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# **Are E-Assessments the Future of Assessments for Engineering Students?**

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## **ABSTRACT**

Replacing traditional examinations with electronic assessments (e-assessments), also known as digital assessments, is gaining more popularity. However, it has become controversial as people have raised serious concerns about the limitations of these e-assessments, especially when the assessments have high stakes, like the end-of-term examinations. In this paper, we have evaluated whether e-assessments will replace the traditional end-of-term exams for engineering students in the future. Although this topic is equally valid for non-engineering fields, a few factors that make it unique to engineering are discussed. Different aspects of e-assessments are critically compared to paper-based (off-print) examinations based on existing literature and experiences from personal teaching practices to assess the suitability of these assessments. Furthermore, feedback is collected from students who appeared in the e-assessments to form an opinion on the perception of students about e-assessments. Finally, the factors influencing a shift toward e-assessments and the problems that arise from this are discussed to form an opinion about the future of e-assessments for engineering students.

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# 1 INTRODUCTION

Electronic or e-assessments are digital evaluations used to measure learners' understanding, skills, knowledge, or performance. They can be in various formats, such as quizzes, tests, assignments, or interactive activities conducted through online platforms or digital tools. E-assessments provide immediate feedback, promote personalized learning, and enable educators to track and analyze learners' progress effectively.

The popularity of e-assessments has increased significantly in recent years, which can be attributed to the shift in the learning habits of modern-day learners. While the concept of digital natives and digital migrants proposed by Prensky (2001) has been challenged by people who argue that an age-based classification of learners is not valid (ICDL, 2014), there is a consensus that learners who grew up using electronic devices learn differently than those before them. As a result, the digital transformation of learners is pedagogically significant (Beetham and Sharpe, 2013) and cannot be ignored.

To adapt to this digital transformation of the learners, Siemens (2005) has proposed the learning theory of Connectivism, which emphasizes the mode of learning and how information can be accessed using modern technology rather than the information itself. Siemens (2005) argued, 'The pipe is more important than the content within the pipe'[pg.7]. This theory has led to an increase in the use of technology for evaluations and feedback. However, many other factors need to be evaluated to understand the increased popularity of e-assessments and their potential to replace traditional off-print (paper-based) examinations.

In this paper, the authors have discussed how they have adopted e-assessments and the key advantages and challenges of using these assessments. It can benefit the teachers teaching engineering courses considering using these assessments in the future.

## 2 METHODOLOGY

### 2.1 Study Design

This paper employed a mixed-methods approach, incorporating reflection from the practices of the authors and a survey administered to students. The study aimed to investigate the students' preferences and perceptions regarding e-assessments compared to off-print assessments.

### 2.2 Participants

The participants in this study were engineering students who had experienced both e-assessments (midterm assessments) and paper-based end-of-term examinations. The survey was distributed to the same students who had completed both types of assessments to gather their opinions and feedback.

### 2.3 Data Collection

A survey was designed to collect data from students who had experienced both e-assessments and paper-based examinations. The survey included questions about students' preferences for off-print vs e-assessments (Question 1), if they want to have more e-assessments in the future (Question 2), their perceptions of e-assessments reflecting their understanding of course material (Question 3), and the impact of quick feedback from e-assessments on their learning and preparation for end-of-term assessments (Question 4). The survey also allowed students to provide additional comments about e-assessments.

## **2.4 Data Analysis**

The quantitative data collected is presented in this paper to highlight student preferences. In addition, qualitative data in the form of student comments were also collected. The responses to each question were coded to identify key themes and patterns in the data. A summarising paragraph is written for comments for each survey question. It is used for conclusions and insights into the preferences and perceptions of students regarding e-assessments.

## **2.5 Ethical Considerations**

Appropriate ethical considerations were followed during the research, including obtaining informed consent from the participants and ensuring confidentiality and anonymity of the responses.

## **3 Using E-Assessments - A Reflection on Practice**

The role of assessments in shaping student workload is a critical consideration. As a result, the type of assessments used can significantly impact how students manage their learning. For example, having multiple low-stakes assessments throughout a course can be more effective than a single high-stakes exam at the end of the term, as it allows for more opportunities to provide feedback to students (Boston, 2002).

High-stakes assessments are testing methods that have significant consequences for the test-taker based on the outcome. They are often used to make important decisions about a student's academic progression, such as grades, promotions, graduation eligibility, or college admissions. An example of a high-stakes assessment could be a final examination.

Low-stakes assessments, on the other hand, carry less immediate or significant consequences for the test-taker. These assessments often include quizzes, homework assignments, in-class activities, or informal checks for understanding. Low-stakes assessments also allow students to reflect on their learning and improve their performance. Additionally, course instructors can use the results of these assessments to adjust and tailor their delivery of course content based on student performance.

However, incorporating more frequent assessments into a course can substantially increase the marking workload for instructors. This has motivated many educators to consider automatically marked e-assessments as a solution which can help reduce the marking burden. Reducing the marking workload has been critical in the recent shift towards e-assessments.

We experienced similar challenges in incorporating distributed assessments into a curriculum. When our department revised its curriculum, we aimed to provide more feedback points to students and move away from relying solely on high-stakes end-of-term exams. We found that the feedback from traditional exams, which only provides marks at the end of the year, is not always helpful to students. However, implementing distributed assessments is challenging, especially in large courses with hundreds of students. To address this challenge, we adopted automatically marked e-assessments for mid-term exams. This allowed us to provide more frequent assessments without overburdening instructors with marking responsibilities.

Although we began using e-assessments before the pandemic, the closure of universities during the pandemic resulted in a significant increase in the use of e-assessments, particularly unproctored e-assessments for both mid-term and end-of-term exams. While some were sceptical about the efficacy of e-assessments, the need to adapt to remote teaching forced many instructors to experiment with new assessment methods. However, it is worth noting that most of

the exams conducted during the pandemic were not technically e-assessments but rather traditional paper-based tests delivered through a virtual learning environment (VLE). Nonetheless, this experience has inspired some instructors to explore more advanced forms of e-assessment. Our experience of these assessments was very similar to the findings reported by our colleague from the chemical engineering department in our College (Bhute et al., 2020).

### **3.1 Suitability for Engineering Students**

Although e-assessments can be used in all fields, some factors make them more suited to engineering students. Based on the authors' experiences, engineering examinations usually involve problem-solving, system analysis and design, and programming questions. The answers to these questions are mathematical expressions, computer algorithms, and diagrams that can be marked by a computer automatically. So, many traditional examination questions in engineering disciplines can be easily marked using e-assessment software, and we do not need to design new questions to move from conventional paper-based assessments to e-assessments. The same question banks can be used. We use a software called 'Wiseflow' that allows us to use traditional examination questions on an online platform features. It significantly reduces the marking workload of the teachers and provides instant feedback to the students.

Similarly, more extensive analysis and design questions in engineering are usually modular in structure. They can be easily broken down into smaller questions that are more manageable and easier to mark for correctness using marking software. In addition, engineering examinations traditionally have very few descriptive questions. Even if descriptive questions are on a test, most other questions can be marked automatically, and the marker only has to mark the descriptive questions.

Another important feature of e-assessments for engineering students is the ability to change the numeric parameters in questions for each student. This is especially attractive for engineering students and is unique to STEM subjects that involve problem-solving, where the answer depends on the question's numeric parameters, so each student must find a different answer. We extensively use this feature to stop collusion during tests, especially if the tests are unproctored. However, one limitation of this method is that if a question has a sequential structure where the end calculations depend on the results from the initial computations, a small mistake in the initial steps can result in the complete solution being marked as wrong by the automatic marking software.

### **3.2 Comparison of Student Performance**

The suitability of e-assessments as a direct substitute for off-print tests depends on how students perform in both types of assessments. We were very concerned about it. According to the study by Ardid et al. (2015), students' performances in terms of marks are comparable in both off-print and e-assessments under proctored conditions. The weightage of e-assessments did not affect student performance, but the weightage of off-print exams was significantly higher. However, the study cannot provide conclusive evidence as e-assessments were conducted during the term. All off-print exams were conducted at the end of the term, and the students were better prepared at the end of the term. We also have the same problem. All our e-assessments are conducted as midterm examinations. In contrast, the end-of-term examinations are mostly off-print, except for only two end-of-term exams, which are e-assessments.

Studies conducted during the Covid-19 pandemic cannot be considered valid for comparison with studies conducted before the pandemic. Most teachings during that time were also online, affecting student performance in e-assessments, especially in engineering education, where many learning outcomes depend on spending time in a laboratory and working on group

projects. Several studies are available on students' performance in high-stakes e-assessments during the pandemic, but they cannot be generalized. The study by García-Alberti et al. (2021) reported that students who achieved high grades during in-person teaching also performed well on online electronic examinations. In contrast, the students who achieved lower grades in in-person assessments were affected more, and their performance was worse than the off-print examinations in the previous year. In addition, much larger percentages of students failed and dropped out when teaching and assessments were conducted online. Overall, student performances did suffer in e-assessments during the pandemic, but how much of that was due to the nature of the assessment and how much was due to the different modes of teaching is yet to be determined. Our student performances were similar to the results reported by García-Alberti et al. (2021).

### **3.3 Limitations of E-Assessments**

We identified some severe limitations of e-assessments compared to traditional paper-based examinations based on our practice. The e-assessments require stricter authenticity, reliability, and validity requirements, making them more difficult to implement and adjust to than traditional assessments. While e-assessments can improve content validity, they may lack face validity, which can affect students' confidence (Dent et al., 2021). Additionally, transitioning to e-assessments requires more time and effort, and teachers need significant support to design assessments.

The e-assessments' construct and predictive validity can be improved through better question design and questioning formats, but this requires a shift in the mindset of both students and teachers. For example, the students may prefer traditional numerical and derivation questions to qualitative ones that test their understanding more deeply.

E-assessments also require a significant amount of technology, which can pose a challenge for students and staff, who need practical training on the software before conducting high-stake assessments.

## **4 Feedback from Students About E-Assessments**

After reflecting on our experience, we surveyed to estimate how the students perceived these assessments. Please note that these students appeared in both off-print and e-assessments. The key findings are summarized in this section.

### **4.1 Quantitative Analysis**

The quantitative results of the survey are summarized in this section. They are shown in Figure 1. Out of the 87 participants, 50 (57.47%) preferred electronic assessments, while 27 (31.03%) did not prefer them. 10 (11.50%) participants were unsure. It indicates that a majority of the participants had a positive view of electronic assessments.

Similarly, out of the 87 participants, 47 (54.02%) said they would prefer to sit more electronic exams in the future, while 30 (34.48%) said they would not prefer to. 10 (11.50%) participants were unsure. This suggests that most participants are open to taking more electronic exams in the future.

Also, out of the 87 participants, 48 (55.17%) said that electronic assessments accurately reflected their understanding of the course material, while 25 (28.74%) said that they did not. 14 (16.09%), participants were unsure. This suggests that electronic assessments may not accurately assess all students' understanding of course material.

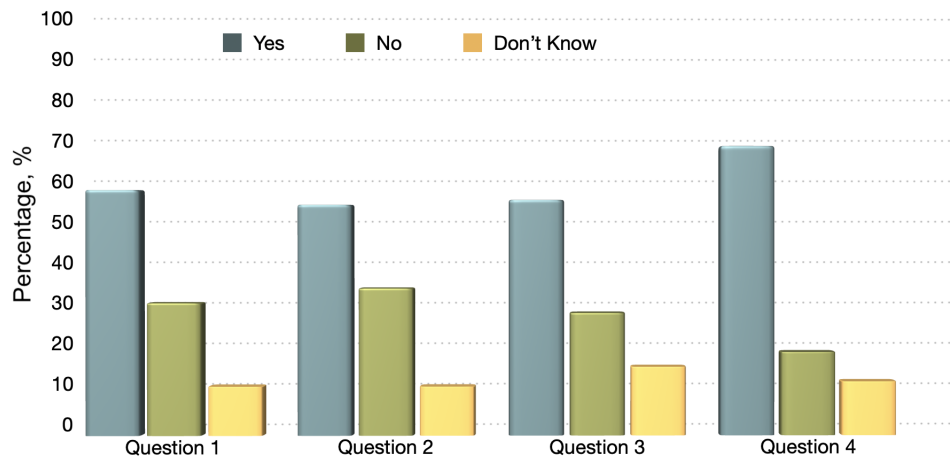


Figure 1: Quantitative results of the survey questions. Question 1: Do you prefer e-assessments as compared to off-print assessments? Question 2: Do you want to have more e-assessments in the future? Question 3: Do e-assessments correctly gauge your learning of the course material? Question 4: Do you find quick feedback from e-assessments useful?

Finally, out of the 87 participants, 59 (67.82%) said that the quick feedback from electronic assessments helped them gauge their learning and improve, while 17 (19.54%) said that it did not. 11 (12.64%) participants were unsure. This indicates that most participants found the quick feedback from electronic assessments helpful.

Overall, the results suggest that a majority of participants prefer electronic assessments and would be willing to take more electronic exams in the future. However, there may be some concerns about the accuracy of electronic assessments in reflecting students' understanding of course material. Nevertheless, the quick feedback provided by electronic assessments is generally seen as beneficial for students to gauge their learning and improve.

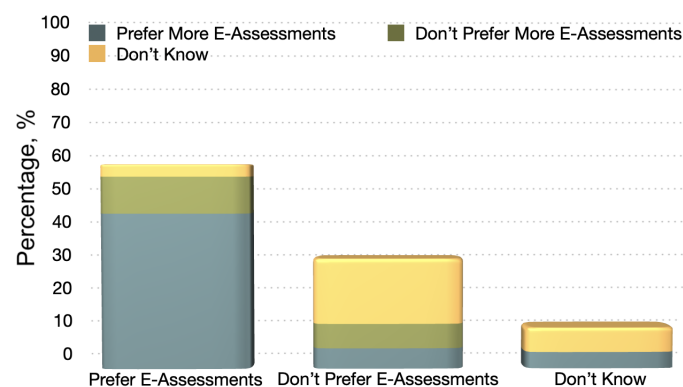


Figure 2: Preference for sitting more E-Assessments in the Future.

Several notable patterns emerged from the data. For instance, as shown in Figure 2, out of the 50 students surveyed who expressed a preference for electronic assessments, only 38 (or 76%) indicated that they would like to have more electronic assessments. Surprisingly, 9 students (18%) reported that they did not want more electronic assessments despite their stated preference for this type of assessment. Another 3 students (6%) responded that they were unsure whether they wanted more electronic assessments.

Similarly, although it is not shown in a figure here, 48 students reported that they believed

electronic assessments effectively measure their understanding of the material. However, of those 48 students, only 36 (or 75%) found the feedback provided to be useful. In contrast, 7 students (14.58%) did not find the feedback useful, while 5 students (10.41%) were unsure about its usefulness.

## 4.2 Qualitative Analysis

For all survey questions, qualitative data like student comments were also collected. The responses to each question were coded to identify key themes and patterns in the data. In addition, a summarising paragraph is written for comments for each survey question. It is used for conclusions and insights into the preferences and perceptions of students regarding e-assessments. Detailed qualitative data analysis will be presented later, in another paper, along with data from staff interviews. Therefore, it is not included in this paper. The summarising paragraphs based on student comments are given below:

- Question 1: Many factors influence students' preference for off-print vs e-assessments. For example, some students prefer e-assessments because they allow for using notes (sometimes) and provide quick feedback. In contrast, others prefer off-print assessments because they feel more legitimate and eliminate issues with cheating and technology. Additionally, some students may find that e-assessments are less stressful and more convenient, while others feel that off-print exams are better for assessing understanding and avoiding mistakes. Ultimately, the choice between e-assessments and off-print assessments may depend on the specific exam and the test taker's individual preferences and circumstances.
- Question 2: There are various reasons why students might prefer to have more e-assessments in the future, including convenience, reduced stress, accessibility, and faster feedback. However, concerns about cheating, the fairness of the exams, and technical issues may arise. Therefore, balancing these factors is essential to increase the number of e-assessments in the future.
- Question 3: Based on the student responses, students have varied opinions on the effectiveness of e-assessments in accurately reflecting their understanding of course material. Some students feel that e-assessments are a better way to test their understanding of the material since they focus on application rather than memorization. In addition, they think these e-assessments are often open-book exams, allowing for a clearer thought process. In contrast, other students feel that e-assessments have poor question format and do not provide credit for workings, which can negatively impact their grades and understanding. Overall, students have different experiences with e-assessments and the effectiveness of e-assessments in accurately reflecting student understanding of the course material depends on various factors such as question format, time constraints, and personal preferences.
- Question 4: Based on the student responses, most students find e-assessment exams helpful for getting quick feedback on their performance. They appreciate seeing where they made mistakes and what areas to improve. However, some students feel that the feedback is too minimal and that more explanation would be helpful, especially for more complicated questions. The difference in question style between mid-term exams and end-of-year assessments was also noted as a potential limitation. Additionally, some students feel that not enough feedback is given by their professors for the end-of-term off-print exams, so the e-assessment midterm exams provide valuable feedback.



## 5 Conclusion

The quick feedback provided by electronic assessments is generally seen as beneficial for students to gauge their learning and improve. However, there may be some concerns about the accuracy of electronic assessments in reflecting students' understanding of course material. Providing more explanation and feedback for complicated questions in electronic assessments may help students better understand their performance and improve their learning. Based on the results, most student participants prefer e-assessments and would be willing to take more electronic exams in the future. Their choice is mostly based on the quick feedback they get. In addition, most teachers are also opting for e-assessments due to the flexibility in assessment design and a reduced marking workload.

Overall, the results suggest that electronic assessments have benefits, but some limitations must be addressed. Further research could investigate ways to improve the accuracy of electronic assessments and address concerns about cheating, fairness, and technical issues. At the moment, the choice between off-print and electronic assessments may depend on the specific exam and the individual preferences and circumstances of the test taker, but surely, with the development of assessment software, e-assessments will completely replace paper-based examinations as they are preferred both by students and staff for different reasons discussed in this paper.

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