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Online Framework of Examination for Evaluating Learner's Knowledge

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Abstract: The COVID-19 pandemic has necessitated a shift to online assessments, posing significant challenges for teachers in fairly evaluating student performance. The absence of invigilation has led to widespread cheating, with students copying answers from the Internet or top-ranked peers. This paper addresses these issues by proposing guidelines and techniques for fair student assessment without invigilation. The research begins with an analysis of traditional assessment methods and their limitations in the context of unmonitored online exams. It then explores various online examination frameworks, including multiple-choice questions, short-answer questions, and interactive simulations. The study identifies key weaknesses in current online assessment practices and highlights the potential of advanced online examination frameworks. By implementing the suggested techniques, educators can improve the reliability and fairness of online assessments, ensuring a more accurate evaluation of students' knowledge. This article serves as a valuable resource for educators, instructional designers, and e-learning professionals seeking to enhance the efficacy of online assessments.

Index Terms: Traditional examination, Online examination, Question generation, Automatic Assessment, Educational learning

1. Introduction

Education [1] is an enlightening process of receiving and providing knowledge through systematic instruction, whereas learning [2] refers to an intellectual process of acquiring new skills and knowledge through experience, study, or teaching. The act or process of transmitting or acquiring broad information, growing one's capacity for logic and judgment, and generally putting oneself or others in an intellectually mature state is known as educational learning. Learning classifies broadly into three categories [3], textual learning, visual learning, and audio-visual learning. Traditional education occurs in a classroom with a teacher who prepares and delivers a topic or lesson. The teacher can use several teaching strategies, including the use of a whiteboard for introducing information, student presentations, group projects, and individual exercises or tasks.

Evaluation is being used to measure student progress, reform education systems, and enhance accountability for outcomes. Specifically, there are three types of evaluation used in the classroom. These are summative evaluation, formative evaluation, and diagnostic evaluation [4]. Summative evaluation is conducted at the end of a course to determine to what extent the previously established objectives have been met. In other terms, it is the assessment of the student's

grade at the end of a course. Formative evaluation is used to monitor the learning progress during the period of the course. Its purpose is to give continuous feedback to teachers and students regarding learning outcomes and deficiencies while the course is in process. The informative information of feedback is used to revise or improve educational practices in formative evaluation. The diagnostic evaluation identifies learners' learning difficulties or weaknesses during the course. It tries to discover the specific weakness area of a student in a given subject and provides remedial classes.

Online learning [5] means you can study remotely through the Internet. It is also known as Distance Learning or E-learning [6]. Through online learning, you can learn from anywhere in the world. You can usually do it at any time that is suitable for you. Some lessons are previously recorded, depending on the topic and format of what you want to learn. Some additionally give you homework that you complete on your own time. The benefits [7] of online learning give teachers an effective way to deliver teaching to students. Teachers can use several tools in their lesson plans for online teaching, including podcasts, PDFs, and videos. It permits students to follow classes from any location they choose. It also reduces financial expenses. Compared to traditional schooling, online education is far less expensive because the costs associated with student transportation, student meals, and—most significantly—the cost of maintaining the classroom are all eliminated in online learning. Additionally, all of the courses or study materials are accessible online, resulting in a paperless learning environment that is affordable and beneficial to the environment. It also improves student attendance [8].

Some disadvantages [7] are also there in this online system. The main difficulty of online learning is maintaining attention on a computer for extended periods of time. Another challenge of online classes is internet connectivity. In an online class, interactions between students and teachers are minimal. Teachers must require basic knowledge to teach students online using digital platforms. Many parents are worried about the health risks of their children who spend a long time watching a screen.

Two components are necessary for online learning: the learning resources [9] and the evaluation of students using the learning resources. Learners have access to a variety of online resources from which they can draw knowledge. The learner's evaluation, on the other hand, calls for manual questions from the course materials. Manually creating questions and grading answers is laborious [10]. So an automatic question generation and answer assessment [11] can solve the problem faced during a manual system. It reduces the time and effort required to assess students in the educational system. To test the proper response, objective-type answer evaluation only has to use a binary form of assessment (true/false). However, the subjective answer evaluation does not produce satisfactory results for its complex nature. Teachers take a lot of time to prepare questions for evaluation. Automatic Question Generation (AQG) [12] is a method for creating questions from text content that can minimize the effort of teachers. The prime challenges [13] of automated examination systems are the extraction of informative-simple-sentences, question generation from multiple sentences, short and long-type answer assessment, answer assessment standard, assessment from video lectures, etc.

In this article, we focus on summative assessment to evaluate students' performance using online examinations. The main contributions of this paper are as follows:

- Identify the limitations of various traditional assessment techniques.
- Review existing online assessment systems and their limitations.
- Propose a framework for conducting online examinations effectively.

2. Traditional Examination System

The traditional assessment is a classic way of evaluating learners' knowledge that has been used for a very long time [14]. The traditional examination assessment system typically involves testing students' knowledge and understanding of a subject through written exams. These exams may cover a wide range of topics and are typically focused on memorization and recall of information.

In this system, students are often graded on a scale, with scores indicating their level of mastery of the subject matter. Traditional assessment tools typically refer to standardized tests, quizzes, and exams to evaluate student knowledge and understanding. These assessments are often multiple-choice or short-answer and are focused on measuring a student's ability to recall and apply information. Quizzes and exams are often used in classrooms to assess student understanding of a specific subject or topic. Standardized tests, such as the SAT (Scholastic Aptitude Test) or ACT (American College Testing), are often used to evaluate a student's readiness for college. They typically assess math, reading, and writing skills, and are designed to provide a standardized measure of student performance. Fig.1 briefly depicts the traditionalexamination and assessment system.

The assessment system requires questions and model answers that are created manually by the teachers, which is a time-consuming and laborious task. Also, the answer script evaluation within a limited time is hardening some. The online system is suggested to overcome these limitations. However, very few applications are available to evaluate the students automatically. The following section describes a few efforts toward developing an automatic system for learners' evaluation of a particular type of question.

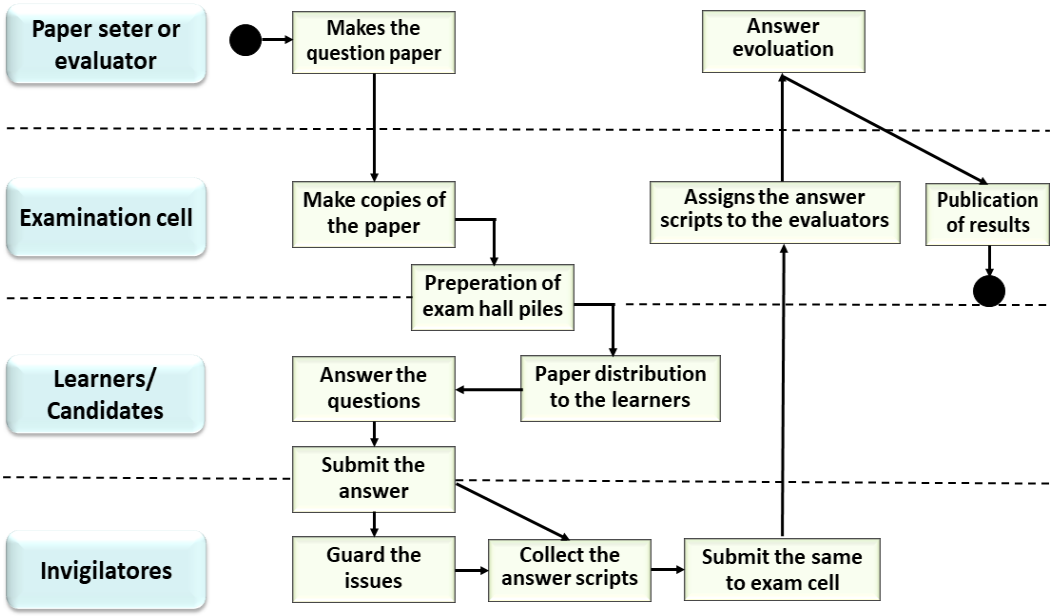

Fig. 1. Traditional Examination and Assessment System

3. Review on Online Assessment Systems

The online examination system is an electronic tool that enables institutions to evaluate students' responses. The institutions can oversee the online test and provide a quick summary of the results [15]. The following subsections describe a few existing online assessment systems used to evaluate responses to a specific type of question. A complete online summative examination system is proposed in Section 5 with the help of existing systems and a few additional new features.

An open-cloze question [16] is a fill-in-the-blank question with one or more blanks. Automatic open-cloze question generation has two steps, sentence selection, and answer identification. To generate questions, omit the answer keys from the selected sentences. The learners are asked to fill in those blanks to complete the sentence, but alternative answers are not provided. It makes solving the open cloze question more complicated. The difficulty level is also increased when a question includes multiple words to fill in a blank. Open-cloze questions judge the more in-depth knowledge of the learner than other objective questions. Automatic open-cloze question generation from text materials can generate random blanks for the learners from the different sections to prevent the malpractice of the students. This automated system also can provide an individual question set for each student.

A cloze question is a fill-in-the-blank question that provides four answer options to complete one or more blanks in a given sentence [17]. One of the options is correct, and the rest are wrong. Online exams frequently employ questions of this nature. There are three primary processes to develop a cloze question automatically [18]; choosing an informative sentence for creating a question, finding the correct response, and creating distractions [19]. Random alternatives and questions might deter students from cheating. Such automated questions can reduce the effort of manual production of questions for evaluation [20].

Another form of objective assessment is multiple-choice, which fills in the blanks of WH-questions, beginning with What, Which, Where etc. [21]. An MCQ has three parts; the stem, the answer key, and the distractors [22]. The literature uses a variety of strategies, including sentence length [23], word appearance [24], parts of speech [25], summarizing, and phrase structure, to choose informative sentences [26]. A novel method for creating multiple-choice questions uses automatic question synthesis in domain ontologies [27]. The online exam can create automated random questions and options to prevent cheating.

For a long time, subjective evaluation or text-based responses has been a barrier to developing e-learning or assessment systems. There is no appropriate technique to analyze short and essay-style questions because real-life online assessments only focus on evaluating MCQ-based questions. Also, they don't focus on giving proper learners' feedback right away with valid outcomes [28]. The time for creating exam papers is reduced when automatic generation is included in the assessment system [29]. The short question can be answered in one of two ways using a phrase or a complete sentence.

The identical response can come from various students. As a result, some measures need to be adjusted to prevent studentfraud.

Long question-based automatic assessment systems have gained significant attention in recent years due to their potential to streamline the grading process. Long-type queries require complex responses that can range in length from a few paragraphs to many pages. In education, the quality of question papers is essential to achieve the goal of assessment. Question papers are created manually in educational institutions, which causes several disputes and requires a huge amount of time and resources [30]. An automatic system for Long question-based assessment can solve the problem and assess students and provide personalized feedback to the students [31].

4. Challenges of Online Assessment System

Online examinations are becoming a valuable method for educational organizations for teaching and learning because of the impressive growth of online learning. But it is suffering from some limitations that create constraints to online exam assessment systems [32]. The following paragraphs enlightens on some challenges with the online examination assessment system.

Online exam assessment systems face the challenge of ensuring the integrity of the exam. Malpractice can take various forms, such as using unauthorized materials, collaborating with others, or using another person to take the exam. Technical issues such as system crashes, power outages, or poor internet connectivity can disrupt the exam and affect the student's performance.

The online exam assessment system should be accessible to all students, including those with disabilities. It must comply with accessibility standards to ensure that all students have equal opportunities to perform in the exam. It is necessary to ensure the quality of assessments through the online system. The system should be capable of creating well-constructed exam questions aligned with learning outcomes and assessing students' knowledge and skills accurately.

5. Question Types in Proposed Framework

This article presents an online framework of examination for evaluating learners' knowledge to overcome the limitations of the traditional examination system. The classroom examination used various question types to assess in different ways, such as objective-type, short-type, and essay-type questions. The primary difficulty with subjective assessment is accurate scoring. Therefore, automatic descriptive answer evaluation is the recent era of research in the educational system [33].

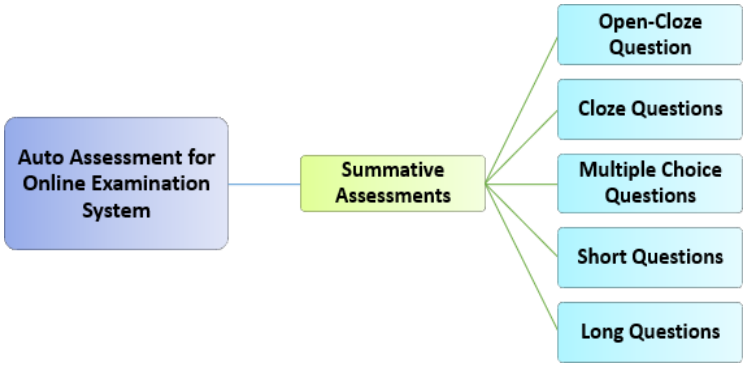

Fig. 2. Question types used for the proposed online framework

Fig.2 depicts the various question types used for the proposed framework. Here, we describe the use of different question types for assessment and their handling techniques in online examinations. The main purpose of both the open-cloze and the cloze questions is to evaluate the learner's understanding of grammar and vocabulary. Each question asks the learner to fill in the blanks in a passage with the appropriate word. So the learners are required to determine the current response by understanding the context of the passage because there are no options provided on the test. Vocabulary and grammar are the most popular and widely used practices in English teaching, but the manual process of generating the questions and the evolution is very time and effort-consuming and costly [34]. In general, it is acknowledged that multiple choice questions are the most broadly applicable and practical kind of objective test items, and also the most crucial educational outcomes such as - information, understanding, judgment, and problem-solving, could be assessed using them. The short answer type questions can show a learner's reasoning, creation, analysis, synthesizing, and evaluation skills, allowing them to only briefly expand on their answers. Compared to other item types, long-question might take less time to make. Any scientific inquiry starts with a question, and the subsequent search for an answer deepens our understanding of the phenomenon. Questioning serves as a psychological instrument for reflection, critical thinking, idea scaffolding, and social interaction, according to the compelling case made by cognitive science [35]. However, the assessment of long questions is challenging. A semi-automated system has been included for assessing the long questions with the subject experts.

6. Proposed Framework for Online Examination

Nowadays, online learning has become very popular throughout the world. Students gather information from the internet but only information gathering will not help them to acquire knowledge, at the same time automatic question generation and answer assessment are also required for assessment. An automatic assessment system helps the students to find their gaps and they can also improve their progress in learning. Automatic Assessment through Online Examination [13] is also very helpful for the teachers as it will reduce their effort of the teachers.

Fig. 3 presents the data flow of the framework. In the proposed system, we have included the above question types and the following examination setup and rules to conduct the online examination. Fig. 4 represents the detailed view of the proposed framework respectively.

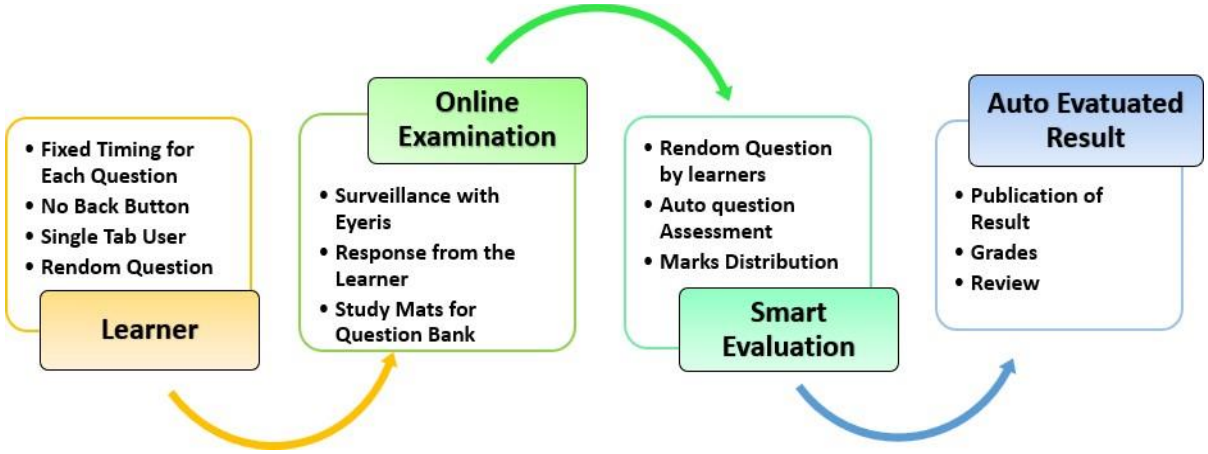

Fig. 3. Dataflow of the framework

Exam duration needs to be reduced to avoid malpractice. We proposed the following time management for different questions depending on the feedback of 200 students and teachers. Based on their average, the time required for 1 mark MCQ is one minute, 2 mark MCQ is 2 minutes, short questions for 2 minutes, and long questions for 5-10 minutes. Therefore, we can easily calculate the exam duration based on the number of questions. Different timing setups may alsobe considered depending on the quality of students.

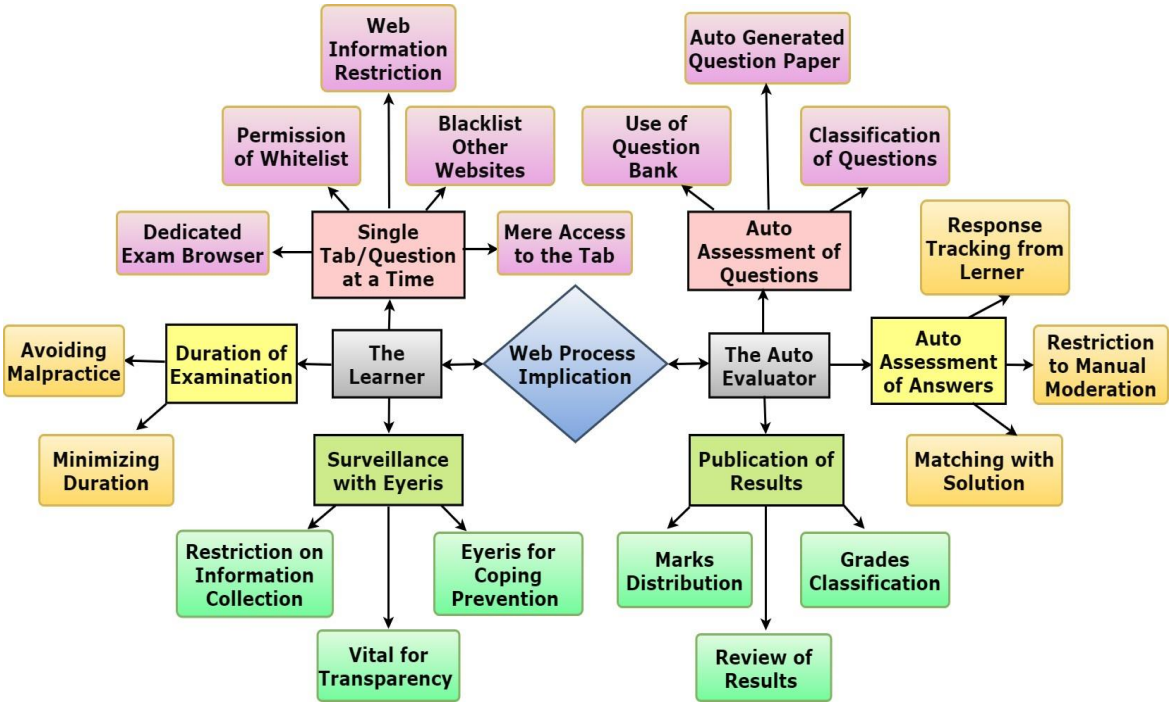

Fig. 4. The detailed view of the proposed framework for automated examination system

Students can open one tab at a time in a browser with a single tab option. As a result, they merely access the exam tab. To find the answer to a question students are not permitted to open any more tabs. To access the online exam, the students must use Blackboard's Respond us Lockdown Browser (RLB) [36]. Students are locked into the test using the special Internet browser known as RLB. They are unable to electronically influence the system, cut and paste, or leave and come back. The RLB makes Blackboard more reliable and less likely to crash or lock up when students submit their exam answers benefits the student.

As the internet is full of information, it will help the students to find their perfect answer from the given questions [37]. So to prevent the students from accessing different websites for their answers, the administrator should centrally allow (whitelist) certain websites and block (blacklist) all other remaining websites.

Webcam monitoring on Eyeris is very much needed to restrict information gathering, prevent copying tendency among learners, and make the process neat and transparent [38]. It has been observed between two groups, one group gave an exam under a webcam, and another group without a webcam. At last, the difference in scores is observed between the two groups. During the exam, the students habitually collect their answers from nearby resources. Applying webcam monitoring on the eyeris technique can prevent the students from copying, as when they move their eyes from the screen, they will get an alert, and at the same time the exam controller is also notified. Fig.5 depicts the invigilation withwebcam monitoring during the online examination.

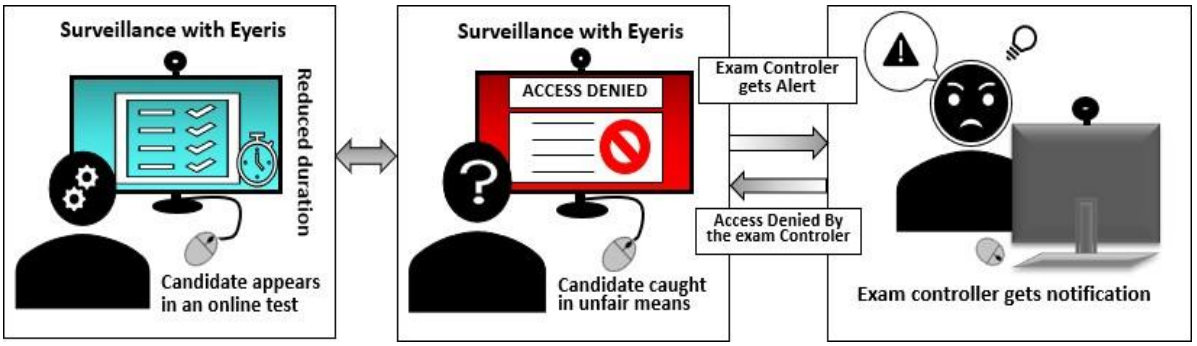

Fig. 5. The Model of Online Exam Invigilation

7. Case Study

In this case study, we examine how an online examination framework is used in an educational institute to assess students' knowledge. The framework intends to improve learning and enable remote learning by giving students and teachers a simple and practical approach to administering and grading exams. Now let's get into the specifics.

Case #1: The first case study has been conducted at the Haldia Institute of Technology, Haldia. Here, the system automatically generates MCQs, checks the response sheets, and creates marks sheets for the examinations. The system is precise and dependable, which helps the university to save time and cost in conducting exams.

Case #2: Another case study has been carried out at the XIM University in Bhubaneswar, Odisha. In this study, the system has used various course materials to generate short-type questions and assess students' responses. The approach has enhanced student learning and proven to be accurate and dependable [11].

Both institutions are renowned colleges that provide a range of undergraduate and graduate degrees. The institutions have decided to create an online examination framework in response to the rising demand for online education and to guarantee a smooth evaluation procedure for students in various programs and disciplines. The detailed setup is as follows:

7.1. System Development:

The framework has been developed in each institution for online examinations with a software development team.

The stages of development are as follows:

- **Requirement Analysis:** The team thoroughly discussed exam needs with professors and administration, includingtypes of questions, exam duration, security measures, and result generation.
- **System Design:** The development team created the system architecture to meet the scalability, security, and usability criteria. This framework supports the multiple-choice, fill-in-the-blank, and short-type questions.
- **Development and Testing:** The team implemented the system utilizing relevant technologies, programming languages, and frameworks. The platform's reliability, functionality, and browser and device compatibility are rigorously tested.
- **Security:** The system included strong security measures to ensure exam integrity. It included cheating prevention,user identification, and access protection.

7.2. Role of Students:

Following the rollout of the online examination framework, students could access a particular site and log in with theircredentials. The gateway had the following capabilities:

- **Exam Registration:** Students can register for forthcoming examinations, examine their exam schedules, and get updates about the dates, times, and locations of their exams.
- **Exam Interface:** On exam day, students logged on to a user-friendly interface where they could view and answer exam questions. Thanks to the UI, they could move between questions, save their responses, and submit them within the allotted time.
- **Timed Assessments:** By imposing time limits on each assessment, the framework ensured that students finished their tests in the allotted time. It included in-the-moment warnings to let learners know how much time was left until completion.
- **Real-time Feedback:** The system marked correct and incorrect responses and gave students immediate feedback on their performance. It also enabled them to track their progress over time.

7.3. Role of Faculty/Administrator:

The online test architecture also provided instructors and administrators with several tools that streamlined the evaluation and reporting processes:

- **Creating Exams:** Instructors may generate questions by this system based on themes, difficulty levels, and learningobjectives. The framework encouraged question randomization to reduce biases.
- **Automated Grading:** The framework offers automatic grading for objective-type and short-type questions, whichdecreases the manual work necessary for evaluation.
- **Analytics and Reporting:** The framework can produce in-depth analytics and reports to instructors and administrators with information on student performance at the individual and course levels. It offers statistics on typical results, question-by-question analysis, and finds knowledge gaps or widespread misconceptions.

7.4. Impact and Benefits:

Institutions and students benefit from the online examination system in the following ways:

- **Scalability and Accessibility:** The system enabled simultaneous assessments for many students across time zones.Assessments might be taken anywhere, allowing remote and flexible learning.
- **Objective and Fair Evaluation:** Automated grading and set assessment criteria ensured consistent and unbiased evaluation. Instant feedback helped students improve and enjoy learning.
- **Time and Resource Efficiency:** Grading processes are automated to reduce instructor workload. It gives time to instructors to provide personalized comments and support for learners.
- **Data-Driven Decision Making:** The framework's comprehensive analytics and reporting helped instructors and administrators make data-driven judgments. They may spot trends, examine course materials and exams, and adjusttraining.

The online examination framework revolutionized the assessment procedure by giving students a simple, practical approach to assessing their knowledge. The framework's features improved student involvement, allowed for fair and impartial evaluation, and made it easier for teachers and administrators to make data-driven decisions. This case study demonstrates the beneficial effects of technology on improving the assessment of student's knowledge in an online learning environment and modernizing examination procedures.

8. Results and Discussion

The accuracy of question generation and answer assessment systems for online examinations depends on different datasets and evaluation metrics. The accuracy of question generation is a complex metric, and there is no single metric to evaluate it. The best metric for a particular task will depend on the specific requirements, such as the type of questions that need to be generated and the quality of the datasets. Therefore, we evaluated our system manually with the subject experts. Generally, accuracy is measured using the following metrics [39].

Precision: It represents the percentage of correctly generated questions. For example, if a system makes 100 predictions and 90 of them are correct, then the precision accuracy of the model is 90%.

Recall: It is the percentage of correct questions that were generated. For example, if a system makes 90 true predictions out of 250 possible questions from the dataset, then the recall accuracy of the model is 36%.

First, we evaluated the system-generated questions and considered only the correct questions for the examination. Therefore, we emphasize precision as the accuracy of question generation. The subject experts in our department evaluated the correctness of the generated questions. Table 1 shows the accuracy of question generation. The accuracy

is low because we considered MCQ's stems with their distractors (Wrong answers of the MCQ). The accuracy improves if we can increase the accuracy of distractor generation. Appropriate distractor generation is challenging, and we will work on it in the future.

Table 1. Question generation accuracy for online examination

Metric	Multiple-choice-question	Short-question
Precision	85%	70%
Recall	75%	50%
F1-Score	80%	57%

We provided students only with the correct questions for their examination. After the online examination, we took a survey about their experiences (Table 2). We asked a few questions and collected the corresponding students' responses. They said that sometimes distractors were not adequate; they easily found the correct answer. Overall, the survey results suggest that online examinations can be a valuable tool for assessing student learning, but they also have some potential drawbacks. Online exams face limitations like relying on technology, restricting student access, privacy concerns with webcam monitoring, adaptability issues, training needs, and costs for implementing and maintaining these systems. Therefore, it is essential to carefully consider the advantages of online examinations before deciding where to use them.

Table 2. The survey of students during online examination

Survey Question	Agree	Neutral	Disagree
The online examination platform was user-friendly?	92%	1%	7%
The instructions provided were clear and understandable?	95%	2%	3%
The exam questions were relevant and aligned with the course material?	70%	2%	28%
The time allocated for the exam was sufficient?	95%	1%	4%
The online exam process was smooth and without technical issues?	81%	2%	17%
Overall, I am satisfied with the online examination experience?	85%	1%	14%

9. Conclusion

This work has provided an overview of the current state of the traditional examination system and its shortcomings. Here, we propose an online examination framework to overcome the limitations of conventional exams. The article emphasizes the benefits of online assessments, such as adaptability and accessibility, and analyzes various aspects of online examination frameworks. It identifies challenges or deficiencies in teaching and learning for both learners and evaluators within traditional assessments. Online examination frameworks do have some limitations, so it is essential to consider how the assessment structure fits with learning objectives. The proposed framework integrates question generation and answer assessment required for online examinations. In the future, online exams may be capable of adapting to individual students' learning styles and providing real-time feedback. This capability will ensure that students learn effectively and make progress towards their goals. Future work could explore enhancements to online examination systems, such as integrating advanced AI techniques for adaptive learning and assessment, improving security measures, and developing interfaces that support diverse learning needs. Further research might also investigate the long-term impacts of online assessments on educational outcomes and student performance across different educational settings. These efforts will contribute to the ongoing refinement and implementation of robust, equitable, and effective online examination systems.

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