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Technology integration challenges faced by EFL teachers: A systematic literature review

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ABSTRACT

Artificial Intelligence (AI) is gradually being used in education, altering how we teach and learn. To inform educational policy and practice, we need to know from the existing empirical literature whether AI improves student outcomes, engagement in learning, teaching effectiveness, or assessment. Methods A systematic literature review was performed in accordance with the PRISMA methodology. We conducted a Google Scholar search of peer-reviewed studies on the use of AI in education, personalized learning, student outcomes, and teaching effectiveness published between January 1st and September 30th in the years 2022–26. Following deduplication, 153 entries were screened by title and abstract against eight predefined criteria (five associated with inclusion and three associated with exclusion). The eligibility of 23 full-text articles was assessed, leading to the qualitative synthesis of 21 of them. The 21 studies included personalized learning systems, adaptive platforms, AI chatbots, gamification tools, and assessment systems across K–12 and higher education levels. Data consistently revealed that AI-based approaches had a positive impact on academic achievement, with effect sizes in language learning, mathematics, science, and management education ranging from moderate to large. Personalized content, timely feedback, and adaptive scaffolding have emerged from AI systems to augment student engagement and motivation. While teachers cited positive pedagogical impacts, implementation hurdles, including technical issues and professional development, existed. AI-powered assessment tools also enhance the quality of feedback and track progress. The results show that AI improves learning outcomes, engagement, teaching effectiveness, and assessment accuracy. Devoted and effective implementation demands the necessary foundation, teacher training, and alignment with the curriculum. This includes the need to explore long-term implications, as well as design for equity and implementation of optimal integration strategies.

KEYWORDS: artificial intelligence, student learning outcomes, teaching effectiveness, educational technology



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1. Introduction

1.1 Rationale

One of the most significant technological changes in modern education is the introduction of AI into the educational space. Examples of learning analytics technologies that have been implemented to personalize learning environments, automate assessments, and inform pedagogy include machine learning algorithms, natural language processing, and adaptive systems (Ouyang et al., 2022). As educational institutions globally spend millions developing and adopting new AI-based tools and platforms, it is essential for educators, policymakers, and researchers to know the evidence in relation to its effectiveness on a case-by-case basis.

Conventional educational methods are often not capable of addressing a wide range of learning needs, providing immediate individual feedback, and adjusting the level of instruction to the state and level of student knowledge. The challenges posed by the increasing complexity of the educational ecosystem are met with the promise of AI-powered educational technologies, as they can help provide personalized learning pathways, intelligent tutoring systems, adaptive content delivery, and data-drawn insights into student progress (Silva et al., 2024). However, while the use of AI in education is rapidly growing, examining its expected impact on fundamental educational outcomes has not kept pace.

An increasingly enthusiastic, albeit cautious, dialogue around AI in education has emerged, along with critical questions about the impact of these technologies on student learning outcomes, engagement and motivation for students and teachers alike, teacher effectiveness, assessment, and feedback accuracy. Additionally, the level of uncertainty surrounding issues pertaining to implementation challenges, effects on equity in education, and the relative impact of AI-assisted instruction versus traditional instructional methods warrants stringent empirical synthesis. Second, by synthesizing recent empirical research on the effects of AI across various dimensions of educational practice, this systematic literature review helps bridge these gaps.

1.2 Objectives and Research Questions

This systematic review aims to aggregate empirical evidence on the effect of AI technologies in education on student outcomes, engagement, teaching practices, and assessment systems. This review addresses four research questions.

Research Question 1: How do AI-Powered Educational Technologies affect students (Learning Outcomes) and Academic Performance In educational settings compared to traditional teaching methodologies?

Research Question 2: What impact do AI-powered personalized learning systems have on learner engagement and motivation compared with conventional instructional methodologies for students in K–12 and higher education?

Impact of AI tools/applications on Teaching Effectiveness and Pedagogical Practices for Educators in Academic Institutions compared to traditional teaching resources (Research Question 3):

This leads to Research Question 4: Compared with traditional assessment forms, how does AI implementation in educational assessment and feedback systems affect the effectiveness of assessments in advising students and the progress of student learning?

2. Methods

2.1 Search Strategy

We performed a systematic search using Google Scholar to find empirical evidence of the effect of AI on education. To ensure that it was able to successfully represent the latest evidence bases reflecting existing AI technologies and educational practices, we limited the search period to 2022–2026. The following query returned two complementary search results:

Question 1: AI in education, with particular attention to students and indicators of academic outcomes. From this query, we received 59 papers that focused (title, abstract, or keywords) on AI-based interventions in relation to measurable learning outcomes.

Question 2: Tailored AI-based adapted learning systems and pedagogical effectiveness From these searches, we identified 100 papers that investigated the use of adaptive learning technologies and their effects on teaching practices.

This search strategy yielded 159 records for the first stage of screening. Because Google Scholar covers multidisciplinary educational research with resources such as journal articles, conference proceedings, and institutional repositories, it was chosen as one of the databases to search. The search encompassed March 2026 to capture the most up-to-date empirical evidence available

2.2 Eligibility Criteria

Eight pre-specified criteria (five inclusion and three exclusion) were used to screen the studies. These criteria were designed to include studies that provided direct empirical evidence related to our research questions.

Inclusion Criteria:

AI-powered Educational Intervention: The Research should analyze Artificial Intelligence technologies, including personalized learning systems, AI-based assessment tools, and adaptive learning platforms that are being integrated into teaching and learning scenarios.

Study Design: The article must include a direct side-by-side comparison of AI-based interventions with traditional pedagogy, standard instructional methods, or manual assessment resources to evaluate their relative efficacy.

Improvements in Learning Outcomes and Progress: The research needs to provide specific measures or findings that show how students' academic performance, learning gains, or tracking an assessment of their progress are more accurate.

Student Motivation and Engagement: The study needs to assess psychological or behavioral outcomes, including student motivation, levels of engagement, and active participation in AI-supported learning environments.

Impact on Pedagogy for Educators: The paper should analyze how AI tools impact the effectiveness of teaching, changes in pedagogy or instructional design of teaching/learning, or work experience of the educator within the workflow at academic institutions.

Exclusion Criteria:

Non-Academic or Non-Formal Setting (corporate training, military training, life-long learning beyond formal school systems or non-instructional commercial contexts)

Purely Technical or Algorithmic Focus: Studies that described the technical architecture or optimization of AI models without engagement measurement (students or teachers) were excluded.

No Empirical Data: Conceptual papers, editorials, opinion pieces, or literature reviews that do not provide original empirical evidence or primary data on the effect of AI in the aforementioned educational contexts were omitted

2.3 Screening Process

The screening process was two-staged and followed the PRISMA guidelines. As the first step, the titles and abstracts of all 153 unique records that remained after deduplication were screened. The eight eligibility criteria were evenly scored for each record. Full-text assessment was conducted for studies that scored 4.0 or higher (on a scale from 0 to 5) on the screening checklist. This threshold was set in such a way as to allow reasonably sensitive award and exclusion of records, avoiding potentially relevant studies from the search while providing greater assurance with documentation clearly ruling out potential eligibility. Of the 153 records screened for titles and abstracts, 23 met the predefined threshold for full-text assessment, while 130 were excluded. The most common exclusion reasons at this stage were lack of empirical data (n=45), technical or algorithmic focus (n=38), non-academic settings (n=27), and other reasons (n=20).

In the second step, a full-text review was performed on the articles that passed the initial screening (n = 23). PDF articles were extracted and thoroughly screened for eligibility. Following this, a stricter cutoff of 4.5 or greater was implemented to include only studies with more substantial empirical support and clear relevance to the research questions for inclusion in the final synthesis. Overall, two studies were not included in the meta-analysis after screening on full-text level that provided no quantitative data and another that evaluated a purely technical but did not assess educational impact. This led to the inclusion of 21 studies in the qualitative analysis.

2.4 Data Extraction

We created a predefined protocol to extract data uniformly across studies. From all 21 studies, six data elements were extracted.

Study Design and Methods (including details on which experimental designs, quasi-experimental studies, case studies, or comparative series were used; sample sizes; analysis techniques).

AI Technology Type: Classifies the category of AI technologies that are studied, such as personalized learning systems, adaptive learning platforms, intelligent tutoring systems, AI chatbots, and gamification tools.

Educational Level and Subject: settings (K-12, higher education) in which the intervention was implemented, any subject area/discipline involved (i.e., mathematics, language learning, science, management education).

Learning Outcomes Key Findings: Extraction of reported effects on academic performance, learning gains, achievement scores, knowledge retention, skill development, and other measurable learning outcomes (e.g., effect size; statistical significance if available).

Effects on student engagement and motivation: Reported results regarding levels of student engagement, level of motivation, and rate of participation; self-efficacy; learning-related attitudes; autonomy; or related psychological or behavioral measures.

What is already known about the topic: The implications of research findings for clinical practice such as a more streamlined approach to education and training What this paper adds to existing knowledge and what happens next Given the relatively trivial level of ill-health in medical students, it is likely that most trainees will be reasonably capable of coping with acute challenges, but may not be mentally prepared; Ideally clinical teams/colleagues should all discuss roles pre-emptively Main conclusions – identify primary author conclusions & practical implications Summary – Identify concrete recommendations for educational practice Limitations / well identified challenges

All 21 accepted studies underwent a systematic data extraction process, and the extracted information was tabulated to enable synthesis and comparison across the studies.

3. Results

3.1 Study Selection

Figure 1 displays the PRISMA flow diagram of the study selection process. The main search yielded 159 records in Google Scholar. Six duplicates were removed, leaving 153 records to be screened through their titles and abstracts. Of the 130 records excluded at this stage according to eligibility, extreme evidence was most often due to the lack of empirical data (n=45), purely technical or algorithmic focus (n=38), and non-academic settings (n=27). A new, harsher eligibility bar: Twenty-three full-text articles were included in the review. At the full-text stage, two articles were excluded: one was a review article without empirical data, and the other only reported on the technical aspects of media reviews without evaluating their educational impact. In total, 21 studies fulfilled all the inclusion criteria and formed the basis of the qualitative synthesis.

PRISMA 2020 Flow Diagram

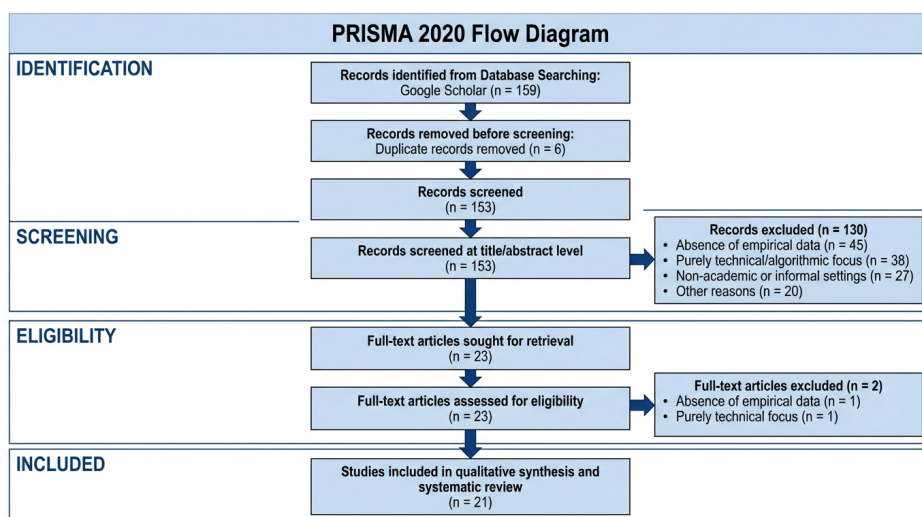


Figure 1. PRISMA 2020 flow diagram showing the study selection process.

3.2 Study Characteristics

The 21 studies included a variety of research designs, flexible AI technologies, stages of school education, and domains. This section summarizes the characteristics of the studies included in data extraction,

Study Designs and Methodologies: Study designs and methodologies of the included studies evaluating AI interventions. Most of them used experimental and quasi-experimental designs, and some employed randomized controlled trials or controlled comparison groups to compare the effectiveness of AI-based interventions with traditional teaching methods (Alneyadi, 2023; Feng, 2024; Lee et al., 2022; Wang et al., 2020). There have also been several case studies and comparative analyses, particularly in the context of higher education, to review real institutional implementations of AI systems (Baba et al., 2024; Ouyang et al., 2023). A few studies have used quantitative outcome measures and qualitative data from teachers and students (Alenezi, 2023; Gjermeni et al., 2024). The sample size varied widely from small classroom-level interventions to a few hundred respondents in survey studies (Rasheed et al., 2025). Statistical comparisons of pre- and post-test scores, path analysis modeling, learning analytics, and thematic analysis of qualitative data were among the analytical methods used.

Types of AI Technology: The studies researched various types of AI technologies deployed in educational contexts. The most thoroughly investigated technologies were personalized learning systems

and adaptive learning platforms, which were present in more than half of the included studies (Adil & S., 2024; Baba et al., 2024; Naseer & Sarwar, 2025; Sari et al., 2024; Silva et al., 2024; Wang et al. These systems use machine learning algorithms to personalize content, pace, and instructional strategy for each student based on their individual needs and performance levels. Research on AI-powered chatbots or conversational agents has focused particularly and in general on language learning and after-class review support (Alneyadi, 2023; Lee et al., 2022). The capability of these systems to deliver formative feedback and student performance predictions through intelligent tutoring systems and AI-driven assessment tools has been explored (Liao et al., n.d.). ; Ouyang et al., 2023). Through this approach, game-based learning is merged with adaptive AI algorithms to support motivation and engagement, forming a category in itself as gamification driven by Artificial Intelligence (Alenezi, 2023). In two other studies, predictive and learning analytics systems were used to identify at-risk students and personalize instructional interventions (Naseer & Sarwar, 2025; Ouyang et al., 2023). Third, some studies have investigated holistic learning frameworks that integrate multiple types of educational technologies, including adaptive content delivery, automated assessment systems, and personalized feedback mechanisms, by employing state-of-the-art AI methods (Dabingaya 2022; Xu 2024; Zaman & Elmoon 2023).

Educational Level and Subject Areas: The included studies were in diverse levels of education and subject areas. The highest context was higher education, in which university-based studies were conducted across a few disciplines, such as management education (Adil & S. 2024), engineering (Ouyang et al., 2023), and general undergraduate courses (Baba et al., 2024; Lee et al., 2022). If education is included, K-12 is also represented, especially in secondary education contexts (Alneyadi, 2023). Language learning was the most-discussed topic, with several studies focusing on the applications of AI in teaching English language and second language acquisition (Feng, 2024; Wei, 2023; Zaman & Doomoon, 2023). Another domain that has been frequently investigated in AI-powered adaptive learning platforms is mathematics education (Dabingaya, 2022). Several studies have also explored physics, including science education (Alneyadi, 2023) and the Investigation of Electronic Magnetism. In addition, other subject areas were management and business education (Adil & S., 2024), literature (Zaman & Elmoon, 2023), and multidisciplinary applications from various academic subjects. Some studies did not focus on specific content areas but explored the impact of AI in general educational settings or multiple disciplines as a unit (Gjermeni et al., 2024; Rasheed et al., 2025; Saleem et al., 2025, Silva et al., 2024).

Geographic/Institutional Contexts: Studies differed in whether they reported across settings, but numerous studies included geographic/setting diversity. Investigations have been performed in the United States, Middle Eastern Countries (United Arab Emirates), and Asian countries such as China, Pakistan, and Kazakhstan. The studies were conducted in several European settings and African institutions (Morocco). Such geographic variety strengthens the external validity of results across systems of education and sociocultural environments

3.3 Synthesis of Evidence

This section synthesizes the empirical evidence organized by the four research questions that guided this systematic review.

3.3.1 Impact of AI on Student Learning Outcomes and Academic Performance (Research Question 1)

In every case examined, the evidence showed that AI-based educational technologies improved both learning outcomes and academic performance across a range of educational contexts and subjects. Several studies have reported statistically significant increases in academic achievement for AI-based interventions over traditional teaching methods.

AI-assisted instruction generates large learning outcomes in language learning contexts. According to Feng (2024), AI-assisted language learning strategies significantly improved learning outcomes and cognitive load compared to traditional instruction. As Wei (2023) stated, ‘findings of the meta-analysis showed that AI in language instruction had a significant positive effect on English learning outcome measures which added to their standardized test scores.’ AI systems, for instance, are flexible enough to provide different instructions based on individual learners proficiency levels and learning speeds.

Studies in mathematics education have also shown the positive impact of AI tools that would allow students to learn math through an adaptive learning platform. For example, Dabingaya (2022) explored AI-powered adaptive learning platforms for mathematics education and determined that these systems greatly increase student achievement compared to traditional instruction. The adaptive algorithms used in the program intelligently ramped up challenges while providing appropriately targeted scaffolding depending on student performance, making learning much more efficient by shortening learning paths.

ChatGPT has been studied in the context of eleventh-grade students learning about electronic magnetism through science courses (Alneyadi,2023) in Emirati schools. They learned from research into AI-based instruction, which showed that it could transform student achievement, as the normally taught students had more efficient pre-test scores than the control group but fell well short of the experimental group performance on post-tests measuring conceptual understanding and problem-solving. The AI system delivered instant explanations, responded to students’ questions in natural language, and offered bespoke examples that clarified more challenging physics ideas.

Positive findings have also been reported in higher education contexts. Furthermore, Adil and S. (2024) also demonstrated the positive impact of AI-enabled personalized learning on management students’ academic performance, with autonomy as an important determinant in close association with better academic outcomes. Ouyang et al. Chai et al.(2023)Integration of Predictive ModelsPerformance PredictionAIWhat is IntegratedTISSUE210026731147059::2667321214204322A predictive model aimed to identify students flagged at risk of poor study in online engineering courses for more targeted learning analytics. Lee et al. (2022) discussed that AI based chatbot have positively influenced academic performance of college students through improved post-class review and timely question-answering assistance.

Four studies examined the effectiveness of AI in filling learning gaps and providing support for struggling learners. The AI-driven adaptive feedback Naseer and Sarwar (2025) assessed to minimize conceptual learning gaps in mixed-ability classrooms. The way they evaluated the use of AI systems via learning analytics showed that misconceptions were identified correctly, and tailored feedback helped struggling learners close their achievement gaps. Rasheed et al. AI technologies have been shown to narrow educational inequality, with personalized learning showing a positive impact on student outcomes (Zawacki-Richter et al. 2025).

This was especially the case when they directly compared AI-based and traditional instruction in comparative studies. Wang et al. To compare an adaptive learning system with teacher-led instruction, the effectiveness of adaptive learning as effective learning was analyzed (2020). Sari et al. Adaptive learning systems meet the criteria for high-quality educational interventions because they are useful in multiple individual performance indices related to achievement, and Liang et al.

Effect sizes were small to moderate for some studies and as high as large for others. Nonetheless, the direction of the effects was uniformly positive, and no study reported that AI-based interventions produced worse learning outcomes than traditional approaches. Multiple studies have mentioned that the performance of AI systems is contingent upon implementation quality, characteristics of students, and the match (or lack thereof) between what an AI does well and teaching goals (Ouyang et al., 2022; Xu, 2024).

3.3.2 Impact of AI on Student Engagement and Motivation (Research Question 2)

At all educational levels and contexts examined, AI-powered personalized learning systems showed large positive effects on student engagement and motivation. Results: Evidence is provided through multiple mechanisms by which AI technologies enhance these psychological and behavioral outcomes.

Individualized content delivery has emerged as a major factor in boosting engagement. It was also found that students' psychological need states were influenced by AI-enabled personalized learning, which positively influenced students' perceptions of autonomy, competence, and relatedness (three fundamental psychological needs described in Self-Determination Theory), thereby enhancing intrinsic motivation and engagement (Adil & S., 2024). The study found that autonomy played a unique critical role, as students found that AI systems adapting to their preferences and learning pace led to a greater sense of ownership of their learning process. Baba et al. For example, (2024) in their case study of mobile-optimized AI-driven personalized learning, found that students were more engaged when content was personalized and delivered through mobile platforms.

This swift feedback and scaffolding helped them stay hooked to the task. Lee et al. Chao et al. (2022) showed that an AI chatbot improved college students' self-efficacy, learning attitude, and motivation due to instantaneous responses to questions and personalized after-class review support. Students indicated greater confidence and motivation when immediate clarification of concepts was delivered rather than having to wait for the instructor to be available. It is visible that AI-supported language instruction could stimulate L2 motivation and self-regulated learning (Wei, 2023), and students reported that they demonstrated more persistence and independent learning behaviors as a result of the support from AI systems.

Specifically, AI-driven gamification is a well-suited method for increasing motivation and involvement. Alenezi's (2023) research on teachers' views of AI-driven gamification revealed strong agreement regarding its positive influence on student motivation, participation, and learning experiences. Teachers said that gamification features supported AI-based individualized everchanging approaches to learning, turning ordinary lessons into fun and purposeful journeys, providing students with the freedom of choice and immediate feedback. Students showed the highest motivation and engagement rates when learning activities incorporated gamified elements tailored by AI algorithms, and the participation rate and time-on-task were higher.

Comparative analyses validated that AI approaches hold several advantages over traditional approaches for engagement results. Gjermeni et al. Nguyen et al. (2024) compared the effect of AI vs. student engagement, finding that learning environments with AI produced markedly higher levels of engagement than conventional instructional settings. These differences were attributed to the ability of AI to personalize, engage, and respond to each student. AI-powered adaptive content delivery led to improved flipped classroom engagement and personalized learning, with Zharmukhanbetov and Singh (2023) reporting that students showed increased preparedness for class lectures and more active participation in collaborative activities.

Unique Engagement Indicators Across Various Studies that Showed an Improvement from AI Saleem et al. personalized learning systems were positively correlated with student performance and engagement when a comprehensive analysis was undertaken, leading to significant increases in the login frequency per student, duration of time per student in learning activities, and completion rate of assignments (Baker et al. (2025)). Silva et al. AI-based personalized learning and educational analytics [19] have been reported to improve student engagement by providing data-driven insights into progress and learning goals [19].

Another finding was that AI enabled student autonomy and self-regulated learning, which led to an increase in motivation. After investigating AI in language instruction, Wei (2023) discovered that students engaged in self-regulated learning behaviors and took charge of their learning by actively setting learning goals, monitoring their learning process, and seeking more resources independently. Liao et al.

A study indicated that a formative assessment visual report tool, supported by AI, was a good way to support self-regulated learning because visualizations provided to students displayed their learning progress as well as their stages of learning and improvement needs clearly (n.d.)

However, other studies have indicated that not all engagement benefits are universal and that implementation factors are important. Although teachers commonly reported beneficial effects, Alenezi (2023) found that some students faced initial challenges with gamification interfaces based on AI, pointing to the need for orientation and assistance. Rasheed et al. The engagement improvements observed were more pronounced for students with sufficient digital literacy and access to technology, which raises potential equity considerations (2025).

3.3.3 Impact of AI on Teaching Effectiveness and Pedagogical Practices (Research Question 3)

The findings relating to AI's impact on teaching effectiveness and pedagogy were presented along two dimensions that could represent either opportunities or challenges: Although fewer studies investigated teacher outcomes than student outcomes, the available data showed meaningful ways in which AI tools impacted pedagogy practices.

AI systems remotely provided teachers with insights on data that informed their instructional decision-making. Ouyang et al. (2023) To improve teaching effectiveness in online engineering courses, Lee et al. found that AI performance prediction and learning analytics helped instructors recognize students at risk for academic struggle early in the course so that instruction could be changed. Teachers said that predictive analytics allowed them to deploy attention and support more wisely by honing in on which interventions would most help which students, making their efforts more efficient. Silva et al. It was explained by (2024) that AI-enhanced educational analytics improved pedagogical practices by providing teachers with a wealth of information about student learning patterns, misconceptions, and trajectories of progress (e.g., Tomlinson, 2003).

Differentiated instruction and personalized support were made possible at scale through the use of AI tools. According to Naseer and Sarwar (2025), AI-based adaptive feedback systems allow teachers to fill conceptual learning gaps in mixed-ability classrooms better than traditional methods. AI-generated insights could inform teachers, who could offer tailored assistance to struggling learners, while students excelling could be free to work independently. AI-enabled education platforms for English literature classrooms have helped teachers implement adaptive learning strategies that would be difficult to implement manually (Zaman and Elmoon, 2023).

Teachers' views on the implementation of AI approaches were fairly positive in general, but there were some challenges to implementing AI based on responses. In a study by Alenezi (2023), teachers' thoughts on AI-driven gamification were helpful for students as an approach to help with motivation, engagement, and learning outcomes. Teachers talked about the shift gamification powered by AI could make to learning experiences — giving students agency and instant feedback. However, educators also pinpointed some roadblocks: the requirement of professional development, technical hiccups, and curriculum alignment. Rasheed et al. (2025) surveyed 300 university teachers, found somewhat positive effects of AI-assisted personalized learning on reducing educational inequality and commitment and that teacher role changes were limited, reflecting as evolving rather than a substitutive adjunct to traditional teaching functions.

AI systems decrease some administrative burdens while prompting new ones. Liao et al. (n.d.) and Ouyang et al. (2023) found that AI-enabled assessment and feedback systems streamline mechanical tasks such as grading, tracking student progress, and creating reports on performance, allowing teachers to dedicate more time to valuable instructional activities. The domain of AI systems was not without its challenges, necessitating that teachers learn new skills to navigate the practicalities of data analysis, system management, and incorporation of the information generated by AI into their own teaching (Alenezi, 2023).

The data revealed that the successful use of AI tools requires professional development and consistent support. Professional development was classified by Alenezi (2023) as one of eight core factors affecting the successful adoption of AI-driven gamification, which requires training in both the technical features of gamification methods and effective pedagogical strategies to leverage AI capabilities. Ouyang et al. A systematic review of artificial intelligence in online higher education by (2022) recommended teacher preparation and institutional support as key elements in optimizing the potential of AI for effective teaching.

Some studies have examined the impact of AI on the way teachers interact with students. Wang et al. When adaptive learning systems handled course content and practice activities, teachers spent less time lecturing in front of the class and subsequently had more time for one-on-one consultations, small-group discussions, and complex questions that technology could not answer (Michael & O'Reilly, 2020). Overall, teachers recognized facilitating and mentoring as a positive attitude shift but also worked to transition from the previously traditional concept of teaching.

The data also showed how the impact of AI on pedagogical efficacy differs across subject areas, education levels, and institutional environments. Baba et al. Mobile-optimized AI-driven personalized learning implementation was successful in a university context, and teachers successfully integrated the system into their courses (2024). However, the case study nature of the present research limits its generalizability to other contexts. While some subjects may lend themselves more readily to AI-enhanced instruction than others, Dabingaya (2022) found AI-powered adaptive learning platforms particularly successful in mathematics education, where content could be arranged hierarchically and algorithms were able to adapt difficulty levels in a systematic way.

3.3.4 Impact of AI on Assessment and Feedback Systems (Research Question 4)

Improved assessment accuracy, feedback quality, and tracking of learning progress with AI implementation in educational assessment and feedback systems. Evidence indicates multiple ways in which AI-augmented assessment practices are superior to conventional practices.

Traditional methods of implementing formative assessment tools are less consistent, ded, and persond than those enabled by reported on formative assessment conducted using an AI-enabled visual report tool n.d. and described outcomes of enhanced learning achievement and self-regulated learning. AI reports provided students with clear,, actionable visual feedback about their performance and learning progres and identified the topics that needed more attention. AI-assisted assessment tool feedback strategies outperformed traditional feedback strategies in terms of students learning gains and self-regulation skills sophistication.

The use of predictive analytics improved the assessment accuracy and allowed for early intervention. Ouyang et al. (2023) showed that AI performance prediction models correctly identified at-risk students for poor performance in some engineering courses delivered online, allowing instructors to offer relevant support without students risking significant underperformance. These predictive models examine a variety of data sources, such as assignment submissions, quiz results, forum activity, and the utilization of learning resources, to provide finer-grained assessments of risk than traditional grade-based markers. This early warning system was a dramatic improvement over the old traditional assessment methods, which generally only identified students who were struggling after they had already failed.

Unlike traditional tests, which are often conducted periodically, AI systems offer continual assessments of learning progress with greater granularity. Adaptive Feedback systems powered by AI constantly track students understanding and mastery of concepts in real time (Naseer and Sarwar 2025) Continuous assessment makes it possible to detect misconceptions as they occur rather than after summative assessments, so that remediation can take place in a timely manner. The results of the learning analytics-based evaluation showed that AI systems successfully monitored learning advancements and

adapted feedback in response to the dynamic needs of students.

Automated assessment capabilities allowed for a lower grading burden without losing improvements in precision. Multiple reviews indicate that some types of student work (most notably objective assessments, highly structured responses, and some limited forms of writing) could be evaluated by AI systems with comparable accuracy to human graders and could provide results to students more quickly (Ouyang et al., 2022; Xu, 2024) and this, in turn, left some advocates suggesting that such approaches could free instructors to focus on less conventional forms of assessment where human evaluators might be better suited (this latter point has not been universally accepted among researchers [insert citation]). Thus, automating tasks that are common to assessment and liberating instructors to focus on judgment-based assessment of students while providing students with timely feedback.

Personalized learning pathways are facilitated by assessment systems powered by AI through adaptive testing and dynamic difficulty adjustment. Wang et al. The continuous assessment data used by adaptive learning systems are then used to tailor instruction to the individual student, meaning that the content, difficulty, and pacing are customized to their demonstrated proficiency (Karp et al., 2020). Compared to an adaptive type of traditional test with fixed-difficulty items, this adaptive type of traditional test provided a more accurate estimation of student capabilities, particularly for low- and high-ability students, as can be expected given that these traditional tests were constructed considering the greatest portion of the ability distribution.

A highlight of this study was the quality and specificity of the feedback generated from an AI source. Lee et al. More recently, Chai et al. (2022) reported an AI-based chatbot generating comprehensive, personalized feedback on student questions and assignments, with students finding that the feedback offered clear guidance on how to correct errors and improve performance. It could provide explanations in different ways, generate examples based on student questions, and provide hints instead of full solutions, teaching students in a way that is more effective than generic feedback.

However, the data also showed the limits of assessment systems designed by AI. AI was noted to be most effective for evaluating structured knowledge and skills and had less reliable performance on complex, open-ended work requiring cognitive nuance (Ouyang et al., 2022). According to Alenezi (2023), teachers valued AI-driven assessment for specific purposes but insisted that human assessment would remain important for assessing creativity, critical thinking, and other higher-level competencies.

AI assessment combined with learning analytics provides a full view of learning processes. Silva et al. Using assessment data in conjunction with behavioral data (e.g., time on task, patterns of resource access, interaction logs), {Shah and Yi (2024)} provided a holistic view of learning using AI-powered educational analytics. In contrast to standard assessment data alone, these integrated analytics facilitate improved diagnosis of learning difficulties and more specific interventions.

Four studies focused on students' perspectives on AI-based assessment and feedback. Automated feedback in language learning contexts has been found to be perceived mostly positively by students (Wei, 2023), who appear to value its immediacy, specificity, and non-judgmental character. However, some students signed off on the veracity of AI grading for simple tasks and said that some homework assignments offered more of an opportunity for advantageous feedback written by a human.

4. Discussion

4.1 Summary of Findings

We conducted this systematic review by synthesizing empirical evidence from 21 studies on the role of AI in education across multiple dimensions. These results demonstrate strong evidence for the genuineness of AI-powered educational technologies and highlight the implications for their implementation and future research directions.

For Research Question 1, the reviewed evidence consistently showed that AI-based educational technologies produced positive effects on student outcomes and academic performance across subject

areas, educational levels, and settings. These studies found significant achievement improvements in language learning (Feng, 2024; Wei, 2023), mathematics (Dabingaya, 2022), science (Alneyadi, 2023), management education (Adil & S., 2024), and engineering (Ouyang et al. These enhancements were based on personalized content delivery, adaptive pace, targeted scaffolding, and prompt feedback—things that could be done at scale by AI systems much more efficiently than by other methods. Interestingly, AI systems also have great potential to support struggling learners and close achievement gaps (Naseer & Sarwar, 2025; Rasheed et al., 2025), which shows potential for addressing concerns around equity in education.

In response to Research Question 2, the synthesis demonstrated that AI-based personalized learning systems had a significant positive effect on student engagement and motivation in the studies reviewed. Innovative studies have recorded higher levels of engagement, motivation, self-efficacy, and learning attitude scores for students in AI-enhanced learning environments (Adil & S., 2024; Gjermeni et al., 2024; Lee et al., 2022; Wei, 2023). The evidence suggests that engagement was enhanced by various mechanisms provided by AI systems, including the following: personalization that increased relevance and autonomy (Adil and S., 2024), immediate feedback that sustained motivation (Lee et al. The strong, consistent, and cross-context findings also suggest that the engagement and motivation benefits of AI in education may be one of the strongest effects.

Findings regarding the final Research Question about AI's impact on teaching effectiveness and pedagogical practices were much more limited but largely positive, elaborated on here to address Research Question 3. AI tools have provided teachers with data-driven guidance for instructional decision-making (Ouyang et al., 2023; Silva et al., 2024), helped teachers scale differentiated instruction (Naseer & Sarwar, 2025), and offloaded mundane tasks so that teachers could focus on higher-order teaching (Liao et al., n.d.). Teachers viewed the tool positively, recognizing its potential to improve student outcomes and transform classroom practices (Alenezi 2023). However, challenges of implementation, such as professional development needs, tech issues, and curriculum alignment concerns, have been frequently cited (Alenezi, 2023; Rasheed et al., 2025). This indicates that AI is a partner to the conventional teaching approach, not a substitute, and effective adoption of AI was contingent upon teachers acquiring competencies to harness the power of AI-led insights.

Regarding Research Question 4, AI use for assessment and feedback systems had the clearest benefit over traditional systems. AI-enabled formative assessment tools offer more regular, granular, and individualized feedback (Liao et al., n.d.), predictive analytics allow for the early detection of students at risk (Ouyang et al., 2023), and continuous assessment fosters more precise monitoring of learning progression (Naseer & Sarwar, 2025). Automating repetitive work in performance assessment reduced the instructor's load while retaining accuracy, and learning analytics offered a more complete picture of learning after linking all the data assessed (Silva et al., 2024). However, AI's ability to judge complicated, open-ended tasks that require fine-grained human judgment is limited (Ouyang et al., 2022).

The synthesis suggests some common cross-cutting themes. Most importantly, AI interventions only worked when the implementation was done well, including being underpinned by technical infrastructure, teacher readiness to teach with AI, and learning objectives aligned with the AI. Second, when AI systems supplemented human instruction rather than seeking a full replacement, they yielded the best outcomes, which was hardly surprising because the purpose of AI in education should be to augment not replace the efforts and knowledge of skilled educators. Third, AI's ability to deliver personalized education has proven to be a dominant mechanism for improving various outcomes in learning achievement, engagement, motivation, and assessment accuracy. Fourth, equity appeared front and center, with some evidence that AI risk could alleviate educational inequality (e.g., it could provide personalized support, Rasheed et al., 2025) but it could exacerbate inequality if barriers to access and digital literacy are not addressed?

Important gaps in the current evidence base were also uncovered during synthesis. The longer-

term impact of AI interventions has been largely untested, as the majority of studies have assessed short-term outcomes over a time horizon of weeks or months rather than sustained impacts over a period of years. Often, the mechanisms that supported the observed effects were incompletely specified for any of these methods, meaning that understanding why some interventions were successful (and others less so) was more difficult. Few studies have directly compared various AI systems or implementation strategies. Lastly, we identified that the included studies paid scant attention to the potential negative effects and unintended consequences of implementing AI. This systematic review synthesized empirical evidence from 21 studies exploring the implications of AI on 'education' through multiple matrices. The results support the promise of AI-based educational technologies but also highlight significant implications for their implementation and future research.

Findings answering Research Question 1 unanimously indicated that AI-based educational technology enhanced students learning outcomes and academic performance, regardless of subject area, education level, or context. Math (Dabingaya 2022), science (Alneyadi 2023), management education (Adil & S. 2023), and engineering (Ouyang et al. 2023) reported statistically significant improvements in achievement when compared to traditional instruction. These improvements were driven by personalized content delivery, adaptive pacing, targeted scaffolding, and immediate feedback, which AI systems can deliver at scale better than traditional systems. AI systems have shown particular potential for supporting at-risk learners and closing achievement gaps (Naseer & Sarwar, 2025; Rasheed et al., 2025), highlighting their potential to address concerns related to educational equity.

The synthesis conducted for Research Question 2 found that AI-enabled personalized learning systems generally have a large positive effect on student engagement and motivation. Several studies have reported higher levels of engagement, greater motivation, higher levels of self-efficacy, and better learning attitudes whenever students used AI-enhanced learning environments (Adil & S., 2024; Gjermeni et al., 2024; Lee et al., 2022; Wei, 2023). Data suggest that AI systems have heightened engagement through various mechanisms: personalization that increases relevance and autonomy (Adil & S., 2024), immediate feedback that keeps motivation high (Lee et al., 2022), gamification elements that make learning fun (Alenezi, 2023), and adaptive challenges that keep difficulties challenging but not too hard (Zharmukhanbetov & Singh, 2023). The positive effects on engagement and motivation found in such a diverse set of contexts suggest that these benefits may be the most well-documented effects of AI in education.

For Research Question 3, only limited evidence was available on AI influencing teaching effectiveness and pedagogical practices, but its impact was generally positive. Data-assisted AI tools have informed instructional decisions (Ouyang et al., 2023; Silva et al., 2024), enabled differentiated instruction at scale (Naseer & Sarwar, 2025), and automated routine tasks to reserve teachers' time for higher-order teaching (Liao et al., n.d.). Overall, the responses were positive, as teachers acknowledged AI's capability to improve student performance and transform pedagogical methods (Alenezi, 2023). Nevertheless, challenges in implementation, such as the need for IT professionals, technical issues, and curriculum alignment concerns, have always been pointed out (Alenezi, 2023; Rasheed et al., 2025). Even though the evidence strongly suggests that AI is intended to supplement traditional teaching rather than replace teachers entirely, integrating AI into the classroom would require teachers to acquire new skills to make magic out of the understandings generated from AI.

In contrast, AI implementation in assessment and feedback systems proved to be typically advantageous for Research Question 4 over conventional approaches. Examples include AI-enabled formative assessment tools, which offer more frequent, fine-grained, and personalized feedback (Liao et al., n.d.), predictive analytics, which allows for the proactive identification of at-risk students (Ouyang et al., 2023), and formative assessments, which more accurately track learning progress (Naseer & Sarwar, 2025). It decreases the burden of instructors on routine assessment tasks while remaining accurate and integrates assessment data with learning analytics to provide a holistic understanding of how learning

processes occur (Silva et al., 2024). However, there are limits to AI's ability to evaluate intricate, open-ended work that demands a higher level of subtle human judgement (Ouyang et al., 2022).

The synthesis highlighted a range of common cross-cutting themes. At each visited organization, the success of AI interventions was heavily mediated by implementation characteristics, such as technical infrastructure, teacher preparedness, and targeted learning goals, all of which played a role in determining whether a given intervention would achieve greater success than a more traditional approach. Second, AI systems were found to be most beneficial when supplementing human teaching rather than wholly taking on the task, with optimal results occurring only when AI capabilities were used carefully and in synergy with teacher know-how. Personalization was the third key mechanism through which AI improved several, if not all, outcomes. For example, learning achievement, engagement, motivation, and assessment accuracy all rely on AI's ability to provide individualized instructional content to match the needs of the individual learner. Fourth, equity drew heavy attention: research indicating that AI could help reduce educational inequality by providing personalized support (Rasheed et al. 2025) was undermined by the observation that, without equal access and digital literacy, these children continue to be placed behind.

The synthesis also highlights significant gaps in the current evidence base. AI interventions have not been adequately characterized over the long term, with most studies measuring outcomes on the scale of weeks and months rather than sustained impacts over years. The mechanisms by which AI systems produced observed effects were often poorly specified, with a narrow sense of why some interventions worked while others were less effective. There is little information on comparative effectiveness research directly comparing different AI systems or implementation methods. Finally, studies included important information on the effects or unintended consequences of AI implementation, but they paid little attention to the possible negative impacts of AI.

4.2 Limitations

This systematic review has several limitations that should be considered when interpreting the results. Limitations included a narrowed search strategy to that of Google Scholar and only a timeline of 2022-2026. Although this strategy captured more recent evidence relevant to contemporary AI technologies, other relevant studies may have been published in 2021 before 2022 or indexed in other databases. This potential temporal requirement may also have excluded seminal work, which is often necessary for context, since AI technologies evolve rapidly, and older studies often have limited relevance to current systems.

Second, there was substantial clinical heterogeneity across the included studies in terms of research design, AI technology type, educational context, outcome measure, and data analysis approach. Such heterogeneity hinders meta-analysis and resource availability to obtain more precise quantitative conclusions regarding effect sizes. Qualitative integration of findings was performed; however, the relatively heterogeneous evidence base limits the interpretive capability of the synthesis.

Third, the evidence may have been affected by publication bias. Positive studies of AI interventions are more likely to be published than null or negative studies, which may lead to an overestimation of the benefits of AI. The included studies were generally positive, with few implementation failures or negative outcomes reported, raising concerns about publication bias.

Although some studies used a more robust experimental design with appropriate controls, the quality of individual studies varied in terms of study methodology. Empirical data and comparative designs were essential for establishing eligibility criteria; however, the strength of causal inferences differed across studies. Some had small sample sizes, lacked randomization, or were short-term or low-intensity, which made the conclusions weak.

Fifth, the extent to which the findings are generalizable across different educational, student, and cultural contexts is unknown. Although the included studies were conducted in wide-ranging geographical

contexts, most were conducted in higher or secondary education settings in specific countries. These conclusions may not apply to learners at different levels, disciplines, or cultural contexts, which require a degree of contextualization.

Sixth, the extraction of data depended on information reported in the published papers, which varied in completeness and detail. Certain studies provided thorough methodological inquiries and comprehensive reporting of results, while others provided less exhaustive information. Several aspects could not be synthesized deeply (e.g., sample sizes, effect sizes, implementation details) due to missing data for individual extracted elements.

While relevant and useful, the review concentrated on empirical studies assessing AI's influence on educational outcomes; therefore, aspects of implementation, cost-effectiveness analyses, and ethical ramifications received proportionately limited attention (p. 73). In contrast to the 671 pieces of evidence, a broader scope can lead to a deeper comprehension of AI in education by integrating evidence from diverse study types that can be found outside the empirical impact studies reported here.

Finally, the speed of AI development, which means that some of the technologies evaluated in the studies included in this analysis are already outdated, and emerging capabilities of AI (e.g., large language models and multimodal AI systems) may not be reflected in the evidence base. The key findings herein should be viewed as a snapshot of what AI in education looks like, today, in the 2022-2026 timeframe, with the understanding that this is a rapidly changing field

5. Conclusions

This systematic literature review delivers strong empirical evidence that AI technologies are beneficial to all facets of education in terms of student learning outcomes, engagement and motivation, teaching practices, and assessment practices. Synthesizing findings from 21 studies, each of which looked at studies from 2022 through 2026, we found that AI-based education interventions either significantly outperformed or outperformed traditional approaches across subjects, school levels, and contexts.

The evidence points to several important conclusions: First, AI-driven adaptive learning systems positively enhance academic performance as a result of adaptive content delivery, individualized pacing, scaffolding, and immediate feedback. Second, AI tools engage students much more and promote motivation because they increase the sense of independence of students, as well as support and avail personalized learning in a timely manner, making their learning more interactive and enjoyable. Third, AI tools promote effective teaching by enabling targeted and differentiated instructional strategies, and by automating tasks that are routine (though success in making this happen in classrooms will require sufficient training and organizational support.) Fourth, conventional assessment and feedback, enabled by AI systems, provides the advantage of interactive feedback mechanisms, providing more frequent personalized feedback, better prediction of at-risk students, and a more holistic view of ongoing learning analysis.

However, unlocking AI for education means paying close attention to how it is applied. The effectiveness of AI interventions depends on technical infrastructure, teacher preparation, curriculum alignment, and equity considerations. AI works best alongside human interaction and lightening the load on teachers ltyd2hx5c22, especially when utilized with consideration alongside a teacher's know-how.

There are priorities that future research should address. Longitudinal studies examining the long-term effects of AI interventions are needed to test whether rapid gains are sustained. Evidence from direct comparisons of the comparative effectiveness of different AI systems and approaches to implementation would support evidence-based selection and deployment decisions. Studying the mechanisms by which AI gives rise to the observed effects, in a manner more mechanistic than functional, would help in theory development and inform system design. Journalism that looks at what could go wrong, the potential unintended consequences, and who is being left behind would help build a fuller picture of the

effects of AI. Ultimately, studies measuring cost-effectiveness and scalability, which is the ability to easily and quickly replicate positive programs, would provide policymakers with the information needed to determine whether investing in AI for education is worth it.

AI technologies are rapidly evolving and diffusing in education, necessitating continuous systematic evaluation of their impact. Through this review, we build a case for a body of empirical studies that show the potential of AI to improve education, noting that careful implementation, sufficient infrastructure, and ongoing research can optimize benefits and mitigate challenges. This evidence base should inform the choices made by educational institutions, policymakers, and technology developers to guide AI adoption and use for student learning, equity, and educational quality.

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