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Review Article

The Advantages and Achievements of Electronic Assessment: A Systematic Review

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Abstract

Along with technological developments, electronic devices and tools have increasingly affected many aspects of our lives, including teaching, learning, and assessment processes. Over the last decade, the growing use of e-learning methods has sparked considerable discussion about how these tools can be effectively applied to assessment and evaluation, making this a central topic in educational research. This paper presents a systematic review of the literature on the advantages of electronic assessment from 2000 to 2024. Following the PRISMA guidelines, 34 of the most significant studies were selected, analyzed in depth, and sourced from Scopus, Google Scholar, and Science Direct databases using a combination of keywords including "Artificial Intelligence," "Electronic," "Technology," "Assessment," "Training," "Learning," and "Achievements." The review examines electronic assessment in education, particularly in evaluating student performance at different levels, while also identifying and compiling its limitations to provide a clear overview of current challenges and to guide future research. The main findings reveal two broad categories of benefits. The first category, Technical Advantages, includes enhanced feedback and learning analytics (such as instant feedback and speed of results), authentic learning experiences (centralized knowledge, learning analytics, and enhanced learning), consistency and objectivity in grading (collaborative question authoring, automated test assembly, automated marking, and randomization features), efficiency and time management (real-time feedback and reduced administrative burden), and security. The second category, Operational Advantages, encompasses cost-effectiveness and resource efficiency (reduced physical costs, scalability, and improved efficiency), flexibility and convenience (geographical flexibility and a variety of assessment formats), and accessibility and inclusivity (accessible features and inclusive design).

Keywords: Electronic assessment; E-assessment; Education; PRISMA; Evaluation

INTRODUCTION

The incorporation of technology in education has transformed numerous facets of teaching and learning, with electronic assessment (e-assessment) emerging as one of the

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most significant developments. E-assessment includes many evaluation methods executed using digital platforms, such as online examinations, digital portfolios, and automated grading systems. The increasing utilization of e-assessment is propelled by its myriad advantages, which improve the efficiency, effectiveness, and accessibility of the educational process. This study examines the principal benefits of e-assessment, substantiated by pertinent academic and industry references.

A principal advantage of e-assessment is the marked enhancement in efficiency and time management for both educators and pupils. Conventional assessment techniques frequently entail protracted procedures of paper dissemination, manual grading, and result aggregation, which can be laborious and susceptible to human mistake. E-assessment, conversely, optimizes these processes by automation and digital instruments. Automated marking systems, particularly for multiple-choice questions, deliver instantaneous feedback, alleviating the administrative load on educators and enabling greater emphasis on instructional tasks [1]. Furthermore, the digital submission and evaluation of tasks expedite turnaround times, allowing students to obtain prompt feedback and implement essential enhancements in their learning process. The promptness of feedback is vital for formative exams, where continuous evaluation and feedback are imperative for student growth. E-assessment provides significant cost reductions and enhanced resource efficiency relative to conventional paper-based examinations. The removal of physical resources, including paper, printing, and distribution expenses, results in substantial financial savings for educational organizations. Furthermore, the digital storage of evaluation data diminishes the necessity for physical storage space and lessens the environmental impact linked to paper use [3]. The scalability of e-assessment platforms increases cost-effectiveness. Institutions can do extensive evaluations without the logistical difficulties and costs linked to conventional approaches. Standardized examinations can be administered to hundreds of students concurrently, with automated systems managing the majority of the effort, thus decreasing personnel costs and assuring grade uniformity [4].

E-assessment offers exceptional flexibility and accessibility for both students and educators. The expansion of online learning platforms enables students to complete assessments from any location with internet connectivity, eliminating geographical constraints and catering to varied student requirements. This flexibility is also advantageous for non-traditional students, such as those managing education with employment or familial obligations, as it enables them to complete examinations at their convenience [5]. E-assessment platforms include diverse question formats, including multiple-choice, short response, and interactive simulations, accommodating various learning styles and assessment goals. This adaptability allows instructors to create more interesting and thorough exams that more accurately represent student comprehension and abilities. A notable benefit of e-assessment is the improved feedback and learning analytics it offers. Digital evaluations can be crafted to provide immediate, comprehensive feedback to students, emphasizing their strengths and areas needing work. This prompt

feedback mechanism is essential for cultivating a growth mindset and promoting ongoing learning. Moreover, e-assessment tools gather comprehensive data on student performance, which may be evaluated to discern learning trends, deficiencies, and patterns. Educators can utilize this data to customize lessons for particular student requirements, execute targeted interventions, and enhance overall pedagogical tactics. Learning analytics allows institutions to measure and evaluate the efficacy of their assessment procedures, fostering ongoing enhancement in educational quality [8].

E-assessment guarantees enhanced consistency and impartiality in evaluation, minimizing the likelihood of human bias and inaccuracy. Automated grading systems utilize consistent standards for all entries, guaranteeing equitable and unbiased assessment. This uniformity is especially crucial in large-scale examinations, since manual grading may be subjective and differ among several evaluators [9]. Additionally, digital exams may incorporate elements such as randomized question sequences and question banks, so reducing the likelihood of cheating and bolstering the integrity of the assessment process. These indicators enhance the reliability and credibility of student performance assessments [10]. E-assessment platforms can be tailored to meet diverse accessibility requirements, guaranteeing that all students, including those with disabilities, can engage in assessments equitably. Features like screen readers, customizable font sizes, and extra time allowances can be seamlessly integrated into digital examinations, fostering a more inclusive evaluation environment [11]. The benefits of e-assessment are numerous, including increased efficiency, cost-effectiveness, flexibility, superior feedback, and higher uniformity in grading. These advantages not only enhance the evaluation process but also foster a more efficient and inclusive educational experience. As educational institutions increasingly incorporate technology into their assessment methodologies, the proliferation of e-assessment is anticipated to grow, fostering additional innovations and enhancements in the evaluation of student learning. This paper carefully reviews existing research, summarizes findings, categorizes valid e-assessment achievements, and presents a general consensus on the subject.

STATEMENT OF THE PROBLEM

Due to technological advancements and heightened individual demands, the integration of technology in the educational process has become imperative. Computer technology is always evolving and has influenced education and learning. Global tertiary institutions have recognized the significance of electronic assessment (e-assessment). Electronic assessment is described as the utilization of information technology for tasks linked to assessment [13]. The scarcity of personnel and the necessity for improved throughput both contribute to the justification for transitioning to this new assessment approach. Conventional paper-and-pencil testing is now regarded as antiquated and archaic in comparison to contemporary methods of instruction, learning, and evaluation [14]. Computer literacy has become a need, dictated by business regulations and norms that demand skilled and digitally proficient staff. This has resulted in a heightened need for computerized assessments in training and education [15].

Educational assessments undergoing significant transformations. The manner in which examinations are administered essentially dictates these modifications. The management of examinations facilitates a crucial and substantial transformation. The design, printing, grading, and feedback processes associated with paper-based assessments demand substantial time, effort, and financial resources, rendering their adoption less acceptable. Moreover, the rising demand for repeated assessments will lead to an escalation in the expenses associated with administering paper-based examinations. Utilizing a computerized CBT exam system [16] is one method to mitigate the expenses associated with these cases. It provides significant economic advantages for society.

In the 1990s, as the significance of educational testing grew, public discourse increasingly centered on test results and the rationale for testing, prompting efforts to identify evidence for monitoring and teaching practices aimed at enhancing student performance and learning outcomes. And what they were acquiring knowledge about. Consequently, scholars and practitioners commenced concentrating on formative evaluation [17,18]. Constructive evaluation is a procedure employed throughout education to provide targeted feedback based on the educational context and to enhance learning, enabling students to achieve optimal educational outcomes. Timely and effective feedback is crucial for obtaining specific educational information about each individual, enabling evaluators to make informed educational decisions that facilitate each student's progress in acquiring diverse knowledge and skills more effectively. Empirical research findings indicate that constructive feedback can yield substantial benefits for pupils. Consequently, educational assessments, previously mandated solely to fulfill the objectives of design instructors, are now restricted to a summary of students' scientific accomplishments, anticipated to deliver prompt and precise feedback to assist in addressing and rectifying students' educational and learning challenges. be situated [20,21].

Research in science, technology, and engineering evidently benefits from artificial intelligence. Upgrading educational qualifications and advancing through stages of education without achieving satisfactory scores renders assessment meaningless, indicating a lack of efficient training; nevertheless, this is a requisite within the educational system. The foundational elements of the educational system aimed at enhancing qualifications and advancing educational levels include assessment, alongside the substantial and ever increasing volume of educational data seen daily [22]. The administration of these educational ideals, alongside the growing student population and the diversity of fields and trends in engineering education, necessitates the optimization of time and costs [23]. Consequently, educators and students should familiarize themselves with the many capabilities of artificial intelligence in evaluation [24]. Understand the significance and necessity of artificial intelligence in evaluation, benefits, and accomplishments.

Methods

This study thoroughly identified and analyzed publications pertaining to the issue published in international journals in Latin. Analyzing theoretical underpinnings is a crucial preliminary step before to undertaking any research project [25]. This establishes a framework for information accumulation, facilitating theory building, addressing research gaps, and uncovering overlooked regions in prior studies [26]. A theoretically grounded review qualifies as a systematic background review only when it clearly articulates the research issues, identifies and analyzes pertinent papers, and evaluates their quality based on defined criteria [27]. This review adheres to the principles of [28]. This review adheres to established principles, including PRISMA, and the methodological framework is illustrated in Figure 1. The systematic review adhered to established protocols, alongside the methodologies of earlier systematic reviews [29-31], executed in four distinct phases. Independently executed: delineation of inclusion and exclusion criteria, identification of data sources and search methodology, quality evaluation, and data coding and analysis. The subsequent subsections provide a detailed account of these steps.

Protocol

The review process constitutes the initial and important step in executing a systematic review. A protocol is a comprehensive plan outlining the methodology for conducting e-assessment advantages and achievements, encompassing research questions, search strategy, study selection procedure and criteria, quality evaluation, and data synthesis and extraction. The subsequent sections delineate each phase.

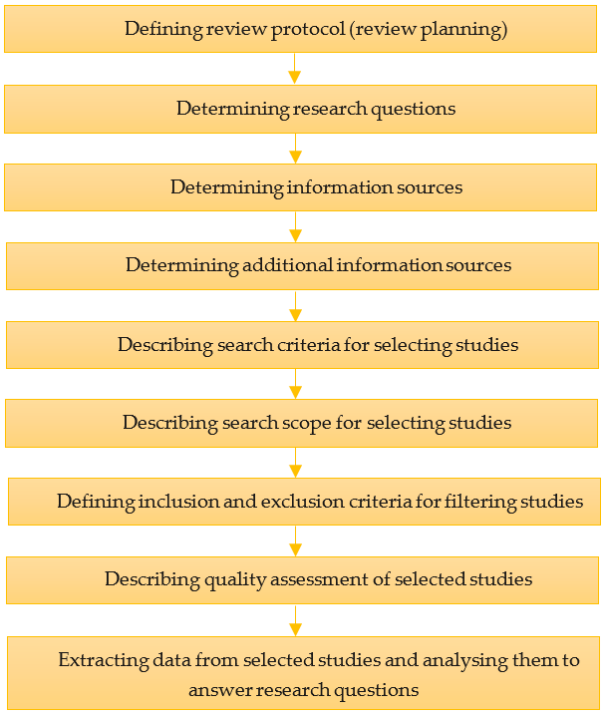

Figure 1. Research methodological framework

This study aims to identify and categorize the available literature on the benefits and achievements of conducting e-assessment, as outlined in Table 1.

Table 1. Research Questions Directing the Examination of the Advantages and Accomplishments of Implementing E-Assessment

Identifier	Research question
Q_1	Examining the benefits and achievements of electronic assessment from the point of view of professors and students and different educational members?
Q_2	What is the opinion of supporters and critics about benefits and achievements of electronic assessment?
Q_3	Examining the benefits and achievements of electronic assessment from the perspective of infrastructures?
Q_4	Examining the challenges of electronic assessment from the perspective of technical issues?
Q_5	What factors are associated with the emergence/development of Challenges of electronic assessment?
Q_6	Examining the benefits and achievements of electronic assessment from the perspective of ethical issues?
Q_7	Examining the benefits and achievements of electronic assessment from the point of view of security and academic plagiarism?
Q_8	Examining the benefits and achievements of electronic assessment from the perspective of curriculum, educational goals and teaching and learning factors?
Q_9	Examining the benefits and achievements of electronic assessment from the perspective of cost?
Q_{10}	What is the role of benefits and achievements of electronic assessment in Academic progress and educational integration?
Q_{11}	What roles do Persons and the environment play in the benefits and achievements of electronic assessment?
Q_{12}	What are the determining factors in benefits and achievements of electronic assessment?
Q_{13}	Categorize e-assessment benefits and achievements and What are the components of Challenges of electronic assessment?

Sources of Information

This research has chosen a suitable array of databases to comprehensively encompass the literature and enhance the probability of identifying highly pertinent studies. Consequently, the search encompasses the electronic source databases enumerated in Table 2.

Table 2. Information sources for systematic review

Source	**URL**
Eric	https://eric.ed.gov/
IEEE explore	https://ieeexplore.ieee.org/

ScienceDirect	https://www.sciencedirect.com/
SpringerLink	https://link.springer.com/
ACM Digital Library	https://dl.acm.org/
Wiley Online Library (WOL)	https://onlinelibrary.wiley.com/
Emerald Insight	https://www.emerald.com/
Tandt online	https://www.tandfonline.com/
Inder science	https://www.inderscience.com/
Scholar googles	https://scholar.google.com/

Relying solely on keyword searches is improbable to provide all pertinent material. Consequently, with the aforementioned information sources, the subsequent sources were also included in the study searches: A reference list comprising primary investigations and additional review papers; A compilation of research that references primary studies; Literature and technical documentation.

Search Criteria

The primary aim of the search criteria is to discover studies centered on the benefits and accomplishments of electronic assessment. In this context, previous review articles were utilized to identify the context, keywords, and principal references. This technique considers acronyms, synonyms, related works and terms, as well as Boolean operations. The parameters are described in Table 3: Definition of Search parameters.

Table 3. Definition of search criteria

Criterion	Definition
Population	Keywords such as Evaluation, benefits, results, achievements, Education, electronic evaluation, evaluation with artificial intelligence
Intervention	Search terms such as Evaluation and methods of electronic evaluation and other terms with the same meaning
Comparison	Comparison of tools, methods, and places
Outcome	Methods and process for identifying the benefits and achievements of e-assessment
Context	Education, school, and college

Search Scope

The search scope involves acquiring reference studies from designated electronic resources through the utilization of keywords. The search commenced in early 2000 and was last updated at the conclusion of September 2023. The searches were confined to English-language research spanning 24 years (January 2000–September 2023). The selected time frame was highly suitable as the majority of research on e-assessment has been evaluated, and the studies conducted during these years have been analyzed. The search parameters and strings are enumerated in Table 4.

Table 4. The searching terms used

Searching strings	Operation	field
("Assessment " OR "Benefits" OR " Results" OR" Achievement " OR "Academic aptitude" OR " Electronic Assessment " OR " Assessment With Artificial Intelligence" OR " Education " OR " Evaluation " OR " Measure" OR " Education "	OR	Title-Abstract-Keywords
("E-Assessments " OR " E-Learning " OR " Electronic Assessment " OR " Assessment With Artificial Intelligence " OR "Benefits" OR " Results" OR" Achievement " OR " Education" OR " Training" OR " Teaching" OR " Schooling" OR " Learning"	OR	Title-Abstract-Keywords
(("E-Assessments " OR " Assessment With Artificial Intelligence " OR " Assessment Evaluation " OR " E-learning ") AND ("Academic" OR "Scholastic" OR "Student" OR "School" OR "Talent center" OR "College" OR "Children" OR "Child") AND ("Benefits" OR " Results" OR" Achievement ")AND " Education" OR " Training" OR " Teaching" OR " Schooling" OR " Learning")	OR	Title-Abstract-Keywords

This analysis encompasses research articles detailing the application of Artificial Intelligence (AI) in student assessment, published in peer-reviewed publications from 2000 to 2024. The year 2000 has been designated as the commencement year for the investigation, owing to the significant advancement of this technology. The language utilized for the search was English. Upon completion of the search, the inclusion and exclusion criteria employed were those defined in Table 1 below. The review primarily focuses on the application of AI in student assessment for both online and in-person courses.

Table 5. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
• Published 2000–2024	• Published before 2000
• English language	• Not in English
• Empirical research	• Not empirical (e.g., review)
• Peer review journal	• Not peer review journal
• Use of artificial intelligence to assess and learners	• Not artificial intelligence Not learning setting Not for assessment
• We must include access to the entire text of the article	• Only their abstracts are available

Data Sources and Search Strategy

In accordance with PRISMA guidelines [32], articles indexed in the Scopus, Google Scholar, and Science Direct databases from 2009 to 2022 were examined using the keyword combination (("Artificial Intelligence" or "Electronic Assessment" or "Assessment with Artificial Intelligence") and ("Achievements") and ("Education") and ("Benefits" and "Assessment" or "Evaluation" with "Electronic Assessment" or "Artificial Intelligence").

Keyword selection is a crucial phase in any systematic review, as it dictates the articles that must be physically retrieved [33]. An umbrella review methodically aggregates and assesses the findings of multiple systematic reviews or meta-analyses pertaining to a certain subject; the original search yielded 3,509 papers. Ultimately, with the application of constraints and exclusion criteria, the initial count was diminished to 80 articles with specified entry and leave parameters. Following further scrutiny, 20 high-quality articles were incorporated into the analytical process. The search and refining processes in this review adhered to the Preferred Reporting Items for Meta-Analytical Systematic Reviews (PRISMA) [34]. Figure 2 illustrates the PRISMA flowchart. This work comprised a systematic analysis and synthesis of peer-reviewed research publications published from 2005 to 2022, initially identified using searches of the databases Google Scholar, Scopus, and Science Direct, and subsequently selected for inclusion based on defined criteria [35]. We adopted components of the protocol outlined in [27]. Our research topics encompassed the identification of pertinent work, evaluation of study quality, synthesis of evidence, and interpretation of findings. The articles must satisfy four criteria, including 1. relevance to the research topic; 2. Must be published between 2000 and 2024; The articles have attained final publication. Articles must incorporate the keywords (Artificial Intelligence or Electronic) and (Assessment or Evaluation) and (Education). Document classification: articles. Chronological span: 2000–2024. Language: English.

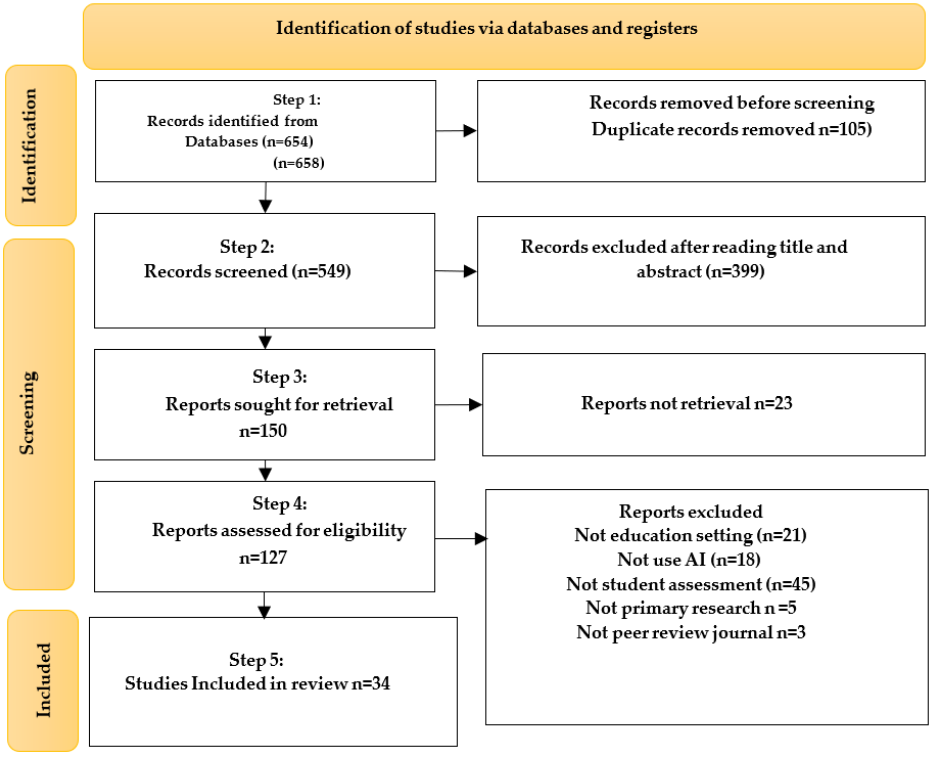

Figure 2. The research roadmap derived from a literature review.

RESULTS

The overview of the papers that were investigated for this study is presented in Table 6.

Table 6: Overview of the articles used for the review

Methods	Title	Summary of results	Authors
Experimental research method	Rethinking Homework in the Age of Artificial Intelligence	Natural language processing Easy, conversational help Enhanced learning experience Improved study habits Accessible learning too	Ibrahim et al., 2023[36]
Experimental research method	Sophisticated tasks in e-assessment: what are they and what are their benefits?	E-assessment supports sophisticated tasks Evaluates higher-order thinking skills Provides immediate feedback Goes beyond traditional tests Requires critical perspective on innovations Growing use shows strong potential Success depends on careful implementation Needs ongoing empirical research	Boyle & Hutchison (2009).[37]
Review study	Review on e-readiness assessment tools	Focus on e-learning readiness Key factors: technical skills & self-directed learning Tools: OLRQ and OLRS Identifies strengths and weaknesses Guides improvement strategies Ensures competencies for online learning success	Đurek, Reðep, (2016).[38]
Editorial Paper	Hacettepe Üniversitesi Eğitim Fakültesi Dergisi Hacettepe University	Increased demand for online learning and e-assessment COVID-19 as a driving force Importance of secure online assessments Reference to ITC (2006) guidelines Guidelines ensure assessment integrity Crucial for educational institutions	KAYIŞ ,et al (2023).[39]
Experimental research method	Construction and evaluation of a web-based learning portfolio system: An electronic assessment tool.	E-portfolios boost students' computer and writing skills Enhance teachers' tech understanding and pedagogy Traditional & digital portfolios both beneficial Support teacher identity and professional growth Encourage reflection and tech skill development	Chang, (2001).[40]
Experimental research method	AMEE Guide 32: e-Learning in medical education Part 1: Learning, teaching and assessment.	Flexible use of e-learning in medical education Applied independently or with traditional methods Enhances teaching philosophies and practices Acknowledges evolving nature of the field Previews next section: tech, management, design Aims to deepen understanding and implementation	Ellaway, Masters, (2008).[41]
review	Physical and virtual laboratories in science and engineering education	Importance of addressing learning styles in online exams Focus on cost-effective cheating prevention methods Emphasis on privacy and convenience Advanced tech can enable cheating Need for improved detection and prevention tools Goal: maintain academic integrity in e-assessment	De Jong, 2013[42]

	Students' Perceptions of E-Assessment at Saudi Electronic University.	Positive student perceptions at Saudi Electronic University Appreciation for immediate feedback and fair grading Preference for e-exams over traditional methods Belief: e-assessment is easy to use, doesn't promote cheating Findings align with previous research Highlights benefits in enhancing evaluation experiences	Alsadoon, (2017).[43]
A systematic review approach	Student online readiness assessment tools: A systematic review approach.	Content validity ensures accurate measurement of learning objectives Establish clear learning objectives for assessments Choose appropriate assessment methods Provide clear instructions and evaluation criteria Ensure accessibility for all students Implement quality assurance and feedback mechanisms Align assessments with these principles for fair evaluations Supports student success and enhances the learning experience	Alem et al . (2014).[44]
The data gathering method was a questionnaire administered to 247 students on the Education Degree at the University of Barcelona.	University students' perceptions of e-portfolios and rubrics as combined assessment tools in education courses.	Varied student perceptions of portfolios and rubrics Rubrics seen as helpful for understanding assessment criteria Portfolios had limited impact on motivation Teacher experience and technical support influenced perceptions Older students had more favorable views Guidance and training for students and teachers are essential Ensures effective portfolio use and assessment transparency	Contreras-Higuera et al.,. (2016).[45]
systematic review	A systematic review of formative assessment tools in the blended learning environment.	Increasing use of formative assessment tools in blended learning Enhances learning quality and guides assessment selection Highest usage: automatic assessment (87%) and semi-automatic (13%) No manual assessment usage identified Emphasis on the transformative role of technology in education Technology shifts assessment methods from manual to automatic	Febriani, I., & Abdullah, M. I. (2018).[46]
mixed method	Integrating electronic instructional and assessment tools into teacher education programs.	Faculty and students favor e-tools like e-mail and interactive PowerPoint Effective assessment tools: assignments and quizzes Positive attitude toward technology in education, especially hybrid courses Benefits: flexibility, adaptability to learning styles High technology integration (71-100%) in teacher education courses	Petriashvili, I. (2012).[47]
Quantitative research method	Corporate governance in the 2007–2008 financial crisis: Evidence from financial institutions worldwide.	Examined positive and negative washback effects of e-portfolio tests Evaluation included 18 students and teachers from a university in Taiwan E-tests found to be more accurate and faster than traditional methods	Erkens,et al,.(2012)[48]
mixed method	E-assessment: Wash-back effects and challenges (examining students' and teachers' attitudes towards e-tests).	Positive student perceptions of e-assessments at Saudi Electronic University Valued features: immediate feedback and unbiased grading Emphasis on standardized assessment practices Need for lecturer training to use e-assessment tools effectively Addressing challenges in teaching and learning	Binnahedh, I. A. (2022).[49]

mixed method	E-classroom interactional competencies: Mediating and assisting language learning during synchronous online lessons.	E-assessment enhances student learning and provides immediate feedback Standardized assessment practices are essential for effectiveness Teacher training crucial for successful e-assessment implementation in higher education	Moorhouse et al, (2023).[50]
review	Electronic practical skills assessments in the health professions: a.	eOSCEs are user-friendly, accessible, and time-efficient. They reduce staffing costs, minimize errors in scoring and data entry. 3.eOSCEs offer prompt feedback to students and provide automated storage of examination data for academics.	Snodgrass et al, (2014).[51]
Experimental research method	EduComponents: Experiences in e-assessment in computer science education.	Successful integration of diverse content types into CMS Enhances teaching effectiveness and provides better student oversight Positive feedback from both students and teachers CMS as a central repository for materials Facilitates resource reuse and personalized assessments Potential for personalized assessments based on stored metadata	Amelung et al. (2006, June).[52]
mixed method	E-assessment for e-learning..	E-assessment evaluates learner progress and knowledge online Offers insights into training quality and effectiveness Utilizes various formats: tests, projects, etc. Provides valuable feedback to identify strengths and weaknesses Tools like Ithenticate and Turnitin ensure originality Promotes responsibility in assessing graduate attributes in e-learning	Prakash, L. S., & Saini, D. K. (2012, July).[53]
qualitative	User experience of interRAI assessment tools in New Zealand.	Future research: Integrate assessment tools into existing workflows Aim: Reduce clinician burden and improve adoption Explore benefits of interRAI assessments for continuity of care Focus on both efficiency and quality of care improvements	Smith, J., Whiddett, D., & Hunter, I. (2013).[54]
descriptive quantitative methodological	Experiencing e-assessment during COVID-19: an analysis of Indian students' perception.	Study focused on Indian students' perceptions of e-assessment during COVID-19 Increased interest in e-assessment observed Moderate overall perception with positive views on usefulness and ease of use Challenges included infrastructure issues E-assessment streamlined evaluation processes Helped students better prepare for higher education amid rising enrollment	Kundu, A., & Bej, T. (2021).[55]
systematic review	Can electronic assessment tools improve the process of shared decision-making? A systematic review.	Based on the information provided in the search results, the key points regarding the use of electronic assessment tools and patient-reported outcome measures (PROMs) are: Electronic assessment tools have shown promise in enhancing communication related to health-related quality of life and psychosocial issues. Using PROMs can improve communication in clinical practice, as they allow patients to directly report on their own health status, symptoms, and well-being.	Wickramasekera, N., Taylor, S. K., Lumley, E., Gray, T., Wilson, E., & Radley, S. (2023).[56]
Review	. E-assessment in higher education: A review. *International*	E-assessment uses technology to deliver and manage evaluations Provides immediate and personalized feedback to boost performance Supports learning and monitors student progress Evaluates learning outcomes effectively Shifts traditional assessments toward user-centered approaches Assesses higher-order thinking skills Highlights the role of technology in advancing assessment in higher education	Appiah, M., & Van Tonder, F. (2018).[57]

Quantitative method	E-Assessment of student's performance during the E-Teaching and learning.	Use of multiple tech tools in formative assessment supports clear guidance Enhances student participation and optimizes learning outcomes E-assessment is effective for online instruction Offers flexibility, cost reduction, and less instructor effort Provides immediate feedback to students Useful as a substitute in emergency situations Improves accessibility for students with disabilities	Al-Hattami, A. A. (2020).[58]
Review	E-assessment: Past, present and future.	The effectiveness of e assessment and e-learning methods depends on the learner's profile and desired learning outcomes. Mapping between e assessment and learning outcomes is critical to ensure the quality and validity of e assessment. Computers can enhance the quality of questions, such as using machine learning for answer matching rules in short answer free text questions.	Jordan, S. (2013).[59]
Case Study	e-Assessment for learning and performativity in higher education: A case for existential learning.	Emphasizes the importance of Assessment for Learning (AfL) Promotes learner engagement, decision-making, and understanding of learning Highlights the need for e-AfL practices that support learner development Recognizes the influence of assessment discourses on learner subjectivity Advocates for pedagogies centered on learner growth Suggests evaluating e-AfL by its impact on learner reflexivity, agency, and identity	Charteris, J., Quinn, F., Parkes, M., Fletcher, P., & Reyes, V. (2016).[60]
	An electronic web-based assessment	The use of e assessment systems and e portfolios in engineering education can provide a comprehensive, measurable, and flexible approach to evaluating educational objectives and outcomes. This allows for continuous improvement and benchmarking against other institutions and programs.	Petrova, R., Tibrewal, A., & Sobh, T. (2006).[61]
research is true experimental research with the posttest end experimental control group design	Effectiveness of Using E-Module and E-Assessment.	Highlights effectiveness of e-assessment and mobile learning in various fields E-modules in physics outperform traditional print materials Online physical education yields high student satisfaction (communication & grade control) Automated assessment and personalized feedback enhance learning outcomes Promotes self-reflection, peer assessment, and discussion Emphasizes the positive impact of educational technologies on success	Kurniawan, W., Anwar, K., & Kurniawan, D. A. (2019).[62]
qualitative approach	E-assessment: Institutional development strategies and the assessment life cycle	E-assessment is essential in modern higher education Offers benefits: reliability, flexibility, and accessibility Faces challenges: unfamiliarity, piracy, cheating, and impersonation Assessment life cycle framework suggests a hybrid system (electronic + paper) Institutions should prioritize: Electronic submission Electronic marking Electronic feedback Medium/low priority: computer-based assessments and online exams	Tomas, C., Borg, M., & McNeil, J. (2015).[63]
Quantitative method	Online formative assessment in higher education: Its pros and cons..	Formative assessment is crucial in online learning Enables continuous evaluation and personalized feedback Enhances student learning and improves teaching methods Uses tools like online polls and discussion boards Helps identify understanding gaps Allows teachers to adjust instruction accordingly Promotes effective and engaging learning experiences	Baleni, Z. G. (2015).[64]

mixed-type experimental method	Pattern-based anomaly detection in mixed-type time series.	Reviewing and changing answers in e-tests boosts student performance Enables error correction and overall improvement Computer familiarity enhances success in e-assessment Key features: question skipping and review options Importance of effective assessment design by educators Need for clear regulations to support academic success	Feremans et al., (2019) [65]
meta-analysis	A systematic literature review of assessment tools for programming assignments.). IEEE	SLR focuses on assessment tools for programming assignments Highlights efficiency in streamlining the assessment process Introduces classification schemes by type and approach Identifies research gaps in current tools Suggests future research directions Emphasizes integration into Learning Management Systems (LMSs) Proposes development of a Software Product Line (SPL) for tailored assessments	Souza, D. M., Felizardo, K. R., & Barbosa, E. F. (2016, April).[66]
an experiment	Advancing electronic assessment. 65.	Electronic tests positively impact student performance and academic achievement Key features: immediate feedback, automation, reduced testing time Some studies show paper-based tests yield higher scores Computer familiarity is crucial for success in e-assessments Need for further research on comparative impact of electronic and paper tests	Doukas, N., & Andreatos, A. (2007).[67]
Quantitative method	The comprehensive evaluation of electronic learning tools and educational software (CEELTES).	**CEELTES**: Specialized evaluation tool for digital learning aids Assesses quality across four key areas Criteria for quantifying results: stability, user comfort, content, interactivity Enables effective evaluation of complex educational tools Ensures comprehensive assessment of product quality	Karolcík, Š., Cipková, E., Hrušecký, R., & Veselský, M. (2015).[68]
	Best practices in e-assessment.	**E-portfolios**: Dynamic tool for showcasing skills (lesson plans, reflective entries) Enhances employability by demonstrating mastery of essential principles Introduced in the Department of Business, Management, and Accounting Aligns with student learning outcomes Uses multiple assessors and rubrics for flexible, accessible assessments Enhances teaching quality and facilitates continuous review	Buzzetto-More, N. A., & Alade, A. J. (2006).[69]

What Are the Advantages or Benefits of Electronic Assessment?

Assessment is integral to the learning process and is a vital component of instruction. It is the paramount factor that affects pupil learning. Benson asserts that the concepts of assessment remain constant in an online context; nevertheless, the methodologies employed should align with the characteristics of online learning, which assigns greater responsibility to the student for their education. Robles and Braathen (2002) [71] elucidate the transformation that occurs with the transition to online learning, wherein the student assumes responsibility for their education while the instructor facilitates communication and interaction among peers. Liang and Creasy [72] assert that assessment methodologies employed in an online context should align with the characteristics of online learning, such as fostering self-directed learners and positioning the teacher as a facilitator. E-assessment encompasses providing immediate feedback to students, enhancing student performance, minimizing the teacher's time and effort, reducing institutional costs, and promoting

higher-order thinking, which constitutes a fundamental educational objective [73]. E-assessment encountered challenges including inadequate technical infrastructure, student unfamiliarity with computers, a high student population, and rapid technological advancements. Automated assessment was necessary to ensure equitable grading, expedite question evaluation, and minimize time expenditure and human effort in the assessment process.

Information and Communication Technologies have consolidated the world into a singular space, facilitating more efficient and rapid operations. Likewise, e-assessment has rendered evaluations more developed, precise, and expedient in comparison to conventional, time-consuming paper-based methods [74,75,76]. Several studies reported many advantages of e-assessment, such as providing more accessible, flexible, efficient and convenient assessment experiences for learners, teachers and institutions [77,78,79,76,80] being fast and easy to use, providing students more control [81], friendly interfaces and recreational experiences [82,83] providing immediate feedback compared with paper-based test that improves the learning level [84] increasing the students' motivation to enhance their performance (study in University of Winchester) [84] saving teachers' time [84,82,81,78,2]; adding more value to students' learning [78] saving valuable time for the institutions [84,82,78,2]; easing tracking students' performance [56]; making assessment fast and accurate [82]; reducing the teachers' burden to assess large number of students [101] helping teachers to improve the quality of feedback for the students [82] adding a higher level of security to assessment procedures [78] and finally supporting high-order thinking skills such as critiquing, reflection on cognitive processes and facilitating group work projects [82].

Research indicated that undergraduate students preferred electronic examinations over traditional assessments and generally held favorable attitudes towards e-assessment [85,78]. The item with the highest mean score was: "Online assessment provides immediate feedback regarding my performance," which was recognized as a significant benefit of e-assessment, receiving unanimous agreement from the students [82,85].The second item that received a high mean score was "Online assessment provides an opportunity for impartial grading," which has also been identified as an advantage of e-assessment [82]. Participants in this study contended that the e-assessment necessitates no prior abilities and does not promote cheating. The findings indicated that involvement in e-assessment does not influence students' perceptions of e-assessment, aligning with the results of [86].

Certain assessment formats, including multiple-choice, true/false, matching, and fill-in-the-blank questions, can be readily evaluated by a system due to their straightforward design and implementation. However, free-text responses enhance students' writing abilities and reduce the incidence of academic dishonesty. Evaluating essay responses and short answers necessitates textual analysis and comprehension, rendering its implementation and design a challenging and intricate endeavor. E-assessment, or electronic assessment, offers several advantages compared to conventional paper-based

methods. It offers accessible, adaptable, efficient, and convenient assessment experiences for learners, educators, and institutions.

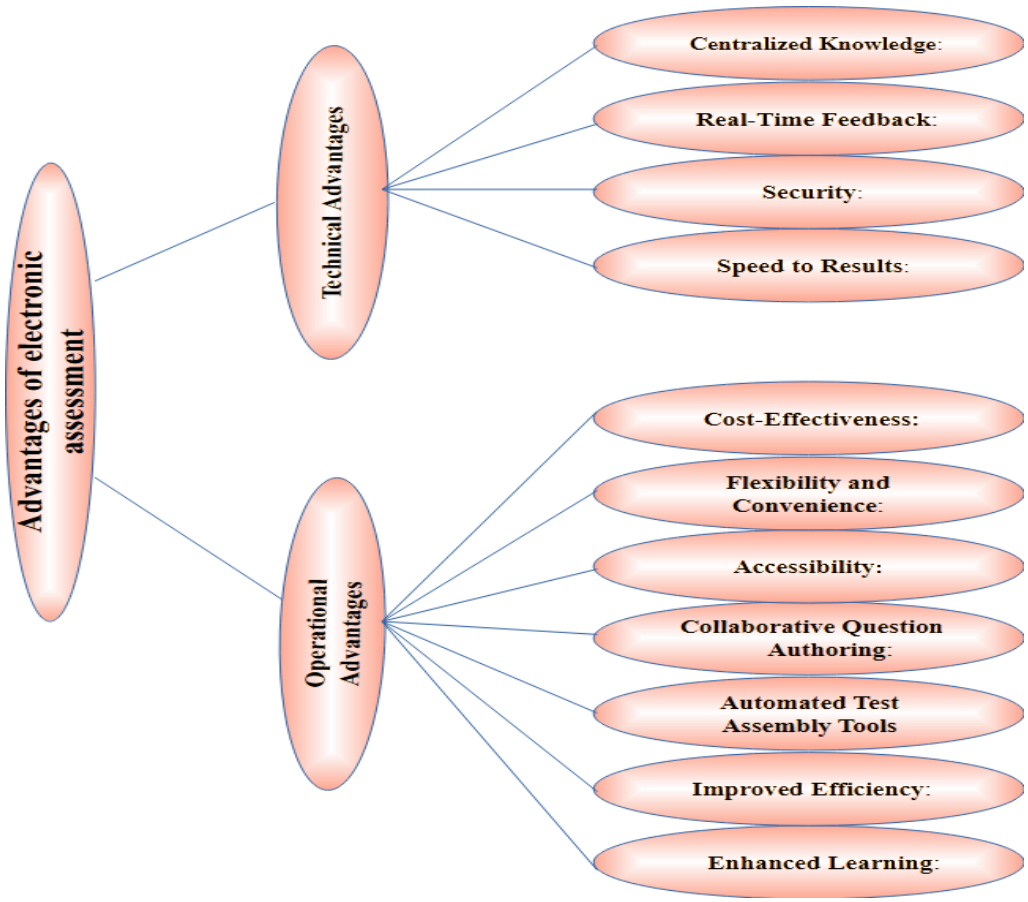

Figure 3 . Advantages of Electronic Assessment

Technical Advantages

Centralized information: E-assessment platforms consolidate all Subject Matter Expert (SME) information in a uniform manner, facilitating accessibility and mitigating the risk of knowledge attrition upon the departure or retirement of SMEs. This centralization facilitates adaptive pathways for participants, permitting them to engage in practice or examinations at their respective levels, with difficulty tiers associated with the questions. E-assessment offers a genuine experience for users, enabling them to utilize a computer in a comfortable manner, hence diminishing the necessity for manual editing tools. Accelerated Outcomes: E-assessment facilitates expedited grading and dissemination of results, offering instantaneous feedback and continuous insights from test outcomes. Security: All online examination papers, candidate information, scores, and results are digitally archived, thereby enhancing security and mitigating the danger of misplacement,

theft, or loss. Immediate Feedback: Online tests offer instantaneous feedback, facilitating prompt and efficient review and analysis.

Operational Advantages

Cost-Effectiveness: Online assessments obviate the necessity for tangible materials, hence substantially decreasing expenses in comparison to conventional paper-based exams. Automated grading eradicates human mistake and bias, guaranteeing equitable and precise assessment. Flexibility and Convenience: Online examinations can be completed remotely and at any time, negating the necessity for test takers to visit to a physical test facility. This flexibility facilitates the scheduling and administration of examinations at the test taker's convenience, thereby alleviating stress and anxiety. Accessibility: Online exams can be modified for candidates with impairments by adjusting font size, background color, and providing more time for specific accommodations. Collaborative Question Authoring: Online education enables collaborative question creation, establishing transparent protocols for the review and approval of questions prior to their inclusion in the question bank. Automated Test Assembly methods: Following the approval of a question bank, examination papers can be efficiently generated by picking questions or utilizing automated methods for the creation of randomized assessments. Enhanced Efficiency: Online assessment technologies augment system efficiency, alleviating faculty workload and enhancing flexibility in examination procedures. Improved Learning: E-assessment technologies allow educators to establish learning standards, monitor student performance, and detect learning deficiencies, thereby improving student learning outcomes.

What are the results of electronic assessment?

Suggestions for enhancing educational practice encompass augmenting teachers' proficiency in utilizing e-portfolios, refining e-portfolio pedagogical approaches, increasing the significance of portfolios in evaluations, offering ongoing technical assistance, and emphasizing collaborative projects over individual portfolio assignments. Additionally, it underscores the necessity of utilizing rubrics in conjunction with portfolios to preserve a beneficial impact on the creative process. The highest-rated finding indicated that rubrics improved evaluation transparency, and the study recommends additional techniques to mitigate initial opposition to the portfolio, with rubrics being one such strategy [45].

CONCLUSION

Information technology and communication technologies are ubiquitous in all social domains, including education, due to the necessity of acquiring information from beyond geographical boundaries. Such technologies offer higher education institutions the opportunity to improve the learning environment for students, as well as the management and administration of program and module delivery and support. The introduction of e-learning is one of the advancements to the learning environment. eLearning is the

acquisition and application of knowledge disseminated and facilitated predominantly through electronic channels. The Commission on Technology and Adult Learning characterized e-learning as the instructional content or learning experiences facilitated by electronic technology. It integrates a diverse array of learning methodologies and technologies. A diverse array of technologies include e-learning, ranging from students utilizing email and accessing coursework online while attending campus courses to programs delivered fully online. This form of ICT-enhanced learning is "increasingly dominant in higher education" [87]. The shift from conventional to contemporary assessment methods is substantial, since automated assessment offers flexibility and prompt response to students, so conserving instructors' time and minimizing work in the evaluation process. The review indicates the promise of computer-based testing in blended learning contexts, presenting benefits over conventional paper-based approaches, including instantaneous feedback, flexibility regarding location and timing, and enhanced involvement. The review advocates for the enhancement of automatic formative assessment systems in online blended learning contexts for subsequent study. The study emphasizes the necessity of resolving connectivity challenges and delivering sufficient staff training, which includes access to computers when needed, as well as ensuring that training include the end consumers of the assessment data. indicates that the effective use of electronic assessment tools necessitates overcoming obstacles such as inadequate access to technology, insufficient training and assistance, and a lack of comprehension regarding the consequences associated with the software's use. emphasizes the necessity of ensuring that the implementation of evaluation tools does not impose a further burden on an already overextended workload, and that sufficient resources are allocated to facilitate the adoption and utilization of these technologies. The advantages of e-assessment in education are considerable. E-assessment facilitates immediate and personalized evaluation, aiding pupils in comprehending their advancement and enhancing their self-assurance. It also facilitates students in obtaining prompt and pertinent feedback, which is frequently absent in conventional evaluation systems. Moreover, e-assessment can direct students to supplementary resources, enhance digital literacy, engage learners, and furnish educators with real-time, comprehensive learning analytics. Moreover, e-assessment corresponds with the changing educational scene, highlighting the necessity for creative pedagogical methods and the incorporation of technology to improve learning results. The transition to e-assessment is essential for addressing contemporary educational difficulties and fostering lifetime learning opportunities. The shift to computerized assessment, especially the utilization of mobile devices for practical skills evaluations (EOSCES), is expanding in the education sector owing to its considerable advantages, despite certain technological and financial obstacles. The incorporation of educational content types into a general-purpose CMS has proven effective, resulting in enhanced teaching and learning outcomes, along with the capacity to reuse and customize educational materials.

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