

Developing Strategies for Preventing and Reducing E-Learning Assessment Errors Based on Expert Perspectives: A Qualitative Study

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Purpose: This study aimed to develop a comprehensive set of strategies for preventing and reducing errors in e-learning assessment based on the perspectives of experts in e-learning, educational assessment, and educational technology.

Methods and Materials: This applied qualitative study employed thematic analysis. Participants were 12 experts in e-learning, educational assessment, and educational technology who were selected through criterion-based purposive sampling. Data were collected through semi-structured interviews and analyzed using Braun and Clarke's (2021) six-phase thematic analysis approach. The analytical process involved familiarization with the data, initial coding, generation and review of themes, definition and naming of themes, and preparation of the final thematic framework. To enhance the trustworthiness of the findings, multiple expert perspectives were incorporated, the consistency of the findings with previous research was examined, and a systematic audit trail of the data analysis process was maintained.

Findings: The thematic analysis identified eight major strategic domains for preventing and reducing e-learning assessment errors: (1) improving assessment design, (2) enhancing the competencies and professional empowerment of human agents, (3) strengthening technological infrastructure, (4) ensuring assessment integrity, security, and authenticity, (5) improving the quality of assessment instruments, (6) enhancing feedback systems, (7) strengthening management and policymaking mechanisms, and (8) promoting educational ethics and equity. The findings revealed that assessment-error prevention constitutes a multidimensional process extending from assessment design and measurement quality to human competencies, technological reliability, academic integrity, feedback mechanisms, institutional governance, ethics, and educational equity.

Conclusion: Preventing and reducing e-learning assessment errors requires a systemic and multidimensional approach rather than reliance on isolated technological solutions. The proposed framework integrates educational, human, technological, managerial, ethical, and equity-related dimensions across different levels of the electronic assessment process. This framework can provide a practical foundation for developing institutional guidelines, professional development programs, quality-assurance mechanisms, and evidence-informed policies aimed at improving the accuracy, fairness, validity, and reliability of e-learning assessment in higher education institutions.

Keywords: E-Learning Assessment; Assessment Errors; Prevention Strategies; Error Reduction; Educational Assessment; Thematic Analysis

1. Introduction

The rapid expansion of digital technologies has fundamentally transformed the organization, delivery, and evaluation of learning in higher education. E-learning has evolved from a supplementary instructional option into a central component of contemporary educational systems, supported by learning management systems, virtual classrooms, digital content platforms, learning analytics, and increasingly sophisticated assessment technologies. This transformation has been reinforced by broader processes of digitalization in universities and by the growing expectation that higher education institutions develop flexible, scalable, and technology-enhanced learning environments. Research on online teaching and learning has demonstrated that digital environments can expand access, increase instructional flexibility, support learner autonomy, and enable diverse forms of interaction and assessment; however, these advantages also introduce new pedagogical, technological, managerial, and ethical challenges that differ from those encountered in conventional face-to-face education (Farias-Gaytan et al., 2023; Martin et al., 2020). The accelerated adoption of e-assessment following the COVID-19 pandemic further demonstrated that assessment is one of the most critical and vulnerable elements of technology-enhanced higher education, requiring systematic attention not only to technological functionality but also to validity, fairness, integrity, accessibility, and educational quality (Liu et al., 2025; St-Onge et al., 2022).

Assessment occupies a central position in the teaching-learning process because it provides evidence regarding students' achievement, supports instructional decision-making, guides feedback, influences student learning behavior, and contributes to decisions concerning progression, certification, and educational quality. In online and blended environments, assessment may include computer-based examinations, automated quizzes, electronic portfolios, discussion activities, peer assessment, online assignments, simulations, performance tasks, and technology-supported formative assessment. Systematic reviews indicate that online assessment practices have expanded considerably in both variety and complexity, yet their quality depends on the alignment of assessment design with learning outcomes, the appropriateness of the technological environment, the quality of measurement instruments, and the capacity of instructors and students to use assessment systems effectively (Heil & Ifenthaler, 2023; Huber et al., 2024). Therefore, the effectiveness of e-

learning assessment cannot be reduced to the availability of digital tools; rather, it reflects the interaction of instructional design, assessment literacy, technological infrastructure, institutional policy, and the characteristics of learners and instructors.

One of the major concerns associated with e-learning assessment is the possibility of errors that may distort the interpretation of student performance. Assessment error can occur at different stages, including assessment design, item construction, administration, scoring, feedback, interpretation, and decision-making. Errors may originate from ambiguous items, inappropriate answer keys, poorly aligned assessment tasks, technical malfunctions, unstable digital platforms, inconsistent scoring procedures, inadequate instructions, inappropriate timing, or insufficient quality assurance procedures. Research focused specifically on educational assessment instruments has shown that seemingly minor errors in wording, formatting, scoring keys, instructions, or item construction can compromise the quality of assessment evidence and influence decisions made on the basis of students' scores (Suto & Ireland, 2021; Suto et al., 2023). In high-stakes contexts, unreliability may also arise from interacting test-related, administration-related, examinee-related, and contextual factors, indicating that assessment error is often multidimensional rather than attributable to a single source (Nikmard et al., 2023).

The issue of validity is particularly important in electronic assessment because the recorded score should represent the intended learning construct rather than students' technological resources, Internet stability, familiarity with platforms, or capacity to manage unforeseen technical problems. Evidence from technology-supported assessment suggests that carefully designed multimodal assessment can improve both reliability and validity when the assessment format is appropriately matched to the intended competencies (Renes et al., 2023). Similarly, validation frameworks for e-assessment emphasize that the selection and implementation of digital assessment solutions should be systematically evaluated in relation to educational purposes, users, technological performance, security, and the consequences of assessment decisions (Van Haastrecht et al., 2023). Learning analytics may further support evidence-informed assessment design, but its value depends on the validity of the assessment itself and on whether data are interpreted within a student-centered learning framework (Divjak et al., 2023). Studies applying psychometric methods to large-scale online courses also demonstrate that assessment stability and item functioning should be

continuously monitored rather than assumed simply because assessment is technologically administered (Gershon et al., 2024).

A further source of assessment error lies in inadequate assessment literacy among both educators and learners. Assessment literacy includes knowledge of assessment principles, purposes, methods, criteria, interpretation, and the appropriate use of assessment information. Faculty members who lack adequate assessment competence may use poorly aligned tasks, rely excessively on limited assessment formats, misinterpret performance data, or fail to provide sufficiently informative feedback. Research on teachers' digital assessment competence has shown that educators differ considerably in their knowledge, confidence, practices, and professional development needs regarding electronic assessment (Al-Bahlani & Ecke, 2023; Grosseck et al., 2024). Current models of digital assessment practice similarly suggest that instructors' future assessment behavior depends on their technological competence, assessment beliefs, institutional conditions, and perceived educational usefulness of digital tools (Viberg et al., 2024). At the student level, assessment literacy involves understanding assessment expectations, criteria, processes, and the use of feedback; limited student assessment literacy can therefore reduce the fairness, transparency, and learning value of assessment (Hannigan et al., 2022; Zhu & Evans, 2024). Supporting teachers' professional judgment is also essential because interpreting assessment information requires the capacity to distinguish meaningful evidence of learning from irrelevant or misleading variation in assessment data (Wyatt-Smith et al., 2024).

The design of assessment itself is another fundamental determinant of accuracy and quality. Traditional assessment practices cannot necessarily be transferred directly to online environments without adaptation because e-learning changes the nature of learner interaction, access to resources, supervision, communication, and evidence of performance. Contemporary scholarship increasingly emphasizes authentic and performance-based assessment as an alternative to overreliance on conventional examinations. Authentic assessment requires students to demonstrate knowledge and skills through meaningful tasks that resemble real-life or professional situations, thereby improving alignment between learning objectives, assessment activities, and transferable competencies (Vlachopoulos & Makri, 2024). Personalization of online assessment may further support responsiveness to learners' needs, characteristics, and contexts, although

personalization must be balanced with comparability, validity, and fairness (Hattingh & Northcote, 2023). From this perspective, assessment-error prevention begins during the design phase by ensuring that intended outcomes, task formats, assessment criteria, technological affordances, and learner circumstances are considered before implementation.

Feedback represents another essential component of assessment quality because the educational value of assessment depends not merely on producing a score but on enabling students to understand their performance and improve subsequent learning. Research on feedback literacy emphasizes that effective feedback processes require teachers to design feedback regimes that are timely, dialogic, understandable, actionable, and connected to opportunities for improvement (Carless, 2023). Formative feedback can enhance learning when students receive sufficiently specific information about the gap between current and expected performance and are given opportunities to use this information in subsequent tasks (Olsen & Hunnes, 2024). Online peer feedback and peer assessment also offer opportunities for deeper engagement, reflection, and collaborative learning, but their effectiveness depends on structured criteria, appropriate task design, student preparation, and technological usability (Gao et al., 2024; Taghizadeh Kerman et al., 2024). Reviews of online peer-review and assessment systems similarly indicate that the quality of digital peer assessment depends on the interaction among technological functions, pedagogical design, user participation, and assessment processes (Babik et al., 2024). Consequently, deficiencies in feedback timing, specificity, accessibility, or usability may themselves function as assessment errors by limiting the extent to which assessment information supports learning.

Academic integrity constitutes another major challenge in e-learning assessment. Online environments may increase opportunities for unauthorized collaboration, impersonation, use of prohibited resources, contract cheating, and inappropriate external assistance. Systematic reviews indicate that cheating occurs in online examinations and that concerns regarding academic misconduct increased substantially during the rapid transition to remote assessment, although reported prevalence varies depending on definitions, methods, institutional contexts, and assessment formats (Newton & Essex, 2024). Students' cheating behavior is influenced not only by opportunity but also by psychological needs, perceptions of assessment, motivations, social norms, and reasons for engaging in

dishonest behavior (Rüth et al., 2024). Research on trustworthy online assessment therefore recommends moving beyond purely punitive approaches by redesigning assessment, clarifying expectations, increasing authenticity, and improving academic integrity education (Surahman & Wang, 2022). Experimental evidence also suggests that monitoring mechanisms can influence academic dishonesty in online examinations, although monitoring alone cannot address all underlying causes of misconduct (Alguacil et al., 2024).

Digital proctoring has consequently become an important institutional response to concerns regarding identity verification and academic integrity. Proctoring technologies can include identity authentication, browser lockdown systems, webcam monitoring, artificial intelligence-supported behavior detection, and human supervision. However, systematic reviews indicate that digital proctoring raises substantial questions regarding technological accuracy, privacy, accessibility, student anxiety, data protection, and ethical legitimacy (Han et al., 2024). Scholars have also questioned the assumption that increased surveillance automatically produces trustworthy assessment, arguing that proctoring should be considered in relation to proportionality, privacy, institutional trust, and the educational purpose of assessment (Khalil et al., 2022). Moreover, online proctored examinations may intensify existing digital inequalities because students differ in access to stable Internet connections, appropriate devices, quiet spaces, and other technological or environmental resources (Hartnett et al., 2023). These issues demonstrate that preventing integrity-related errors requires a balance among security, authenticity, privacy, equity, and practicality rather than reliance on surveillance alone.

Fairness and educational equity are equally central to the quality of e-learning assessment. Students' perceptions of fairness are influenced by transparency, equal treatment, access to learning and assessment resources, consistency in procedures, appropriateness of assessment tasks, and opportunities to demonstrate learning (Bazvand & Rasooli, 2022). In online contexts, fairness may be compromised by technological disparities, unfamiliarity with platforms, unequal access to devices or Internet connectivity, and inconsistent implementation of assessment rules. Qualitative evidence from higher education students demonstrates that perceptions of online assessment fairness are closely associated with technological accessibility, communication, assessment design, consistency, and institutional responsiveness (Eltahir et al., 2023). Similar research has

identified technical problems, connectivity limitations, inadequate preparation, time pressures, and assessment-related stress as persistent challenges experienced by students during online assessment (Waheeda et al., 2023). Therefore, an assessment system may be technically functional yet still generate unfair outcomes if contextual differences among students systematically influence their capacity to participate or demonstrate learning.

The rapid emergence of generative artificial intelligence has further complicated the concepts of academic integrity, authorship, originality, and valid evidence of learning. Generative AI tools can assist students with brainstorming, writing, coding, translation, problem solving, and content generation, thereby challenging conventional assumptions regarding whether submitted work represents independent student performance. Reviews of generative AI in higher education assessment indicate that institutions are increasingly reconsidering assessment formats, integrity policies, and expectations regarding student authorship (Xia et al., 2024). Critical analysis of institutional GenAI policies has highlighted conceptual difficulties surrounding the notion of "originality," particularly when AI-supported production becomes embedded in routine academic and professional practices (Luo, 2024). Accordingly, scholars have proposed redesign principles that emphasize authentic, process-oriented, dialogic, and higher-order assessment practices rather than attempting to preserve older assessment models solely through detection and restriction (Lye & Lim, 2024). These developments suggest that assessment-error prevention must remain adaptive because technological innovations continually alter the conditions under which evidence of learning is produced and interpreted.

At the institutional level, effective e-learning assessment also depends on coherent policies, standards, resources, technical support, and management structures. Sustainable digital assessment requires more than individual instructors' efforts; institutions need governance mechanisms that define responsibilities, establish quality standards, allocate resources, provide professional development, ensure technical support, and coordinate assessment procedures. Models of sustainable educational management emphasize that effective digital assessment practices must integrate institutional leadership, policy, technological readiness, human capacity, and continuous quality assurance (Kasse & Nansamba, 2024). The broad mapping of research on online assessment likewise indicates that challenges are distributed across pedagogical, technological, institutional, psychometric, and ethical dimensions, reinforcing the need

for integrated rather than fragmented responses (Liu et al., 2025). Such integration is particularly important because an error generated at one level—for example, inadequate institutional infrastructure—may manifest at another level as student underperformance, inconsistent scoring, or reduced assessment validity.

Despite substantial research on individual components of e-learning assessment, much of the literature remains organized around specific problems or isolated solutions. Some studies emphasize academic integrity and cheating, whereas others focus on proctoring, fairness, psychometric quality, assessment literacy, feedback, technological infrastructure, authentic assessment, or artificial intelligence. While these streams provide valuable evidence, preventing assessment errors requires attention to how these dimensions interact across the full assessment process. An assessment may be psychometrically sound but technologically inaccessible, secure but ethically problematic, technically reliable but poorly aligned with learning objectives, or pedagogically meaningful but implemented without sufficient institutional support. Consequently, reducing assessment error requires a systemic perspective in which design quality, human competence, technological reliability, measurement quality, integrity, feedback, policy, ethics, and equity are treated as mutually dependent components rather than separate concerns.

A qualitative expert-based approach is particularly suitable for examining this multidimensional problem because experienced professionals can provide contextualized knowledge regarding the mechanisms through which errors emerge and the practical strategies used to prevent them. Expert interviews are especially useful for investigating specialized and partly implicit knowledge embedded in professional practice, institutional routines, and decision-making processes (Döringer, 2021). Thematic analysis provides a flexible yet systematic approach for identifying patterned meanings across such qualitative datasets and for organizing complex perspectives into conceptually coherent themes (Braun & Clarke, 2021). By

integrating expert knowledge across e-learning, educational assessment, and educational technology, it becomes possible to move beyond the identification of isolated error sources and toward a multidimensional framework capable of informing institutional policies, quality assurance procedures, faculty development, assessment design, and technological decision-making.

Accordingly, the present study aimed to develop strategies for preventing and reducing errors in e-learning assessment based on the perspectives of experts in e-learning, educational assessment, and educational technology.

2. Methods and Materials

The present study is part of a broader investigation into errors in e-learning assessment and was conducted independently with the aim of developing strategies for preventing and reducing errors in e-learning assessment based on expert perspectives. The study adopted a qualitative approach and employed thematic analysis. The participants consisted of 12 experts in the fields of e-learning, educational assessment, and educational technology, who were selected using purposive sampling based on predetermined criteria. The inclusion criteria comprised holding a doctoral degree in a relevant field, having academic or professional experience in e-learning, and possessing relevant experience in the design, implementation, management, or evaluation of e-learning courses and activities. Participant recruitment continued until the resulting dataset was considered sufficiently diverse in terms of experiences, rich in information, and comprehensive in covering the dimensions related to the research questions for conducting thematic analysis. In the final interviews, the data primarily contributed to elaborating and confirming the emerging conceptual patterns and did not result in substantial changes to the thematic structure. The characteristics of the study participants are presented in the following table.

Table 1

Characteristics of the Study Participants

Participant Code	Discipline/Area of Expertise	Academic Degree	Relevant Experience in E-Learning and Assessment
P1	Information Technology in Higher Education	PhD	Design and management of technology-enhanced learning environments; research on advanced learning technologies
P2	Educational Management	PhD	Teaching and research in educational management and innovative learning approaches
P3	Higher Education Management	PhD	Instructional design, educational needs assessment, and evaluation of training effectiveness
P4	Curriculum Studies	PhD	Instructional design, educational planning, and design of learning systems
P5	Information Technology in Higher Education	PhD	Management of learning systems, assessment in electronic environments, and evaluation of training effectiveness
P6	Educational Technology	PhD	Design of learning environments, e-learning and blended learning, and research in educational technology
P7	Educational Management	PhD	Management and planning of e-learning and administration of virtual education courses and units
P8	Higher Education Management	PhD	Teaching and research in e-learning, learning assessment and evaluation, and blended learning
P9	Information Technology in Higher Education	PhD	Instructional design and development of electronic content
P10	Curriculum Studies	PhD	Design and research in e-learning and electronic learning environments
P11	Higher Education Development Planning	PhD	Higher education, e-learning, instructional design, and virtual human resource development
P12	Educational Management	PhD	Educational consulting and professional activity in educational technology and learning environments

The primary data collection instrument was the semi-structured interview. The interview framework was developed in accordance with the research aim and questions. Before conducting the interviews, the purpose of the study and the manner in which the information would be used were explained to the participants, and their participation was based on informed consent. With participants' permission, the interviews were audio-recorded and subsequently transcribed verbatim. To comply with ethical principles, the confidentiality of participants' information was maintained, and identification codes rather than personal names were used throughout the analysis and reporting of the findings. The interview data were analyzed using the thematic analysis approach proposed by Braun and Clarke (2021). The analysis was conducted in six phases. First, the interview transcripts were read several times to enable the researcher to become deeply familiar with the dataset. Second, meaningful segments of the data were identified and initially coded. Third, related codes were grouped together and shared patterns were examined to generate preliminary themes. Fourth, the preliminary themes were reviewed and refined in relation to both their constituent codes and the entire dataset. Fifth, the conceptual boundaries of each theme were clarified, and the themes were defined and named. Sixth, the final thematic structure was developed, and the research report was prepared based

on evidence derived from the data. These phases were not conducted in a strictly linear manner; rather, during the analytical process, the researcher moved iteratively between different phases when necessary in order to strengthen the internal coherence of the themes and the conceptual distinctions among them. To enhance the trustworthiness of the findings, the four criteria proposed by Lincoln and Guba (1985)—credibility, transferability, dependability, and confirmability—were considered. To ensure credibility, strategies such as selecting expert participants, maintaining appropriate engagement with participants, and comparing the findings with previous studies were employed. To enhance transferability, the characteristics of the participants, the research context, and the data analysis process were described in detail. With regard to dependability, the research procedures, including the sampling process, interview implementation, coding, and analytical decisions, were recorded and documented. To ensure confirmability, efforts were made to derive the findings directly from the actual interview data and to minimize the influence of the researcher's personal perspectives.

3. Findings and Results

The interview data were analyzed using Braun and Clarke's (2021) six-phase thematic analysis. In the first

phase, the transcribed interviews were read several times to ensure thorough familiarity with the content of the data. Subsequently, during the initial coding phase, statements related to strategies for preventing and reducing errors in e-learning assessment were extracted and coded. A large number of initial codes were identified from the interview transcripts. Following comparison, consolidation of similar codes, and repeated review, these codes were organized into subthemes and subsequently into overarching themes. Ultimately, the findings indicated that strategies for

preventing and reducing e-learning assessment errors could be classified into eight main themes: improving assessment design; enhancing the competencies and empowerment of human agents; strengthening technological infrastructure; ensuring assessment integrity, security, and authenticity; improving the quality of measurement instruments; improving the feedback system; management and policymaking; and educational ethics and equity. The extracted conceptual codes, subthemes, and main themes are presented in detail in the following table.

Table 2

Main Themes, Subthemes, and Conceptual Codes of Strategies for Preventing and Reducing E-Learning Assessment Errors

Main Themes	Subthemes	Conceptual Codes Extracted from the Data
Improving Assessment Design	Alignment of learning objectives and assessment	Defining clear learning objectives; selecting assessment methods appropriate to the objectives; aligning assessment instruments with learning objectives
	Diversification of assessment methods	Employing diverse assessment methods; using different types of assignments and assessment activities; reducing reliance on a single assessment method
	Designing authentic and performance-based assessment	Using performance-based tasks; designing activities based on real-life situations; focusing on students' actual performance
	Reviewing and testing assessment before implementation	Reviewing assessment instruments before implementation; pilot testing the assessment
Enhancing the Competencies and Empowerment of Human Agents	Faculty empowerment	Increasing faculty members' assessment knowledge; developing assessment design and implementation skills; developing skills in using assessment technologies and systems
	Preparing learners for assessment	Training and preparing students for assessment; familiarizing students with the assessment process
Strengthening Technological Infrastructure	Improving infrastructure and systems	Selecting an appropriate system; improving and strengthening technical infrastructure
	Technical support	Providing access to technical support during implementation; timely resolution of technical problems
	Technical preparedness before implementation	Pilot testing the system; checking technical conditions before assessment
	Management of emergency conditions	Anticipating potential disruptions; developing guidelines for emergency situations
Ensuring Assessment Integrity, Security, and Authenticity	Identity verification and access control	Verifying the identity of examinees; controlling access to the assessment environment
	Ensuring authenticity of performance	Ensuring the authenticity of students' responses and performance; verifying the originality of assignments and submitted work
	Strengthening assessment security	Protecting assessment data and results; ensuring the security of the assessment system
	Preventing academic misconduct	Using question banks; randomizing questions; controlling unauthorized use of resources
Improving the Quality of Measurement Instruments	Ensuring the psychometric quality of instruments	Examining instrument validity; examining instrument reliability; observing measurement principles and standards in instrument design and use
	Item analysis and revision	Analyzing assessment items; identifying inappropriate items; correcting and revising items
Improving the Feedback System	Providing timely and continuous feedback	Providing immediate feedback; providing feedback at an appropriate time; providing continuous feedback
	Providing targeted and corrective feedback	Avoiding overly general feedback; explaining weaknesses and errors; providing guidance for improvement
	Providing opportunities for learning improvement	Enabling review, performance correction, and relearning
	Strengthening the learning-oriented function of feedback	Reducing exclusive emphasis on grades; using feedback to improve learning
Management and Policymaking	Developing standards and implementation guidelines	Developing standardized assessment guidelines; determining implementation requirements; defining institutional standards for electronic assessment
	Strengthening institutional policymaking	Developing overarching policies for electronic assessment; coordinating organizational procedures; defining the responsibilities of relevant units

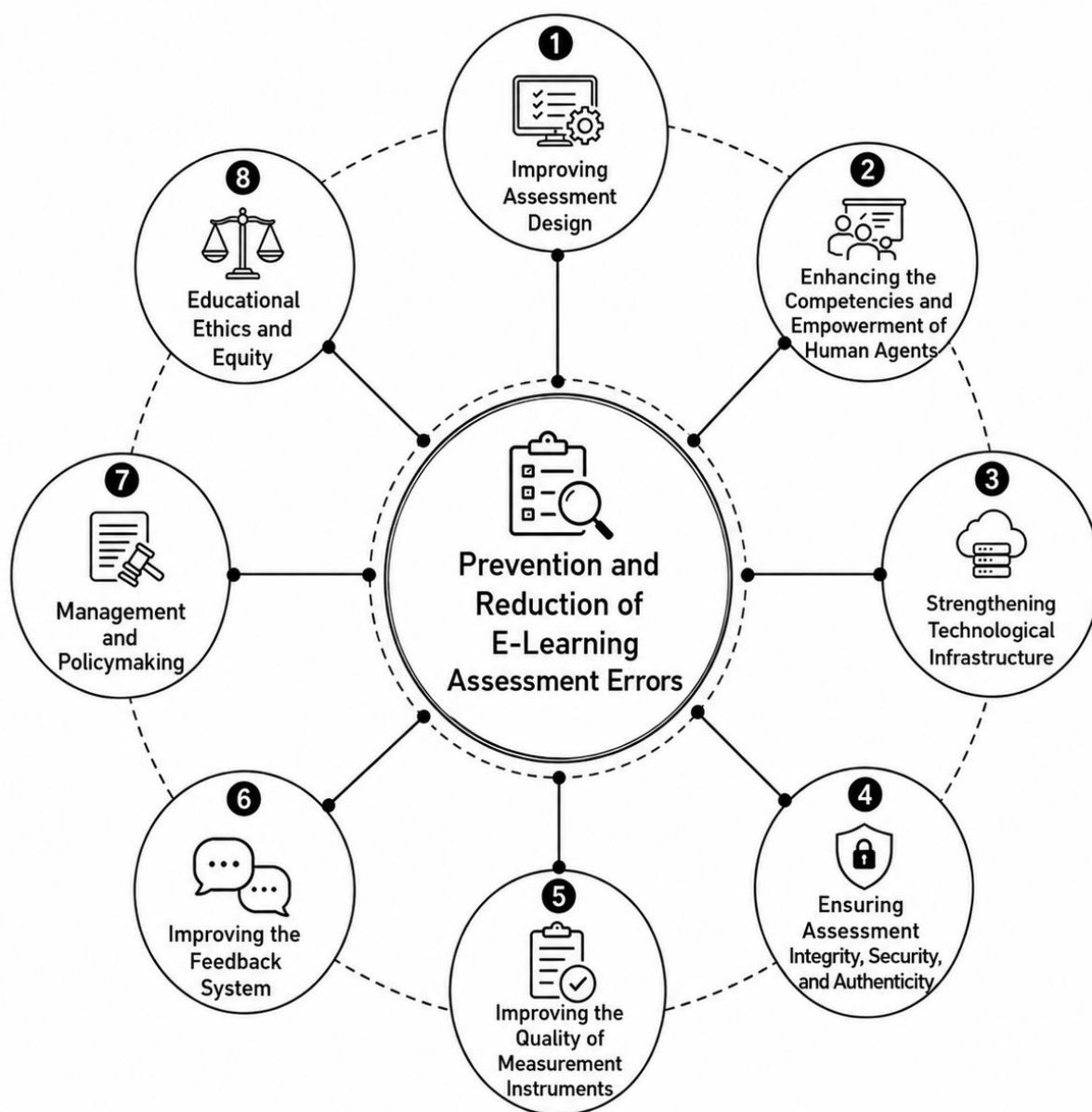
	Managerial and organizational support	Providing managerial support for electronic assessment; providing organizational support for assessment implementation
	Provision of organizational resources	Providing required financial resources; providing required human resources; allocating sufficient time for assessment design and implementation
Educational Ethics and Equity	Ensuring equity in access	Considering differences in students' access to resources; reducing inequalities in opportunities to participate in assessment
	Protecting privacy	Protecting students' personal information; maintaining confidentiality of student data
	Ensuring fairness in assessment	Preventing discrimination; considering students' different circumstances in the assessment process
	Assessment transparency	Ensuring clarity of assessment criteria and regulations; transparently communicating the assessment process

To provide an integrated representation of the study findings and illustrate the extracted main themes, these

themes are presented in the conceptual model shown in Figure 1.

Figure 1

Final Conceptual Model



Theme 1: Improving Assessment Design

One of the most important strategies identified from the experts' perspectives was the proactive consideration of the assessment design stage. Participants believed that error prevention should begin before the implementation of assessment by clearly specifying learning objectives and expectations. From their perspective, the selection of assessment methods and instruments can lead to an appropriate evaluation of learning only when they are aligned with educational objectives, content, and expectations. One expert stated in this regard: "Before the assessment stage, you need to have a design; that is, an assessment design. This design should be consistent with your objectives and expectations for the course or program... Your objectives and expectations should be clear, the content and methods should be specified, and you should design your assessment accordingly."

Another dimension that emerged prominently from the data was the necessity of avoiding the direct transfer of traditional assessment methods into electronic environments without modification. One participant stated in this regard: "Sometimes the main problem is not the technology itself; the problem begins when we transfer the same traditional assessment into the online environment without making any changes. If the design is inappropriate, even the best system cannot produce high-quality assessment."

Diversifying assessment activities and considering individual differences among learners were also among the strategies highlighted within this theme. One expert, criticizing the use of identical assessment practices for all students, suggested offering learners several activities or assignments so that they could choose options that better matched their circumstances and preferences. Describing personal experience, the participant stated: "I define several assignments and always give the students the freedom to choose." In the same interview, the use of several discussion forums with different topics and the design of elective assignments were mentioned as practical examples of this approach. Taken together, these perspectives indicate that aligning assessment with learning objectives and expectations, diversifying assessment methods and activities, designing authentic and performance-based assessments, and reviewing assessment design prior to implementation constitute the principal components of the "improving assessment design" strategy.

Theme 2: Enhancing the Competencies and Empowerment of Human Agents

The findings showed that experts did not regard the quality of electronic assessment as being determined solely by technology and emphasized the knowledge, skills, and preparedness of faculty members and students. From their perspective, some errors that appear to be attributable to systems or technology are, in fact, the result of inappropriate use of tools, insufficient digital literacy, or users' lack of familiarity with the underlying logic of electronic assessment. One participant stated: "A large proportion of the problems attributed to technology actually arise because the user does not know how educational technology should be used."

Another expert emphasized the distinction between changing the assessment tool and changing the underlying assessment perspective: "If the instructor is not familiar with the logic of electronic assessment, we have only changed the tool, while the assessment perspective remains traditional." The interview data also emphasized the necessity of preparing users before they encounter an assessment situation, such that neither instructors nor students should encounter the assessment process or system for the first time during the actual implementation of the assessment. Accordingly, faculty empowerment and preparing learners for electronic assessment constitute the principal components of this strategy.

Theme 3: Strengthening Technological Infrastructure

Another major theme concerned strengthening the technological infrastructure required for assessment implementation. Participants emphasized that technical problems go beyond being merely "technological disruptions" when they influence recorded assessment outcomes and prevent an accurate representation of learner performance. One expert stated: "Sometimes a student is academically prepared, but a technical problem at the time of the examination causes the recorded result not to reflect the student's actual ability."

Another expert emphasized: "Sometimes we expect that purchasing a system will solve the assessment problem, whereas if the necessary infrastructure, support, and training are not available, that same system can itself become a source of error."

One participant also explained the direct relationship between technological disruptions and assessment validity as follows: "An Internet outage or system disruption is not merely a technical problem; when it changes a student's assessment result, it becomes an educational and assessment-related issue." Therefore, improving infrastructure and systems, providing technical support,

ensuring technical preparedness before implementation, and managing emergency conditions were identified as the most important strategies within this theme.

Theme 4: Ensuring Assessment Integrity, Security, and Authenticity

Assessment integrity, security, and authenticity represented another prominent area in the experts' perspectives. Participants believed that, in online environments, ensuring that the recorded performance genuinely belongs to the learner is an important component of assessment validity. Weaknesses in identity verification, involvement of other individuals, unauthorized use of resources, and the growing use of artificial intelligence tools were identified in the data as factors affecting assessment authenticity. One expert stated: "If we do not know who actually completed the examination, the credibility of the entire assessment result becomes questionable."

Another expert described the limitations of relying exclusively on a final online examination as follows: "In an online environment, we cannot rely only on the final examination, because there is always the possibility that someone else may have contributed to completing the activity or that unauthorized resources may have been used."

The emergence of artificial intelligence was also explicitly raised in the data: "The issue is no longer limited to traditional cheating; the use of intelligent tools has made it necessary to redefine the concept of authenticity in students' work." Accordingly, the experts emphasized a combination of strategies involving identity verification, assurance of performance authenticity, strengthening assessment security, and preventing academic misconduct.

Theme 5: Improving the Quality of Measurement Instruments

The fifth theme identified through the data analysis was improving the quality of measurement instruments. Analysis of participants' perspectives indicated that instruments used in assessment must possess adequate quality and that measurement principles and standards should be observed in their design and application. The importance of this issue was clearly illustrated by one participant's experience with a problematic measurement instrument: "A large proportion of the questions were completely incorrect; that is, both the question design and the answer key were problematic... because these questions have been used for years and the incorrect answer key has continued to be considered correct."

In addition, participants emphasized that the quality of assessment items should not be considered only at the design

stage; rather, their performance should also be examined after administration. Referring to the capacity of electronic examinations to facilitate such analyses, one participant stated: "In electronic examinations, we can more easily examine the difficulty index, discrimination index, variance, and item correlations, and in the future we can develop a standardized item bank." This statement directly highlights the importance of item analysis, as examining indicators related to item performance can facilitate the identification of inappropriate items and inform decisions regarding their correction and revision. The same participant further emphasized the improvement-oriented function of item analysis: "Analyzing examination items helps us greatly, both in creating a repository of high-quality questions and in gradually promoting the practice of item analysis." Overall, the findings associated with this theme indicated that reducing assessment errors requires attention to the psychometric quality of the instruments used and the continuous evaluation of assessment items.

Theme 6: Improving the Feedback System

Analysis of the interviews showed that, from the experts' perspective, assessment should not end with the reporting of a grade. Rather, feedback should constitute an integral part of the learning process and provide learners with information about the quality of their performance and pathways for improvement. One participant stated: "In e-learning, if students do not know why they received a particular grade and how they can improve, assessment effectively becomes nothing more than a number and loses its learning function."

Another expert commented on the quality of feedback: "One of the problems is that feedback is often too general. For example, it may simply say 'good' or 'needs more effort,' but the student does not understand exactly where the problem lies."

Another section of the interviews emphasized the continuation of interaction after assessment: "Assessment should not be the end of communication between the instructor and the student. After assessment, there should be an opportunity for dialogue, correction, and relearning." Accordingly, timely, targeted, and corrective feedback, providing opportunities for learning improvement, and strengthening the learning-oriented function of feedback constitute the principal strategies within this theme.

Theme 7: Management and Policymaking

The findings indicated that preventing and reducing electronic assessment errors cannot be achieved solely at the level of the instructor, student, or technological system and requires organizational-level support. The absence of

common standards, differences in instructors' procedures, weaknesses in policymaking, and inadequate organizational support were among the issues identified by experts. One participant stated: "When a university does not have clearly defined standards for electronic assessment, each instructor acts according to personal experience, and this leads to inconsistency and errors."

Another expert stated: "The problem is not limited to the classroom or the system; the organization must also provide support. If there are no policies, training, and support, the implementation of electronic assessment will not be sustainable." Based on these findings, developing standards and implementation guidelines, strengthening institutional policymaking, providing managerial and organizational support, and ensuring adequate organizational resources and facilities were identified as the most important strategies within this theme.

Theme 8: Educational Ethics and Equity

The final theme concerned ethical dimensions and educational equity. Participants emphasized that assessment quality is not defined solely by measurement accuracy and that protecting learner rights, ensuring equity in access, safeguarding data, and maintaining transparency are also integral components of electronic assessment quality. Regarding the protection of learner rights, one expert stated: "Electronic assessment is not merely a technological issue; we must ensure that fairness and learner rights are protected throughout this process."

Regarding privacy, one participant stated: "When a large amount of student information is stored in systems, it must be clear how these data are used and who has access to them."

Regarding equity in access, one participant stated: "If all students do not have equal access conditions, the assessment result no longer reflects learning alone; it also measures some of the differences in their environmental circumstances." Accordingly, ensuring equity in access and assessment implementation, protecting privacy, and maintaining assessment transparency were identified as the principal strategies within this theme.

4. Discussion and Conclusion

The present study aimed to develop strategies for preventing and reducing errors in e-learning assessment based on the perspectives of experts in e-learning, educational assessment, and educational technology. The findings revealed eight major strategic domains: improving

assessment design; enhancing the competencies and empowerment of human agents; strengthening technological infrastructure; ensuring assessment integrity, security, and authenticity; improving the quality of measurement instruments; improving the feedback system; management and policymaking; and educational ethics and equity. Taken together, these findings indicate that errors in e-learning assessment cannot be attributed to a single technological, pedagogical, or psychometric factor. Rather, they emerge from the interaction of multiple dimensions across the assessment process. This multidimensional interpretation is consistent with recent reviews demonstrating that the quality of online assessment depends simultaneously on assessment design, technological conditions, institutional structures, assessment literacy, validity, academic integrity, fairness, and learner experience (Heil & Ifenthaler, 2023; Liu et al., 2025). Accordingly, the findings of the present study extend previous work by organizing these dimensions into an integrated framework focused specifically on the prevention and reduction of assessment errors.

The first theme, improving assessment design, showed that error prevention should begin before assessment implementation. Experts emphasized the alignment of assessment methods with learning objectives, diversification of assessment approaches, use of authentic and performance-based tasks, and pre-implementation review and pilot testing. This finding is consistent with the view that the quality of assessment depends fundamentally on constructive alignment between intended learning outcomes, learning activities, and assessment tasks. Previous research has shown that online assessment becomes more valid and meaningful when assessment tasks are deliberately designed around intended competencies rather than merely transferred from face-to-face settings into digital environments (Divjak et al., 2023; Huber et al., 2024). The emphasis on authentic and performance-based assessment also aligns with evidence showing that authentic assessment can improve the evaluation of higher-order competencies and reduce dependence on decontextualized recall-based examinations (Vlachopoulos & Makri, 2024). Similarly, personalization and diversification of online assessment have been recommended as means of accommodating learner differences and creating more meaningful opportunities for demonstrating competence (Hattingh & Northcote, 2023). Therefore, the present findings suggest that many assessment errors can be prevented upstream through careful design rather than corrected only after problems emerge during implementation.

The second theme concerned the competencies and empowerment of human agents. Participants emphasized that instructors and students need appropriate assessment knowledge, digital competence, and familiarity with electronic assessment processes. This finding suggests that technological errors may sometimes reflect human-system interaction problems rather than deficiencies in the technology itself. Previous studies support this interpretation. Research has shown considerable variation in teachers' assessment competence and digital assessment literacy, with deficiencies in these areas influencing the quality of assessment design, administration, and interpretation (Al-Bahlani & Ecke, 2023; Grosseck et al., 2024). Similarly, future digital assessment practices have been linked to teachers' technological competence, confidence, beliefs, and institutional support (Viberg et al., 2024). From the learner perspective, assessment literacy is also essential because students need to understand assessment criteria, expectations, procedures, and the meaning of feedback in order to participate effectively in assessment (Hannigan et al., 2022; Zhu & Evans, 2024). Thus, strengthening the capacities of both instructors and learners can reduce errors arising from inappropriate tool use, misunderstanding of procedures, and inaccurate interpretation of assessment information.

The third theme, strengthening technological infrastructure, highlighted the importance of reliable systems, technical support, readiness checks, and contingency planning. The experts emphasized that a technical problem becomes an assessment problem when it influences the student's recorded performance. This finding is especially important because online assessment introduces sources of construct-irrelevant variance that may have little to do with actual learning. Internet instability, system outages, device incompatibility, authentication problems, and inadequate technical support may prevent scores from accurately representing student competence. Previous research has similarly shown that technological failures and connectivity difficulties are among the most frequently reported challenges in online assessment (Waheeda et al., 2023). Studies conducted during large-scale remote assessment also demonstrated that inequalities in digital resources and technological conditions could meaningfully affect students' assessment experiences and outcomes (Hartnett et al., 2023). The validation of e-assessment systems therefore requires consideration of technical reliability, usability, and implementation conditions in addition to educational appropriateness (Van Haastrecht et

al., 2023). The current findings reinforce the idea that technological readiness should be treated as an integral component of assessment validity rather than merely an operational concern.

The fourth theme focused on assessment integrity, security, and authenticity. Participants identified identity verification, control of access, authenticity of student performance, system security, and prevention of academic misconduct as essential strategies. The findings are consistent with the extensive literature documenting concerns regarding cheating and unauthorized assistance in online assessment. Systematic reviews have shown that academic dishonesty is a significant concern in online learning environments and that trustworthy assessment requires a combination of assessment redesign, integrity policies, monitoring, and student education (Newton & Essex, 2024; Surahman & Wang, 2022). The present findings also align with research showing that cheating behavior is influenced by students' motivations, perceptions, needs, and opportunities, suggesting that prevention cannot rely exclusively on surveillance (Rüth et al., 2024). Although monitoring may reduce some forms of misconduct, experimental evidence indicates that it is only one component of a broader integrity strategy (Alguacil et al., 2024). Digital proctoring may improve identity verification and control, but it also introduces concerns related to privacy, technological accuracy, accessibility, and student experience (Han et al., 2024; Khalil et al., 2022). Accordingly, the experts' preference for combining authentication, security, assessment redesign, and prevention strategies appears to offer a more balanced approach than relying on proctoring alone.

The growing role of generative artificial intelligence further strengthens the importance of this theme. Participants noted that AI has changed the meaning of originality and authenticity in student work. This observation is strongly supported by recent scholarship indicating that generative AI has disrupted established assumptions about authorship, independent performance, and academic integrity in higher education assessment (Xia et al., 2024). Existing institutional policies have been criticized for treating originality as a simple distinction between human and machine-generated work when contemporary academic production may involve complex forms of human-AI collaboration (Luo, 2024). For this reason, assessment redesign has increasingly been proposed as a more sustainable response, particularly through authentic, process-based, dialogic, and higher-order tasks that make

student thinking and learning more visible (Lye & Lim, 2024). The findings of the present study therefore suggest that ensuring authenticity should not be understood solely as detecting misconduct, but as redesigning assessment in ways that generate credible evidence of learning under changing technological conditions.

The fifth theme, improving the quality of measurement instruments, emphasized validity, reliability, adherence to measurement standards, and systematic item analysis. This finding shows that digital delivery does not eliminate traditional psychometric requirements. Indeed, electronic assessment may magnify the consequences of poorly designed items if large numbers of students are assessed automatically using flawed questions or incorrect answer keys. Previous studies have demonstrated that errors in assessment instruments can arise from wording, content, scoring keys, formatting, and technical construction and may significantly compromise the defensibility of assessment outcomes (Suto & Ireland, 2021; Suto et al., 2023). Research on high-stakes testing also indicates that unreliability can result from a range of interacting sources related to the test, administration, scoring, and examinee conditions (Nikmard et al., 2023). At the same time, computer-based assessment offers opportunities to improve measurement quality through multimodal formats, item-level analysis, and psychometric monitoring (Renes et al., 2023). Item response theory studies in large-scale online courses likewise demonstrate the importance of examining item functioning and assessment stability over time (Gershon et al., 2024). The findings therefore support continuous quality assurance of assessment instruments before and after administration.

The sixth theme, improving the feedback system, demonstrated that assessment quality depends not only on scoring but also on whether assessment information contributes to subsequent learning. Experts emphasized timely, continuous, targeted, and corrective feedback, as well as opportunities for students to revise performance and learn again. This finding closely aligns with contemporary feedback research, which conceptualizes feedback as an interactive process through which learners interpret information and act on it rather than as the simple transmission of evaluative comments (Carless, 2023). Formative feedback has been shown to improve learning when it is specific, actionable, appropriately timed, and linked to opportunities for revision (Olsen & Hunnes, 2024). Online peer feedback can similarly contribute to learning when students are adequately prepared and when criteria, processes, and technological environments are carefully

structured (Gao et al., 2024; Taghizadeh Kerman et al., 2024). Systematic evidence concerning online peer-review systems also shows that technology alone is insufficient; pedagogical structure and user engagement determine whether peer assessment produces meaningful learning outcomes (Babik et al., 2024). Thus, inadequate or purely grade-oriented feedback may be considered a form of assessment failure because it weakens the formative function of assessment.

The seventh theme concerned management and policymaking. The findings indicated that reducing e-learning assessment errors requires institutional standards, coordinated policies, managerial support, clearly assigned responsibilities, and sufficient financial, human, and temporal resources. This finding highlights that assessment quality cannot depend entirely on individual instructors. Without university-level standards, similar courses may employ highly inconsistent assessment procedures, creating variation in fairness, reliability, security, and educational quality. Previous studies support the need for institution-wide approaches to digital assessment. Sustainable digital assessment has been linked to leadership, policy coordination, adequate infrastructure, professional development, resource allocation, and quality assurance systems (Kasse & Nansamba, 2024). The rapid expansion of e-assessment during the pandemic also demonstrated that emergency adoption without mature organizational structures can expose weaknesses in policy, support, and staff preparedness (St-Onge et al., 2022). Thus, the findings suggest that institutional governance functions as a higher-level mechanism through which many other error-prevention strategies become possible and sustainable.

The eighth theme, educational ethics and equity, emphasized fairness in access and assessment, protection of privacy, and transparency. These findings demonstrate that technically accurate assessment may still be educationally problematic if students do not have equitable opportunities to participate or if personal data are used without adequate safeguards. Previous studies show that students' experiences of fairness in assessment are strongly influenced by transparency, consistency, opportunity to demonstrate learning, and perceived equal treatment (Bazvand & Rasooli, 2022). In online assessment specifically, fairness is closely related to access to technology, clarity of procedures, institutional responsiveness, and the extent to which individual circumstances are considered (Eltahir et al., 2023). Digital inequalities can also affect the validity of remotely proctored assessment when students differ in

access to devices, stable connectivity, quiet environments, and suitable physical conditions (Hartnett et al., 2023). Furthermore, the use of surveillance technologies creates ethical tensions between academic integrity and privacy (Khalil et al., 2022). The findings therefore indicate that fairness, transparency, and privacy should be treated as substantive components of assessment quality rather than secondary ethical considerations.

Overall, the eight themes identified in this study demonstrate that e-learning assessment error is a systems-level phenomenon. Improving only one component is unlikely to produce consistently reliable and fair assessment. For example, a secure examination may still be invalid if poorly aligned with learning outcomes; a psychometrically strong test may still be unfair if students experience unequal technological access; and a well-designed assessment may still fail if faculty lack the competence or institutional support necessary for appropriate implementation. This interpretation is consistent with broader research showing that high-quality online assessment requires coordination among pedagogical design, validity, technology, human competence, feedback, academic integrity, and institutional governance (Heil & Ifenthaler, 2023; Liu et al., 2025). It also emphasizes the importance of teacher judgment in interpreting assessment evidence accurately and ensuring that assessment decisions remain focused on student learning rather than mechanically relying on digital data (Wyatt-Smith et al., 2024). Therefore, the principal contribution of the present study lies in integrating previously fragmented strategies into a coherent multidimensional framework extending from assessment design and implementation to institutional governance, ethics, and quality assurance.

The present study has several limitations that should be considered when interpreting its findings. First, the study was based on the perspectives of 12 experts, and although participants were selected to represent relevant areas of expertise, their perspectives may not encompass the full diversity of experiences found across different higher education institutions, disciplines, technological environments, and educational systems. Second, the findings were derived from qualitative interviews and therefore represent expert interpretations rather than direct observations of assessment practices or experimentally verified causal relationships. Third, the study focused on strategies for preventing and reducing assessment errors at a broad conceptual level and did not quantitatively determine the relative importance, feasibility, cost, or effectiveness of

each strategy. Finally, rapid developments in artificial intelligence and digital assessment technologies may introduce new sources of error and new preventive mechanisms that were not fully represented at the time of data collection.

Future studies could validate the proposed framework using larger and more heterogeneous samples of faculty members, students, educational managers, assessment specialists, and information technology professionals. Quantitative studies could develop and validate an instrument based on the identified themes and examine the relative contribution of each dimension to perceived assessment quality, validity, reliability, fairness, and integrity. Delphi studies could also be conducted to prioritize the identified strategies and establish consensus regarding their importance and feasibility. Experimental and quasi-experimental research may evaluate the effectiveness of specific interventions, such as faculty assessment-literacy training, pre-assessment technical readiness protocols, authentic assessment redesign, or structured feedback systems. Comparative studies across universities, academic disciplines, and countries would also be useful for examining the contextual applicability of the framework. Future research should additionally investigate how generative artificial intelligence changes the nature of assessment error, authenticity, authorship, and the design of trustworthy electronic assessment.

Higher education institutions should adopt an integrated quality-assurance approach to electronic assessment rather than addressing problems only after they occur. Universities can develop clear standards for assessment design, alignment with learning outcomes, item construction, technical readiness, academic integrity, feedback, privacy, and accessibility. Faculty development programs should provide practical training in digital assessment literacy, authentic assessment design, item analysis, feedback practices, and appropriate use of assessment technologies. Students should also receive orientation regarding assessment procedures, academic integrity expectations, technological requirements, and mechanisms for reporting technical difficulties. Institutions should establish technical support systems and contingency protocols for disruptions that occur during assessment and ensure that students are not penalized for circumstances beyond their control. Finally, assessment policies should be reviewed regularly in response to emerging technologies, particularly generative artificial intelligence, so that electronic assessment remains

valid, fair, secure, transparent, and educationally meaningful.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in studies involving human participants were under the ethical standards of the institutional and, or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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