Opportunities and Challenges for Integrating Technology and Assessment in Learning: A Systematic Review

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Abstract **– The integration of technology and assessment in learning has the potential to optimize student learning outcomes. This study examines articles on technology and assessment in learning to identify the opportunities and challenges of integrating them into learning. A systematic review approach was used to review 44 selected articles. The systematic review found that incorporating technology and assessment into education has been accelerated. Some of the opportunities that teachers have when integrating technology and assessment in the classroom are to provide better formative feedback, to create more interactive and adaptive assessments, to add value to tests and assignments, to raise the effectiveness and efficiency of assessments. However, there are still several barriers that educators and learners have to overcome when trying to integrate technology and assessment. Other pedagogical and contextual issues include technical limitations, assessment design, teacher and learner preparedness, ethics and equity, ongoing adaptation, and teacher competence. The opportunities and challenges identified can be used as a basis for implementing the integration of technology and assessment in learning.**

Keywords **– Assessment, formative assessment, formative feedback, learning, technology.**

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1. Introduction

Initially, teachers use assessment only to measure student achievement. Nevertheless, the function of assessment has expanded from simply measuring student performance to being one of the processes that can support the achievement of a student's learning process. Research focusing on the field of assessment has found many benefits of assessment in the learning process [1]. Assessment has served as a basis for providing feedback, strengthening metacognitive skills [2], and influencing students' thinking [3]. The role of assessment has been an important component in encouraging students to achieve the specified knowledge, skills, and values competencies.

As assessment has evolved, advances in information technology have directly impacted changes in education, particularly in the area of assessment. Manual assessment has been transformed into a more dynamic assessment. Technology has begun to transform paper-and-pencil-based assessment into technology-based assessment and has changed the way student understanding is measured [4]. The development of technology-based assessments has increased the effectiveness of their use through faster data collection, more accurate data processing, and more detailed descriptions of students' skills and performance. It is, therefore, essential to examine the development of assessment and its integration with technology, the opportunities and challenges, and how the integration of technology and assessment will affect learning in the future.

Many studies have shown the crucial role of assessment in improving students' educational attainment, facilitate the choice of strategies to be used in learning, and strengthen students' involvement in learning. In short, assessment plays an important role in students' academic performance.

Furthermore, systematic literature reviews on the development of assessment have been widely conducted and have identified various important aspects of learning assessment, such as the relationship between educational attainment with self-assessment, and formative assessment. Other systematic literature reviews cover topics such as the relationship between assessment and learning outcomes, the alignment of assessment with the assessment of others [5], the relationship between assessment and self-regulated learning, the usefulness of assessment [6], and factors influencing the implementation of assessment [7]. Other systematic literature reviews also indicate how assessment instruments should be developed in the future. Assessment Instruments must take into account their proven validity and reliability, the concept of the material being assessed, and their effectiveness and efficiency [8]. However, the existing literature review has not discussed the integration of technology and assessment in learning in a detailed and comprehensive way. The integration of technology and assessment refers to the practice of applying technological tools to facilitate the implementation of assessment in the classroom.

This systematic review aims to fill this gap.

It attempts to address the questions outlined below:

1) How is the assessment paradigm changing in learning?

2) How technology and assessment integration are developing and their different contributions?

3) What are the opportunities for technology and assessment integration?

4) What are the challenges faced in the process of technology and assessment integration?

Therefore, this systematic review was conducted to synthesize and discuss research evidence on the necessity of integrating technology and assessment, and the opportunities and challenges of integrating technology and assessment in learning. Broad and in-depth insights into this topic can be used by educators and educational practitioners to guide the integration of technology and assessment in learning in the future. This systematic review begins with an explanation of the methods used.

2. Methodology

This study used a systematic literature review. Articles were searched and selected according to the research question, and the review results of all selected articles were compiled inductively. In detail, the research design, article search and selection, and data analysis are as follows.

2.1. Research Design

This literature review uses the systematic literature review method described by Petticrew and Roberts [9], with systematic, structured, and comprehensive procedures. This study begins with the definition of questions and problems, followed by the delineation of the database for searching literature. In the next step, several inclusion criteria were proposed as a basis for the selection of relevant scientific articles. Selected relevant articles were reviewed in detail using a special data form to record important information from the articles. This facilitates the process of assessing the quality of the selected articles and the synthesis process to explain the questions raised.

2.2. Article Search and Selection

The process of searching for and selecting articles is shown in Figure 1. This process includes identification, screening, eligibility assessment, and inclusion processes.

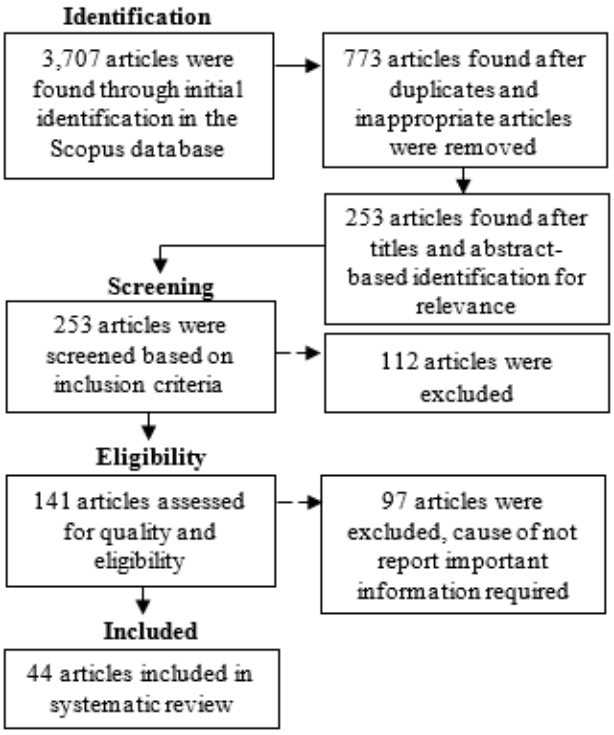

Figure 1. Diagram of article search and selection

The initial identification in the article search process identified 3,707 articles. These 253 articles were selected based on the matching of the titles or abstracts of the initial 3,707 articles to the research question and the identification of duplicate articles. Further screening was performed using the inclusion criteria, resulting in 141 full-text articles. These 141 articles discussed the use of different technologies in the learning process.

Furthermore, the eligibility of the 141 full-text articles was assessed based on the availability of key information to determine which articles were worthy of review. Articles with insufficient information were not included in the review process. In the end, 44 articles were identified for review.

Scientific article documents were searched only in the Scopus database using several keywords, including assessment, summative assessment, formative assessment, assessment as learning, assessment for learning, diagnostic assessment, assessment of learning and technology, and other related terms. In addition to using these terms, the literature search was narrowed down using Boolean operators such as AND, OR, and NOT. All articles found were systematically selected according to the inclusion criteria.

The following inclusion criteria were set:

1) Documents are limited to the form of research articles published in Scopus journals in the period 2016 to 2025 to ensure the quality of the articles. Documents in the form of conference papers, conference reviews, books, book chapters, and other scholarly documents are not included in the systematic review section.

2) Articles report on the integration of technology and assessment in learning.

3) Articles available in full-text. Meanwhile, the assessment and review of articles have used a special form. The selected article data form contains key research information, including general information consisting of title, author, and country; research design, including research questions, methods, research samples, and instruments used; assessment and type of technology used; and main research findings.

The results of searching for articles using a multi-stage selection process are shown in Table 1.

Table 1. Result of article selection for review

Article selection process	Number of articles found
The first identification	3.707
Screening process	253
Eligibility valuation process	141
Articles found for review	44

2.3. Data Analysis

The results of the synthesis and review are compiled inductively based on three issues, namely the development of assessment and its integration with technology, the opportunities for integrating assessment and technology in the future, and the challenges of integrating assessment and technology. Several researchers carry out the process of data acquisition, synthesis, and review together to reduce bias in the study [10], [11].

3. Results and Discussion

An overview of the reviewed articles that discussed the integration of assessment and technology in learning in the period from 2016 to early 2025 is shown in Table 2. In general, the articles have discussed changes in the assessment paradigm, as well as the integration of assessment and technology in learning.

Table 2. Overview of articles reviewed

Reference	Research context			Assessment context	
	Design	Subject	Country	Tool	Types
[12]	QTR	Mathematics	Spain	Moodle	FA
[13]	D&R	Intrapreneur	Germany	n.a	DA
[14]	D&R	Law	United Kingdom	Video games	FA, SA
[15]	QLR	English language	United States	CyWrite (a web-based tool)	AfL, FA
[16]	PA	Multidisciplinary	United Kingdom	MOOC, online videos, social media	FA, SA
[17]	CS	Multidisciplinary	China	Moodle	AfL, AoL
[18]	QTR	n.a	United States	Quizzes	FA
[19]	DCSS	Health sciences	Sri Lanka	Kahoot	FA
[20]	QLR	English language	Colombia	ICT tool/ n.a	FA, SeA, PA
[21]	QLR	Mathematics	Australia	Maple (computer algebra), LaText, PDF form	FA
[22]	QLR	Business, Political science, Dentistry	United States	Plickers	FA
[23]	QTR	English language	Malaysia	Kahoot	FA, SA
[24]	CS	n.a	India	Plickers	FA
[25]	QLR	Physical Education	United Kingdom	Digital video	FA
[26]	QLR	Kindergarten	United States	KEA Digital	FA
[27]	QTR	Medical Sciences	Barbados	Firecracker	FA
[28]	QLR	Science, Language	Ireland	JCQuest	AfL
[29]	QTR	Engineering	Egypt	Gamified e-quizzes	FA
[30]	QTR	English language	China	Cctalk, MuClass tasks	FA
[31]	QTR	Science, Art	African	CBA	SA
[32]	QTR	Physical education	Spain	Plickers	AA
[33]	QE	Computer science	Japan	CAT	FA
[34]	CR	n.a	United States	CBFA	FA
[35]	MM	Chemistry	Ethiopia	TIFA	FA
[36]	QTR	Web Programming	Turkiye	Web	FA, SA
[37]	CS	n.a	United Kingdom	Digital games	n.a
[38]	D&R	Nursing education	Morocco	NursE-Quiz (a mobile educational application)	FA
[39]	CCR	Engineering, Information technology, Animation	Malaysia	Kingdom Quizzes (android-based formative assessment mobile application)	FA
[40]	LA	Biology	Israel	MOOC	n.a
[41]	CS	Mathematics	United Kingdom	CAA	FA
[42]	QLR	Mathematics	Sweden	CBFA	FA
[43]	MM	Language	Iran	CFA	FA
[44]	CS	Academic writing	Japan	OMFA	FA
[45]	QE	English language	China	GFA, Quizizz	FA
[46]	CS	Mathematics	Sweden, Italy	CAA	n.a
[47]	DCSS	English language	Japan	WELL	FA
[48]	QTR	n.a	Philippines	ICT tool	FA
[49]	MM	Economics	Indonesia	Moodle, Quizizz, Kahoot	FA
[50]	D&R	Mathematics	Germany	ItemForge, AI	FA, SA
[51]	QTR	Mathematics, Science	Saudi Arabia	Kahoot, Quizizz, Quizlet, Socrative, Padle	FA
[52]	QLR	n.a	Netherlands	AI	SA
[53]	QLR	n.a	Iraq	Blockchain technologies, AI	SA
[54]	QE	Engineering education	Turkiye	Gamified online quizzes	FA
[55]	D&R	n.a	Germany	AI	FA

Note: Quantitative research (QTR), Qualitative research (QLR), Quasi experimental (QE), Descriptive cross-sectional studies (DCSS), Case study (CS), Correlational research (CR), Cross-sectional & correlational research (CCR), Mixed methods (MM), Development and research (D&R), Phenomenographic approach (PA), Learning analytics (LA), Formative assessment (FA), Summative assessment (SA), Authentic assessment (AA), Assessment for learning (AfL), Assessment of learning (AoL), Self-assessment (SeA), Kindergarten entry assessment (KEA), Computer-based Assessment (CBA), Computerized adaptive testing (CAT), Computer-based formative assessments (CBFA), Technology-integrated formative assessment (TIFA), Computer-Aided Assessment (CAA), Computerized Formative Assessment (CFA), Online module for formative assessment (OMFA), Gamifed Formative Assessment (GFA), Web-Enhanced Language Learning (WELL), Artifcial intelligence (AI), Specific information not available (n.a)

3.1. Shifting of the Assessment Paradigm

Research trends on assessment topics in the period 2016 to 2024 are generally shown in Figure 2. Over the past decade, research on assessment in learning has been dominated by discussions on formative assessment, followed by discussions on assessment for learning, summative assessment, diagnostic assessment, assessment of learning, and assessment as learning. This explains that formative assessment is one of the topics that is of concern to researchers.

This positive development is in line with the paradigm shift from assessment of learning to assessment for learning and assessment as learning [56]. In the context of learning assessment, the changing perception of assessment as an integral part of the learning process has increased research on formative assessment practices in learning. Figure 2 provides evidence of the development of assessment research to date with a focus on formative assessment. Research on formative assessment reached 76% overall (FA: 59%, FA and SA: 13%, FA and others: 4%). The large number of studies on formative assessment reflects that formative assessment plays an important role in the evaluation of student learning and development [57], and making it one of the main pillars in education [58]. Formative assessment can have several positive effects because of the feedback activity to students in practice. Feedback is the main tool of formative assessment in learning, which distinguishes it from other assessments [59]. However, fast and accurate feedback can only be done well if teachers use technology as a tool in the process of implementing formative assessment.

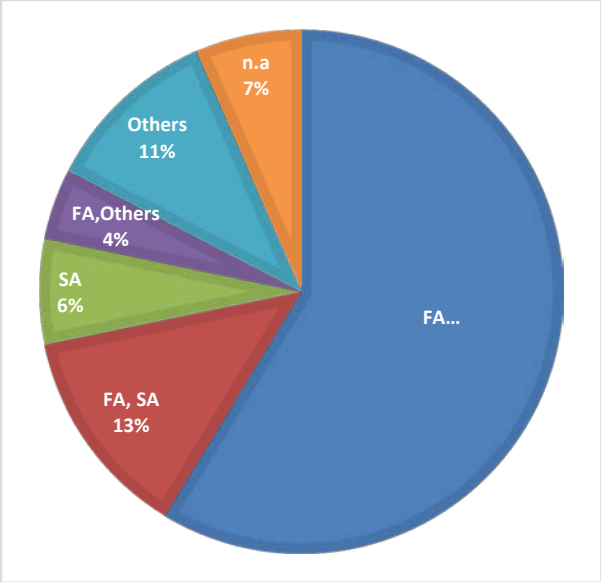

Figure 2. Research trends of assessments used

3.2. Integration of Assessment and Technology in Learning

In line with the development of technology, research on the use of technology in learning assessment has begun to emerge. The integration of assessment and technology in learning is undertaken to support the assessment process, maximize the learning process [60], and improve student learning outcomes [53].

From 2019 to the present, there has been an acceleration in the integration of technology and assessment in learning. One of the factors driving this acceleration is the Covid-19 pandemic [28], and the development of technology, which has become an inseparable part of global education [61]. Various technological tools, especially those used by teachers in the context of assessment to improve the quality of learning from 2016-2025, are shown in Table 3.

Table 3. Technological tools used in the context of assessment

Year	Tool
2016	CBA, Moodle.
2017	Video games, e-portfolios.
2018	CyWrite (a web-based tool), eye trackers, MOOC, online videos, social media, web, electronic management of assessment, Moodle.
2019	Quizzes, Kahoot, Maple (computer algebra), LaText, PDF form, Plickers.
2020	Plickers, Digital video, KEA Digital, Firecracker.
2021	JCQuest, Gamified e-quizzes, Cctalk, MuClass tasks, CBA.
2022	Plickers, CAT.
2023	CBFA, TIFA, Web, MOOC, Digital games, NursE-Quiz (a mobile educational application), Kingdom Quizzes (android-based formative assessment mobile application).
2024	CAA, CBFA, CFA, OMFA, GFA, WELL, Moodle, Quizizz, Kahoot, Quizlet, Socrative, Padle, Gamified online quizzes, ItemForge, Blockchain technologies, Artifcial intelligence.
2025	Artifcial intelligence.

In general, technological tools used in the assessment can be divided into three clusters, including computer-based assessment and digital platform-based assessment (around 2016-2022), mobile application-based assessment (around 2023), blockchain technology-based assessment, and artificial intelligence-based assessment (around 2024-2025). The use of technological tools in assessment, in line with technological developments, strengthens the evidence that the integration of assessment and technology in learning is very important in the world of education [62].

In addition, various studies on the integration of assessment and technology in learning have made important contributions to the body of knowledge, especially in the field of education.

The articles reviewed in the context of the integration of assessment and technology in learning made contributions to knowledge related to learning, and their main findings are presented in Table 4.

Contributions to knowledge related to learning include the framework for the practice of integrating assessment and technology, the practice and design of integrating assessment and technology, and Empirical evidence of the positive contribution of the implementation of the integration of assessment and technology.

Table 4. Overview of essential results and contribution of articles reviewed related to the integration of assessment and technology in learning

References	Essential results	Contribution
[12]	Formative assessment using technology has a positive impact by providing quick and accurate feedback to students.	Emphasize the importance of technology to support the implementation of formative assessment to speed up the feedback process.
[13]	Validation of the development of technology-based diagnostic assessments.	Outline principles for designing technology-based diagnostic assessments.
[14]	The use of video games effectively assesses students' multiple intelligences and provides a positive learning environment.	Demonstration of the potential of video games for improving the quality of assessment and learning.
[15]	The use of technology in the implementation of assessment allows a detailed analysis of the process, insights, habits, and strategies of students' writing.	Demonstration of the effectiveness of technology in formative assessment processes to provide detailed insights into how it is used to enhance the learning process.
[16]	Conceptual framework for e-assessment practice and its impact on the learning process.	Explain the importance of using e-assessment to support better assessment.
[17]	Teachers understand that technology can help them in the assessment process, particularly in providing fast and accurate feedback.	Understanding the complexity of teachers' understanding of technology's role in assessment.
[20]	The implementation of assessment in English language learning is supported by effective information technology.	Recommendations for using information technology in conducting assessments.
[18]	The effectiveness of using technology in formative assessment is influenced by the technology used, and the appropriateness of the device used to the course content.	The appropriateness of technological tools to course content and teaching style is the main topic of discussion.
[19]	Students were positive about the use of technology (Kahoot) in assessment and recommended its use in the formative assessment process.	Presentation on using Kahoot as a technology-based formative learning assessment tool.
[21]	The use of LaTeX, PDF form, and Maple in the context of formative assessment can increase student engagement in mathematics learning.	Description of a new approach to assessment using LaTeX, PDF forms and Maple.
[22]	Using Plickers in assessments can increase the diversity of student responses, thereby encouraging active learning and improving students' information literacy.	The showcasing of Plicker's capabilities facilitates formative assessment practices for formative assessment.
[23]	The use of Kahoot as an interactive learning assessment platform has a significant impact on student performance.	Present empirical evidence on the effectiveness of assessment using Kahoot.
[24]	Plickers is described as a web-based technology that is easy to use, efficient, and engaging for teachers and students.	Demonstration of Plickers as a web-based technology for formative assessment practice.
[25]	The use of digital video synchronized with formative assessment increases student engagement, particularly in the feedback process when implementing learning assessments.	Exploring student engagement with live video feedback synchronized with formative assessment.
[26]	Integration of digital technology in kindergarten entry assessments.	A comprehensive report on the integration of digital technology in kindergarten entry assessments.
[27]	The integration of e-learning platforms and formative assessment has a positive impact on the feedback process and student engagement in learning.	Empirical evidence from the use of e-learning platforms as formative assessments correlates with better learning outcomes.

References	Essential results	Contribution
[28]	The implementation of assessment for learning using JCQuest is influenced by digital literacy, access to technology and pedagogical beliefs.	Insight into the integration of assessment for learning and technology in learning.
[29]	The integration of assessment and technology in the form of gamified e-quizzes can improve academic performance, student engagement in learning, and the effectiveness of learning assessment.	The development of gamified e-quizzes provides insight into the importance of innovative approaches to teaching and assessment.
[30]	Technology-based assessment activities using MuClass tasks/quizzes were very positively perceived by students, particularly in terms of increasing their engagement.	Exploring technology-based formative assessment as an effective learning intervention to increase student engagement.
[31]	Student satisfaction with the use of CBA is strongly influenced by willingness to use technology and other factors that require further research.	A detailed explanation of the quality factors that influence student satisfaction with CBA.
[32]	The Plickers application in assessment practice was positively received by students and increased the efficiency of the student assessment process.	The integration of technology, in particular Plicker, into learning assessment practice has improved the quality of student assessment.
[33]	Assessment systems using technology increase student motivation and engagement in learning.	Introduction of an adaptive formative assessment system using assessment algorithms and learning memory cycles.
[34]	The use of CBFA is positively correlated with teachers' perceived comfort and benefits.	Understanding of CBFA practices, comfort and benefits received by teachers.
[35]	Technology-integrated formative assessment has a significant impact on students' conceptual and procedural knowledge of chemical equilibrium.	Insights into the benefits of technology-integrated formative assessment.
[36]	Student behaviour in online formative assessment practices shows positive things, especially in their involvement in learning assessment.	A framework for analysing student behaviour in online formative assessment.
[37]	Game-based assessment practices in the form of virtual reality and augmented reality that are structured and efficient for educators.	Framework for implementing virtual reality and augmented reality assessments.
[38]	A mobile educational application called NursE-Quiz to improve the quality of learner-centred formative assessment.	Development of technology-enhanced formative assessment.
[39]	The main reasons for using Kingdom Quizzes are the ease, convenience, and benefits of using the learning application.	Insights into the key factors that influence students to use gamified formative assessment applications.
[40]	A MOOC assessment model reduces academic dishonesty and increases student engagement in learning assessment.	A study of the impact of a MOOC assessment model on academic dishonesty and learner engagement.
[41]	CAA has the potential to make a positive contribution to learning with certain materials.	Insight into the use of CAA in learning.
[42]	CBFA effectively supports problem-solving, reasoning, students, and their interactions with technology in learning.	Understanding CBFA can improve problem-solving and reasoning skills in learning.
[43]	CFA is a reliable, well-structured instrument that effectively reflects the intended construct.	Framework for using CFA in learning.
[44]	An online formative assessment module has a positive impact on improving student performance.	Design an online module specifically for the formative assessment of writing skills.
[45]	A gamifed formative effectively improves student performance, engagement and motivation in formative assessment.	Insight into gamifed formative specifically through the Quizizz platform.
[46]	Computer-assisted assessment is effective in assessment practice, and providing immediate feedback.	Developing innovative feedback mechanisms in computer-assisted assessment.
[47]	Formative assessment using ICT tools effectively increases student engagement, feedback, and student learning outcomes.	Understanding of ICT tools in supporting formative assessment practices.

References	Essential results	Contribution
[48]	ICT-based assessments on different platforms have received positive responses and are effective in increasing student motivation.	Identify ICT-based assessments specifically designed for physical education.
[49]	Integrating gamification into distance learning assessment can increase student engagement, togetherness, collaboration, and motivation.	A comprehensive analysis of how gamification can be effectively integrated into distance learning assessment.
[50]	ItemForge (a Python-based web application) is capable of producing high quality items that are aligned with the selected concept and target cognitive level.	Development and validation of assessment instruments using ItemForge.
[51]	The effectiveness of formative assessment and technology integration is positively correlated with student learning outcomes when managed effectively.	Empirical evidence on the effectiveness of technology-mediated formative assessment in secondary schools.
[52]	Perspectives on summative assessment using artificial intelligence in terms of increasing efficiency, speeding up the process, and reducing human bias.	Teacher and student perspectives on summative assessment using artificial intelligence.
[53]	Emphasize the need for a framework for integrating summative assessment and technology in learning.	Develop a framework for summative assessment and its integration with technology in outcomes-based education.
[54]	Integrating formative assessment and gamification into learning significantly increases student engagement.	Empirical evidence of the positive impact of integrating formative assessment and gamification into learning.
[55]	Analysis of the degree of truth of AI use in formative assessment.	Introduction to methods of using AI in high quality formative assessment.

The framework for implementing assessment and technology integration emphasizes the importance of the use of technology and the role of teachers, the principles for designing assessment and technology integration, the practice of using technological tools, and the behaviour of teachers and students. This framework provides a roadmap for the practice of integrating assessment and technology and is aligned with the broad goals of education. This roadmap ensures that the practice of integration promotes effectiveness and efficiency in the assessment of learning and improves the overall quality of learning. The practice of integrating assessment and technology is widely undertaken using available digital platforms and other technologies, such as the practice of using Kahoot, Plickers, Quizzes, Moodle, LaTeX, PDF forms, and Maple in formative assessment.

In addition, researchers have developed many designs for integrating assessment and technology, such as the development of gamified e-quizzes, the development of assessment tools using ItemForge, the development of innovative feedback mechanisms in computer-assisted assessment, the development of NursE-Quiz, and the development of Kingdom Quizzes. Other contributions and key findings are the presentation of empirical evidence of the positive impacts of the practice of integrating assessment and technology in learning.

Some of these positive impacts include increased participation and involvement, quality of learning processes, listening, reading, and writing skills, problem-solving skills, and student learning outcomes. However, the practice of integrating assessment and technology in learning still offers opportunities and challenges for the future.

3.3. Opportunities for Integrating Assessment and Technology in Learning

The integration of assessment and technology in learning is important in education [63]. In the 21st century, the practice of integration offers several opportunities, including refining formative feedback, interactive and adaptive learning design, enriching tests and assignments, improving the efficiency and effectiveness of assessment, boosting student engagement in learning assessment, and increasing insight into the learning process.

(1) Refinement of Formative Feedback: One of the strong features of formative assessment practices is the presence of feedback to students. Feedback is an important part of learning [64]. Feedback focuses on providing students with information to explain their actual learning performance. This information is then used to further regulate the learning process towards the target learning outcomes [65]. Feedback interactions between teachers and students can take the form of discussion, guidance, scaffolding, and other forms of communication. The integration of technology and assessment, especially formative assessment, allows for the automation of constructive feedback directly into learning. Detailed feedback to students and teachers can help students understand the lesson and improve their thinking [46], [47].

(2) Interactive and Adaptive Learning Design: The design of interactive, dynamic, and adaptive assessments to meet different learner needs is very possible through the integration of assessment and technology in learning. Technology can support the implementation of well-designed and structured interactive learning based on educational objectives [66]. An automated assessment system using technology supports the implementation of interactive feedback processes and learning that adapts to different student needs. Increased interactive and adaptive learning will shift traditional teacher-centered learning practices to student-centered learning [38]. Interactive and fun learning practices have been shown to have a positive impact on learning [42], increasing students' attention, curiosity, interest, and critical thinking skills [67].

(3) Enriching Tests and Assignments: The integration of assessment and technology can facilitate the creation of more varied, interactive, and complex test items to assess knowledge, critical thinking, and problem-solving skills. Dynamic and interactive test items often cannot be created well using traditional methods. This is due to the limitations of traditional methods with their one-size-fits-all questions. Dynamic assessments allow assessments to automatically adapt to student responses. Assessments are adapted to students' abilities, learning styles, interests, and cultures, so the assessment tools developed will have a large number of highly varied test items.

(4) Improving the Efficiency and Effectiveness of Assessment: The integration of technology and learning assessment in the context of large-scale testing can simplify the process of test development, administration, scoring, and reporting, making the assessment process more efficient and effective [68]. This integration can improve assessment consistency, increase the speed of the assessment process, reduce human error, and reduce costs. In addition, technology supports assessment practices on a large scale and with large groups, and the analysis process is fast and accurate, accompanied by a variety of feedback to students [69].

(5) Boosting Student Engagement in Learning Assessment: Student engagement in learning assessments, can be improved by integrating assessment and technology. Technology, in the form of digital applications and platforms, can improve the interaction process in the classroom, simplify the creation and assessment of assignments, and provide direct feedback, thereby increasing student engagement. Actively involving students in learning is an important component in improving their performance [54]. Involvement in completing assignments, either independently or in groups; being involved in class discussions about the completion of tests or lesson topics; and being involved in practical activities are forms of student involvement in the learning process. This student involvement will have a positive impact on student performance [47] and learning outcomes [45].

The opportunities for integrating assessment and technology in learning are very well being realized. This is because technological advances continue to develop rapidly. Technology provides various tools and digital platforms to support the implementation of quality learning assessments. Even in recent years, blockchain technologies and artificial intelligence have started to be used in learning assessment practices. However, the opportunity to maximize the integration of assessment and technology in learning faces several challenges in the future.

3.4. Challenges for Integrating Assessment and Technology in Learning

The integration of assessment and technology in learning presents a diverse set of challenges that educators, developers, and institutions need to address. These challenges include accessibility issues, technical difficulties, digital literacy, teacher or student resistance to change from traditional methods, and the need for adequate training and support for effective implementation. Generally, these challenges can be categorized as technical, pedagogical, and contextual.

(1) Technical Challenges: The most common challenges in integrating assessment and technology in learning are technical. These challenges include infrastructure and accessibility, usability issues, and data management. These challenges are often found in developing and underdeveloped areas.

a) Infrastructure and Accessibility: Infrastructure and access to technology resources, which are uneven in some areas, are significant barriers [28]. Students and teachers in rural or low-income areas may not have adequate technology-based tools and internet connectivity to effectively conduct technology-based assessments. Inadequate internet access and technology devices have affected the use of information and communication technologies [48]. Infrastructure and accessibility issues have also affected the implementation of technology in learning [49].

b) Usability and Data Management Issues: The problem of usability of technological tools is an issue that hinders the implementation of the integration of assessment and technology in learning. The effectiveness of integrating assessment and technology can be hampered by technical difficulties in using technological tools [53], and lack of standard protocols for its implementation in learning. For example, the difference between the physics notation entered by students in the digital platform and the notation in general. This difference will lead to adjustments or debugging. This is because the learning platform used does not recognize the variation in notation entered by students [41]. In addition, the use of increasingly complex digital platform tools on a large scale will be a complicated and complex problem. Issues of data management, data interpretation, and translating raw data into meaningful insights are some of the problems that will arise.

(2) Pedagogical Challenges: The pedagogical challenges of implementing the integration of assessment and technology in learning are strongly influenced by changes in the mindset of teachers. From being used as a tool to measure or grade student learning in the classroom, assessment has become an inseparable part of classroom learning. This is also driven by recent technological developments that have helped in the implementation process. Some pedagogical challenges in general include teacher competence and training, and assessment design.

a) Teacher Competency and Training: Many teachers and trainers may not have the necessary digital skills [31] or have never been trained to use technology effectively in assessment. In addition, teachers may feel overwhelmed by the demands of technology, both in terms of the time commitment required and their own technological competence [32]. This gap in pedagogical competence may limit the success of integrating assessment and technology in the classroom. The role of schools is therefore necessary to help teachers overcome these challenges. Schools can provide support and professional development for the implementation of assessment and technology integration in learning [34].

b) Assessment Design: Designing the integration of assessment and technology in learning to deliver meaningful, practical, and efficient learning requires careful planning and expertise. Traditional assessment and learning methods may not be implemented well and efficiently in digital formats. The transfer and integration of assessment and technology activities in learning requires careful planning to have a positive impact on students [54]. Assessment design needs to take into account the level of student literacy in the technology or digital platform being used.

(3) Contextual Challenges: In addition to technical and pedagogical challenges, there are contextual challenges. These challenges include teacher and student preparedness, ethical and equity issues, and continuous adaptation.

a) Teacher and student preparedness: Teachers' and students' readiness to engage in technology-enhanced assessment varies widely. Factors such as digital literacy and familiarity with the tools used can affect their performance and the overall effectiveness of the assessment. Low levels of digital literacy among teachers and students, will lead to resistance to the integration of assessment and technology in learning [31].

b) Ethical and Equity Issues: The use of advanced technologies in learning, such as AI in assessment, raises ethical issues, including privacy and potential bias. Ensuring equitable access to these technologies is also a significant challenge. Ethical and equity issues arise from the lack of transparency and predictability inherent in the output of AI systems. This can make it difficult to assess the accuracy and reliability of assessments that use AI to classify responses [55]. The use of advanced technologies in assessments will raise doubts about the results of measuring students' abilities. Whether the measured results accurately reflect students' abilities or are influenced by students' digital literacy levels.

c) Continuous Adaptation: Teachers and schools must continue to adapt to new tools and methods in order to keep pace with the rapid development of technology. This adaptation must be continuous and sustained. Continuous adaptation is resource-intensive and requires a flexible approach to assessment and teaching. Continuous adaptation is a challenge in itself to ensure that the integration of assessment and technology in learning continues to be implemented consistently and effectively [35].

4. Conclusion

Teachers have been integrating assessment and technology into learning for a long time. However, there is still room for improvement and refinement in the practice of integration. Some of the opportunities that teachers have in implementing assessment and technology in learning include refining formative feedback, designing more interactive and adaptive assessments, enriching tests and assignments in assessments, increasing the efficiency and effectiveness of assessments, and increasing student involvement in learning assessments.

However, teachers and students still face several challenges in the practice of integrating assessment and technology. Some of the challenges are technical constraints, including infrastructure and accessibility issues, as well as usability and data management issues. In addition, pedagogical and contextual challenges include issues of teacher competence and training, assessment design, teacher and student readiness, ethics and equity, and ongoing adaptation. Addressing these challenges requires a comprehensive approach and the involvement of many stakeholders; providing infrastructure, supporting teacher development, designing valid and reliable assessment instruments, and ensuring ethical and equitable use of technology.

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