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Formative Assessment for Improving Learning Outcomes and Self-Regulated Learning: A Systematic Literature Review

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ABSTRACT

Purpose This study examines the role of formative assessment in improving learning outcomes and self-regulated learning across diverse educational contexts. Despite extensive research, evidence remains fragmented across educational levels and technology-enhanced learning environments. This review synthesizes recent findings on the educational impact, implementation, and emerging trends of formative assessment.

Methods A Systematic Literature Review (SLR) was conducted following the PRISMA framework. Fifty peer-reviewed journal articles published between 2022 and 2026 were selected through a structured identification, screening, eligibility, and inclusion process. The selected studies were analyzed using evidence mapping and thematic synthesis to identify recurring themes and research trends.

Findings Four major themes emerged: formative assessment as a pedagogical strategy, feedback as the primary mechanism for self-regulated learning, educational outcomes, and technology-enhanced assessment. Formative assessment consistently improved academic achievement, learner engagement, critical thinking, motivation, and learner autonomy through continuous feedback and reflective learning. Recent studies also demonstrated the increasing integration of learning analytics, digital feedback platforms, and artificial intelligence to support personalized and adaptive assessment. However, technological dependence, algorithmic bias, and ethical implementation remain important challenges.

Research Implications The findings emphasize the need to strengthen assessment literacy, feedback quality, and responsible technology integration to maximize formative assessment in learner-centered education.

Originality This review provides an updated synthesis of formative assessment research published between 2022 and 2026 by integrating evidence on learning outcomes, self-regulated learning, and technology-enhanced assessment across diverse educational settings.

INTRODUCTION

The increasing complexity of contemporary learning environments has shifted educational attention from the transmission of knowledge toward the development of learners who can actively monitor, regulate, and improve their own learning processes. Educational systems are expected not only to enhance academic achievement but also to cultivate learners' capacity to plan, evaluate, and adapt their learning strategies in response to changing academic demands. Within this perspective, formative assessment has emerged as a central component of effective instruction

because it provides continuous evidence of learning progress and enables instructional adjustments that support student development. Research has consistently demonstrated that formative assessment contributes to improved learning outcomes across educational levels and subject domains, while also strengthening learners' engagement with learning processes (Yao et al., 2024; Solis Trujillo et al., 2025). The growing emphasis on learner-centered education has intensified scholarly interest in understanding how formative assessment influences both academic achievement and self-regulated learning.

Formative assessment is commonly characterized as an ongoing process through which evidence of student learning is collected, interpreted, and used to inform subsequent teaching and learning activities. Rather than functioning solely as a mechanism for measuring performance, formative assessment facilitates learning through feedback, reflection, self-assessment, peer assessment, and instructional adaptation. According to Sabbar (2025), formative assessment creates opportunities for learners to monitor their progress and develop greater awareness of their strengths and weaknesses. Similar observations were reported by Fukuda et al. (2022), who found that formative assessment practices support the development of learning skills beyond immediate classroom achievement. Evidence synthesized by Müller and Wagner (2026) further indicates that formative assessment promotes active participation and autonomy across diverse educational settings. These findings suggest that formative assessment serves both evaluative and developmental functions within contemporary educational practice.

A substantial body of literature has documented the positive relationship between formative assessment and learning outcomes. Meta-analytic evidence involving hundreds of primary studies indicates that formative assessment produces meaningful improvements in academic performance across different educational contexts and disciplines (Yao et al., 2024). Additional studies have shown that formative feedback contributes to higher achievement by helping learners identify misconceptions, refine strategies, and focus attention on learning goals. Chen (2024) demonstrated that learning analytics–based formative feedback improved students' academic performance in blended English language learning environments. Similar improvements have been observed in technology-supported learning contexts where timely feedback enables students to make immediate adjustments to their learning behaviors (Huang et al., 2024; Zhang et al., 2023). These findings reinforce the view that formative assessment functions as a mechanism for enhancing academic achievement through continuous instructional support.

Alongside its influence on achievement, formative assessment has increasingly been associated with the development of self-regulated learning (SRL). Self-regulated learning refers to learners' ability to set goals, monitor progress, regulate motivation, select strategies, and evaluate outcomes independently. Theoretical perspectives developed by Zimmerman, Winne, and Hadwin position self-regulation as a cyclical process involving planning, performance monitoring, and reflection. Empirical studies indicate that formative assessment supports these processes by providing information that learners can use to guide their decision-making and learning behaviors. Sabbar (2025) reported that formative assessment enhances cognitive, metacognitive, and motivational dimensions of SRL among language learners. Research conducted by He et al. (2024) further revealed that formative assessment encourages learners to modify and improve their self-regulatory behaviors over time. Such findings highlight the close conceptual relationship between assessment practices and learner self-regulation.

Recent developments in educational technology have expanded the potential of formative assessment to support self-regulated learning in digital environments. Learning analytics, artificial intelligence, adaptive feedback systems, and online learning platforms have created new opportunities for delivering personalized and timely feedback. Zhang et al. (2023) identified a significant increase in research examining the integration of learning analytics with formative assessment practices. Boulahmel et al. (2025) similarly noted that digital trace data can be used to identify self-regulatory behaviors and provide targeted learning support. Studies focusing on AI-supported learning environments indicate that intelligent systems can facilitate planning, monitoring, and reflection processes associated with SRL (Saftari et al., 2025; Yang & Sun, 2026). The integration of technological tools into formative assessment practices has consequently become an important area of investigation within contemporary educational research.

Peer assessment and self-assessment have also attracted considerable attention as formative assessment strategies that strengthen learner autonomy and reflective thinking. Ortega-Ruipérez and Correa-Gorospe (2024) found that technology-supported peer assessment encourages critical reflection and metacognitive engagement, leading to stronger self-regulatory behaviors. Research in medical education further demonstrated that self-assessment activities contribute positively to learners' attitudes, skills, and reflective capacities when supported by effective feedback mechanisms (Zheng et al., 2024). Similar findings were reported by Liu et al. (2025), who observed that programmatic assessment structures incorporating feedback and reflection promoted learners' motivation, planning, and self-monitoring. These studies suggest that active learner participation in assessment processes represents an important pathway through which formative assessment contributes to self-regulated learning.

Although evidence supporting formative assessment is substantial, several challenges remain. Studies have reported variations in implementation quality, assessment literacy, technological readiness, and contextual factors that influence the effectiveness of formative assessment practices. Sabbar (2025) identified teacher assessment literacy and

institutional constraints as significant barriers to successful implementation. Research by Ritz et al. (2023) highlighted difficulties associated with maintaining meaningful feedback interactions in technology-mediated learning environments. Babayev (2025) further argued that excessive dependence on AI-generated feedback may reduce learner autonomy despite improving engagement and performance. These findings indicate that the effectiveness of formative assessment depends not only on assessment design but also on the broader educational context in which assessment practices are implemented.

The literature also reveals increasing interest in understanding how formative assessment influences self-regulated learning across different educational levels and learning environments. Systematic reviews conducted by Edisherashvili et al. (2022), Nan Cenka et al. (2024), and Tur et al. (2024) demonstrated that numerous interventions support SRL development; however, evidence remains fragmented across disciplines, methodologies, and educational contexts. Xu et al. (2023) confirmed the positive effect of SRL interventions on academic achievement in online and blended learning environments, while Zheng and Sun (2025) reported significant associations between SRL strategies and learning outcomes in medical education. Despite these advances, the mechanisms through which formative assessment contributes simultaneously to learning outcomes and self-regulated learning remain insufficiently synthesized within the broader educational literature.

Existing reviews often focus on either formative assessment or self-regulated learning as separate constructs. Some studies emphasize academic achievement outcomes, whereas others concentrate on learner autonomy, motivation, or metacognitive development. A comprehensive understanding of how formative assessment influences both learning outcomes and self-regulated learning across educational settings remains limited. The rapid expansion of digital learning environments, learning analytics technologies, and AI-supported feedback systems further necessitates an updated synthesis of current evidence. Integrating findings from recent empirical studies can provide a clearer understanding of emerging trends, effective practices, and unresolved challenges related to formative assessment and self-regulated learning.

This systematic literature review addresses this need by synthesizing contemporary research examining the role of formative assessment in improving learning outcomes and self-regulated learning. The review analyzes current empirical evidence regarding formative assessment practices, feedback mechanisms, technological innovations, and learner-centered assessment strategies. Through a comprehensive examination of recent studies, this review seeks to identify dominant research trends, evaluate the effectiveness of formative assessment interventions, and clarify the mechanisms through which formative assessment contributes to academic achievement and self-regulated learning. The findings are expected to contribute to theoretical development and provide evidence-based recommendations for researchers, educators, and policymakers seeking to enhance learning quality through effective assessment practices.

METHOD

Research Design

This study employed a Systematic Literature Review (SLR) combined with evidence mapping and thematic synthesis to examine the contribution of formative assessment to learning outcomes and self-regulated learning (SRL). The review aimed to synthesize empirical evidence, identify research trends, classify methodological approaches, and analyze how formative assessment practices influence students' academic achievement and self-regulatory behaviors across different educational contexts.

The review followed a structured procedure consisting of literature identification, article selection, evidence classification, data extraction, thematic coding, and synthesis. This approach enabled the integration of findings from quantitative, qualitative, mixed-methods, systematic review, meta-analysis, and bibliometric studies. The use of evidence mapping provided a broader understanding of the relationships among formative assessment, feedback processes, learning outcomes, and self-regulated learning.

Data Sources

The literature corpus consisted of peer-reviewed journal articles published between 2022 and 2026. The articles were obtained from journals indexed in Scopus and Web of Science and represented various disciplines, including educational technology, language education, higher education, medical education, learning analytics, online learning, and instructional design.

A total of 50 articles met the eligibility requirements and were included in the review. The selected studies represented diverse educational settings, including primary education, secondary education, higher education, professional education, and technology-supported learning environments.

Table 1. Distribution of Articles by Publication Year

Publication Year	Number of Articles	Percentage (%)

2022	11	22.0
2023	10	20.0
2024	16	32.0
2025	10	20.0
2026	3	6.0
Total	50	100

The distribution shows a substantial increase in publications during 2024 and 2025, indicating growing academic interest in formative assessment, self-regulated learning, learning analytics, feedback literacy, and artificial intelligence-supported educational practices.

Eligibility Criteria

The selection of studies was guided by predetermined inclusion and exclusion criteria to ensure relevance and methodological quality.

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal articles	Editorials and commentaries
Published between 2022 and 2026	Publications before 2022
Written in English	Non-English publications
Studies focusing on formative assessment, learning outcomes, or self-regulated learning	Studies unrelated to the topic
Full-text articles available	Articles without accessible full text
Empirical studies, systematic reviews, meta-analyses, and bibliometric studies	Opinion papers

Only studies meeting all inclusion criteria were retained for analysis. Applying these eligibility criteria ensured that the meta-analysis incorporated studies with sufficient methodological quality and directly relevant evidence on cooperative learning and students' learning outcomes. Restricting the synthesis to recent peer-reviewed publications enhanced the relevance of the findings to contemporary educational practices, while excluding studies with insufficient empirical evidence reduced the risk of biased or unreliable effect size estimation.

Evidence Mapping Framework

An evidence mapping framework was developed to organize the reviewed studies according to their conceptual focus. Formative assessment was positioned as the central construct because all selected studies examined assessment practices designed to support learning improvement. The framework connected formative assessment with three primary dimensions: learning outcomes, self-regulated learning, and feedback mechanisms.

Learning outcomes included academic achievement, learning performance, engagement, and skill development. Self-regulated learning encompassed goal setting, strategic learning, self-monitoring, reflection, motivation regulation, and metacognitive regulation. Feedback mechanisms included teacher feedback, peer feedback, self-assessment, learning analytics feedback, and artificial intelligence-assisted feedback. These dimensions were further associated with digital learning environments such as blended learning, online learning, virtual learning environments, learning analytics platforms, and AI-supported educational systems.

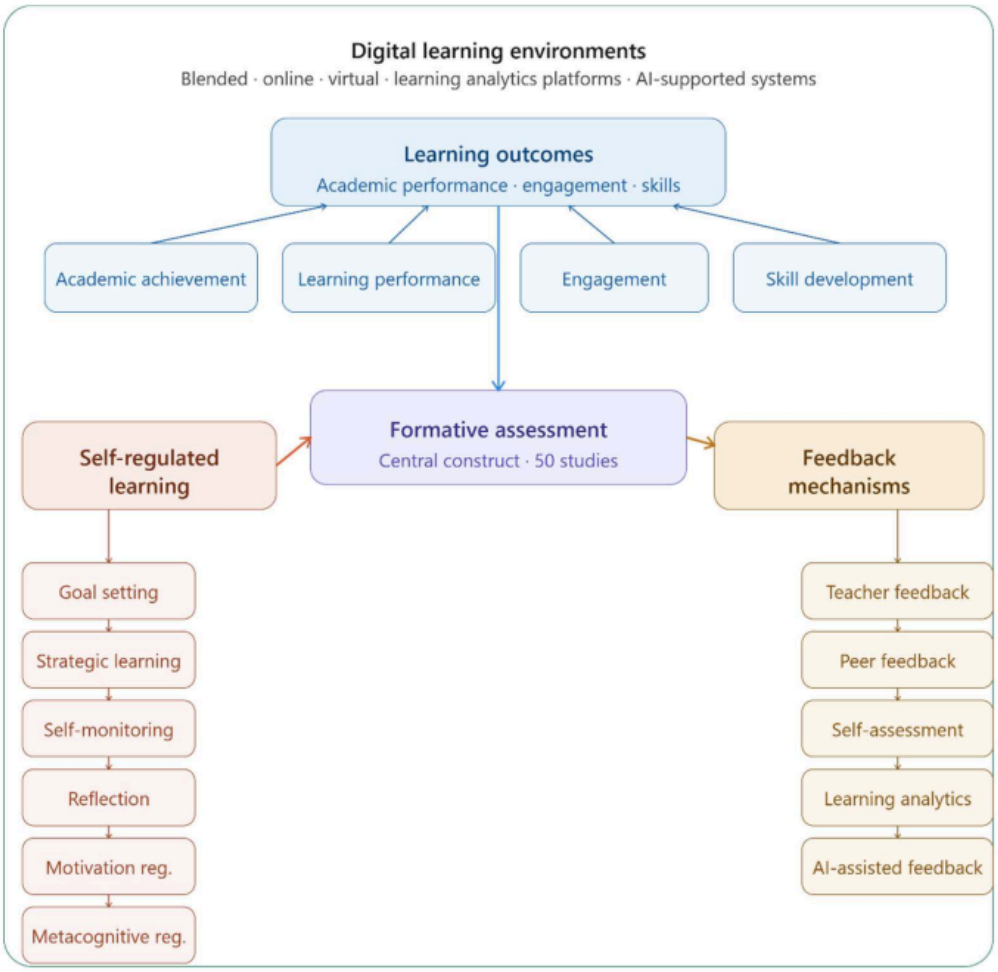

Figure 1 illustrates the evidence mapping framework generated from the reviewed literature.

Figure 1 presents the evidence mapping framework derived from the reviewed literature. The framework identifies formative assessment as the central construct connecting digital learning environments with students' learning outcomes through two complementary mechanisms: self-regulated learning and feedback mechanisms. Self-regulated learning encompasses goal setting, strategic learning, self-monitoring, reflection, motivational regulation, and metacognitive regulation, whereas feedback mechanisms include teacher feedback, peer feedback, self-assessment, learning analytics, and AI-assisted feedback. These interconnected components illustrate how formative assessment supports academic achievement, learning performance, engagement, and skill development across diverse digital learning environments.

Classification of Research Designs

The selected studies were classified according to their methodological approaches to identify dominant research trends and the types of evidence available in the literature on formative assessment. This classification provides an overview of the methodological diversity supporting the evidence synthesis.

Table 3. Classification of Research Designs

Research Design	Frequency	Percentage (%)
Quantitative Studies	21	42.0
Mixed Methods Studies	6	12.0
Qualitative Studies	4	8.0
Systematic Literature Reviews	9	18.0
Meta-Analyses	3	6.0

Bibliometric Studies	2	4.0
Quasi-Experimental Studies	5	10.0
Total	50	100

The predominance of quantitative studies (42.0%) indicates that research on formative assessment has primarily focused on evaluating measurable educational outcomes, including academic achievement, engagement, motivation, and self-regulated learning. The presence of systematic reviews and meta-analyses further demonstrates the maturity of the field by providing opportunities to consolidate accumulated empirical evidence. At the same time, the comparatively limited number of qualitative and mixed-methods studies suggests that the contextual processes through which formative assessment influences learning remain less extensively investigated, highlighting an area for future research.

Educational Context Classification

To understand the contexts in which formative assessment has been investigated, the studies were grouped according to educational settings. This classification provides an overview of the educational environments in which evidence on formative assessment and self-regulated learning has been generated.

Table 4. Distribution of Studies by Educational Context

Educational Context	Frequency
Higher Education	24
Primary and Secondary Education	11
Medical and Health Education	6
Online and Distance Learning	5
Mixed Educational Contexts	4
Total	50

The predominance of studies conducted in higher education indicates that formative assessment has been most extensively examined in learning environments characterized by greater learner autonomy, continuous assessment, and technology-supported instruction. The inclusion of primary and secondary education, medical and health education, and online learning contexts demonstrates that formative assessment has broad educational applicability across diverse instructional settings. The uneven distribution of studies across contexts, however, suggests that evidence remains more limited in several educational environments, highlighting the need for further investigation to strengthen the generalizability of existing findings.

Data Extraction Procedure

A structured extraction matrix was developed to ensure consistency throughout the review process. Each study was examined and coded according to several analytical categories, including publication information, educational setting, participant characteristics, research design, assessment strategies, self-regulated learning dimensions, learning outcomes, and major findings. The standardized extraction process facilitated systematic comparison across studies and ensured that all relevant evidence was captured for subsequent synthesis.

Table 5. Data Extraction Matrix

Analytical Component	Description
Authors and Year	Bibliographic information
Educational Context	School, university, online learning, medical education
Participants	Students, teachers, trainees
Research Design	Quantitative, qualitative, mixed methods, review
Assessment Strategy	Feedback, peer assessment, self-assessment, analytics
SRL Dimension	Cognitive, metacognitive, motivational, behavioral
Learning Outcomes	Achievement, performance, engagement
Main Findings	Principal results of the study
Research Implications	Recommendations and future directions

The structured extraction matrix ensured that comparable information was systematically collected across all included studies, thereby enhancing the transparency, consistency, and reproducibility of the review process. Capturing methodological characteristics together with educational contexts, formative assessment strategies, self-regulated learning dimensions, and learning outcomes enabled a comprehensive synthesis of the evidence and facilitated the identification of recurring patterns, methodological differences, and research gaps within the literature.

Data Analysis

The selected studies were analyzed using thematic synthesis. The analysis began with open coding to identify recurring concepts and findings reported in the literature. Similar codes were then grouped into broader categories and subsequently synthesized into overarching themes. The thematic synthesis generated four major themes: formative assessment and academic achievement; feedback-supported self-regulated learning; technology-enhanced formative assessment; and artificial intelligence as an emerging direction in self-regulated learning research. These themes formed the basis for interpreting relationships among formative assessment practices, learning outcomes, and self-regulated learning.

RESULTS

Publication Trends and Research Characteristics

The first stage of the analysis examined the general characteristics of the studies included in the review. A total of 50 articles published between 2022 and 2026 were analyzed to identify publication patterns, methodological tendencies, and educational contexts. The distribution of studies demonstrates the increasing scholarly interest in formative assessment and self-regulated learning, particularly in technology-supported educational environments. The reviewed literature also reflects a growing emphasis on learning analytics, digital feedback systems, and artificial intelligence applications that support learners' autonomy and academic achievement.

Table 6. Distribution of Studies by Publication Year

Publication Year	Number of Articles	Percentage (%)
2022	11	22.0
2023	10	20.0
2024	16	32.0
2025	10	20.0
2026	3	6.0
Total	**50**	**100**

The temporal distribution reveals a noticeable increase in research activity during 2024. Sixteen studies were published in this year alone, representing nearly one-third of the reviewed literature. The rise coincides with growing attention to learning analytics, digital assessment, and adaptive learning technologies. Several studies published during this period investigated the integration of formative assessment with online learning platforms, automated feedback systems, and personalized learning environments.

The number of publications remained relatively stable between 2022 and 2025, suggesting sustained academic interest in the relationship between formative assessment and learner development. Although only three studies were published in 2026 at the time of data collection, these studies indicate a growing shift toward artificial intelligence-supported self-regulated learning and intelligent feedback systems. To further understand methodological developments within the field, the selected studies were classified according to research design.

Table 7. Classification of Research Designs

Research Design	Frequency	Percentage (%)
Quantitative Studies	21	42.0
Mixed Methods Studies	6	12.0
Qualitative Studies	4	8.0
Systematic Literature Reviews	9	18.0
Meta-Analyses	3	6.0
Bibliometric Analyses	2	4.0
Quasi-Experimental Studies	5	10.0
Total	**50**	**100**

Quantitative studies represented the largest methodological category, accounting for 42% of the reviewed literature. These studies primarily focused on measuring the effects of formative assessment interventions on achievement, engagement, motivation, and self-regulated learning indicators. Common analytical techniques included structural equation modeling, regression analysis, multivariate analysis of variance, and learning analytics.

Review-based studies also occupied a substantial proportion of the literature. Nine systematic reviews and three meta-analyses synthesized evidence concerning self-regulated learning, formative assessment practices, and technology-supported learning environments. The presence of these review studies suggests that the field has reached a level of maturity sufficient to support secondary research and evidence synthesis.

The educational settings represented in the selected studies were also examined.

Table 8. Distribution of Studies by Educational Context

Educational Context	Frequency
Higher Education	24
Primary and Secondary Education	11
Medical and Health Education	6
Online and Distance Learning	5
Mixed Educational Contexts	4
Total	**50**

The findings indicate that higher education remains the dominant context for investigating formative assessment and self-regulated learning. Nearly half of all reviewed studies were conducted in universities, reflecting increasing institutional interest in supporting independent learning, feedback literacy, and academic performance among undergraduate and postgraduate students.

Primary and secondary education constituted the second largest category. Studies conducted in school settings frequently focused on mathematics achievement, language learning, engagement, and formative feedback interventions. Medical and health education also emerged as a significant area of application, particularly through reflective practice, clinical feedback, and programmatic assessment approaches designed to strengthen professional competence and self-regulation.

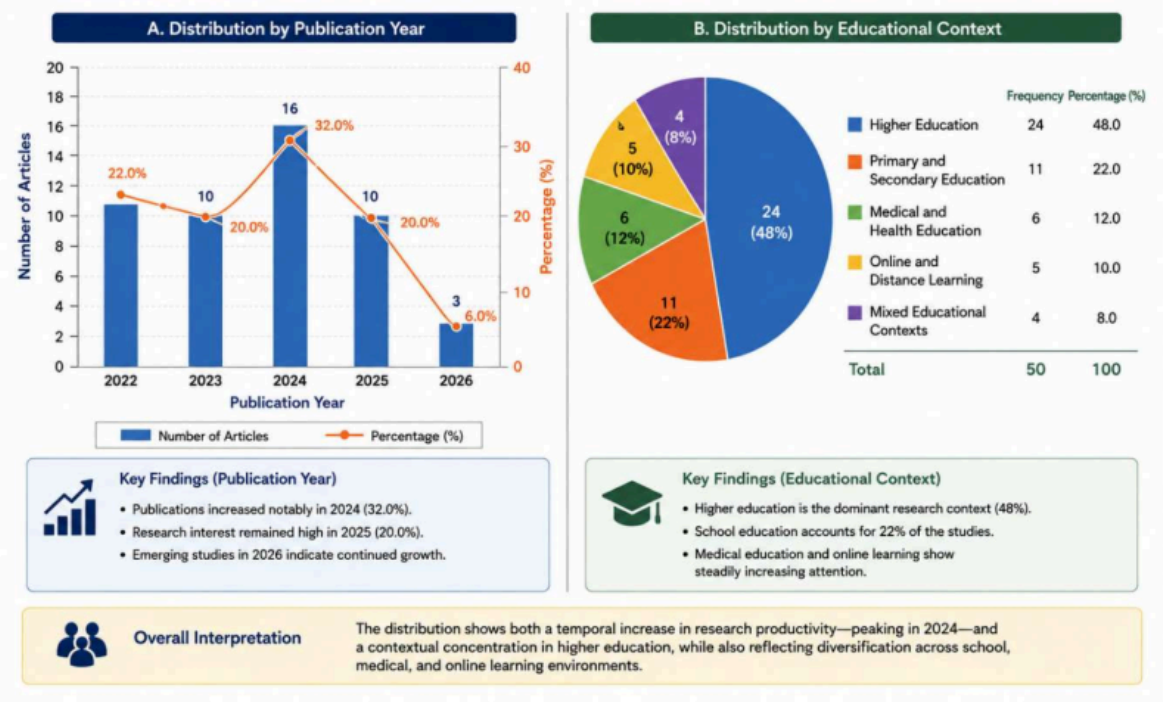

Figure 2 summarizes the overall distribution of reviewed studies across publication years and educational contexts.

Figure 2 summarizes the temporal and contextual distribution of the reviewed studies. The publication trend indicates growing scholarly interest in formative assessment during the review period, reaching its highest level in 2024 before remaining relatively stable in subsequent years. The educational context distribution shows that higher education accounts for the largest proportion of the evidence base, followed by primary and secondary education, while medical and health education and online learning also contribute meaningful representation. Collectively, these patterns suggest that formative assessment has become an increasingly important area of educational research across diverse learning environments, although the current evidence remains concentrated in higher education. This distribution should be considered when interpreting the overall findings, as differences in educational settings may influence the implementation and effectiveness of formative assessment practices.

Formative Assessment and Learning Outcomes

The second theme focused on the contribution of formative assessment to students' learning outcomes. Across the reviewed literature, formative assessment consistently demonstrated positive effects on academic achievement, learning performance, engagement, critical thinking, and skill development. Although intervention designs varied considerably, the majority of studies reported improvements in measurable learning outcomes following the implementation of feedback-oriented assessment practices.

To identify the most common formative assessment strategies employed in the reviewed studies, the interventions were classified according to their primary assessment mechanisms.

Table 9. Types of Formative Assessment Strategies Identified in the Literature

Assessment Strategy	Frequency
Feedback-Based Assessment	17
Learning Analytics Feedback	8
Self-Assessment	6
Peer Assessment	5
Reflective Journals	4
AI-Assisted Assessment	4
Programmatic Assessment	3
Gamified Assessment	3
Total	**50**

Feedback-based assessment emerged as the most frequently reported formative assessment strategy. Seventeen studies highlighted the role of continuous teacher feedback in improving learning performance and supporting learners' understanding of instructional expectations. Feedback interventions commonly involved written comments, verbal guidance, progress monitoring, and reflective discussions designed to assist learners in identifying strengths and weaknesses.

Learning analytics feedback represented the second most common strategy. Several studies demonstrated that data-driven feedback generated through digital platforms improved students' awareness of learning progress and promoted more effective learning behaviors. Self-assessment and peer assessment also appeared frequently, indicating a growing emphasis on learner-centered approaches that encourage students to take active responsibility for monitoring and evaluating their own learning. The effects of these formative assessment practices on learning outcomes were examined across the reviewed studies.

Table 10. Reported Learning Outcomes Associated with Formative Assessment

Learning Outcome	Frequency
Academic Achievement	18
Course Performance	12
Learning Engagement	8
Critical Thinking	4
Language Achievement	3
Clinical Skill Performance	3
Reflective Learning Skills	2
Total	**50**

The distribution of reported learning outcomes indicates that formative assessment has been investigated primarily for its contribution to academic achievement and overall course performance, suggesting that improving measurable learning outcomes remains the principal focus of existing research. Learning engagement also emerged as a frequently reported outcome, highlighting the role of formative assessment in promoting active participation throughout the learning process. Although critical thinking, language achievement, clinical skill performance, and reflective learning skills were reported less frequently, their inclusion demonstrates that the educational benefits of formative assessment extend beyond academic performance to encompass higher-order thinking, professional competence, and reflective practice. The variation in reported outcomes further suggests that the effectiveness of formative assessment depends on the educational objectives and instructional contexts in which it is implemented.

Feedback-Supported Self-Regulated Learning

The third theme emerging from the reviewed literature concerns the role of formative assessment in fostering self-regulated learning (SRL). Across diverse educational contexts, feedback was consistently identified as the primary mechanism through which learners developed greater autonomy, self-monitoring capacity, strategic learning behavior, and metacognitive awareness. The findings demonstrate that formative assessment extends beyond measuring performance by actively shaping how students plan, monitor, regulate, and evaluate their own learning processes.

Several studies emphasized that effective formative assessment creates opportunities for learners to identify performance gaps, reflect on learning strategies, and adjust subsequent actions. This process encourages students to become active participants in their learning rather than passive recipients of instructional content. As a result, self-regulated learning emerged as one of the most frequently reported outcomes associated with formative assessment interventions.

Table 11. Self-Regulated Learning Components Enhanced Through Formative Assessment

SRL Component	Frequency
Self-Monitoring	16
Metacognitive Regulation	14
Goal Setting	11
Motivation Regulation	10
Reflection	9
Strategic Learning	8
Self-Evaluation	7
Time Management	5

The results indicate that self-monitoring was the most frequently reported self-regulated learning component. Studies involving learning analytics dashboards, reflective journals, and formative feedback systems demonstrated that students became increasingly capable of tracking their progress and identifying areas requiring improvement. Through continuous feedback, learners developed stronger awareness of their strengths, weaknesses, and learning trajectories.

Metacognitive regulation also appeared prominently across the reviewed studies. Research conducted in higher education, language learning, and medical education contexts revealed that formative assessment encouraged students to think critically about their own learning processes. Learners who regularly engaged with feedback were more likely to evaluate learning strategies, modify ineffective approaches, and adopt more efficient methods for achieving academic goals. These findings suggest that formative assessment contributes substantially to the development of higher-order learning skills.

Goal setting and motivation regulation emerged as additional benefits. Students exposed to formative assessment practices demonstrated clearer learning objectives and greater persistence in completing academic tasks. Feedback provided explicit performance indicators that helped learners establish realistic goals and maintain motivation throughout the learning process. Consequently, formative assessment appears to support both cognitive and motivational dimensions of self-regulated learning.

To further understand the mechanisms responsible for these improvements, the studies were analyzed according to the type of feedback employed.

Table 12. Feedback Types Reported in the Reviewed Studies

Feedback Type	Frequency
Teacher Feedback	18
Learning Analytics Feedback	8

Reflective Feedback	8
Peer Feedback	7
Automated Feedback	5
AI-Generated Feedback	4

Teacher feedback represented the most prevalent form of formative feedback. Traditional instructor comments remained highly influential across educational levels because they provided personalized guidance, clarification, and encouragement. Studies consistently reported that teacher feedback improved learners' understanding of performance expectations and facilitated corrective action.

Learning analytics feedback and reflective feedback constituted the second most common categories. In these studies, learners received visual representations of their progress through dashboards, reports, and analytics tools. Such feedback enabled students to evaluate their learning patterns, identify weaknesses, and make informed decisions regarding future learning strategies. Reflective feedback further encouraged students to critically examine their learning experiences and engage in self-evaluation activities.

Peer feedback also demonstrated positive effects on self-regulated learning. Through collaborative assessment activities, students developed evaluative judgment, critical thinking skills, and greater responsibility for learning. These findings suggest that peer assessment not only supports content mastery but also promotes metacognitive and reflective processes essential for self-regulation.

The relationship between feedback and self-regulated learning was particularly evident in technology-enhanced learning environments. Digital platforms provided learners with immediate and continuous feedback, increasing opportunities for self-monitoring and adaptive learning. Consequently, the integration of formative assessment and feedback systems appears to be a key factor in strengthening students' self-regulatory capabilities.

Table 13. Reported Outcomes of Feedback-Supported Self-Regulated Learning

Outcome	Frequency
Improved Learning Autonomy	15
Increased Motivation	11
Enhanced Reflection	9
Better Learning Strategies	8
Improved Goal Achievement	4
Greater Learning Persistence	3

The findings indicate that learning autonomy was the most frequently reported outcome of feedback-supported self-regulated learning. Students receiving regular formative feedback demonstrated increased independence in managing learning tasks and making academic decisions. Many studies described a transition from teacher-dependent learning toward more autonomous and self-directed learning behaviors.

Enhanced reflection and improved learning strategies were also consistently observed. Learners became more capable of evaluating their progress, identifying ineffective approaches, and implementing alternative strategies. This capacity for adaptive learning is widely recognized as a core characteristic of successful self-regulated learners. The evidence suggests that formative assessment contributes significantly to self-regulated learning through its feedback function. Whether delivered by teachers, peers, digital systems, or artificial intelligence tools, feedback serves as a catalyst for self-monitoring, reflection, motivation regulation, and autonomous learning.

Technology-Enhanced Formative Assessment and Emerging AI Directions

The fourth theme identified in the review concerns the increasing integration of technology into formative assessment practices. Recent studies demonstrate a substantial shift from traditional paper-based assessment toward digital, analytics-driven, and artificial intelligence-supported assessment systems. These developments have expanded opportunities for providing personalized feedback, monitoring learning behaviors, and supporting self-regulated learning in real time.

The growing presence of educational technology reflects broader changes in contemporary learning environments. Online learning platforms, virtual classrooms, learning management systems, and artificial intelligence applications have transformed the manner in which formative assessment is implemented. As a result, technology-enhanced formative assessment has emerged as one of the fastest-growing research areas within the literature.

Table 14. Technology Utilized in Formative Assessment Studies

Technology Type	Frequency
Learning Analytics Systems	9
Virtual Learning Environments	8
Artificial Intelligence Systems	7
Digital Dashboards	4
Gamification Platforms	4
Personal Learning Environments	3
Adaptive Learning Systems	3
Mobile Learning Applications	2

Learning analytics systems represented the most commonly reported technological intervention. These systems collected and analyzed learner data to generate actionable feedback regarding participation, performance, and progress. Studies consistently reported that analytics-supported feedback enhanced self-monitoring and promoted more effective learning behaviors. Virtual learning environments constituted another prominent category. Research conducted in online and blended learning settings demonstrated that digital platforms facilitated continuous assessment, immediate feedback, and flexible learning opportunities. Such environments allowed students to access learning resources, track progress, and engage in reflective activities independently.

Artificial intelligence systems emerged as an increasingly important area of investigation. Recent studies published in 2025 and 2026 reported the growing use of intelligent tutoring systems, AI-generated feedback, adaptive recommendation engines, and large language model-based learning assistants. These technologies provided individualized support and enabled more personalized learning experiences. To better understand the contribution of emerging technologies, the reviewed studies were further analyzed according to their primary educational functions.

Table 15. Educational Functions of Technology-Enhanced Formative Assessment

Function	Frequency
Personalized Feedback	14
Learning Progress Monitoring	11
Self-Regulated Learning Support	9
Adaptive Learning Guidance	6
Performance Prediction	4
Reflective Learning Support	3
Engagement Enhancement	3

Personalized feedback emerged as the most prominent function. Technology-enabled systems provided learners with individualized recommendations based on performance data and learning behavior. Such feedback increased relevance, timeliness, and responsiveness compared with conventional assessment approaches. Learning progress monitoring also appeared frequently. Through dashboards and analytics systems, learners gained access to visual representations of performance trends, helping them identify strengths, weaknesses, and areas requiring improvement. This transparency enhanced learners' capacity for self-monitoring and informed decision-making. Adaptive learning guidance represented another important function. AI-supported systems were increasingly capable of adjusting learning pathways according to learner needs, thereby facilitating individualized learning experiences. These technologies demonstrated particular potential for supporting diverse learners with varying levels of prior knowledge and learning preferences. Despite these benefits, several studies also highlighted potential challenges associated with artificial intelligence-supported assessment.

Table 16. Opportunities and Challenges of AI-Supported Formative Assessment

Opportunities	Frequency
Personalized Learning Support	8
Immediate Feedback	7
Adaptive Learning Pathways	6
Improved Self-Monitoring	5
Enhanced Learning Analytics	4

Challenges	Frequency
Overdependence on Technology	5
Reduced Learner Autonomy	4
Algorithmic Bias	3
Data Privacy Concerns	3
Ethical Considerations	2

The findings indicate that AI technologies offer substantial opportunities for enhancing formative assessment and self-regulated learning. Personalized support, immediate feedback, and adaptive guidance can improve learner engagement and academic performance while strengthening self-regulatory processes. However, the reviewed literature also emphasizes the importance of maintaining learner autonomy. Excessive reliance on intelligent systems may reduce opportunities for independent decision-making and critical reflection. Concerns regarding algorithmic bias, transparency, and data privacy further suggest the need for careful implementation of AI-supported formative assessment practices. The evidence indicates that technology-enhanced formative assessment is becoming a central component of contemporary education. The integration of learning analytics, digital feedback systems, and artificial intelligence has expanded the possibilities for supporting learning outcomes and self-regulated learning. At the same time, ensuring ethical, transparent, and learner-centered implementation remains a critical priority for future research and practice.

DISCUSSION

The Expanding Role of Formative Assessment in Contemporary Learning Environments

The findings indicate a substantial increase in scholarly attention to formative assessment between 2022 and 2025, reflecting broader transformations in educational assessment practices. The growing number of publications suggests that formative assessment is increasingly viewed not merely as a mechanism for measuring learning but as a pedagogical approach that actively shapes learning processes and learner development. This trend aligns with recent reviews emphasizing that formative assessment has evolved from a classroom-based feedback practice into a comprehensive learning support system integrated with digital technologies, learning analytics, and personalized instructional strategies (Müller & Wagner, 2026; Solis Trujillo et al., 2025). The prominence of higher education within the reviewed studies further indicates that universities are becoming major sites for the implementation of assessment practices designed to promote lifelong learning competencies and independent learning behaviors.

The concentration of studies in higher education also reflects changing expectations regarding learner responsibility and autonomy. Contemporary educational frameworks increasingly require students to regulate their own learning, evaluate their progress, and engage in reflective practices. Under such conditions, formative assessment serves as an essential mechanism for supporting these expectations. Similar conclusions were reported by Edisherashvili et al. (2022), who found that formative assessment plays a critical role in supporting learner agency in distance learning environments. Likewise, Ritz et al. (2023) demonstrated that embedded assessment interventions can strengthen learner adaptation and resilience in blended learning settings. These findings suggest that formative assessment has become closely associated with broader educational goals related to self-directed and lifelong learning.

Another notable finding concerns the diversification of assessment contexts. The presence of studies across school education, medical education, online learning, and professional training indicates that formative assessment principles are increasingly transferable across disciplinary boundaries. Ballouk et al. (2022) and Fatima et al. (2026) reported that formative assessment contributes significantly to the development of reflective clinical competence in medical education, while Teng (2022) and Lu et al. (2022) highlighted similar benefits in language learning contexts. Such consistency across domains strengthens the argument that formative assessment functions as a universal pedagogical mechanism capable of supporting learning regardless of disciplinary context.

Formative Assessment as a Driver of Learning Outcomes

One of the most consistent findings of the review is the positive relationship between formative assessment and learning outcomes. Academic achievement emerged as the most frequently reported outcome across the reviewed studies, indicating that learners generally perform better when assessment is integrated into the learning process rather than implemented solely at the end of instruction. This finding is consistent with the meta-analysis conducted by Yao et al. (2024), which demonstrated that formative assessment exerts a positive effect on learning achievement across multiple educational levels and subject areas. The results also support the conclusions of Borter (2023), who found that additional formative assessment opportunities positively influence both learning behaviors and academic performance.

The effectiveness of formative assessment can be explained through its capacity to reduce the gap between current performance and desired learning goals. By providing continuous information regarding learner progress, formative assessment enables students to make timely adjustments to their learning strategies. This mechanism is particularly evident in studies involving feedback-based interventions and learning analytics systems. Chen (2024) reported that analytics-supported feedback significantly improved both self-regulated learning and academic achievement in blended language learning environments. Similarly, Huang et al. (2024) found that data-driven feedback enhanced mathematics problem-solving performance among school learners by providing actionable information regarding learning progress.

The findings also indicate that formative assessment contributes to outcomes extending beyond achievement scores. Several studies reported improvements in engagement, critical thinking, language performance, and professional competence. These broader outcomes suggest that formative assessment supports deeper forms of learning rather than merely improving examination performance. Such observations are consistent with Teng (2022), who argued that formative assessment facilitates strategic learning behaviors that contribute to sustainable academic development. Similar conclusions were reached by Zeng et al. (2024), whose quasi-experimental findings demonstrated that assessment, reflection, and critical thinking collectively strengthen learners' capacity for meaningful learning.

The diversity of positive outcomes identified in the review supports the view that formative assessment functions as a multidimensional instructional practice. Rather than operating solely as an evaluative instrument, formative assessment appears to influence cognitive, motivational, behavioral, and affective dimensions of learning simultaneously. This interpretation is reinforced by Xu et al. (2023), whose meta-analysis showed that interventions supporting self-regulated learning significantly improve academic achievement in both online and blended learning environments.

Feedback as the Central Mechanism Linking Assessment and Self-Regulated Learning

A major contribution of the reviewed literature lies in its demonstration of feedback as the primary mechanism connecting formative assessment and self-regulated learning. Across diverse educational contexts, feedback consistently facilitated self-monitoring, reflection, goal setting, strategic learning, and metacognitive regulation. These findings strongly support theoretical perspectives that conceptualize self-regulated learning as a cyclical process involving planning, monitoring, and evaluation. Formative assessment provides the informational resources necessary for learners to engage effectively in each stage of this cycle.

The prominence of self-monitoring and metacognitive regulation within the findings is particularly significant. Research by He et al. (2024) demonstrated that formative assessment interventions alter learners' self-regulation patterns by encouraging more active monitoring of learning progress. Similar findings were reported by Ahmad (2024), who found that reflective learning diaries support learners' capacity to evaluate their own performance and regulate subsequent learning behaviors. These results suggest that formative assessment contributes to the development of metacognitive awareness, which remains one of the strongest predictors of academic success.

The review also highlights the importance of feedback literacy in the development of self-regulated learning. Chen et al. (2026) argued that learners must possess the ability to interpret, evaluate, and utilize feedback effectively if assessment is to support learning. The findings of the present review support this perspective by demonstrating that feedback becomes most effective when learners actively engage with assessment information rather than passively receiving evaluative comments. Similar observations were reported by Lu et al. (2022), who found strong relationships among feedback perceptions, self-efficacy, self-regulated learning, and language achievement.

Another noteworthy finding concerns the role of peer assessment and self-assessment in strengthening learner autonomy. Ortega-Ruipérez and Correa-Gorospe (2024) concluded that peer assessment activities encourage learners to develop evaluative judgment and reflective thinking. Likewise, Zheng et al. (2024) demonstrated that self-assessment practices improve learners' ability to identify strengths and weaknesses in their performance. These findings suggest that formative assessment becomes particularly effective when responsibility for assessment is shared between teachers and learners rather than remaining exclusively teacher-directed.

Technology, Learning Analytics, and the Transformation of Formative Assessment

The review demonstrates that technological innovations are fundamentally transforming formative assessment practices. Learning analytics systems, virtual learning environments, digital dashboards, and adaptive learning platforms increasingly function as mechanisms for generating timely and personalized feedback. These developments reflect a broader shift toward data-informed educational decision making and learner-centered assessment.

Learning analytics emerged as one of the most influential technological developments identified in the literature. Studies by Zhang et al. (2023), Nguyen et al. (2024), and Song et al. (2024) collectively indicate that analytics-based assessment systems provide learners with detailed information regarding participation patterns,

learning trajectories, and performance outcomes. By visualizing learning progress, these systems enhance learners' capacity for self-monitoring and strategic decision making. The findings therefore support the growing consensus that learning analytics can strengthen both formative assessment and self-regulated learning simultaneously.

The integration of digital technologies also expands opportunities for continuous assessment. Traditional assessment practices often provide delayed feedback, limiting learners' ability to respond effectively. In contrast, digital environments enable real-time feedback that supports immediate learning adjustments. Hu et al. (2024) demonstrated that gamified analytics dashboards improve self-regulated learning through enhanced monitoring and co-regulation mechanisms. Similar findings were reported by Nan Cenka et al. (2024) and Tur et al. (2024), who emphasized the capacity of personal learning environments to support learner autonomy and self-regulation.

The increasing prominence of technology-supported formative assessment suggests that assessment practices are moving toward more dynamic, adaptive, and learner-centered models. However, technological effectiveness depends not only on system functionality but also on learners' ability to interpret and utilize feedback. Consequently, technological innovation should be accompanied by efforts to strengthen feedback literacy and self-regulated learning competencies.

Artificial Intelligence and Future Directions for Formative Assessment

One of the most recent developments identified in the review concerns the emergence of artificial intelligence as a tool for supporting formative assessment and self-regulated learning. Studies published between 2025 and 2026 increasingly examined AI-supported feedback systems, adaptive recommendation engines, and intelligent learning assistants. This trend reflects broader educational interest in leveraging artificial intelligence to personalize learning experiences and improve assessment efficiency.

The reviewed studies suggest that artificial intelligence offers considerable potential for enhancing formative assessment. Achuthan (2025) found that AI-supported learning environments contribute positively to learner autonomy and self-regulated learning development. Similarly, Ge et al. (2025) demonstrated that large language model-assisted learning systems can strengthen self-regulation through personalized guidance and gamified support mechanisms. Saftari et al. (2025) further reported that AI technologies increasingly align with established self-regulated learning frameworks by supporting planning, monitoring, and reflection processes.

Despite these benefits, the findings also reveal emerging concerns regarding overreliance on intelligent systems. Babayev (2025) highlighted the possibility that excessive personalization may create forms of algorithmic dependence that reduce learner autonomy. Similar concerns are reflected in Yang and Sun (2026), who argued that educational technologies should support rather than replace learners' self-regulatory capacities. These observations suggest that future implementations of AI-supported formative assessment must balance personalization with opportunities for independent learning and critical reflection.

The evidence indicates that artificial intelligence represents an important future direction for formative assessment research. However, the long-term effectiveness of AI-supported assessment will depend on its ability to complement human feedback, preserve learner agency, and promote sustainable self-regulated learning practices. The challenge for future educational research lies not merely in developing more sophisticated technologies but in ensuring that these technologies remain pedagogically meaningful and learner-centered.

CONCLUSION

This study reinforces the view that formative assessment should be understood as a pedagogical mechanism that supports learning development rather than merely an evaluative procedure. The reviewed literature demonstrates that formative assessment occupies a strategic position within contemporary educational systems because it facilitates the alignment between instructional processes, learner engagement, and the development of autonomous learning capacities. The increasing integration of formative assessment into diverse educational contexts reflects a broader paradigm shift from assessment of learning toward assessment for learning, where assessment activities are embedded within instructional practices to continuously support learner growth and adaptation. From this perspective, formative assessment contributes to the creation of more responsive, learner-centered, and development-oriented educational environments.

The findings have important implications for educational practice, policy, and curriculum development. Educational institutions should consider formative assessment as a core component of instructional design rather than an additional assessment activity. Teachers and instructors are encouraged to develop assessment practices that provide meaningful feedback, facilitate learner reflection, and promote active participation in learning processes. At the institutional level, the integration of formative assessment into curriculum frameworks may strengthen the development of twenty-first-century competencies, including critical thinking, self-direction, adaptability, and lifelong learning. Furthermore, the increasing use of digital technologies and learning analytics suggests the need for

professional development initiatives that equip educators with the competencies required to design and implement technology-enhanced formative assessment effectively.

Several limitations should be acknowledged when interpreting the findings of this review. First, the analysis was restricted to peer-reviewed journal articles published between 2022 and 2026, which may exclude relevant evidence reported in conference proceedings, books, dissertations, and other scholarly sources. Second, although the review covered diverse educational settings, higher education studies constituted the largest proportion of the included literature, potentially limiting the generalizability of conclusions to other educational levels. Third, the rapid evolution of digital assessment technologies and artificial intelligence applications means that emerging developments may not yet be fully represented within the current evidence base. These limitations suggest that the findings should be interpreted as reflecting the contemporary state of research rather than providing definitive conclusions regarding all forms of formative assessment practice.

Future research should investigate the long-term sustainability of formative assessment interventions across different educational levels, cultural contexts, and disciplinary domains. Additional studies are needed to explore how emerging technologies, particularly artificial intelligence, can support formative assessment while preserving learner autonomy, ethical accountability, and meaningful human interaction. Comparative investigations examining the effectiveness of different feedback models, assessment designs, and technology-supported interventions would further contribute to the refinement of formative assessment theory and practice. Research integrating longitudinal designs may also provide deeper insights into how formative assessment influences learner development over extended periods of time. Beyond its academic contribution, this study offers practical value for educators, curriculum developers, educational leaders, and policymakers by synthesizing contemporary evidence regarding the role of formative assessment in supporting more adaptive, reflective, and learner-centered educational systems. As educational environments continue to evolve, the insights generated by this review may serve as a foundation for designing assessment practices that better prepare learners for continuous learning and participation in increasingly complex knowledge societies.

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REFERENCE

Abbott, M. L., & Lee, K. K. (2023). Relationships between students' emotions, self-regulated learning, and literacy gains in beginning/basic level ESL literacy classes for adults. *System, 115*, 103061. https://doi.org/10.1016/j.system.2023.103061

Achuthan, K. (2025). Artificial intelligence and learner autonomy: A meta-analysis of self-regulated and self-directed learning. *Frontiers in Education, 10*, 1738751. https://doi.org/10.3389/feduc.2025.1738751

Ahmad, M. O. (2024). A deep dive into self-regulated learning: Reflective diaries role and implementation strategies. *Communications of the Association for Information Systems, 54*(1), 868-888. https://doi.org/10.17705/1CAIS.05432

Araka, E., Oboko, R., Maina, E., & Gitonga, R. (2022). Using educational data mining techniques to identify profiles in self-regulated learning: An empirical evaluation. *The International Review of Research in Open and Distributed Learning, 23*(1), 131-162. https://doi.org/10.19173/irrodl.v22i4.5401

Babayev, J. (2025). Algorithmic autonomy or dependence? A mixed-methods study on AI personalization and self-regulated learning in higher education. *Journal of Azerbaijan Language and Education Studies, 2*(4), 32-39. https://doi.org/10.69760/jales.2025004002

Ballouk, R., Mansour, V., Dalziel, B., McDonald, J., & Hegazi, I. (2022). Medical students' self-regulation of learning in a blended learning environment: A systematic scoping review. *Medical Education Online, 27*(1), 2029336. https://doi.org/10.1080/10872981.2022.2029336

Bernacki, M. L., Yu, L., Kuhlmann, S. L., Plumley, R. D., Greene, J. A., Duke, R. F., ... & Hogan, K. A. (2025). Using multimodal learning analytics to validate digital traces of self-regulated learning in a laboratory study and

predict performance in undergraduate courses. *Journal of Educational Psychology, 117*(2), 176. https://doi.org/10.1037/edu0000890

Borter, N. (2023). Differential effects of additional formative assessments on student learning behaviors and outcomes. *Studia Paedagogica, 28*(3), 9-38. https://doi.org/10.5817/SP2023-3-1

Boulahmel, A., Djelil, F., & Smits, G. (2025). Investigating self-regulated learning measurement based on trace data: A systematic literature review. *Technology, Knowledge and Learning*. https://dx.doi.org/10.1007/s10758-025-09816-y

Chen, J. (2024). Effects of learning analytics-based feedback on students' self-regulated learning and academic achievement in a blended EFL course. *System, 124*, 103388. https://doi.org/10.1016/j.system.2024.103388

Chen, R., Wang, X., & Zhu, K. (2025). A bibliometric and content analysis of strategy-based instruction and self-regulated learning in second or foreign language teaching from 1994 to 2024. *Frontiers in Psychology, 16*, 1474689. https://doi.org/10.3389/fpsyg.2025.1474689

Chen, S., Zhang, L., & Li, A. W. (2026). Leveraging self-regulated learning to support university students' feedback literacy in blended learning environments. *Assessment & Evaluation in Higher Education, 51*(1), 174-193. https://doi.org/10.1080/02602938.2025.2546349

Edisherashvili, N., Saks, K., Pedaste, M., & Leijen, Ä. (2022). Supporting self-regulated learning in distance learning contexts at higher education level: Systematic literature review. *Frontiers in Psychology, 12*, 792422. https://doi.org/10.3389/fpsyg.2021.792422

Fatima, S., Hong, W. H., Mohd Noor, M. N., Foong, C. C., & Pallath, V. (2026). Evaluating the instructional strategies influencing self-regulated learning in clinical clerkship years: A mixed studies review. *Teaching and Learning in Medicine, 38*(1), 47-65. https://doi.org/10.1080/10401334.2025.2468953

Fukuda, S. T., Lander, B. W., & Pope, C. J. (2022). Formative assessment for learning how to learn: Exploring university student learning experiences. *RELC Journal, 53*(1), 118-133. https://doi.org/10.1177/0033688220925927

Ge, W., Sun, Y., Wang, Z., Zheng, H., He, W., Wang, P., ... & Wang, B. (2025). SRLAgent: Enhancing self-regulated learning skills through gamification and LLM assistance. *arXiv preprint arXiv:2506.09968*. https://doi.org/10.48550/arXiv.2506.09968

Greenquist-Marlett, S., Bol, L., & Hill, C. (2025). Teachers' perceptions of their self-regulated learning practices in elementary school classrooms. *Frontiers in Education, 9*, 1464350. https://doi.org/10.3389/feduc.2024.1464350

Hashmi, Z. F., Iqbal, J., Asghar, M. Z., & Siming, L. (2026). The influence of online learning interactions on self-regulated learning: Mediating role of technology proficiencies among higher education students. *Open Learning: The Journal of Open, Distance and e-Learning, 41*(1), 41-66. https://doi.org/10.1080/02680513.2025.2492657

He, S., Epp, C. D., Chen, F., & Cui, Y. (2024). Examining change in students' self-regulated learning patterns after a formative assessment using process mining techniques. *Computers in Human Behavior, 152*, 108061. https://doi.org/10.1016/j.chb.2023.108061

Hu, Y. H., Liao, B. K., & Hsieh, C. L. (2024). Effectiveness of a gamified learning analytics dashboard with coregulation mechanism for self-regulated learning in college ethics courses. *Interactive Learning Environments, 32*(10), 6628-6644. https://doi.org/10.1080/10494820.2023.2277741

Huang, J., Cai, Y., Lv, Z., Huang, Y., & Zheng, X. L. (2024). Toward self-regulated learning: Effects of different types of data-driven feedback on pupils' mathematics word problem-solving performance. *Frontiers in Psychology, 15*, 1356852. https://doi.org/10.3389/fpsyg.2024.1356852

Liu, X., Dolmans, D., Asoodar, M., Li, Z., & Verstegen, D. (2025). How to close the learning circle? Students' perspectives on how programmatic assessment influences self-regulated learning in a global online programme. *Assessment & Evaluation in Higher Education, 50*(8), 1207-1222. https://doi.org/10.1080/02602938.2025.2513008

Lu, S., Cheng, L., & Chahine, S. (2022). Chinese university students' conceptions of feedback and the relationships with self-regulated learning, self-efficacy, and English language achievement. *Frontiers in Psychology, 13*, 1047323. https://doi.org/10.3389/fpsyg.2022.1047323

Miao, J., & Ma, L. (2023). Teacher autonomy support influence on online learning engagement: The mediating roles of self-efficacy and self-regulated learning. *Sage Open, 13*(4), 21582440231217737. https://doi.org/10.1177/21582440231217737

Müller, J., & Wagner, I. (2026). Formative assessment of motor learning through digital tools in physical education: A systematic literature review. *European Physical Education Review, 32*(2), 383-403. https://doi.org/10.1177/1356336X251357207

Nan Cenka, B. A., Santoso, H. B., & Junus, K. (2024). Using the personal learning environment to support self-regulated learning strategies: A systematic literature review. *Interactive Learning Environments, 32*(4), 1368-1384. https://doi.org/10.1080/10494820.2022.2120019

Nguyen, A., Lämsä, J., Dwiarie, A., & Järvelä, S. (2024). Lifelong learner needs for human-centered self-regulated learning analytics. *Information and Learning Sciences, 125*(1-2), 68-108. https://doi.org/10.1108/ILS-07-2023-0091

Oportus-Torres, R., Contreras-Soto, Y., Sanhueza-Campos, C., Maluenda-Albornoz, J., Pérez-Villalobos, C., & Quintanilla-Espinoza, A. (2024). Self-regulated learning and engagement through emergency remote teaching in EFL undergraduate students. *Frontiers in Education, 9*, 1416507. https://doi.org/10.3389/feduc.2024.1416507

Ortega-Ruipérez, B., & Correa-Gorospe, J. M. (2024). Peer assessment to promote self-regulated learning with technology in higher education: Systematic review for improving course design. *Frontiers in Education, 9*, 1376505. https://doi.org/10.3389/feduc.2024.1376505

Ritz, E., Rietsche, R., & Leimeister, J. M. (2023). How to support students' self-regulated learning in times of crisis: An embedded technology-based intervention in blended learning pedagogies. *Academy of Management Learning & Education, 22*(3), 357-382. https://doi.org/10.5465/amle.2022.0188

Sabbar, S. (2025). The role of formative assessment in enhancing self-regulated learning in EFL contexts: A comprehensive review study. *At-Tasyrih: Jurnal Pendidikan dan Hukum Islam, 11*(2), 418-431. https://doi.org/10.55849/attasyrih.v11i2.471

Saftari, R., Mulyadi, H., & Supardi, E. (2025). Tracing the role of artificial intelligence in self-regulated learning: A systematic review using the Winne and Hadwin framework (2007-2025). *JP (Jurnal Pendidikan): Teori Dan Praktik, 10*(1), 78-92. https://doi.org/10.26740/jp.v10n1.p78-92

Solis Trujillo, B. P., Velarde-Camaqui, D., Gonzales Nuñez, C. A., Castillo Silva, E. V., & Gonzalez Said de la Oliva, M. D. P. (2025). The current landscape of formative assessment and feedback in graduate studies: A systematic literature review. *Frontiers in Education, 10*, 1509983. https://doi.org/10.3389/feduc.2025.1509983

Song, Y., Li, C., Xing, W., Li, S., & Lee, H. H. (2024). A fair clustering approach to self-regulated learning behaviors in a virtual learning environment. In *Proceedings of the 14th Learning Analytics and Knowledge Conference* (pp. 771-778). https://doi.org/10.1145/3636555.3636863

Tambak, A., Setiawan, H. R., Nurdianti, N., Lestari, S. P., & Intan, N. (2025). An analysis of the implementation of formative evaluation as an effort to improve students' academic achievement. *Kitabah: Jurnal Pendidikan Sosial Humaniora, 3*(3), 145-155. https://doi.org/10.56114/kitabah.v3i3.12606

Teng, L. S. (2022). Explicit strategy-based instruction in L2 writing contexts: A perspective of self-regulated learning and formative assessment. *Assessing Writing, 53*, 100645. https://doi.org/10.1016/j.asw.2022.100645

Teng, L. S., Wei, J., & Zhang, L. J. (2024). Longitudinal interactions of L2 learners' motivations and strategic behavior in strategies-based writing instruction: A self-regulated learning perspective. *AILA Review, 37*(2), 188-214. https://doi.org/10.1075/aila.24026.ten

Tur, G., Castañeda, L., Torres-Kompen, R., & Carpenter, J. P. (2024). A literature review on self-regulated learning and personal learning environments: Features of a close relationship. *Interactive Learning Environments, 32*(4), 1402-1421. https://doi.org/10.1080/10494820.2022.2121726

Xu, J., Li, J., & Yang, J. (2024). Self-regulated learning strategies, self-efficacy, and learning engagement of EFL students in smart classrooms: A structural equation modeling analysis. *System, 125*, 103451. https://doi.org/10.1016/j.system.2024.103451

Xu, Z., Zhao, Y., Zhang, B., Liew, J., & Kogut, A. (2023). A meta-analysis of the efficacy of self-regulated learning interventions on academic achievement in online and blended environments in K-12 and higher education. *Behaviour & Information Technology, 42*(16), 2911-2931. https://doi.org/10.1080/0144929X.2022.2151935

Yang, B., & Sun, Y. (2026). From the self-learning of machine to the self-regulated learning of students: An affordance actualization perspective. *International Journal of Human-Computer Interaction, 42*(7), 4953-4972. https://doi.org/10.1080/10447318.2025.2543990

Yao, Y., Amos, M., Snider, K., & Brown, T. (2024). The impact of formative assessment on K-12 learning: A meta-analysis. *Educational Research and Evaluation, 29*(7-8), 452-475. https://doi.org/10.1080/13803611.2024.2363831

Yigletu, A., Michael, K., & Atnafu, M. (2023). Professional development on assessment for learning and its effect on pre-service teacher's self-regulated learning. *Cogent Education, 10*(1), 2222875. https://doi.org/10.1080/2331186X.2023.2222875

Zeng, W., Goh, Y. X., Ponnamperuma, G., Liaw, S. Y., Lim, C. C., Chia, S. Y., & de Bruin, A. (2024). Promotion of self-regulated learning through internalization of critical thinking, assessment and reflection to empower

learning (iCARE): A quasi-experimental study. *Nurse Education Today, 142*, 106339. https://doi.org/10.1016/j.nedt.2024.106339

Zhang, K., Yılmaz, R., Ustun, A. B., & Yılmaz, F. G. K. (2023). Learning analytics in formative assessment: A systematic literature review. *Journal of Measurement and Evaluation in Education and Psychology, 14*(Özel Sayı), 359-381. https://doi.org/10.21031/epod.1272054

Zheng, B., & Sun, T. (2025). Self-regulated learning and learning outcomes in undergraduate and graduate medical education: A meta-analysis. *Evaluation & the Health Professions, 48*(4), 430-450. https://doi.org/10.1177/01632787241288849

Zheng, B., He, Q., & Lei, J. (2024). Informing factors and outcomes of self-assessment practices in medical education: A systematic review. *Annals of Medicine, 56*(1), 2421441. https://doi.org/10.1080/07853890.2024.2421441

Zhong, L. (2025). An examination of the literature on self-regulated learning in EFL education: A bibliometric analysis. *Cogent Education, 12*(1), 2464363. https://doi.org/10.1080/2331186X.2025.2464363.

AI DISCLOSURE STATEMENT

The authors confirm that the preparation of this manuscript involved the assistance of ChatGPT, an AI-based language model developed by OpenAI. Its use was strictly limited to supporting editorial tasks such as grammar refinement, sentence polishing, and improving readability. ChatGPT was not employed for generating research ideas, determining methodology, or producing analytical interpretations. All scientific content, including research design, data analysis, interpretation of findings, and drawing of conclusions, was fully developed and verified by the authors. The authors carefully reviewed all AI-assisted revisions to ensure academic accuracy and integrity. Responsibility for the final content rests entirely with the authors, and ChatGPT is not listed as a contributor or author of this work.

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1	Heidi L. Andrade, Gregory J. Cizek. "Handbook of Formative Assessment", Routledge, 20	Publication
2	Vera Monteiro, Brunna Brito Passarinho. "Formative Assessment and Self-Regulated Learning in Lower Secondary Mathematics: Students' and Teachers' Perceptions", Education Sciences, 2026	Publication
3	files.eric.ed.gov	Internet Source
4	Elliott-Taylor, Phillip. "Teachers Perceptions of Teaching Strategies for Developing Self-Regulated Learning in Preschoolers.", Grand Canyon University	Publication
5	www.mdpi.com	Internet Source
6	McNichols Irvin, Kathleen. "Online Student Perspectives of Impactful Feedback.", Arkan State University	Publication
7	pressbooks.openeducationalberta.ca	Internet Source
8	Ru Yan, Letian Xiong, Shutao Wang. "The relationship between digital readiness and college students' learning outcomes: An urban-rural comparative analysis", Internation Journal of Educational Research, 2026	Publication
9	Saleh Alwahaishi, Waqas Ahmed. "Modeling learning engagement in AI-supported education: a crossover enabler–inhibitor framework", Frontiers in Psychology, 2026	Publication
10	Maitreyee Das, Abhishek Dutta, Gautam Dutta, Atanu Bhattacharyya. "Impact of format assessment on learning outcome – an analysis with an Indian B-school", Asian Educatic and Development Studies, 2026	Publication
11	Paul A. Schutz, Krista R. Muis. "Handbook of Educational Psychology", Routledge, 2023	Publication
	jurnal.umt.ac.id	

12 Internet Source

13 N. Fardhana Begum, D. Venkatesan. "Self-regulated learning behaviours and employab skills in online learning environments: the mediating role of self-evaluation", Frontiers i Education, 2026
Publication

14 erjee.uniku.ac.id
Internet Source

15 Yuling Jiao, Qiuli Wang. "Large language models for formative feedback in writing instruction: a systematic review of classroom interventions, feedback quality, and stud outcomes", Frontiers in Education, 2026
Publication

16 publications.uadventus.ro
Internet Source

17 www.irrodl.org
Internet Source

18 Ehsan Namaziandost, Ferdi Çelik. " RETRACTED: Demystifying the nexus between social support, teacher support and psychological needs fulfilment with peace of mind, achievement emotions and situational motivation in -integrated language learning ", British Educational Research Journal, 2025
Publication

19 diposit.ub.edu
Internet Source

20 ojs.brazilianjournals.com.br
Internet Source

21 public-pages-files-2025.frontiersin.org
Internet Source

22 www.preprints.org
Internet Source

23 Azhar Al-Khulaifi, Malkan Khatib, Elrazi Ali, Mohamed Yousif Ali, Mohammed Ibn-Mas'u Danjuma. "What is Polypharmacy in Patients with Chronic Kidney Disease? A Systemati Review", Clinical Therapeutics, 2023
Publication

24 Charles, Judy. "Elementary Teachers' Knowledge and Application of Formative Assessm to Improve Instruction.", Walden University
Publication

25 Submitted to RMIT University
Student Paper

26 jurnal.iicet.org
Internet Source

27 Submitted to Infrastructure University Kuala Lumpur
Student Paper

28 Submitted to Mancosa
Student Paper

29 Toni Mäkipää, Dina Tsagari. "Feedback and self-regulation in L2 writing: A research timeline of formative assessment practices", Language Teaching, 2026
Publication

30 Submitted to University of Nottingham
Student Paper

31 Submitted to University of South Africa
Student Paper

32 Submitted to Central Methodist University
Student Paper

33 Serap Uğur. "Transforming Education with Singularity Technologies - Lifelong Learning from Childhood to Adulthood", CRC Press, 2026
Publication

34 Zhihong Xu, Yingying Zhao, Bingsheng Zhang, Jeffrey Liew, Ashlynn Kogut. "A meta-analysis of the efficacy of self-regulated learning interventions on academic achieveme in online and blended environments in K-12 and higher education", Behaviour & Information Technology, 2022
Publication

35 journal.foundae.com
Internet Source

36 jurnal.uii.ac.id
Internet Source

37 Chunwen Yang, Shuai Hou, Jing Chen. "Enhancing interpreting performance, engageme and self-regulated learning through peer assessment: an attachment theory perspectiv Frontiers in Psychology, 2025
Publication

38 Jitendra Sharma, Manjari Rai, Udit Mamodiya, Gunja Soni, Aastha Saxena. "Emerging Trends in Design and Arts - A Multidisciplinary Approach to Aesthetics, Media and Innovation", CRC Press, 2026
Publication

39 Submitted to The Hong Kong Institute of Education
Student Paper

40	cris.maastrichtuniversity.nl	Internet Source
41	www.ecohumanism.co.uk	Internet Source
42	download.bibis.ir	Internet Source
43	journals.aiac.org.au	Internet Source
44	www.wiseguyreports.com	Internet Source

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