

Rethinking Learning Assessment in Lifelong Education: The Relationship Between Educational Technology and the Sustainable Development Goals

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Abstract: The transformation of education in the 21st century calls for an assessment system that not only measures academic achievement but also supports the continuous development of competencies aligned with the Sustainable Development Goals (SDGs). This study aims to analyse and reconstruct the concept of learning assessment in sustainable education through the integration of educational technology and artificial intelligence. The study employed a Systematic Literature Review (SLR) method in accordance with the PRISMA 2020 guidelines. Data were obtained from Scopus-indexed international articles published between 2020 and 2025. Following a process of identification, screening and selection based on inclusion and exclusion criteria, 10 articles were identified as eligible for in-depth analysis. Data analysis was conducted using a thematic synthesis approach and interpreted through the Context, Input, Process, Product (CIPP) evaluation model. The findings of the study indicate that lifelong learning requires an assessment system capable of holistically measuring 21st-century competencies, including critical thinking, creativity, collaboration, communication and problem-solving. Educational technology plays a key role in creating flexible, adaptive and data-driven assessments. Artificial intelligence enhances the evaluation process through personalised learning, real-time data analysis, and the provision of more effective feedback. The research findings have produced a conceptual framework for continuous assessment that integrates Education for Sustainable Development (ESD), educational technology, artificial intelligence, and technology-enhanced assessment to support the achievement of the SDGs. This study makes a theoretical contribution to the development of future assessment models that are more inclusive, adaptive, and oriented towards educational sustainability.

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Introduction

The transformation of education in the 21st century positions sustainability as one of the key priorities of global development. This commitment is reflected in the Sustainable Development Goals (SDGs), particularly Goal 4 on quality education, which emphasises

inclusive, equitable and sustainable education. In this context, Education for Sustainable Development (ESD) integrates environmental, social and economic dimensions into the learning process to foster the competencies, values and behaviours that support sustainable development (Arsyad et al., 2026; Glavič, 2020). Various studies indicate that the implementation of ESD can enhance learners' awareness of sustainability when supported by a curriculum, learning strategies and an assessment system that are aligned (Nousheen et al., 2020; Vilmala et al., 2022; Thoriq & Mahmudah, 2023).

Advances in educational technology have shifted the paradigm of learning and assessment towards a more personalised, adaptive and data-driven approach (Morel & Spector, 2022). The use of technology through Technology-Enhanced Assessment (TEA) enables real-time data collection, faster feedback, and the implementation of authentic assessments that are more relevant to real-world needs (Chiu & Mok, 2020; Fuller et al., 2022; Jopp, 2020). Advances in artificial intelligence (AI) are further driving this transformation through personalised learning, data analysis, and more accurate adaptive assessment (Lin et al., 2023; Strielkowski et al., 2025; Caspari-Sadeghi, 2023). However, its implementation still requires attention to ethical considerations, academic integrity, algorithmic bias and the digital divide (Crawford et al., 2023; Sok & Heng, 2023).

In the Indonesian context, the transformation of assessment has in fact become a key priority in various education policies. The assessment reforms under the Merdeka Curriculum emphasise the importance of diagnostic, formative and summative assessment as tools for developing learners' competences (Satria, 2024). However, various studies indicate that the implementation of assessment still faces a number of challenges. Efendi et al. (2021) found that assessment practices in schools remain focused on measuring learning outcomes and administering marks. Mundia and Heru (2020) reported that teachers' pedagogical competence in conducting assessment is not yet consistent. Lestari et al. (2024) also found that the assessment instruments used are still dominated by measures of lower-order cognitive skills.

The use of technology in assessment in Indonesia is also not yet optimal. Fitriani (2021) shows that the integration of information technology into learning assessment is still in its early stages and faces limitations in terms of infrastructure and teachers' digital competence. Rahmawati et al. (2022) found that the use of digital platforms such as Quizizz can enhance the effectiveness of learning assessment, but their implementation remains sporadic and has not yet become part of a sustainable assessment system. This situation highlights a gap between global developments in assessment technology and the assessment practices still in place in many educational institutions across Indonesia.

This gap is also evident in Indonesia, where the implementation of sustainable education and 21st-century competence-based assessment has not yet been optimised. Although the concept of sustainability is beginning to be integrated into the national curriculum, assessment practices are still not fully capable of measuring the skills of critical thinking, creativity, collaboration, communication, digital literacy and problem-solving that are required by 21st-century education.

In Lampung Province, these challenges have their own distinct characteristics. Various regions in Lampung still face disparities in the quality of education between urban

and peripheral areas. The digital transformation of education has progressed quite rapidly since the pandemic, but the implementation of technology in assessment has not yet been systematically integrated. Many schools still use traditional assessment approaches that focus on written tests and academic achievement. This situation indicates that the use of educational technology to support continuous assessment still requires strengthening in terms of policy, infrastructure, teacher capacity and the culture of evaluation. This is particularly relevant as Lampung is one of the provinces currently striving to improve the quality of its human resources as part of a regional development agenda aligned with the SDGs.

A review of the literature indicates that research on ESD largely focuses on the curriculum, attitudes towards sustainability, and learning strategies (Nousheen et al., 2020; Glavič, 2020; Vilimala et al., 2022). Research on educational technology generally addresses technology adoption, learner engagement, and the effectiveness of learning (Bond et al., 2020; Granić, 2022). Research on technology-enhanced assessment tends to highlight the effectiveness of digital platforms, feedback, and personalised learning (Fuller et al., 2022; Caspari-Sadeghi, 2023; Ibarra-Sáiz et al., 2025). Studies that specifically integrate these three aspects—continuing education, educational technology, and learning assessment—remain relatively limited.

The research gap that has emerged lies in the lack of a comprehensive synthesis on how learning assessment can be reconceptualised within the framework of sustainable education through the use of educational technology and artificial intelligence to support the achievement of the SDGs. Most studies examine ESD, educational technology, or technology-enhanced assessment in isolation. The conceptual links between these three areas still require more systematic mapping in order to produce an assessment framework relevant to the needs of 21st-century education and the sustainable development agenda.

In light of these circumstances, this study aims to conduct a systematic literature review to reconstruct the concept of learning assessment in sustainable education by examining the relationship between educational technology, technology-enhanced assessment, artificial intelligence, and the Sustainable Development Goals (SDGs). The findings of this study are expected to provide a conceptual foundation for the development of assessment models that are more adaptive, inclusive and future-oriented, and that support the transformation of sustainable education in Indonesia.

Research Method

This study employs a Systematic Literature Review (SLR) approach to identify, evaluate and synthesise various research findings relating to learning assessment, educational technology, artificial intelligence (AI) and lifelong learning within the context of the Sustainable Development Goals (SDGs). The SLR approach was chosen as it provides a systematic overview of research developments, trends, and research gaps, whilst also yielding a more comprehensive conceptual framework. The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, which encompass the stages of identification, screening, eligibility assessment, and inclusion of articles (Page et al., 2021).

The literature search was conducted using the Scopus database, which indexes various reputable international journals from publishers such as Elsevier (ScienceDirect), Springer, Taylor & Francis, Wiley, and Emerald. The search strategy utilised a combination of keywords with the Boolean operators AND and OR, and was restricted to English-language journal articles published between 2020 and 2025. The identification process yielded 487 articles, which were subsequently screened in accordance with the PRISMA 2020 guidelines, resulting in 10 articles that met the inclusion criteria. The search keywords were formulated using a combination of Boolean operators covering the concepts of learning assessment, technology-enhanced assessment, educational technology, artificial intelligence, sustainable education, education for sustainable development (ESD), and the Sustainable Development Goals (SDGs). The publication range was restricted to 2020–2025 to identify studies relevant to developments in digital technology and AI in education.

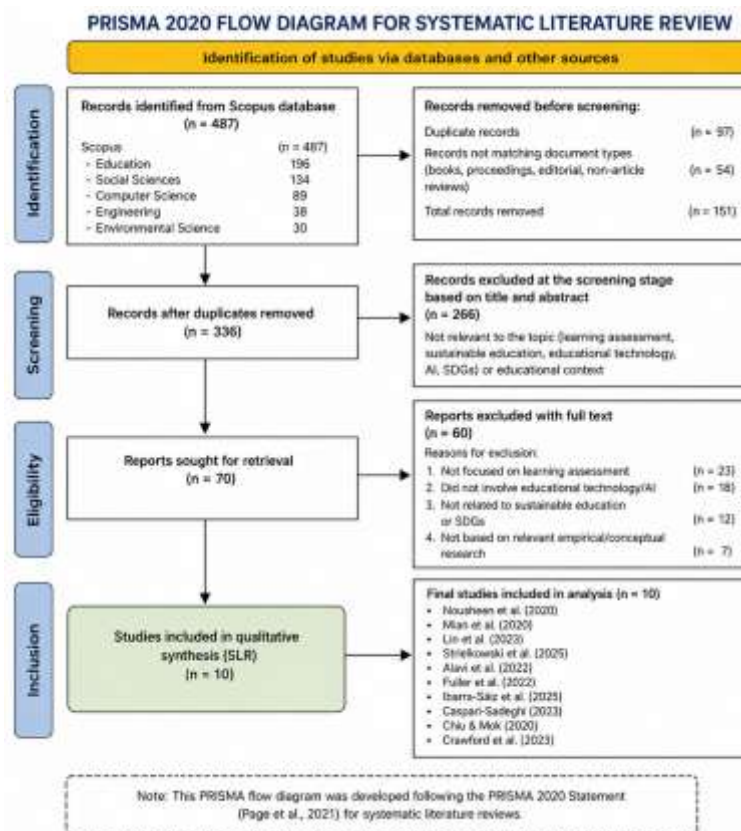
Selected articles must meet the following criteria: they must be international journal articles indexed in Scopus, written in English, available in full text, and deal with continuing education, educational technology or technology-based assessment. Articles in the form of conference proceedings, editorials, book reviews, conference abstracts, duplicate articles and articles not directly related to the research focus will be excluded from the selection process.

The data were analysed using a thematic synthesis approach, grouping articles according to their research focus, research methods, technologies used, assessment models applied, and their contribution to the SDGs. The synthesis yielded five main themes: Education for Sustainable Development (ESD), Educational Technology for Sustainable Learning, Technology-Enhanced Assessment, Artificial Intelligence in Assessment, and Reframing Learning Assessment towards the SDGs. This synthesis produced a conceptual model demonstrating that educational technology and artificial intelligence support sustainable assessment through continuous feedback, the development of 21st-century skills, the improvement of sustainable learning outcomes, and the achievement of the Sustainable Development Goals.

To provide a more detailed overview of the article identification process, this study presents supporting data covering search sources, the distribution of articles by subject area, and the number of articles at each stage of the selection process in accordance with the PRISMA 2020 guidelines. The presentation of this information aims to enhance transparency and make it easier for readers to trace the process of selecting the articles used in the study. These details are presented in the following table.

Table 1: Information on the number of articles

Research Method	Number of Studies	Percentage (%)
Qualitative	7	46.7
Quantitative	3	20.0
Systematic Literature Review	2	13.3
Scoping Review	1	6.7
Mixed Methods	1	6.7
Bibliometric Review	1	6.7
Total	15	100



Picture 1. Diagram Prisma Literature Review

Result and Discussion

Analysis of Literature Findings on Reframing Learning Assessment in Continuing Education

A systematic review of ten Scopus articles shows that the transformation of learning assessment has shifted from a paradigm of measuring learning outcomes to a paradigm of continuous learning supported by digital technology. The literature review identified four main themes: (1) lifelong learning as the foundation for future assessment, (2) the role of educational technology in the transformation of assessment, (3) the use of artificial intelligence in learning evaluation, and (4) the contribution of technology-based assessment to the achievement of the Sustainable Development Goals (SDGs). The following are the results of the literature review for this study

Table 2: Results of the literature review

No	Author	Journal	Focus	Research Findings
1	Nousheen et al, (2020)	Journal of Cleaner Production	Education for Sustainable Development	Education for sustainable development (ESD) has been shown to enhance students' knowledge, awareness, attitudes, and behaviors regarding sustainability issues through the integration of social, economic, and environmental values into learning.

No	Author	Journal	Focus	Research Findings
2	Mian et al, (2020)	Sustainability	Sustainability Education in Industry 4.0	Sustainable education integrated with Industry 4.0 technology helps students develop 21st-century competencies, digital literacy, and problem-solving skills related to sustainable development.
3	Glavič, (2020)	Sustainability	ESD Framework	The study produced a framework for Education for Sustainable Development (ESD) that emphasizes the integration of sustainability competencies into the curriculum, instruction, and educational assessment.
4	Lin et al, (2023)	Smart Learning Environments	AI for Sustainable Education	Artificial Intelligence (AI) can support lifelong learning through the personalization of learning materials, the analysis of learning needs, and the improvement of the effectiveness of the learning process.
5	Strielkowski et al, (2025)	Sustainable Development	AI-Driven Adaptive Learning	AI-based adaptive learning systems enhance student engagement, learning outcomes, and students' ability to understand sustainability issues in a more in-depth and contextual manner.
6	Fuller et al, (2022)	Medical Teacher	Technology Enhanced Assessment	The use of technology in assessment improves the accuracy of evaluations, enhances the efficiency of feedback, and supports a more objective and sustainable measurement of student competencies.
7	Caspari-Sadeghi, (2023)	Journal of Educational Technology Systems	Machine Learning Assessment	Machine learning can be used to analyze student performance, predict learning outcomes, and provide more personalized and adaptive assessment recommendations.
8	Alavi et al, (2022)	Journal of Further and Higher Education	Technology-Enhanced Assessment	Technology-based assessments help improve the quality of learning evaluations, speed up the assessment process, and provide more comprehensive data for educational decision-making.
9	Ibarra-Sáiz et al, (2025)	Technology, Knowledge and Learning	Digital Feedback Assessment	Digital feedback has been shown to enhance students' self-reflection, motivation to learn, and ability to continuously improve their learning outcomes.
10	Chiu & Mok, (2020)	Educational Psychology	Technology Enhanced Learning and Assessment	The integration of technology into learning and assessment enhances student participation, the quality of the learning experience, and the effectiveness of achieving learning objectives.

Table 2 shows that research into Education for Sustainable Development (ESD), educational technology, artificial intelligence (AI) and technology-enhanced assessment has

seen significant growth during the period 2020–2025. In general, all the research indicates the same trend, namely that educational transformation is no longer solely focused on improving learning outcomes, but also on developing 21st-century skills through the use of digital technologies that support sustainable education.

With regard to sustainable education, research by Nousheen et al. (2020), Mian et al. (2020) and Glavič (2020) confirms that the implementation of ESD contributes to improving learners' knowledge, awareness, attitudes and sustainability competencies. Furthermore, ESD is not only integrated into the curriculum but must also be supported by learning strategies and an assessment system capable of comprehensively measuring the attainment of sustainability competencies.

Meanwhile, in the field of artificial intelligence, research by Lin et al. (2023) and Strielkowski et al. (2025) shows that AI has great potential to create more adaptive learning through the personalisation of materials, the analysis of learning needs, and increased learner engagement. These findings suggest that AI serves not only as a learning aid, but also as a technology capable of supporting decision-making in the learning assessment process.

Furthermore, studies by Fuller et al. (2022), Caspari-Sadeghi (2023), Alavi et al. (2022), Ibarra-Sáiz et al. (2025), and Chiu and Mok (2020) demonstrate that the use of technology in assessment can improve the accuracy of assessment, speed up the feedback process, provide more comprehensive learning data, and support more objective, adaptive and continuous assessment. These findings indicate that technology-enhanced assessment has evolved from the mere digitisation of assessment instruments into an assessment system that utilises data analysis and artificial intelligence to support improvements in the quality of learning.

Overall, the results of the literature review reveal a strong correlation between sustainable education, educational technology, artificial intelligence and technology-based assessment. However, the majority of studies still examine these four aspects separately. Research on ESD focuses more on the curriculum and sustainability competencies, AI research emphasises personalised learning, whilst research on technology-enhanced assessment examines the effectiveness of technology in the assessment process. Consequently, a research gap remains: there is currently no conceptual framework that comprehensively integrates sustainable education, educational technology, artificial intelligence and learning assessment into a single, cohesive model. It is this gap that forms the key basis for this study to reconstruct the concept of learning assessment in line with the objectives of the Sustainable Development Goals (SDGs) and the educational needs of the 21st century.

In this study, learning assessment is defined as the entire process of collecting, analysing and interpreting information regarding learners' learning outcomes to support decision-making in education. The term 'technology-enhanced assessment' (TEA) is used consistently to refer to assessment systems that utilise digital technology, learning analytics and artificial intelligence in the assessment process. Meanwhile, sustainable education refers to the implementation of Education for Sustainable Development (ESD), which aims to develop sustainability competencies in line with the Sustainable Development Goals (SDGs), particularly Goal 4 on quality education.

The synthesis results were interpreted using the Context, Input, Process, Product (CIPP) model developed by Stufflebeam. This model was chosen because it not only groups findings by theme, but is also capable of explaining the logical relationships between the need for change (context), the resources supporting change (input), the implementation mechanisms (process), and the resulting impact (product). Compared with conceptual synthesis approaches such as thematic synthesis, narrative synthesis, or meta-aggregation which are more oriented towards thematic grouping CIPP provides an evaluative framework that enables analysis to be carried out systematically. This approach is relevant to the research objective, namely to reconstruct the concept of learning assessment as a system that supports sustainable education, rather than merely describing research developments.

1. Context Evaluation

In the CIPP model, context evaluation aims to identify needs, problems, opportunities and environmental demands that underpin the necessity for a programme or change (Stufflebeam & Zhang, 2017). Consequently, the theme of Education for Sustainable Development (ESD) is placed within the context component as it represents the global need for the transformation of education systems, including a shift in the assessment paradigm. The primary focus at this stage is not on discussing technology or the implementation of assessment, but rather on identifying why conventional assessment systems are no longer adequate for measuring sustainability competencies and 21st-century skills. Most research (Nousheen et al., 2020; Glavič, 2020; Mian et al., 2020) indicates that 21st-century education no longer emphasises academic achievement alone, but also the development of sustainability competencies, critical thinking, collaboration, creativity, and social and environmental responsibility. Consequently, assessment systems are required to be capable of evaluating competencies that are multidimensional in nature.

The literature reveals differences in emphasis. Nousheen et al. place greater emphasis on changes in attitudes and sustainable behaviour, whilst Glavič considers changes to the curriculum and assessment to be key prerequisites for the success of ESD. On the other hand, Mian et al. link sustainable education to the need for digital competences in the Industry 4.0 era. These differences indicate that the transformation of assessment is influenced by differing theoretical perspectives and research contexts.

Methodologically, these variations in findings can be explained by the characteristics of the research. Nousheen et al. adopted an approach focused on the implementation of ESD in educational settings, whilst Glavič developed a conceptual framework based on a literature review. Consequently, the focus of the research findings is not entirely the same, despite sharing similar objectives. From a CIPP perspective, this situation indicates that the primary need for assessment transformation is not merely the digitisation of assessment instruments, but rather a shift in the evaluation paradigm so that it can measure sustainable competencies more comprehensively.

2. Input Evaluation

In the CIPP model, input evaluation serves to assess the various resources, strategies, capacities and alternative solutions required to achieve the programme's objectives. Based on this concept, educational technology, learning analytics and artificial intelligence are positioned as input components, as all three constitute strategic resources that enable the

transformation of learning assessment. At this stage, attention is focused on technological readiness, digital infrastructure, educators' competencies, and analytical capabilities, which are prerequisites for the implementation of technology-enhanced assessment.

Most research agrees that educational technology is the primary foundation of TEA. However, there are differences regarding the role of artificial intelligence. Fuller et al. (2022) view technology primarily as a means of enhancing the efficiency and objectivity of assessment. Conversely, Lin et al. (2023) and Caspari-Sadeghi (2023) view AI as an analytical tool capable of delivering personalised learning through the analysis of learner data. These differences stem from the scope of the research. Fuller et al. focused on the implementation of digital assessment in medical education, whilst Lin et al. and Caspari-Sadeghi explored the capabilities of AI in educational data processing. Consequently, the differences in findings reflect differences in research focus rather than substantive contradictions.

3. Proses Evaluation

Process evaluation within the CIPP model aims to assess how a programme is implemented and the extent to which its implementation aligns with the established objectives. Therefore, the theme of technology-enhanced assessment is positioned within the process component as it relates to the mechanisms of assessment delivery, such as the provision of digital feedback, real-time monitoring of learning, interaction between educators and learners, and the use of AI to support an ongoing evaluation process. Research findings indicate that digital assessment is transforming the patterns of interaction between teachers and learners. Ibarra-Sáiz et al. (2025) found an improvement in the quality of feedback and evaluative judgement through digital platforms. Alavi et al. (2022) demonstrated that learners are more actively reflecting on their learning outcomes.

Lin et al. (2023) explained that AI enables a continuous monitoring process. The system is capable of providing immediate feedback based on learners' learning activities. Fuller et al. (2022) also found that digital assessment improves the efficiency of data management and accelerates the evaluation process. Most articles highlight positive impacts. Although the majority of studies report increased efficiency through AI, Crawford et al. (2023) and Sok and Heng (2023) point out that the use of AI also raises issues of ethics, algorithmic bias, decision transparency and academic integrity. Consequently, the effectiveness of TEA depends heavily on technology governance, not merely on the capabilities of the algorithms.

4. Product Evaluation

In the CIPP model, product evaluation focuses on identifying the outcomes, benefits and impacts generated following the implementation of a programme. Consequently, the enhancement of 21st-century skills, the quality of learning, critical thinking skills, sustainability competencies, and contributions towards the achievement of the Sustainable Development Goals (SDGs) are positioned as product components, as they all constitute outputs and outcomes of the implementation of technology-enhanced assessment.

Research indicates that technology-based assessment contributes to improving the quality of learning, the development of 21st-century skills, and the achievement of sustainable education goals. Strielkowski et al. (2025) found that AI-based adaptive learning

improves learners' learning outcomes and learning experiences. Nousheen et al. (2020) demonstrated an improvement in sustainability attitudes among learners involved in ESD programmes.

Ibarra-Sáiz et al. (2025) reported improvements in reflective and self-assessment skills. Fuller et al. (2022) demonstrated that technology-based assessment generates richer data to support learning development. Research findings indicate a consensus that technology-enhanced assessment (TEA) improves the quality of learning. However, empirical evidence regarding its contribution to the achievement of the SDGs remains relatively limited. Most studies merely measure improvements in learning outcomes, learner engagement, or the quality of feedback. Very few studies directly evaluate sustainability indicators as formulated in the SDGs.

Discussion

Synthesis of Research Findings The results of the mapping exercise using the CIPP model indicate that the four components are interconnected in a systemic manner. Context explains why a transformation of assessment is necessary to meet the demands of sustainable education. Input describes the strategic resources—namely educational technology, learning analytics and artificial intelligence—that support this transformation. Process demonstrates how technology is implemented in assessment practice through data-driven feedback, monitoring and evaluation mechanisms. Furthermore, 'Product' demonstrates that the implementation of technology-enhanced assessment leads to improvements in the quality of learning, 21st-century skills, and support for the achievement of the SDGs. Thus, the CIPP model serves not only as a framework for classifying findings but also as an analytical tool that explains the cause-and-effect relationships between the need for change, resources, implementation, and the outcomes achieved.

A synthesis of ten articles indicates that the transformation of assessment has evolved through four interrelated stages. The first stage was triggered by the need for continuous education, which demanded a more comprehensive evaluation system than conventional assessment. The second stage is characterised by the use of digital technology and artificial intelligence as key resources in developing adaptive assessment systems. The third stage demonstrates changes in the evaluation process through the use of learning analytics, digital feedback and continuous monitoring of learning. The final stage shows that the implementation of TEA contributes to improving the quality of learning and the development of 21st-century skills.

The findings of this study indicate that Technology-Enhanced Assessment (TEA) not only serves as a technological innovation in the evaluation process, but also represents a paradigm shift from summative assessment towards assessment for learning. The integration of artificial intelligence, learning analytics and digital platforms enables the assessment process to be continuous, adaptive and data-driven, thereby providing faster and more accurate feedback to both learners and educators. This reinforces the role of assessment as an integral part of the learning process, rather than merely a tool for measuring learning outcomes.

Furthermore, the findings of the synthesis indicate that the implementation of TEA makes a significant contribution to the development of 21st-century competences, such as critical thinking, creativity, collaboration, communication, digital literacy and the ability to engage in lifelong learning. These findings suggest that the success of assessment transformation is not solely determined by the availability of technology, but also by institutional readiness, educators' competencies, and educational policies that support the sustainable implementation of technology. Thus, the CIPP model provides a comprehensive evaluation framework as it is able to explain the relationship between the need for change (context), resource readiness (input), the effectiveness of implementation (process), and the resulting impact (product). Consequently, the conceptual framework developed in this study can serve as a reference for the development of a sustainable assessment system that supports improvements in the quality of learning whilst contributing to the achievement of Sustainable Development Goal 4 (SDG 4), particularly in realising inclusive, high-quality education oriented towards lifelong learning.

Here is the conceptual model that I recommend be included as Figure 3: Conceptual Framework of Technology-Enhanced Assessment for Sustainable Education

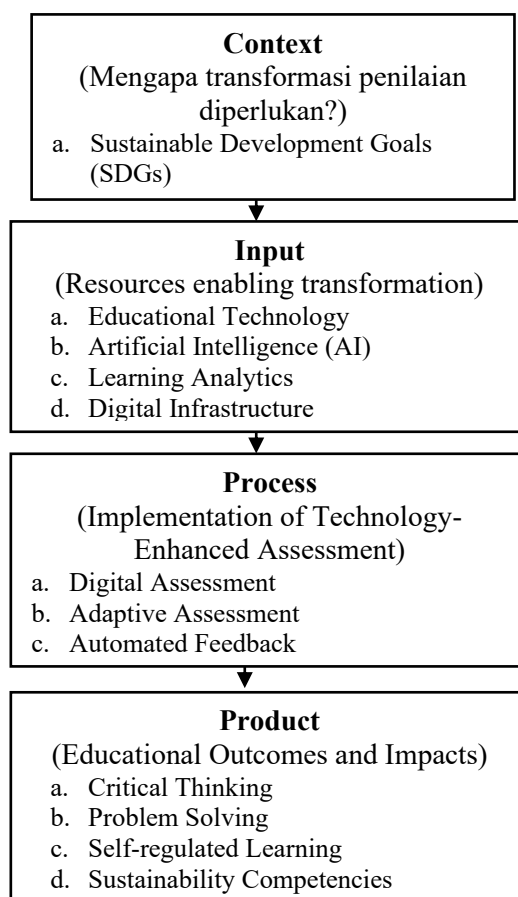


Diagram of the Continuous Feedback Loop: Product → Context (Continuous Improvement)

Conclusion

This systematic literature review of ten Scopus-indexed international articles demonstrates that learning assessment is evolving from a traditional outcome-oriented approach towards technology-enhanced assessment (TEA) that supports lifelong learning, the development of 21st-century competencies, and sustainable education. Educational technology, learning analytics, and artificial intelligence (AI) play a central role in enabling adaptive, personalised, data-driven, and continuous assessment. The CIPP model further illustrates that the transformation of assessment is a systemic process in which future competency needs (context), digital technologies and AI (input), continuous feedback and monitoring (process), and improved learning quality and sustainability competencies (product) are closely interconnected, contributing to the achievement of Sustainable Development Goal 4 (Quality Education).

These findings have significant theoretical and practical implications. Theoretically, they reinforce the perspective that assessment should function as an integral part of learning rather than merely a tool for measuring academic achievement. Practically, educational institutions should adopt authentic and technology-based assessment supported by digital platforms, learning analytics, and AI, while enhancing educators' competencies in digital assessment design and the ethical use of AI. At the policy level, governments and educational stakeholders should strengthen digital assessment standards, ensure equitable access to technological infrastructure, and establish regulations that safeguard transparency, privacy, data security, algorithmic fairness, and academic integrity while promoting the assessment of 21st-century and sustainability competencies.

Despite these contributions, this review is limited by its inclusion of only ten Scopus-indexed articles published between 2020 and 2025 and by its reliance on qualitative synthesis without meta-analysis. Future research should expand the review to include additional international databases, integrate systematic reviews with meta-analytical approaches, and empirically validate the proposed technology-enhanced assessment framework across diverse educational contexts. Such efforts will provide stronger evidence for developing adaptive, inclusive, and sustainability-oriented assessment systems that effectively improve learning quality and support the achievement of the Sustainable Development Goals.

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