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Evaluation in the Trap of Error: Identifying Common Evaluation Errors in the Context of E-Learning

ABSTRACT

The present study aimed to identify evaluation errors in e-learning environments. The research adopted a qualitative approach using the meta-synthesis method. The research population consisted of scholarly articles published in international databases including Scopus, ERIC, and ScienceDirect, which were retrieved based on predefined keywords within the time frame of 2010 to 2025. In this study, various parameters such as title, abstract, content, and methodological quality were considered. Accordingly, 969 articles related to the research topic were initially evaluated, and ultimately, 20 articles were purposively selected. Data analysis was conducted using the seven-step meta-synthesis method proposed by Sandelowski and Barroso (2007). The results of the meta-synthesis led to the identification of nine categories of e-learning evaluation errors, including: (1) ethical errors, (2) design errors, (3) implementation errors, (4) feedback errors, (5) measurement errors, (6) contextual errors, (7) technological errors, (8) human errors, and (9) security errors. These findings indicate that improving the quality of evaluation in e-learning environments requires careful attention to multiple dimensions of error and a thorough reconsideration of evaluation design and implementation processes.

Keywords: Evaluation, evaluation errors, e-learning, meta-synthesis.

Introduction

The rapid expansion of digital technologies has fundamentally transformed educational systems, giving rise to new paradigms of teaching, learning, and assessment. E-learning environments, characterized by flexibility, accessibility, and

scalability, have become central to contemporary education, particularly in higher education contexts (1, 2). Within these environments, assessment plays a pivotal role in measuring learning outcomes, guiding instructional decisions, and supporting student development. However, the shift from traditional face-to-face assessment to technology-mediated evaluation has introduced complex challenges that require systematic investigation and theoretical reconsideration (3, 4).

Assessment in e-learning is not merely a technical process but a multidimensional construct that integrates pedagogical, technological, and ethical dimensions. Early conceptualizations of online assessment emphasized its potential to enhance feedback, promote self-regulated learning, and support continuous evaluation processes (5, 6). Furthermore, frameworks such as Bloom's revised taxonomy highlight the importance of aligning assessment with cognitive processes, ensuring that evaluation captures higher-order thinking rather than rote memorization (7). Despite these theoretical advancements, practical implementation often falls short, leading to discrepancies between intended and actual assessment outcomes.

The COVID-19 pandemic marked a turning point in the adoption of e-learning and online assessment worldwide. Educational institutions were compelled to transition rapidly to remote learning, resulting in what has been described as emergency remote teaching rather than fully developed online education systems (8, 9). This abrupt shift exposed significant weaknesses in assessment practices, including lack of preparedness, inadequate infrastructure, and insufficient training for both instructors and students. Studies have documented widespread challenges in maintaining academic integrity, ensuring fairness, and providing meaningful feedback in online environments (10-12).

One of the most critical issues in e-learning assessment is the increasing prevalence of academic dishonesty. The anonymity and physical separation inherent in online environments create opportunities for cheating, plagiarism, and identity fraud. Research indicates that students often perceive online assessments as less secure and more susceptible to misconduct compared to traditional examinations (13, 14). In response, various technological solutions, such as biometric authentication and proctoring systems, have been proposed; however, these solutions raise concerns related to privacy, accessibility, and ethical considerations (15-17). Consequently, ensuring academic integrity remains a persistent challenge in digital assessment contexts.

In addition to ethical concerns, the design and implementation of online assessments present substantial difficulties. Effective assessment design requires alignment with learning objectives, incorporation of diverse question types, and consideration of learners' characteristics. Nevertheless, many online assessments rely heavily on traditional testing formats, which are not always suitable for digital environments (18, 19). The lack of standardized frameworks and guidelines further contributes to inconsistencies in assessment quality, as instructors often adopt ad hoc approaches based on limited experience or institutional constraints (20, 21). These issues highlight the need for systematic approaches to assessment design that are grounded in pedagogical theory and empirical evidence.

Feedback, as a central component of assessment, also faces significant challenges in e-learning environments. Effective feedback should be timely, specific, and actionable, enabling students to reflect on their performance and improve their learning strategies. However, research suggests that online feedback is often delayed, superficial, or insufficiently personalized, limiting its impact on learning outcomes (22, 23). The concept of feedback literacy emphasizes the importance of developing students' ability to interpret and use feedback effectively, yet this dimension is frequently overlooked in digital contexts (6). As a result, the formative potential of assessment is not fully realized.

Technological factors play a crucial role in shaping the effectiveness of e-learning assessment. While digital platforms offer innovative tools for assessment, they also introduce challenges related to system reliability, user interface design, and accessibility. Technical issues such as unstable internet connections, software incompatibility, and system failures can disrupt assessment processes and negatively affect student performance (24, 25). Moreover, disparities in access to digital resources

exacerbate inequalities among learners, particularly in developing contexts, where infrastructure limitations are more pronounced (26, 27). These challenges underscore the importance of addressing technological barriers to ensure equitable assessment practices.

Human factors, including psychological and cognitive dimensions, further complicate e-learning assessment. Students may experience increased anxiety and stress during online examinations due to unfamiliarity with digital tools, lack of direct interaction with instructors, and concerns about technical failures. Similarly, instructors may struggle with adapting to new assessment methods and technologies, leading to variability in assessment practices (28, 29). The role of motivation, self-regulation, and digital literacy is therefore critical in determining the effectiveness of online assessment, highlighting the need for comprehensive support systems for both learners and educators.

The broader educational context, including institutional policies and cultural factors, also influences assessment practices. Effective implementation of e-learning assessment requires coherent policies, clear guidelines, and alignment between stakeholders. However, many institutions lack integrated strategies for online assessment, resulting in fragmented practices and inconsistent standards (30, 31). Additionally, cultural differences in perceptions of assessment, academic integrity, and learning can affect students' engagement and behavior in online environments (32, 33). These contextual factors must be considered to develop culturally responsive and contextually appropriate assessment models.

From a theoretical perspective, the evaluation of learning has evolved from behaviorist models focused on observable outcomes to constructivist approaches emphasizing active engagement and knowledge construction. The integration of technology in assessment further extends this evolution, requiring new conceptual frameworks that account for the complexities of digital learning environments (34, 35). Models such as Kirkpatrick's four levels of evaluation and contemporary approaches to e-assessment highlight the need for multidimensional evaluation strategies that consider not only learning outcomes but also processes, experiences, and contextual factors (36, 37). Despite these advancements, there remains a gap between theoretical models and practical implementation in e-learning assessment.

Meta-synthesis, as a qualitative research method, provides a systematic approach to integrating findings from multiple studies and generating comprehensive insights into complex phenomena. By synthesizing qualitative evidence, researchers can identify patterns, themes, and gaps in the literature, contributing to the development of more robust theoretical frameworks and practical recommendations (38, 39). In the context of e-learning assessment, meta-synthesis enables the identification of recurring errors and challenges across different studies, offering a holistic understanding of the factors affecting assessment quality.

Recent studies have emphasized the growing importance of addressing emerging challenges in e-learning assessment, particularly in the era of artificial intelligence and advanced digital technologies. The integration of generative AI tools introduces new dimensions of complexity, including concerns about authenticity, authorship, and ethical use of technology (40, 41). These developments necessitate continuous adaptation of assessment practices to ensure their relevance and effectiveness in rapidly evolving educational landscapes.

Given the multifaceted nature of e-learning assessment and the diverse challenges associated with it, there is a critical need for systematic identification and categorization of assessment errors. Understanding these errors can inform the design of more effective assessment strategies, enhance the quality of learning experiences, and support the development of equitable and reliable evaluation systems. Therefore, the present study aims to identify the errors of e-learning assessment through a meta-synthesis of existing research.

Methods and Materials

The present study is applied in terms of purpose and qualitative in terms of data collection. It was conducted using a library-based research method, classified as secondary research and meta-synthesis, and was grounded in the review of information sources in the field of e-learning assessment. The meta-synthesis approach is a type of qualitative study that examines information and findings extracted from other qualitative studies with similar and related topics. Accordingly, the sample for meta-synthesis is constructed from selected qualitative studies based on their relevance to the research question. Meta-synthesis, similar to meta-analysis, is used to integrate multiple studies to generate new findings and interpretations. However, unlike meta-analysis, which emphasizes quantitative data and statistical events, meta-synthesis focuses on qualitative studies and their in-depth interpretation and analysis to achieve deeper understanding. In the present study, the seven-step model proposed by Sandelowski and Barroso (2007) was employed, as illustrated in Figure 1.

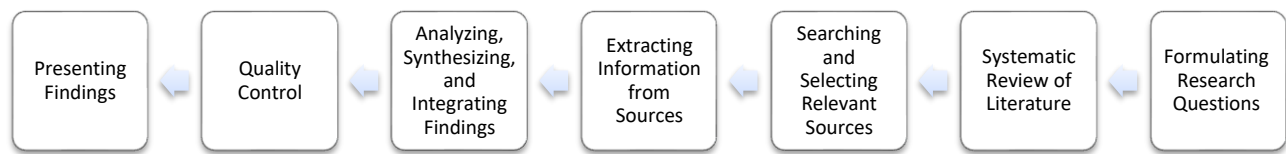


Figure 1. Steps of Meta-Synthesis (Sandelowski & Barroso, 2007)

1. **Formulating the Research Question:** In the present study, the research question is: “What are the evaluation errors in e-learning?”
2. **Systematic Literature Review:** At this stage, the researcher conducted a systematic search of published studies using predefined research keywords. In this study, international databases including Scopus, ERIC, and ScienceDirect were searched for articles published between 2010 and 2025. A total of 969 initial articles were identified through the systematic literature review process.

Table 1. Relevant Keywords for Database Search

Persian Equivalent of Keywords	English Search Keywords
یادگیری الکترونیکی- یادگیری برخط- یادگیری از راه دور- یادگیری مجازی- یادگیری سیار	e-learning; online learning; distance learning; virtual learning; mobile learning
سنجش- ارزشیابی- اندازه-گیری- آزمون	assessment; evaluation; measurement; test
خطا- سوگیری- چالش- اشتباه- تله- محدودیت	error; bias; challenge; mistake; pitfall; limitation

3. **Search and Selection of Relevant Articles:** At this stage, the researcher excluded studies that were not aligned with the research objectives through multiple screening phases. In the present study, after screening based on title, abstract, and full text, 20 articles were selected from the initial pool of 969 identified studies and entered the next stage.

Table 2. List of Final Selected Articles

No.	References
1	Al-Maqbali, A. H., & Al-Shamsi, A. (2023). Assessment strategies in online learning environments during the COVID-19 pandemic in Oman. <i>Journal of University Teaching and Learning Practice</i> .
2	Shraim, K. Y. (2019). Online examination practices in higher education institutions: Learners’ perspectives. <i>Turkish Online Journal of Distance Education</i> .
3	Aluko, F. R., & Omidire, M. F. (2020). A critical review of student assessment practices in distance education in an emerging economy: Benchmarking practices against policy. <i>Africa Education Review</i> , 17, 76–94.
4	Heil, J., & Ifenthaler, D. (2023). Online assessment in higher education: A systematic review. <i>Online Learning</i> .
5	Altınay, F., Alpturk, K., Berigel, M., Ayaz, A., Dagli, G., & Altınay, Z. (2024). Evolution of online assessment in higher education: A bibliometric analysis. <i>Pakistan Journal of Life and Social Sciences</i> .
6	Wahas, Y. M., & Syed, A. J. (2024). E-assessment challenges during e-learning in higher education: A case study. <i>Education and Information Technologies</i> , 29, 14431–14450.

- 7 Khlifi, Y., & El-Sabagh, H. A. (2017). A novel authentication scheme for e-assessments based on student behavior over e-learning platforms. *International Journal of Emerging Technologies in Learning*, 12, 62–89.
- 8 Butler-Henderson, K., & Crawford, J. (2020). A systematic review of online examinations: A pedagogical innovation for scalable authentication and integrity. *Computers & Education*, 159, 104024.
- 9 Muna, F., Waheeda, A., Shaheeda, F., & Shina, A. (2024). Challenges in implementing online assessments at Maldivian higher education institutions: Lessons from the COVID-19 pandemic. *Environment and Social Psychology*.
- 10 Torres-Madroño, E. M., Torres-Madronero, M. C., & Botero, L. D. (2020). Challenges and possibilities of ICT-mediated assessment in virtual teaching and learning processes. *Future Internet*, 12, 232.
- 11 Florjancic, V. (2022). The challenges of distance assessment in higher education: A case study. *International Journal of Learning Technology*, 17, 77–93.
- 12 Chaudhary, S. V., & Dey, N. (2013). Assessment in open and distance learning system (ODL): A challenge. *Open Praxis*, 5, 207–216.
- 13 Garg, M., & Goel, A. (2022). A systematic literature review on online assessment security: Current challenges and integrity strategies. *Computers & Security*, 113, 102544.
- 14 Koçdar, S., Karadeniz, A., Peytcheva-Forsyth, R., & Stoeva, V. (2018). Cheating and plagiarism in e-assessment: Students' perspectives. *Open Praxis*.
- 15 Al Hashimi, S., Alamarat, Y., & Zaki, Y. (2022). Students' perceptions of online assessment, feedback practices, and challenges. *International Journal of Evaluation and Research in Education*, 11(4), 1939–1949.
- 16 Fatima, S. S., Idrees, R., Jabeen, K., Sabzwari, S. R., & Khan, S. (2021). Online assessment in undergraduate medical education: Challenges and solutions from a LMIC university. *Pakistan Journal of Medical Sciences*, 37, 945–951.
- 17 Gupta, T., Shree, A., Chanda, P., & Banerjee, A. (2023). Online assessment techniques adopted by university teachers during the COVID-19 pandemic: A case study. *Social Sciences & Humanities Open*, 8, 100579.
- 18 Guangul, F. M., Suhail, A. H., Khalit, M. I., & Khidhir, B. A. (2020). Challenges of remote assessment in higher education in the context of COVID-19: A case study of Middle East College. *Educational Assessment, Evaluation and Accountability*, 32, 519–535.
- 19 Surahman, E., & Wang, T. (2022). Academic dishonesty and trustworthy assessment in online learning: A systematic literature review. *Journal of Computer Assisted Learning*, 38, 1535–1553.
- 20 Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies*, 2, 113–115.

4. **Data Extraction from Articles:** At this stage, the researcher organized the extracted information from the selected studies in a structured manner. In the present study, the collected data were categorized based on authors' names, publication year, title, research method, and findings, and were arranged in tabular form for further analysis.
5. **Analysis and Synthesis of Qualitative Findings:** In this stage, the researcher reviewed the selected articles and extracted relevant words and phrases in the form of open codes. Subsequently, groups of phrases conveying similar meanings were classified into distinct categories as sub-themes. Finally, related sub-themes were grouped under broader main themes.
6. **Quality Control:** To ensure quality control in this study, initial efforts were made to select the most appropriate studies based on criteria such as research objectives, methodological alignment with objectives, research design, systematic data analysis, clarity of findings, ethical considerations, and research value. Additionally, from a content analysis perspective, the recurrence of extracted codes across different studies, along with expert validation, indicated the importance and credibility of the identified codes.

Findings and Results

7. **Presentation of Findings:** In the present study, after completing the aforementioned stages, a total of nine categories were ultimately identified as errors in e-learning assessment, which are introduced below.

Table 3. Conceptual Codes Extracted from the Articles

Subcategory	Conceptual Codes	Sources
Academic dishonesty and misconduct	Collective cheating in answer submission, use of external services, identity fraud, using others to respond, use of artificial intelligence for cheating, copying from internet sources, use of sources without citation	2, 4, 5, 6, 7, 8, 9, 11, 14, 17, 18, 19
Inequity in assessment	Discrimination in evaluation, violation of student rights, unequal access, lack of transparency in grading, distrust in the process	3, 4, 12, 15, 18
Weak ethical system	Lack of awareness of ethical principles, normalization of cheating, weak punitive system, lack of student awareness of plagiarism	13, 19

Weakness in structural test design	Weakness in authentic design, inefficient test design, weak test structure, inappropriate test design for certain disciplines	5, 6, 16, 17
Lack of standard design criteria	Absence of rubric design (criterion-referenced assessment table), lack of test design framework	3, 4
Ineffective policies	Inefficient mechanisms, lack of precise implementation policies	3, 5
Lack of support and coordination	Lack of integrated support, insufficient provision of equipment, lack of institutional coordination, rapid decisions without faculty involvement, misalignment between policymakers and implementers, lack of structural coordination	3, 9, 12, 16, 18
Ineffective and low-quality feedback	Lack of effective instructional feedback after assessment, grading without explanation, superficial feedback, absence of improvement pathways, assessment without revision, lack of oral feedback on assignments, one-way communication, lack of transparent feedback	2, 3, 4, 12, 15, 17, 19
Lack of personalized feedback	Limited personalized feedback in learning management systems (LMS), lack of interactive communication, insufficient review of student content	3, 10, 11, 13
Untimely feedback	Weakness in continuous feedback provision, absence of immediate and individualized feedback, lack of self-assessment, delayed feedback	1, 4, 10, 15, 17, 18
Weakness in test structure and applicability	Lack of standard assessment models, low-quality questions, use of repetitive and stereotypical tests, improper content segmentation, memory-based and non-applied assessment, lack of analytical questions, lack of use of behavioral data	1–19
Misalignment between assessment type and learning objectives	Assessment not aligned with learning objectives, tests inconsistent with feedback or objectives, mismatch between content and students' level	3, 4, 5, 9, 11
Problems in test implementation	Lack of transparent structure to prevent cheating, assessment based solely on images, insufficient time for responses, rapid methodological changes without preparation	14, 15
Infrastructure and access issues	Inadequate online education policies, weak infrastructure, low digital experience, disciplinary differences, insufficient training	2, 4, 5, 6, 11, 17
Family-related and social pressure issues	Anxiety due to unfamiliarity or home environment pressure, unsuitable family environment, lack of quiet space, social pressure, lack of cultural preparation	8, 11, 19
Ineffective policies and lack of coordination	Lack of integrated national policy, emphasis on standardization over meaningful learning, dissatisfaction with the educational system, policy mismatch with online environments, lack of formal training on academic integrity, inequality in infrastructure access, inequality in virtual learning opportunities	9, 10, 12, 13, 17
Cultural and geographical differences	Differences in perceptions between distance and in-person students, differences in experiences between countries (e.g., Bahrain and Jordan)	14, 15
Lack of access to infrastructure and appropriate tools	Unstable internet access, shortage of digital tools and software limitations, weak internet, need for advanced software for online assessment	6, 9, 17, 18, 19
Technical and system compatibility issues	Inefficient platforms, poor user interface, complexity of new tools, incompatible browsers, loading issues, system crashes, server incapacity for high user volume, installation issues, software incompatibility, mismatch between tools and user needs	6, 8, 9, 10, 11, 15, 16, 17
Security issues and system-related cheating	Weak control over used resources, lack of data and online test security, absence of cheating detection tools, weak identity verification, lack of authentication systems	6, 7, 13, 14, 19
Anxiety and psychological pressure in online assessment	Increased anxiety and stress in online tests, feedback-related anxiety, inability to cope with results, lack of psychological readiness among new students, low self-motivation, low concentration, workload pressure	1, 5, 15
Lack of digital skills and unfamiliarity with standards	Lack of familiarity with platforms and poor user experience, need for precise training, resistance to new technologies, weak implementation of continuous authentication and identity verification, superficial assessment, assessment by unqualified individuals, instructors' inexperience, differences in instructors' confidence, students' lack of awareness of processes	3, 6, 9, 10, 12, 14, 16
Insufficient understanding	Misinterpretation of results, overemphasis on tools with neglect of learning quality analysis, inadequate understanding of learner characteristics	4, 5, 19
Data access and security control issues	Unauthorized access, lack of data security and privacy, system hacking, weak privacy protocols	2, 14, 18
Weak monitoring and authentication tools	Lack of strong authentication, need for security checks and exam lockdown, reliance on passwords as the sole authentication method, fake identities, login under another user's credentials, lack of real monitoring of exams and testing environments	2, 5, 7, 8, 11, 13, 14, 16, 17, 18

Table 4. Main and Subcategories Derived from the Synthesis of Findings

No.	Main Category	Subcategory
1	Ethical Error	Academic dishonesty and misconduct

		Inequity in assessment
		Weak ethical system
2	Design Error	Weakness in structural test design
		Lack of standard design frameworks and criteria
3	Implementation Error	Lack of coordination and ineffective policies
		Need for greater support and coordination
4	Feedback Error	Ineffective and low-quality feedback
		Lack of personalized feedback
		Lack of timely feedback
5	Measurement Error	Problems in question design
		Misalignment between assessment and learning objectives
		Lack of diversity and applicability in assessments
		Problems in test implementation
6	Contextual Error	Infrastructure and access issues
		Family-related and social pressure issues
		Ineffective policies and lack of coordination
		Cultural and geographical differences
7	Technological Error	Lack of access to infrastructure and appropriate tools
		Technical and system compatibility issues
		Security issues and system-related cheating
8	Human Error	Anxiety and psychological pressure in online assessment
		Lack of digital skills and unfamiliarity with standards
		Insufficient understanding
9	Security Error	Data access and security control issues
		Weak monitoring and authentication tools

The first main category identified in the findings is **ethical error**, which encompasses issues related to academic dishonesty and integrity in e-learning assessment environments. This category includes subcomponents such as academic dishonesty and misconduct, inequity in assessment, and weakness in the ethical system. These issues reflect behaviors such as cheating, plagiarism, and identity fraud, as well as systemic problems like lack of transparency in grading and insufficient awareness of ethical principles. Together, these factors undermine trust in the assessment process and compromise the fairness and credibility of evaluation outcomes.

The second main category is **design error**, which refers to deficiencies in the structural and conceptual design of assessment tools. This category includes weakness in structural test design and the lack of standard design frameworks and criteria. These issues manifest in poorly constructed assessments that fail to align with pedagogical goals or disciplinary requirements. The absence of clear rubrics and standardized frameworks further exacerbates inconsistencies in evaluation and reduces the reliability and validity of assessment outcomes.

The third main category is **implementation error**, which highlights challenges arising during the execution of assessment processes. This category includes lack of coordination and ineffective policies, as well as the need for greater support and coordination. These problems often stem from inadequate institutional planning, insufficient collaboration among stakeholders, and the absence of clear operational guidelines. As a result, assessment practices may be inconsistently applied, leading to confusion and inefficiency.

The fourth main category is **feedback error**, which addresses shortcomings in the provision of feedback to learners. This category includes ineffective and low-quality feedback, lack of personalized feedback, and lack of timely feedback. These issues indicate that students often receive insufficient guidance for improvement, with feedback that is delayed, generic, or

lacking in depth. Consequently, the formative function of assessment is weakened, limiting opportunities for learning enhancement and self-regulation.

The fifth main category is **measurement error**, which pertains to inaccuracies and inadequacies in the assessment of learning outcomes. This category includes problems in question design, misalignment between assessment and learning objectives, lack of diversity and applicability in assessments, and problems in test implementation. These issues result in assessments that fail to accurately measure students' knowledge and skills, often emphasizing rote memorization over higher-order thinking and practical application.

The sixth main category is **contextual error**, which reflects the influence of external conditions on the assessment process. This category includes infrastructure and access issues, family-related and social pressure issues, ineffective policies and lack of coordination, and cultural and geographical differences. These factors highlight the role of learners' environments, institutional contexts, and socio-cultural conditions in shaping assessment experiences and outcomes, often creating inequities and barriers to effective evaluation.

The seventh main category is **technological error**, which involves challenges related to digital infrastructure and tools used in assessment. This category includes lack of access to infrastructure and appropriate tools, technical and system compatibility issues, and security issues and system-related cheating. These problems indicate that technological limitations, such as unstable internet connections, inefficient platforms, and inadequate security mechanisms, can significantly disrupt the assessment process and compromise its integrity.

The eighth main category is **human error**, which focuses on individual-level factors affecting assessment. This category includes anxiety and psychological pressure in online assessment, lack of digital skills and unfamiliarity with standards, and insufficient understanding. These issues demonstrate that both students and instructors may struggle with the psychological and cognitive demands of online assessment, as well as with the technical competencies required for effective participation.

The ninth and final main category is **security error**, which pertains to vulnerabilities in data protection and identity verification systems. This category includes data access and security control issues, as well as weak monitoring and authentication tools. These challenges highlight risks such as unauthorized access, data breaches, and inadequate identity verification processes, all of which threaten the reliability and confidentiality of e-learning assessments.

Discussion and Conclusion

The findings of the present study revealed that errors in e-learning assessment can be systematically categorized into nine major domains, including ethical, design, implementation, feedback, measurement, contextual, technological, human, and security errors. These results indicate that assessment in digital learning environments is not a unidimensional process but rather a complex, multilayered system influenced by interacting pedagogical, technological, and socio-cultural factors. The identification of ethical errors as a prominent category highlights the persistent challenge of maintaining academic integrity in online environments, where opportunities for cheating, plagiarism, and identity fraud are significantly increased. This finding is consistent with prior research demonstrating that online assessment contexts are more vulnerable to academic misconduct due to reduced supervision and increased reliance on digital tools (13, 14, 17). Furthermore, studies have emphasized that technological solutions alone are insufficient to address these issues, as ethical awareness and institutional policies play a crucial role in promoting integrity (16, 42). Therefore, the prominence of ethical errors in the present findings underscores the need for a comprehensive approach that integrates technological safeguards with educational and cultural interventions.

The identification of design errors as a major category reflects fundamental weaknesses in the construction and alignment of assessment tools in e-learning environments. The results suggest that many online assessments suffer from inadequate

structural design, lack of standard frameworks, and poor alignment with learning objectives. This aligns with previous studies indicating that the effectiveness of e-assessment depends heavily on instructional design principles and the alignment between assessment methods and intended learning outcomes (18, 19). Moreover, the continued reliance on traditional assessment formats in digital contexts has been criticized for failing to capture higher-order cognitive skills and authentic learning experiences (7, 43). The findings of the present study reinforce the argument that effective e-assessment requires a shift toward more innovative and learner-centered design approaches that incorporate authentic tasks, formative assessment strategies, and clear evaluation criteria.

Implementation errors identified in this study further highlight the challenges associated with translating assessment designs into practice. Issues such as lack of coordination, ineffective policies, and insufficient institutional support were found to significantly affect the quality of assessment processes. These findings are consistent with research indicating that successful implementation of e-learning assessment depends on organizational readiness, clear policy frameworks, and collaboration among stakeholders (20, 31). The rapid transition to online learning during the COVID-19 pandemic exacerbated these challenges, as institutions often lacked the infrastructure and planning necessary for effective implementation (8, 10). Consequently, the present results emphasize the importance of institutional capacity building and strategic planning in ensuring the effectiveness of e-assessment practices.

Feedback-related errors identified in the findings point to significant shortcomings in the formative function of assessment. The lack of timely, personalized, and high-quality feedback limits students' ability to reflect on their performance and improve their learning strategies. This finding is consistent with the literature emphasizing the central role of feedback in promoting self-regulated learning and academic achievement (6, 22). In online environments, the challenges of providing effective feedback are further compounded by large class sizes, technological constraints, and limited interaction between instructors and students (23). The present study highlights the need for integrating feedback mechanisms into assessment design and leveraging digital tools to enhance the quality and accessibility of feedback.

Measurement errors identified in this study reflect inaccuracies in evaluating student learning outcomes, particularly due to poorly designed questions, misalignment with learning objectives, and limited diversity in assessment methods. These findings support previous research indicating that traditional assessment approaches are often inadequate for measuring complex learning outcomes in digital environments (37, 44). The overemphasis on objective tests and memory-based questions undermines the validity of assessment and fails to capture students' critical thinking and problem-solving abilities. Therefore, the findings suggest the need for more diverse and authentic assessment methods that align with contemporary educational goals and digital learning contexts.

Contextual errors, including infrastructure limitations, social pressures, and cultural differences, were also identified as significant factors affecting e-learning assessment. These findings highlight the importance of considering the broader learning environment in the design and implementation of assessment practices. Previous studies have shown that disparities in access to technology and digital literacy can create significant inequalities in online learning experiences (1, 26). Additionally, cultural and social factors influence students' perceptions of assessment and their engagement with learning activities (32, 33). The present results underscore the need for context-sensitive assessment strategies that address the diverse needs and conditions of learners.

Technological errors identified in the study further demonstrate the critical role of digital infrastructure in shaping assessment outcomes. Issues such as system instability, software incompatibility, and inadequate security measures can disrupt assessment processes and compromise their reliability. These findings are consistent with research highlighting the challenges of implementing technology-mediated assessment in higher education (24, 27). Moreover, the increasing complexity of digital

tools requires both students and instructors to possess sufficient technical skills, which may not always be the case. Therefore, the findings suggest that technological readiness and continuous support are essential for effective e-assessment.

Human errors, including psychological stress, lack of digital skills, and insufficient understanding, were also found to significantly impact assessment processes. These findings align with studies indicating that online assessment can increase anxiety and cognitive load, particularly for students who are unfamiliar with digital tools or lack adequate support (28, 29). Instructors, too, may face challenges in adapting to new assessment methods and technologies, leading to variability in assessment practices. The present study highlights the importance of addressing human factors through training, support, and the development of digital competencies.

Finally, security errors related to data protection and identity verification were identified as critical concerns in e-learning assessment. The findings indicate that weaknesses in authentication systems and monitoring tools can compromise the integrity and confidentiality of assessment processes. This is consistent with previous research emphasizing the need for robust security measures in online assessment environments (15, 45). However, the implementation of such measures must balance security with ethical considerations, including privacy and accessibility.

Overall, the findings of this study provide a comprehensive framework for understanding the multifaceted nature of errors in e-learning assessment. By integrating insights from multiple studies, the meta-synthesis approach enables a deeper understanding of the interrelated factors affecting assessment quality. These results contribute to the existing literature by offering a systematic categorization of assessment errors and highlighting areas for improvement in both research and practice.

One limitation of this study is that it relies on previously published research, which may be subject to publication bias and variations in methodological quality. Additionally, the selection of articles was limited to specific databases and a defined time frame, which may have excluded relevant studies from other sources or earlier periods. The qualitative nature of meta-synthesis also involves interpretive processes that may be influenced by the researcher's perspective.

Future research should explore the identified categories of assessment errors using empirical and mixed-method approaches to validate and expand upon the findings of this study. Longitudinal studies examining the evolution of e-assessment practices over time would provide valuable insights into the effectiveness of interventions aimed at reducing these errors. Furthermore, research should investigate the impact of emerging technologies, such as artificial intelligence, on assessment design, implementation, and integrity.

In terms of practical implications, educational institutions should prioritize the development of comprehensive policies and frameworks for e-learning assessment that address ethical, technological, and pedagogical dimensions. Providing training and support for both instructors and students is essential to enhance digital literacy and reduce human-related errors. Additionally, the integration of advanced technological solutions should be accompanied by careful consideration of ethical and contextual factors to ensure equitable and effective assessment practices.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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