European Journal of Engineering Education

ISSN: 0304-3797 (Print) 1469-5898 (Online) Journal homepage: www.tandfonline.com/journals/ceee20

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Zohaib Akhtar & Esther Perea-Borobio

To cite this article: Zohaib Akhtar & Esther Perea-Borobio (2026) Navigating the digital shift: investigating the viability of digital assessments for electrical and electronic engineering students, European Journal of Engineering Education, 51:3, 714-733, DOI: 10.1080/03043797.2025.2523549

To link to this article: https://doi.org/10.1080/03043797.2025.2523549

Published online: 25 Jun 2025.

EUROPEAN JOURNAL OF ENGINEERING EDUCATION
2026, VOL. 51, NO. 3, 714–733
https://doi.org/10.1080/03043797.2025.2523549

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Navigating the digital shift: investigating the viability of digital assessments for electrical and electronic engineering students

Zohaib Akhtar and Esther Perea-Borobio

Department of Electrical and Electronic Engineering, Imperial College London, London, UK

ABSTRACT

The shift toward digital assessments in higher education, particularly in engineering, represents a major evolution in student evaluation methods. This paper investigates the viability of replacing traditional print-based exams with digital assessments in Electrical and Electronic Engineering education. Over the past six years, our department has adopted digital assessments to reduce marking loads and provide more frequent feedback. This mixed-methods study draws on semi-structured, 30-min interviews with academic staff and a detailed analysis of both quantitative and qualitative student survey responses. Lecturer interviews offer insights into how digital assessments influence teaching practices, while student data provides a complementary perspective, revealing both shared and contrasting views.

The findings suggest that digital assessments offer clear advantages, including improved efficiency, scalability, and faster feedback. However, they also pose notable challenges, particularly in maintaining academic integrity, ensuring technical reliability, and effectively assessing complex problem-solving skills. These issues highlight the need for ongoing refinement in digital assessment design, especially in developing more robust platforms and feedback mechanisms that support meaningful learning. While focussed on a single departmental case study, the results carry broader implications for engineering education and other technical disciplines adopting digital assessment models. The paper concludes with practical recommendations for improving digital assessment strategies, ensuring they not only meet administrative goals but also enhance the student learning experience and support academic rigour in engineering education.

ARTICLE HISTORY
Received 15 November 2024
Accepted 16 June 2025

KEYWORDS
Digital assessments; e-assessments; engineering education; academic integrity; student engagement; feedback systems

1. Introduction

The integration of digital technologies into educational practices has brought about significant changes in how teaching and assessment are conducted, particularly within engineering disciplines. Traditionally, engineering education has relied heavily on conventional assessment methods, such as closed-book exams and problem-solving tasks, which are designed to evaluate a student's ability to apply theoretical knowledge to practical problems. However, the rapid advancement of digital tools and the increasing digital literacy of students have prompted a re-evaluation of these traditional approaches.

CONTACT Zohaib Akhtar z.akhtar@imperial.ac.uk

The concept of digital natives, introduced by Prensky (2001), suggests that students who have grown up with digital technology are more comfortable and adept at using these tools in their learning. Although this theory is debatable, it highlights the shift in student expectations and learning styles that educators must consider when designing assessments. While the age-based classification of digital natives and digital migrants has been challenged (International Computer Driving Licence Foundation 2014), there is a general consensus that today's students are increasingly reliant on digital tools for learning, communication, and assessment (International Computer Driving Licence Foundation 2014). Nevertheless, recent critiques emphasise that digital literacy and comfort with technology can vary significantly among students, challenging simplistic assumptions that all young learners naturally benefit from digital formats (Berggren, Fili, and Nordberg 2015; Chan 2023).

It is well documented that student workload is often dictated by assessments, with students frequently planning their learning around these key evaluation points (Gibbs and Simpson 2006). Research supports the notion that multiple, distributed low-stakes assessments are more beneficial than a single, large end-of-term assessment (Nicol and Macfarlane-Dick 2009). These low-stakes assessments provide students with timely feedback, enabling them to adjust their learning strategies throughout the course. However, the challenge lies in the increased marking workload that accompanies administering multiple assessments, which can exceed reasonable limits for educators (Gikandi, Morrow, and Davis 2011). Digital assessments offer a solution to this problem by automating much of the grading process, thereby making it feasible to implement more frequent, low-stakes assessments without overwhelming faculty (Jisc 2010). Furthermore, recent advancements in artificial intelligence (AI)-powered formative assessment systems have shown potential to deliver personalised, actionable feedback at scale, further addressing workload concerns and improving learning outcomes (Liu, Wu, and Gong 2022; Zhai et al. 2021).

Although managing increased workload and catering to the digital preferences of modern learners are primary reasons for adopting digital assessments, there are several other motivations. The COVID-19 pandemic, for instance, accelerated the adoption of digital assessments, forcing institutions worldwide to transition to online learning environments almost overnight. This shift exposed both the potential and the limitations of digital assessments, particularly in high-stakes settings like engineering education (Bhute et al. 2020). Recent systematic reviews have highlighted ongoing concerns regarding academic integrity, authentication, and equitable assessment conditions during online examinations, underscoring the need for careful design and robust proctoring solutions (Butler-Henderson and Crawford 2020; Qadir et al. 2023).

This paper explores the suitability of digital assessments for engineering students, focussing on their ability to effectively measure the skills and knowledge required in this field. Engineering assessments typically involve complex problem-solving tasks, system analysis, design, and programming, all of which require not only the correct final answer but also an understanding of the process and reasoning behind it (Andersen et al. 2020). The move towards digital assessments in this context raises important questions about the ability of these tools to accurately and fairly evaluate student performance.

Despite the increasing adoption of digital platforms, significant gaps remain in understanding how these tools align with engineering-specific assessment needs. Although literature broadly supports digital assessment, much of the existing research has not explicitly examined the nuanced requirements of engineering disciplines, where assessments must effectively gauge both procedural understanding and final solutions. Moreover, the perspectives of both students and lecturers–critical stakeholders in the transition to digital assessment–remain under-explored, particularly regarding perceptions of fairness, reliability, and practical challenges.

To address these gaps, this paper investigates the following research questions: (1) How do students and lecturers perceive the implementation of digital assessments in engineering education? (2) What benefits and challenges are associated with digital assessments in this context? (3) How might emerging technologies such as AI improve assessment design and feedback practices?

By answering these questions through a detailed analysis of qualitative and quantitative data, this study aims to offer educators and institutions practical insights into the pedagogical, ethical, and technological implications of transitioning to digital assessments in engineering education.

2. Background and rationale for adopting digital assessments

Six years ago, our department embarked on a significant curriculum review, recognising the need to move beyond the traditional reliance on end-of-term examinations by incorporating continuous assessments throughout the academic year. This shift has been transformative, enabling us to gain early insights into student performance and implement timely interventions for those in need. Digital midterms, introduced as part of this change, have played a crucial role in this process. They allow us to identify students who may require additional support, with results communicated to the senior tutor and subsequently forwarded to personal tutors to ensure targeted assistance is provided. This approach has also contributed to a more balanced evaluation of student progress by reducing the high-stakes nature of end-of-term exams through a distributed assessment structure.

The implementation of digital assessments has revolutionised how we monitor and support student learning, offering the ability to track student performance continuously–something not feasible with traditional assessment methods. These assessments have been pivotal in achieving educational goals such as monitoring academic progress, identifying at-risk students early, and providing a more equitable assessment framework through distributed evaluations. While the primary motivation for adopting digital assessments was to manage the increased marking workload and cater to the needs of modern learners, the six-year mark presents an opportune moment to evaluate how both faculty and students perceive these assessments.

Building on the initial findings presented at SEFI 2023 (Akhtar and Perea Borobio 2023), which primarily focussed on student survey results and quantitative data, this paper shifts its focus to qualitative insights from lecturer interviews, while also incorporating qualitative data from student surveys. The qualitative data from both interviews and surveys are presented here for the first time, offering a comparative analysis that highlights the alignment and divergence between lecturer and student perspectives. The primary aim of this research is to provide a comprehensive evaluation of the feasibility of replacing traditional print assessments with digital assessments in engineering education, addressing the specific challenges and opportunities they present.

This evaluation is especially relevant given recent studies emphasising the diverse implications of transitioning to digital examinations. Research indicates that digital assessments can significantly affect pedagogical practices, student engagement, academic integrity, and logistical considerations for institutions (Butler-Henderson and Crawford 2020; Chan 2023). Recent advancements in artificial intelligence (AI) further highlight the potential benefits of integrating AI-driven adaptive learning and assessment tools, which can provide customised feedback, streamline grading, and detect potential academic misconduct more effectively than traditional approaches (Liu, Wu, and Gong 2022; Qadir et al. 2023; Zhai et al. 2021).

Moreover, while earlier departmental studies like (Akhtar and Perea Borobio 2023) have offered valuable quantitative insights into student acceptance and performance metrics, there remains a significant gap in understanding the qualitative dimensions, such as stakeholder perceptions, pedagogical implications, and practical challenges encountered during digital assessment implementation. Exploring these qualitative dimensions in greater depth, this paper explicitly addresses the following research questions: (1) What are the perceptions of students and lecturers regarding the effectiveness and challenges of digital assessments in engineering education? (2) How do digital assessment practices align with broader pedagogical goals and institutional priorities in engineering disciplines? (3) What specific contributions can emerging

AI-based assessment technologies offer in overcoming current challenges faced by educators and students alike?

By addressing these questions, the current study aims to contribute both theoretical insights and practical recommendations for institutions considering or refining digital assessment strategies in engineering contexts.

3. Review of digital assessment practices in STEM education

The adoption of digital assessments in higher education, particularly within STEM fields, has been a focal point of research over the past two decades. Initial studies primarily concentrated on the technical feasibility and user acceptance of digital tools for assessments, but the scope of research has since expanded to include the pedagogical impact and effectiveness of these tools in enhancing student learning outcomes (Crisp 2007; Redecker and Johannessen 2013).

Bennett (1998) provided a foundational framework for understanding the evolution of digital assessments, categorising them into three generations: substitution, enhancement, and transformation. The first generation involved the direct substitution of traditional paper-based assessments with digital formats, offering minimal pedagogical change beyond increased convenience. The second generation introduced enhancements such as multimedia integration, automated feedback, and immediate grading, which began to leverage the unique capabilities of digital platforms to improve learning outcomes (Crisp 2011; Nicol and Macfarlane-Dick 2007). The third generation, which is still emerging, seeks to transform assessment practices by utilising artificial intelligence (AI) and adaptive learning technologies to create personalised, interactive, and dynamic assessment experiences (Redecker 2017). Recent studies, including those by Qadir et al. (2023) and Zhai et al. (2021), emphasise the growing potential of AI to deliver real-time personalised feedback, adaptive assessment pathways, and enhanced diagnostic capabilities, significantly enriching the educational experiences of students.

In the context of engineering education, digital assessments offer several distinct advantages. The automation of grading for problem-solving tasks, system analysis, and programming assignments significantly reduces the workload for instructors, particularly in large classes where manual grading would be impractical (Kibble 2021; Nicol and Macfarlane-Dick 2009). This efficiency allows educators to focus more on providing detailed feedback and engaging with students to support deeper learning. However, concerns persist regarding the ability of digital assessments to accurately evaluate higher-order cognitive skills, such as critical thinking, creativity, and the application of knowledge in real-world scenarios (Jordan and Mitchell 2020; Stach and Tait 2022). Advances in natural language processing (NLP) and machine learning algorithms offer promising solutions, but current limitations in accurately assessing complex, open-ended tasks like essays, reflective assignments, or engineering designs remain significant (Liu, Wu, and Gong 2022; Qadir et al. 2023).

Academic integrity remains a critical issue in the adoption of digital assessments. The potential for academic dishonesty, particularly in unproctored online environments, has been a significant concern for educators. Bennett and Haertel (2021) emphasised the need for robust security measures, including the use of lockdown browsers, randomised question banks, and AI-driven proctoring solutions, to prevent cheating. The rapid transition to remote learning during the COVID-19 pandemic has further highlighted these challenges, as institutions were forced to adopt digital assessments on an unprecedented scale without sufficient preparation or infrastructure (Graham 2020; Hollister and Berenson 2009). Recent reviews further underscore the urgency of integrating advanced security and proctoring measures powered by AI to effectively mitigate cheating, authenticate student identities, and ensure fair assessment practices in digital environments (Butler-Henderson and Crawford 2020; Qadir et al. 2023).

The role of digital assessments in promoting student engagement and motivation has also garnered considerable attention in recent studies. Stach and Tait (2022) found that simulation-based assessments, which allow students to interact with virtual environments and receive real-time feedback, can significantly enhance engagement and learning outcomes in engineering education. This approach aligns with the principles of experiential learning, where assessments are integrated into the learning process, fostering a more active and student-centred approach to education (Kolb 1984). Additionally, adaptive assessment technologies using AI-driven analytics have been demonstrated to increase student motivation by providing personalised learning experiences tailored to individual student performance and needs (Liu, Wu, and Gong 2022; Zhai et al. 2021).

Despite these advancements, several challenges remain in the broader adoption of digital assessments. Jordan and Mitchell (2020) pointed out that while AI and machine learning have the potential to revolutionise digital assessments, there is still considerable work needed to develop algorithms that can accurately assess complex, open-ended tasks, such as essays or design projects. Furthermore, the transition to digital assessments requires significant investment in technology, infrastructure, and training, which can be a barrier for institutions with limited resources (Boud 2013; Jisc 2010). The development and validation of robust AI assessment tools remain resource-intensive processes, and there is ongoing debate about ethical considerations, data privacy, algorithm transparency, and the potential biases introduced by AI systems, all of which require careful consideration by institutions adopting these technologies (Lu, Deng, and Chan 2021; Qadir et al. 2023).

In summary, while digital assessments offer numerous potential benefits, particularly in terms of convenience, scalability, and engagement, there are substantial challenges that must be addressed to fully realise their potential. These include ensuring the validity and reliability of assessments, maintaining academic integrity, and providing adequate support for both students and educators during the transition to digital assessment platforms. The ongoing evolution of digital assessments in engineering education will depend on the ability to balance these opportunities and challenges effectively. Given the complexity of these issues, further research is required to identify best practices and to understand how emerging technologies can be optimally integrated into existing assessment frameworks to enhance both pedagogical outcomes and operational feasibility.

4. Research design and methodology

This research primarily focuses on lecturer interviews, supplemented by quantitative data from student surveys and qualitative insights from student survey comments, to provide a comprehensive analysis of digital assessments in engineering education. The study was carried out in two distinct phases: first, semi-structured interviews with lecturers were conducted to gather qualitative insights into their views on the implementation and impact of digital assessments; second, a student survey was administered to collect quantitative data on student preferences and experiences with digital assessments. This approach represents a convergent mixed-methods research design, chosen specifically to allow a holistic understanding by integrating qualitative and quantitative insights, enabling a thorough comparison and validation of findings across different stakeholder perspectives.

4.1. Study participants and data collection

The primary participants in this study were 18 lecturers responsible for teaching first- and second-year undergraduate students in the Electrical and Electronic Engineering (EEE) and Electronic and Information Engineering (EIE) programmes. These lecturers were selected because of their direct involvement in delivering and assessing courses within the targeted academic years. In total, the curriculum for these two programmes includes several core and elective modules taught by 20 lecturers. However, interviews were successfully conducted with 18 of these lecturers, each lasting approximately 30 min. To protect their anonymity, these lecturers are referred to as L1 through L18 when quoted directly. All of these lecturers have designed both traditional print examinations and digital assessments over the past six years, giving them experience in both types of assessment design. Lecturers were invited to participate via email and informed consent was obtained before each interview. Demographic data such as teaching experience, specific courses taught, and prior experience with digital assessments were collected to contextualise responses.

Additionally, student perspectives were gathered through an anonymous survey, which was distributed to first- and second-year students in the EEE and EIE programmes. The survey aimed to capture a broad range of opinions on digital assessments, including preferences between digital and print formats, perceived effectiveness, and the usefulness of quick feedback. A total of 87 responses were received, providing both quantitative data and qualitative comments. While the student survey offers valuable insights, it serves as secondary data, with some of the results having been previously presented in other contexts. All of these students participated in both digital and print-based examinations, giving them experience with both forms of assessment. The survey was distributed electronically via institutional mailing lists, with voluntary participation emphasised.

4.2. Thematic analysis of lecturer interviews

The core focus of this research is the qualitative analysis of lecturer perspectives on digital assessments. To gain a deeper understanding of the challenges and benefits of digital assessments from an instructional viewpoint, semi-structured interviews were conducted with 18 lecturers who are responsible for teaching various modules across the first and second years of the EEE and EIE programmes. These modules cover a wide range of topics, reflecting the broad curriculum of these engineering disciplines.

Each interview was transcribed and subjected to thematic coding, a systematic process involving the identification of recurring themes and patterns within the data.

This analysis was conducted in several stages: – *Initial Coding*: Key themes were identified across the interview transcripts. – *Focused Coding*: Themes were refined, organised, and categorised based on their relevance to the research questions. – *Axial Coding*: Relationships between different themes were explored to understand the broader implications of lecturer perspectives.

References on coding and thematic analysis, such as those by Braun and Clarke (2006), were used to guide the analysis process, ensuring rigour and consistency in the thematic exploration. Braun and Clarke's six-step thematic analysis framework provided the theoretical underpinning, guiding the data familiarisation, initial code generation, theme identification, theme review, theme definition, and final reporting.

To enhance the reliability of the thematic analysis, a double-coding process was employed. Two researchers independently coded the interview transcripts and then compared their findings to resolve any discrepancies. This collaborative approach ensured that the identified themes were robust and accurately reflected the concerns and experiences of the lecturers. Inter-rater reliability was ensured through continuous discussion and refinement until consensus was reached on all major themes and sub-themes. To support the comparative visualisation of lecturer and student perspectives, we transformed qualitative interview data into a quantitative format using content analysis. We counted the number of lecturer transcripts (out of 18) in which each theme appeared, enabling a numerical representation of prevalence. This facilitated alignment between the qualitative staff data and the quantitative student survey results for comparative purposes.

4.3. Analysis of student survey data

The student survey was designed to capture diverse opinions on digital assessments, including preferences between digital and print formats, perceived effectiveness, and the perceived benefits of quick feedback. The survey consisted of both closed-ended questions, which were analysed using descriptive statistics, and open-ended questions that allowed students to express their experiences and preferences in more detail. The quantitative data from the closed-ended questions were analysed to identify trends and patterns in student preferences, while the qualitative responses were thematically coded to explore specific factors influencing these preferences, such as convenience, stress levels, and concerns about academic integrity.

While the quantitative analysis offered a broad overview of student attitudes towards digital assessments, thematic coding of the qualitative comments allowed for a more detailed exploration of the specific issues most relevant to students. This combined approach facilitated a comprehensive understanding of the factors influencing student preferences and perceptions of digital assessments. As previously mentioned, preliminary findings from the student survey were presented at SEFI 2023 (Akhtar and Perea Borobio 2023), with a primary focus on the quantitative data. In contrast, this paper emphasises the qualitative analysis of lecturer interviews and student comments, which form the core of the study, offering a more in-depth exploration of the qualitative aspects of digital assessments. Qualitative student responses were analysed using the same rigorous thematic analysis framework applied to lecturer interviews. This allowed for a direct comparative analysis of themes across stakeholder groups, further strengthening the study's validity.

4.4. Alignment with departmental goals

A key aspect of this study is the comparison of lecturer and student perspectives with the department's broader objectives for digital assessments. This section examines whether the administrative measures implemented to shift towards digital assessments are perceived as valuable by both lecturers and students. The analysis considers how these perspectives align with the department's goals of improving marking efficiency, enhancing feedback mechanisms, and ensuring academic integrity in the assessment process. Additionally, this alignment analysis is guided by established assessment frameworks such as Bennett's three-generation digital assessment model (Bennett 1998), ensuring that departmental objectives and findings are situated within broader theoretical perspectives and current best practices in digital assessment.

5. Results

5.1. Qualitative insights from lecturer interviews

The semi-structured interviews conducted with lecturers yielded in-depth insights into the perceived advantages and limitations of digital assessments, particularly within the context of engineering education. Using a systematic thematic approach, the data were analysed in three phases: initial coding revealed several core themes including efficiency, assessment accuracy, academic integrity, and feedback quality; focussed coding allowed for a more granular categorisation of these themes; and axial coding further clarified the interconnections among them, offering a deeper understanding of the lecturers' shared concerns and aspirations.

A strong and recurring theme across interviews was the increased operational efficiency afforded by digital assessments. Many lecturers expressed appreciation for the time-saving aspect of automated grading systems. As L8 highlighted, '*Well, the obvious thing about software is it's a very big group and so having the marking done automatically saves a lot of effort and it avoids errors…I think that's positive.*' This advantage was particularly pronounced in first- and second-year modules, where cohort sizes tend to be high. The ability to automate the marking of multiple-choice or structured-answer questions not only expedited turnaround time but also reduced marking fatigue. This, in turn, aligned with the department's objective of managing academic workload more effectively while maintaining pedagogical quality. Lecturers further noted that the time saved could be redirected toward higher-impact activities such as one-on-one support and the enhancement of learning materials.

Despite these benefits, several lecturers voiced concerns about the limited ability of current digital assessment tools to evaluate complex problem-solving tasks–a cornerstone of engineering education. L5 remarked, 'There are one or two surprises that come up from time to time with anything that's multiple choice…like for example, this year I…was expecting the answer in decimal. Some of them gave it in binary, it was marked wrong.'

This concern highlights a critical tension between efficiency and pedagogical depth. Lecturers identified a pressing need for AI-enhanced assessment tools that can interpret multi-step reasoning and evaluate procedural knowledge, not just final answers. Several suggested hybrid formats where digital tools grade straightforward components, while human assessors evaluate reasoning and structure in student solutions.

The theme of academic integrity also featured prominently in the interviews. Many lecturers expressed discomfort with the potential for dishonest practices, particularly in unsupervised or remotely administered assessments. L14 noted, '*They should be online–otherwise we add extra logistical difficulties, which we are terribly bad at handling. It will backfire.*' While proctoring technologies are commonly used, their effectiveness remains a subject of debate. L13 commented, '*I really think online [assessment] is a problem…You cannot figure out what's wrong with the way of their thinking…you can only see the final result*.' To address these limitations, lecturers advocated for more robust, AI-driven proctoring tools capable of monitoring student behaviour, detecting anomalies, and adapting in real time. Others suggested the use of randomised question banks, time constraints, and question design that favours higher-order thinking as part of a multi-pronged strategy.

Finally, the quality of feedback provided through digital assessment platforms emerged as a key issue. While immediate feedback was broadly acknowledged as a positive feature, lecturers frequently criticised its lack of depth and personalisation. L12 stated, '*You can see, you know, everybody got the question on Fourier wrong…so there's something wrong with the teaching of Fourier*.' Similarly, L16 reflected, 'I do look at the results [to identify] students who are struggling, but I don't provide any targeted support for that.' There was a strong interest in adaptive feedback systems that can deliver student-specific comments based on common errors and patterns of misunderstanding. Lecturers envisioned intelligent feedback generators that could link student performance to relevant course materials, suggest revision strategies, or offer explanatory scaffolding.

5.2. Insights from quantitative student survey data

The student survey, comprising 87 responses from first- and second-year students enrolled in Electrical and Electronic Engineering (EEE) and Electronic and Information Engineering (EIE), offered a robust quantitative snapshot of student attitudes toward digital assessments. A significant majority–65%–of students indicated a preference for digital assessments over traditional paper-based formats. Many students cited the ability to complete assessments in familiar settings and the reduced anxiety associated with home environments as key drivers for this preference.

A comparative analysis between student and lecturer preferences (Figure 1) shows this clear inclination towards digital formats, emphasising convenience and flexibility. To enable the comparison between lecturer and student perspectives presented in Figures 1 and 2, we employed a form of quantitative content analysis. Specifically, for each key theme identified through the lecturer interviews–such as academic integrity, feedback quality, and assessment design–we counted the number of interview transcripts (out of 18) in which the theme was mentioned. This approach allowed us to represent the prevalence of each theme numerically, thereby aligning the qualitative interview data with the quantitative structure of the student survey results and supporting visual comparison across stakeholder groups. While the interview data were inherently qualitative, this transformation to quantitative form was intended to facilitate thematic comparison. In some cases, the interpretation of whether a lecturer's view supported or opposed a particular issue involved subjective judgement, which may reflect the perception of the interviewer during thematic coding.

Despite the overall favourability towards digital formats, 35% of students expressed a preference for traditional print-based assessments. The primary reasons cited were concerns about platform stability, device compatibility, and the potential for technical disruptions during high-stakes

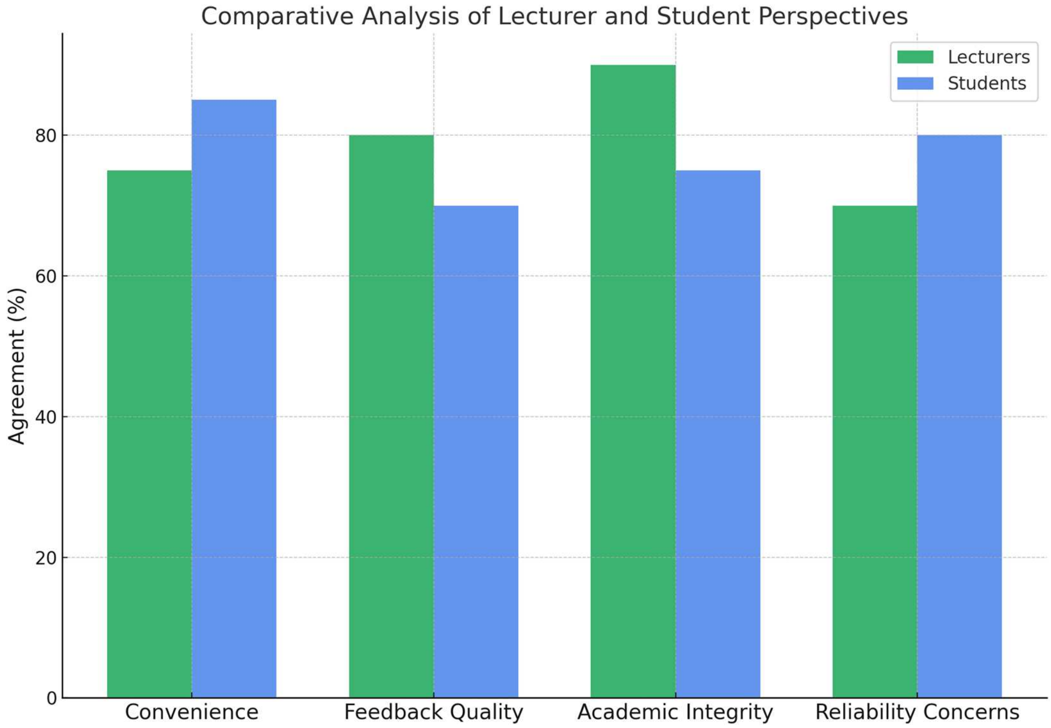

Figure 1. Comparative analysis of lecturer and student perspectives on key assessment issues.

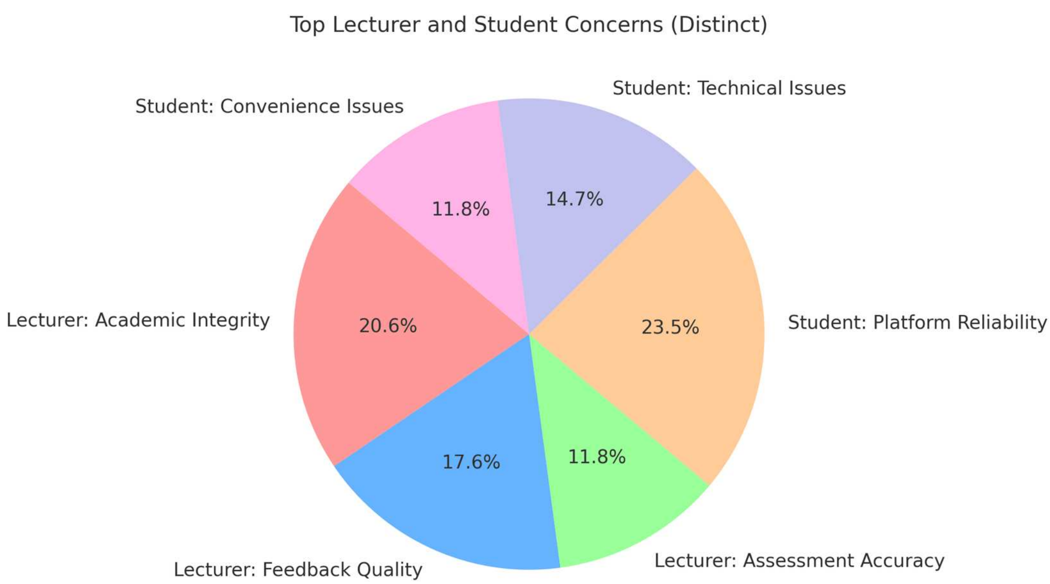

Figure 2. Distinct major concerns expressed by lecturers and students regarding digital assessments.

exams. These concern were echoed by others who noted that digital platforms occasionally lagged, froze, or failed to load properly under stress. For students in high-pressure assessment situations, such issues can lead to significant anxiety and perceived unfairness. These distinct student concerns are summarised in Figure 2, highlighting platform reliability and technical infrastructure as major barriers to full acceptance.

Students also commented on the suitability of digital platforms for expressing their ideas clearly. While digital tools are well-suited for structured question types, several students felt restricted when attempting to sketch diagrams, annotate figures, or show multi-step reasoning–a core expectation in engineering education. These limitations may explain the preference for paper-based exams among a sizeable minority of respondents.

In terms of perceived effectiveness, 77% of students agreed that digital assessments were helpful in reinforcing learning. The primary reason cited was the provision of instant feedback, which helped them quickly identify errors and misconceptions. This aligns with pedagogical literature suggesting that feedback provided close to the learning moment is more likely to influence understanding and retention. Nonetheless, 22% of students expressed dissatisfaction with the depth of feedback received, arguing that it lacked the specificity needed to support improvement. This highlights a significant gap between students' expectations for constructive, formative feedback and the current capabilities of automated digital assessment systems. Students desired feedback that was tailored to their individual errors and linked to relevant course material, such as lecture slides, worked examples, or specific textbook sections.

Overall, the quantitative data underscore the importance of continuing to refine digital assessment systems–particularly in terms of platform reliability and feedback personalisation–to meet the diverse needs of students. While the general trend points toward increasing student acceptance of digital formats, these findings suggest a nuanced reality where technological robustness and pedagogical richness remain critical factors for success.

5.3. Qualitative insights from student survey responses

The open-ended survey responses provided deep qualitative insights into student experiences and expectations surrounding digital assessments. Using initial thematic coding, key themes emerged including convenience and flexibility, academic integrity, technical reliability, stress and fairness, feedback quality, assessment design, and opportunities for improvement. Focused coding further clustered these into sub-themes, and axial coding helped uncover relationships between concerns and proposed solutions, revealing how students conceptualise the role and future of digital assessments in engineering education.

A dominant theme was the convenience and reduced anxiety associated with digital assessments. Students frequently noted that being able to take tests from home contributed to a calmer assessment experience. One student explained, '*Less stressful environment, don't have to spend time travelling meaning better quality sleep and less time wasted*.' Others echoed this sentiment, stating that digital formats reduced the stress of commuting, logistical preparation, and last-minute panic. Some appreciated that online assessments allowed them to manage their time better and prevented the cognitive fatigue associated with in-person examination environments. Several students even mentioned they were less likely to make errors due to misquoting formulas or skipping steps, as they could work in a more familiar and controlled space.

However, this perceived benefit was accompanied by substantial concerns about fairness, academic integrity, and technical reliability. Numerous students highlighted worries about cheating during unproctored digital assessments. One wrote, '*They do, however, promote cheating. This is just a fact. This leads to the assessments being unfair*.' Others reflected on the systemic nature of this concern, suggesting that the prevalence of collaboration or access to unauthorised resources during digital exams was difficult to mitigate and inherently compromised the value of their individual efforts. One student suggested in-person, invigilated exams using laptops with full internet access, arguing that this approach would preserve the advantages of digital tools while safeguarding integrity.

Technical reliability was another frequent issue. Students worried about software crashes, submission errors, or internet disruptions impacting their performance. One respondent noted, '*There's always a worry about the platform crashing or submission issues during online exams*.' Others mentioned that even brief technical issues created significant stress, especially during high-stakes, time-limited assessments. This anxiety was compounded by inconsistent platform behaviour across courses and assessment formats, with students unsure of how potential failures would be handled by the teaching team.

Students also raised concerns about their ability to clearly demonstrate their problem-solving process. In engineering disciplines, where method and logic are as important as the final answer, this limitation is particularly acute. One respondent noted, '*Only problem is that with electronic you can't show your working so can lose a lot of marks even if your working used the right method but the answer was wrong because of wrong inputs into the calculator*.' Several students suggested that assessments should be restructured to include step-by-step components or allow partial marking for processes rather than results. Others proposed that scanned handwritten workings be submitted alongside digital responses, allowing for greater clarity in method-based subjects.

Stress and fairness emerged as intertwined themes. Students expressed frustration that digital midterms, while often shorter and lower-stakes, could still be disproportionately stressful. One student wrote, '*In-person progress tests (not counting towards the final grade) would be much better preparation than electronic assessments*.' Others argued for more formative or mock assessments that would help them build confidence and identify weaknesses without academic penalty. Students also highlighted the emotional impact of losing a single mark in a low-weighted assessment with few questions, describing it as disproportionately damaging to their percentage grade.

Another area of concern was feedback quality and the lack of personalisation in digital assessments. Students consistently indicated that while feedback was quick, it often lacked depth. One student remarked, '*t does help me see what I am weak at and why I am getting things wrong*.' Others recommended linking feedback to specific lecture materials or including suggestions for targeted revision. Some students requested digital tools that would allow iterative feedback loops, enabling them to revisit questions after reflection or resubmission.

There were also thoughtful suggestions for improving assessment design. Some students supported the increased use of open-book or take-home assessments, as used in other departments or institutions. One noted, '*The Design Engineering department already have almost entirely open book exams–the success of this speaks for itself* .' Others proposed group-based digital assignments, such as collaborative problem-solving tasks, take-home labs, or programming e-assessments. One particularly detailed comment recommended adopting practices from MIT's EECS department, including graded problem sets that combine individual responsibility with peer learning.

Finally, a number of students reflected on the role of midterms and e-assessments in shaping the learning journey itself. One wrote, '*Learning feels very unsupervised in third year…midterms might help ensure staff are more involved in their classes*.' Another proposed, '*Progress tests that don't count toward the final grade would be better preparation than electronic assessments*.' Students were not universally opposed to digital formats but called for a more balanced and pedagogically aligned use of e-assessments–used as checkpoints for learning rather than just grading.

In summary, student responses offered a multifaceted view of digital assessments: while many welcomed the flexibility and immediacy, a significant number raised pedagogical, technical, and ethical concerns. Their suggestions point to a strong desire for thoughtful, well-designed assessments that balance rigour, fairness, and accessibility. These insights complement and extend the quantitative findings, underscoring the importance of involving students in shaping future assessment strategies.

5.4. Comparative analysis of student and lecturer perspectives

Comparative thematic analysis, guided by axial coding, revealed important convergences and divergences between lecturer and student perspectives. Common themes included concerns over academic integrity, feedback quality, convenience, and the technical reliability of digital assessment

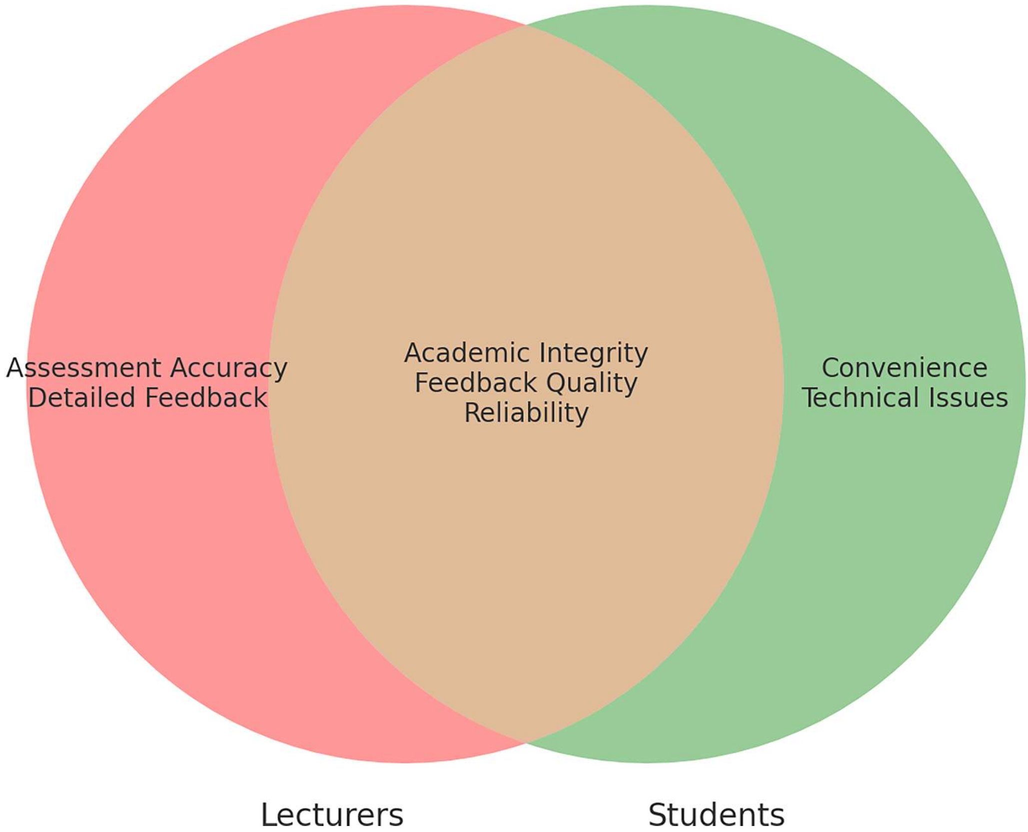

Figure 3. Common and unique concerns among lecturers and students.

platforms. These findings are visually summarised in Figure 3, which highlights areas of overlap and divergence between the two stakeholder groups.

Both students and lecturers strongly valued the convenience of digital assessments, recognising the logistical and practical benefits they offer. Students emphasised flexibility–being able to take exams in familiar environments, manage their own time, and avoid the stress of commuting or time-constrained physical exams. Lecturers appreciated the efficiency gained through automated grading and the streamlined administration of assessments, particularly in large classes. While the underlying motivations differed, both groups agreed that digital assessments contributed positively to overall efficiency and learner autonomy.

Academic integrity was also a shared concern, but it was conceptualised differently by each group. Lecturers were primarily focussed on identifying methods to prevent and detect dishonest behaviour, advocating for technical solutions such as AI-enhanced proctoring, behavioural monitoring, and the use of randomised question banks. Students, however, framed their concerns around fairness. They worried that cheating by peers in unsupervised environments would create a grading disadvantage, undermining the legitimacy of the assessment process. This divergence highlights a subtle but critical tension–lecturers are solution-oriented, while students are consequence-focussed, reflecting a need for institutions to improve not only the mechanisms of academic integrity but also the communication around how these systems ensure fairness.

Feedback quality emerged as a major area of alignment. Both groups acknowledged that the immediacy of digital feedback was a strength of the format, but they also expressed dissatisfaction with its lack of personalisation and instructional depth. Lecturers noted that existing systems failed to adequately capture student reasoning and thought processes, especially in subjects requiring multi-step logic. Students similarly indicated that generic comments or numerical scores were insufficient for guiding improvement. There was a strong consensus on the need for AI-driven feedback systems capable of tailoring responses to individual student needs, offering detailed explanations, and referencing relevant course material.

Technical reliability of the assessment platform also surfaced as a shared concern, albeit weighted differently. Students were particularly vocal about anxiety caused by the fear of system crashes, submission failures, or connectivity issues during high-stakes tests. Lecturers, while also concerned, were more focussed on the administrative burden of troubleshooting and resolving technical issues post-assessment. Both groups indicated that improvements in platform stability, user interface design, and technical support would be essential for widespread acceptance of digital assessments.

Overall, the results indicate several important areas where lecturer and student priorities align, as well as key points of divergence that must be addressed to create a balanced and effective digital assessment strategy. These insights offer valuable guidance for the development of future policies, assessment designs, and support mechanisms that can better serve the needs of both educators and learners in engineering education.

6. Discussion

The findings from this study highlight the complex and multifaceted nature of digital assessments in engineering education. While digital assessments offer significant advantages, such as increased efficiency, scalability, and immediate feedback, these benefits are tempered by substantial challenges related to academic integrity, technical reliability, and adequacy in evaluating complex cognitive skills. The study reveals both alignment and divergence between student and lecturer perspectives, providing critical insights for improving the design and implementation of digital assessments in engineering education.

6.1. Comparing student and lecturer perspectives

Comparative analysis using axial coding clearly identified common themes and distinct priorities between lecturers and students (see Figure 3). Both stakeholder groups acknowledged the transformative potential of digital assessments, but they approached the topic from different experiential and institutional standpoints. This echoes Nicol and Macfarlane-Dick (2007), who emphasise that feedback must be timely, specific, and actionable to foster self-regulated learning. Our findings reinforce the need to move beyond immediacy and toward feedback practices that support deeper understanding.

One area of strong alignment was the shared appreciation for the convenience and flexibility that digital assessments offer. In engineering programmes, where students often juggle dense timetables and complex lab-based work, flexibility emerged as a particularly valued feature. Students repeatedly expressed gratitude for the ability to complete assessments in a controlled, familiar environment such as their homes. Several mentioned that this helped alleviate stress and improve concentration. Lecturers, meanwhile, highlighted the operational efficiencies enabled by digital systems, including streamlined marking, easier data tracking, and logistical simplicity in managing large cohorts. This alignment suggests a strong foundational support for digital assessments and indicates the viability of continued investment in digital infrastructure, platform scalability, and pedagogical training to enhance remote learning capabilities. This is consistent with Berggren, Fili, and Nordberg (2015), who reported that student confidence in digital assessments is closely tied to perceived platform reliability. Our results reinforce the importance of dependable infrastructure in reducing performance-related stress.

Despite these areas of agreement, the data also revealed significant divergences in priorities and perceived challenges. Academic integrity was a central theme for lecturers, who voiced concerns about cheating, impersonation, and unauthorised collaboration in unsupervised digital environments. They advocated for more robust digital proctoring technologies, including AI-based behavioural analysis and real-time identity verification. Some also suggested a redesign of assessments to focus on open-ended or process-based questions that are harder to plagiarise. Students, on the other hand, while acknowledging integrity issues, were more concerned with the broader concept of fairness. They expressed anxiety about how cheating by others could skew grade distributions, especially when grading was on a curve. Their comments also highlighted a lack of confidence in the current proctoring technologies, with some noting that they felt invasive or prone to false flagging.

Another point of divergence centred on technical reliability and infrastructure. Students frequently mentioned the stress induced by the possibility of system crashes, browser freezes, or unstable internet connections during timed assessments. One student commented that 'just waiting for the page to load sometimes is enough to lose focus or panic.' Lecturers acknowledged these issues but generally perceived them as secondary to concerns about academic rigour. This divergence illustrates a critical gap between those designing and administering assessments and those taking them. It highlights the need for assessment policies that include contingency protocols, user support systems, and better-tested platforms to ensure equitable conditions for all students. Figure 2 explicitly illustrates these different emphases, with students prioritising reliability and fairness, and lecturers focussing on integrity and measurement accuracy. These findings align with Butler-Henderson and Crawford (2020), whose review identifies scalable authentication as a persistent challenge in online examinations. Our study extends this concern by showing shared doubts from both students and lecturers regarding the fairness and effectiveness of current proctoring tools.

Feedback quality was a notable point of consensus. Both groups recognised that the immediacy of digital feedback was a positive development, but they also agreed that current feedback mechanisms were often too generic and insufficiently detailed. Students expressed frustration when feedback amounted to a single mark or vague comment, while lecturers acknowledged that the limitations of auto-grading systems constrained the level of insight they could provide. There was mutual interest in more intelligent feedback solutions, such as AI-powered comment banks that adapt based on student performance and generate personalised guidance linked to specific course objectives.

In summary, while lecturers and students broadly support the continued use of digital assessments, their priorities reflect different aspects of the educational experience–educators focus on integrity, structure, and pedagogical alignment, while students emphasise usability, fairness, and emotional security. These dual perspectives provide valuable direction for the future design of digital assessments, particularly in balancing technical, ethical, and pedagogical demands in engineering education.

6.2. Challenges in maintaining academic integrity

Academic integrity remains one of the most complex and persistent challenges associated with the adoption of digital assessments, particularly in engineering education where high-stakes examinations are common. Lecturers expressed concerns that traditional digital safeguards–such as lockdown browsers, webcam monitoring, and timed access windows–were increasingly inadequate in deterring sophisticated forms of academic dishonesty. L13 notably emphasised, '*The challenge is designing assessments inherently resistant to cheating*.' This sentiment was echoed by several others who described current tools as reactive rather than preventative, placing a greater burden on instructors to verify authenticity after the fact.

Lecturers advocated for the adoption of advanced AI-driven proctoring systems and behavioural analytics, which could monitor keystroke dynamics, facial recognition, screen interactions, and anomalous response patterns in real time. Such systems promise a more scalable and consistent approach to academic integrity but also raise ethical and privacy concerns, which were acknowledged during the interviews. The integration of these tools must be balanced with transparency and student consent, as an overly invasive approach may compromise trust between students and institutions.

There was also discussion around the potential for generative AI technologies to further complicate academic integrity. Tools like ChatGPT, if used during remote assessments, could enable students to bypass problem-solving entirely, particularly in conceptual and design-based questions. This added an additional layer of concern, reinforcing the need for authentic, application-oriented assessments that are less susceptible to generic AI-generated answers.

Another key issue raised by lecturers was the inconsistency of integrity measures across departments and institutions. What one academic described as 'a patchwork of policies and enforcement' contributes to both perceived and actual inequities. Students may face stricter surveillance in some modules while operating with minimal oversight in others, raising questions about the fairness and standardisation of assessment conditions. This inconsistency also undermines confidence in digital assessments as a whole, both within the academic community and among students who may perceive enforcement as arbitrary or unfair.

In response, many lecturers advocated for a shift in assessment philosophy–from purely preventative models to constructive alignment of tasks with learning outcomes that are inherently less susceptible to misconduct. For example, assessments that require students to apply principles to novel situations, reflect on their own design decisions, or critique code written by others were seen as more resilient to dishonesty than standardised problem sets. Several interviewees proposed moving away from closed-book replication-style exams toward formats that reward higher-order thinking, creativity, and originality–skills that are difficult to fake, even with AI support.

Open-book assessments emerged as a particularly favoured format. Lecturers noted that when students are allowed access to reference materials, the incentive to cheat is reduced, and the assessment shifts focus toward analysis and application rather than memorisation. This aligns more closely with professional engineering practice, where engineers are expected to use available resources to solve complex problems rather than rely solely on memory. A few lecturers suggested institutional pilots involving open-internet, invigilated digital exams as a middle ground, allowing authentic practice while still controlling the environment.

Future research could also explore hybrid assessment models that combine in-person proctoring with digital submission platforms, or peer-assessment frameworks that encourage collaborative learning while maintaining accountability. These models could not only reduce the pressure on digital invigilation tools but also promote academic integrity as a shared value, rather than a condition enforced through surveillance.

In summary, addressing academic integrity in digital assessments will require a multifaceted approach that blends technological innovation with pedagogical reform. Rather than relying solely on stricter surveillance, educators are encouraged to redesign assessments that inherently promote integrity through task design, student ownership of learning, and alignment with real-world professional practices.

6.3. Evaluating the role of feedback in digital assessments

Feedback quality emerged as one of the most significant and recurring concerns expressed by both lecturers and students, despite the well-recognised advantage of digital assessments in providing immediate responses. While automated feedback systems enable rapid return of marks and general comments, they are often unable to engage with the complexity of student reasoning–particularly in subjects such as engineering where process, design choices, and conceptual development are as important as the final answer.

Students consistently reported that feedback received through digital platforms lacked the detail and personal relevance necessary for meaningful learning. One student noted, 'The feedback is just a score or a short phrase–I don't know what I did wrong or how to fix it.' This sentiment was echoed throughout the qualitative responses, with many students expressing a desire for richer, step-by-step commentary that helped them trace their errors and understand alternative approaches. This highlights a critical disconnection between what feedback is technically capable of offering through current platforms and what learners need to make progress.

Lecturers shared similar frustrations. While many acknowledged that digital systems reduced marking time and simplified logistical processes, they also stressed that automated grading tools often failed to address deeper pedagogical goals. L5 remarked, '*It's great that we can return marks instantly, but it's not teaching if the student doesn't know why something is wrong*.' Others commented on the loss of opportunities to provide formative, coaching-style feedback that could scaffold learning, particularly in first- and second-year modules where students are still mastering foundational skills.

Lecturers specifically identified the need for more advanced feedback mechanisms capable of interpreting the logic and method used by students–whether in mathematical derivations, programming problems, or circuit design–and returning formative advice that corresponds with each student's learning trajectory. Some suggested that feedback systems should include model answers with step-wise breakdowns, comparative visuals, and references to lecture content or tutorials that students can revisit. Others proposed integrating feedback into digital learning environments through interactive dashboards where students could view feedback trends across modules and monitor progress over time.

The problem is especially acute in assessments where correct methodology does not always yield correct answers due to minor calculation or interpretation errors. In traditional formats, markers can award partial credit and annotate reasoning directly. However, digital systems–especially those relying on multiple-choice or single-line numerical inputs–are not yet equipped to replicate this level of granularity. As a result, students may feel penalised for small mistakes and discouraged from engaging deeply with the material.

Advancements in artificial intelligence (AI) and natural language processing (NLP) present promising avenues to close this gap. Emerging systems have begun to offer semi-automated feedback on short-answer and open-ended questions by detecting logic chains, flagging conceptual errors, and suggesting targeted revisions. Adaptive learning platforms can also analyse past performance data to customise feedback, aligning it with individual learning needs. For example, if a student repeatedly makes similar mistakes in applying Kirchhoff's laws, an intelligent system could recognise the pattern and suggest specific revision tasks or practice problems.

However, both students and lecturers raised concerns about over-reliance on such technologies. There was a clear preference for a hybrid approach where digital tools provide preliminary feedback, which can then be supplemented by human insight–particularly in high-stakes summative assessments. This points toward the value of semi-automated feedback frameworks that support, rather than replace, educator judgement, and allow for scalable personalisation without sacrificing depth.

Institutionally, there is also a need to reframe feedback not just as a post-assessment activity, but as an integral part of the learning cycle. Several lecturers advocated for more low-stakes digital assessments with formative feedback loops, allowing students to act on feedback before being summatively assessed. This aligns with well-established pedagogical models such as Nicol and Macfarlane-Dick's principles of formative assessment, which position feedback as a dialogic, student-centred process.

In summary, while immediacy and efficiency are valuable attributes of digital feedback systems, they must be complemented by functionality that promotes learning through depth, clarity, and personalisation. By investing in intelligent feedback technologies and embedding feedback practices within a wider culture of formative assessment, institutions can significantly enhance the educational value of digital assessments. For engineering education in particular, where skills are developed cumulatively and conceptually, high-quality feedback is essential not only for academic success but for long-term professional competence.

6.4. Future directions for digital assessments in engineering education

The challenges identified in this study point toward several critical pathways for future research, practice, and policy development in the domain of digital assessments. As engineering education continues to evolve in response to shifting student expectations, technological advancements, and institutional priorities, digital assessments are poised to play an increasingly central role. However, to maximise their effectiveness and ensure equitable and pedagogically sound implementation, multiple layers of innovation and support are required.

Firstly, the development of sophisticated, AI-driven assessment tools that can deliver detailed, personalised feedback is of paramount importance. Current systems often fall short in their ability to address student-specific misconceptions or provide contextualised advice for improvement. Integrating natural language processing, machine learning, and adaptive learning technologies can enable platforms to assess open-ended responses, track student learning patterns, and tailor feedback to individual performance profiles. Such tools would not only improve learning outcomes but also reduce the burden on educators by automating aspects of formative assessment. Institutions should prioritise the design and implementation of pilot programs that test these technologies in live teaching contexts, evaluating their impact on student understanding, engagement, and satisfaction, as well as on instructor workload and marking accuracy.

Secondly, maintaining academic integrity in digital assessment environments remains a pressing concern. As highlighted in earlier sections, traditional proctoring solutions are insufficient against evolving forms of misconduct. Future digital assessment models must be designed from the ground up with integrity in mind, incorporating secure infrastructures, dynamic question banks, identity verification systems, and AI-supported behavioural monitoring to detect anomalies. However, technological measures alone may not suffice. There is a need for interdisciplinary research into the psychological and sociocultural drivers of academic dishonesty, which can inform the development of proactive, trust-based policies. These may include honour codes, collaborative design of assessment criteria, and greater transparency around the rationale behind academic integrity practices.

Thirdly, the technical robustness and user-friendliness of digital platforms must be significantly enhanced. Students in this study expressed considerable anxiety about system reliability, particularly during high-stakes assessments. To address these concerns, institutions must invest in infrastructure that supports stable, scalable, and accessible platforms. This includes not only the technical backend but also intuitive interfaces, real-time support services, and offline submission contingencies. Further, user experience (UX) research focussed on student interactions with digital systems can uncover friction points and help redesign platforms that align more closely with student needs and habits, especially under stress.

Fourthly, and perhaps most critically, sustained support and training for both students and lecturers is essential for the long-term success of digital assessments. While digital literacy has improved in recent years, this study revealed gaps in both confidence and competence. Students were often uncertain about digital expectations, and lecturers reported needing more guidance on best practices for designing fair and effective online assessments. Institutions should respond with a structured professional development agenda, including interactive workshops, on-demand learning modules, and community-of-practice networks where educators can share experiences, resources, and innovations. Students, meanwhile, should be offered digital induction sessions and ongoing access to tools that help them understand assessment formats, technical requirements, and how to engage with feedback.

Beyond these immediate interventions, institutions should also consider revisiting their overall assessment philosophies. Moving toward a more continuous, formative, and student-centred model–where assessments are used not only to evaluate but also to support learning–can make digital assessments more meaningful and less stressful. This could include greater use of open-book and project-based tasks, diagnostic quizzes, peer feedback systems, and reflective assignments.

In conclusion, digital assessments offer transformative opportunities for improving teaching and learning in engineering education. However, realising their full potential will require sustained effort to address the multifaceted challenges identified in this study. Strategic innovation–grounded in research and co-designed with both educators and students–must be supported by long-term institutional investment and robust digital infrastructure. The perspectives gathered through this research offer a valuable blueprint for such efforts.

As illustrated through this study's findings (Figures 1, 2, and 3), the future of digital assessments lies in their ability to bridge the gap between pedagogical intention and student experience. Success in this domain will ultimately depend on collaborative approaches that unite academics, technologists, educational developers, and policymakers around a shared vision of assessment that is equitable, authentic, and responsive to the needs of modern learners.

7. Conclusion

This study has provided a comprehensive analysis of digital assessments in engineering education, drawing on both lecturer interviews and student survey responses to evaluate their effectiveness, limitations, and future potential. While digital assessments offer significant advantages–such as increased efficiency, scalability, flexibility, and the ability to deliver immediate feedback–these benefits are tempered by complex challenges that require sustained institutional attention.

Foremost among these challenges is academic integrity. Both students and lecturers raised concerns about the adequacy of current proctoring tools and the fairness of remote assessments. Addressing this issue will require more than technological fixes; it demands a redesign of assessment strategies to promote authenticity, critical thinking, and originality.

Technical reliability also emerged as a central concern, with students expressing significant anxiety about the impact of system failures during high-stakes assessments. Robust, user-friendly platforms are essential to ensuring equitable experiences and maintaining student confidence in digital assessment environments.

Another key area is feedback quality. Although students appreciated the immediacy of digital feedback, both groups found current systems too generic and insufficiently personalised–especially in a field like engineering, where understanding and process are as important as outcomes. The development of AI-powered feedback tools that adapt to individual learning patterns could help address this gap.

Moving forward, the integration of intelligent systems, improved user experience design, and investment in digital literacy training for both staff and students will be critical. Institutions must also align digital assessment strategies with their broader pedagogical and equity goals, ensuring that technology enhances, rather than replaces, sound teaching practices.

In summary, while challenges remain, this study affirms the potential of digital assessments to transform engineering education. With thoughtful implementation, ongoing refinement, and a commitment to collaboration between educators, technologists, and students, digital assessments can support more flexible, inclusive, and pedagogically effective learning environments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Zohaib Akhtar received the BSc (Hons) and MSc degrees in Electrical Engineering from the University of Engineering and Technology, Lahore, Pakistan, in 2008 and 2011, respectively. He obtained his PhD in Electrical and Electronic

Engineering from Imperial College London, UK, in 2017. He received an MEd in University Teaching and Learning from Imperial College London, UK, in 2024.

Since 2017, he has been serving as a Senior Teaching Fellow in the Department of Electrical and Electronic Engineering (EEE) at Imperial College London. His current research interests include renewable energy integration in power systems and smart grids. Additionally, his educational research focuses on digital learning and digital assessments. He also serves as the Digital Learning Lead for the EEE department, where he plays a pivotal role in advancing the department's educational research initiatives.

Esther Perea Borobio Esther Perea Borobio is a Mechanical Engineer (MEng, University College London) and Industrial Designer (MDes, Royal College of Art and Imperial College London). She has over ten years of industrial experience in various sectors, including architecture and medical devices. Esther transitioned to academia in 2005 as a Senior Lecturer at London South Bank University, specialising in Engineering Design and Quality Management. She was later promoted to Principal Lecturer and Subject Area Leader. Since 2014, she has been a Principal Teaching Fellow and Senior Tutor in the Department of Electrical and Electronic Engineering at Imperial College London. Esther is fluent in Spanish and English, with intermediate proficiency in French.

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