility with existing technology infrastructure, robust reporting and analytics capabilities, and the availability of extensive support and training. This comprehensive examination will assist institutions in making a decision that is in keeping with their unique requirements and principles, protecting the validity of online exams and the confidence of their students. To compare proctoring systems and make an informed choice, the following crucial considerations in mind:

- 1) **Integrity and Security:** The security and integrity of exams are the main goals of a proctoring system. It's crucial to pick a system that offers strong security features to discourage and stop cheating, impersonation, and unapproved help. Features like screen sharing, identification verification, and real-time proctoring are very important.
- 2) **Flexibility:** The range of needs in your student group needs to be considered. Flexibility is key in a proctoring system, enabling students to take tests from different locations and at convenient times. To serve a wide audience, it ought to support a variety of devices and internet connection speeds.
- 3) **Easy-to-use interface:** Both instructors and students should be able to use a proctoring system with ease. User interface should be simple to understand and navigate. In-depth user support is also necessary to handle any problems or questions that can come up during proctoring.
- 4) **Data Privacy and Compliance:** Privacy of student data and adherence to pertinent data protection rules, such as FERPA, GDPR, and other applicable legislation, are crucial considerations when choosing a proctoring system. The system must adhere to all the compliance standards and is built to protect sensitive student information.
- 5) In addition to these requirements, the cost-effectiveness of the proctoring system is important by considering both the one-time fees and ongoing expenses. Scalability of the system is essential for schools aiming to grow or undergo change since it must be able to handle increasing exam and student loads without sacrificing effectiveness.

Additionally, the proctoring system should work with the learning management system (LMS) and any existing educational technology tools you already have. The proctoring procedure can be streamlined, and administrative difficulties decreased by integration with your present systems.

Examination of the proctoring system's reputation and reading user evaluations from various educational institutions will lead to an informed choice. Getting feedback from current users and asking the supplier for referrals is necessary. A selected system should be in line with the objectives and guiding principles of the institution by carefully considering these elements and undertaking an exhaustive review of alternative proctoring solutions.

### 3.5 Conclusion

Finally, it should be noted that maintaining academic integrity in a time when online learning is becoming more and more commonplace is of the utmost importance. Proctoring systems have

become essential allies in this effort, providing a complex strategy to safeguard the integrity of exams. These systems act as guardians against academic fraud by using real-time proctoring, strong security measures, and customisation possibilities. Adoption of proctoring systems calls for a delicate balance, nevertheless, as privacy and accessibility issues must be carefully taken care of. It is obvious that academic institutions must exercise caution in choosing proctoring systems that most closely correspond to their educational objectives and beliefs, while simultaneously assuring equal access for all students. Institutions may achieve this balance by carefully integrating proctoring systems, protecting the highly valued concepts of academic integrity, and ensuring students that their online educational path will continue to be one of honour, trust, and greatness.

This section has been inspired by the references [5]-[14].

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