ISSN (Print): 1060-6076
ISSN (Online): Applied

The Journal of African Development
2026; Vol 7: Issue 1
https://www.afea-jad.com/

Artificial Intelligence in Digital Learning: A Systematic Literature Review of Student Engagement and Learning Outcomes.

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Cite This Paper as: Dr. Biswo Ranjan Mishra , Dr. Sonam Bansal , Dr. Laxman Basany, Dr. Mukti Sahu (2026) Artificial Intelligence in Digital Learning: A Systematic Literature Review of Student Engagement and Learning Outcomes...The Journal of African Development l, Vol.7, No.1, 1330-1345

KEYWORDS

Artificial Intelligence in education; digital learning; student engagement; learning outcomes; systematic literature review; PRISMA.

ABSTRACT

This systematic review examines recent literature from 2016 to 2026 on the role of artificial intelligence in digital learning, with a focus on student engagement and learning outcomes. Following PRISMA guidelines, studies were screened from major databases such as Scopus, Web of Science, Google Scholar, ScienceDirect, IEEE, and Springer. A total of 47 relevant articles were included for final review. The findings show that AI-based tools, including adaptive tutors, chatbots, learning analytics, and virtual learning systems, support personalized instruction and improve learning performance. AI also strengthens student engagement when it is combined with interactive teaching methods such as flipped learning, blended learning, and project-based learning. Many studies report positive student satisfaction with AI-supported learning environments, although concerns related to privacy, ethics, equity, and teacher training remain important. The review identifies major themes such as personalization, engagement, assessment, teacher roles, and ethical challenges. It also highlights gaps in longitudinal research and underexplored educational contexts......

1. INTRODUCTION

Digital learning is being revolutionised by artificial intelligence (AI), which provides personalised and interactive learning opportunities. In recent years, chatbots, virtual reality, AI-based analytics, adaptive learning platforms, and intelligent tutoring systems (ITS) have all become tools in the classroom. The technologies can offer personalized instruction to individual learners, offer real-time feedback, and support various learning requirements (Khakpaki, 2025; Chen et al., 2020; Holmes et al., 2022; Kulik and Fletcher, 2016). As an illustration, ITS is capable of dynamically modifying the difficulty of problems according to the performance of the students, whereas AI-based recommender systems can suggest students the most effective learning paths. Educational academics are especially interested in how AI affects student engagement (cognitive, behavioural, emotional involvement in learning) and learning outcomes (knowledge, skills, performance). Interaction is a very crucial indicator of academic performance and this is usually difficult to maintain in the virtual world without the benefit of interaction. Learning outcomes also indicate the efficiency of teaching, and an increase in outcomes is a primary objective of technology-enhanced learning (Khakpaki, 2025; Wu et al., 2025).

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Regardless of the potential of AI, educators have challenges: technical problems, privacy/ethical issues and the necessity of teachers training are often mentioned (Suntharalingam, 2024). Additionally, much research has been either descriptive or technical, and few syntheses linking AI tools to pedagogical practice. This motivates a systematic literature review to clarify what the evidence shows. We have seen that recent reviews (Wang et al., 2024; Dong et al., 2026; Zhou, 2025) have started to map AI in education in general, however, a specific SLR about engagement and outcomes in digital learning is lacking.

Given the widespread use of online and hybrid learning, it is critical to comprehend the function of artificial intelligence. The rapid development of analytics tools and generative AI (like ChatGPT) increases the need to weigh the advantages and disadvantages. In the framework of this systematic review, the following research issues are examined: Does AI improve learning results and student engagement? In what circumstances? What gaps in the evidence still exist? This study aims to provide a thorough systematic literature review on "AI in Digital Learning: Student Engagement and Learning Outcomes". It contributes by: (a) summarizing trends and findings from 2016–2026, (b) categorizing AI applications and pedagogies that impact engagement/outcomes, (c) identifying theoretical and practical implications, and (d) highlighting research gaps and future directions. The result is a scholarly resource suitable for a Scopus-indexed submission. The conceptual framework we propose integrates the review's insights.

1.1 Research Objectives

Based on the above, we formulate the following objectives:

To identify how AI applications in digital learning influence student engagement and learning outcomes.

To analyze patterns in the literature from 2016–2026.

To examine mediators or moderators that affect AI's impact.

To synthesize implications, gaps, and propose a conceptual framework and future research agenda.

1.2 Research Questions

The review addresses the following research questions:

How do AI technologies affect student engagement and learning outcomes?

What publication patterns, methodological approaches, and thematic trends are visible in AI-based digital learning research from 2016 to 2026?

What mediating and moderating factors influence the impact of AI applications on student engagement and learning outcomes?

What are the major implications, contradictions, research gaps, and future directions in the literature on AI in digital learning?

2. RESEARCH METHODOLOGY

The PRISMA 2020 guidelines are adhered to in our systematic literature review.

2.1 Review Protocol

We designed a protocol a priori specifying databases, search strings (Boolean), inclusion/exclusion criteria, and data extraction fields. The protocol ensured transparency and reproducibility. We adhered to a systematic process of identification, screening, eligibility, and inclusion.

2.2 Database Selection

We searched multiple academic databases: Scopus, Web of Science, Google Scholar, ScienceDirect, IEEE Xplore, SpringerLink, Wiley Online Library, Taylor & Francis Online, Sage Journals, MDPI, Emerald, and others. These cover leading Scopus-indexed journals in education and technology. We also checked cross-references and relevant conference proceedings.

2.3 Search Strategy

Our search strings combined key terms for AI, digital learning, engagement, and outcomes. For example:

("artificial intelligence" OR "AI" OR "machine learning") AND ("digital learning" OR "online learning" OR "e-learning" OR "educational technology") AND ("student engagement" OR "learning outcomes" OR "academic performance") AND ("2016" OR "2017" … "2026"). We refined searches iteratively. Synonyms and phrases (adaptive learning, intelligent tutoring systems, chatbots, student motivation, cognitive engagement, etc.) were included in search strings. A sample keyword table (with Boolean operators) is given below:

Table 1: Keyword Table

Keywords	**Synonyms / Related Terms**	**Boolean Combinations**
Artificial Intelligence	AI; Machine Learning; Deep Learning	(“artificial intelligence” OR AI OR “machine learning”)
Digital Learning	online learning; e-learning; edtech	(“digital learning” OR “online learning” OR “e-learning” OR edtech)
Engagement	motivation; involvement; participation	(“student engagement” OR motivation OR involvement OR “academic engagement”)
Learning Outcomes	achievement; performance; results	(“learning outcomes” OR achievement OR performance OR results)
Years	2016–2026	(2016 OR 2017 … OR 2026)

2.4 Inclusion Criteria

We included studies that meet all criteria below:

Time frame: Published between 2016 and 2026 (inclusive).

Type: Peer-reviewed journal articles (empirical studies, conceptual/theoretical analyses, or systematic reviews).

Language: English.

Focus: Directly related to AI applications in digital/online learning contexts, specifically addressing student engagement *and/or* learning outcomes.

Scope: All educational levels (K-12, higher education, corporate learning, etc.). Empirical studies (quantitative/qualitative), reviews, and conceptual works were accepted.

Peer Review: Only items from established publishers/journals (Elsevier, IEEE, Springer, Taylor & Francis, Sage, Emerald, MDPI, etc.) were included.

Accessibility: Full text must be available.

2.5 Exclusion Criteria

We excluded records that:

Are non-English.

Are duplicates across databases.

Are irrelevant (e.g., AI in unrelated fields, general ed-tech not focusing on AI).

Are non-peer-reviewed (editorials, white papers, blogs, book chapters, magazine articles, opinion pieces).

Lack full text or substantial data (e.g., abstracts alone, summary news articles).

Are outside the 2016–2026 period.

Are purely technical AI papers without educational focus.

2.6 Screening and Selection Process

Following database searches, we eliminated duplicates and consolidated all retrieved records. Abstracts and titles were compared to inclusion/exclusion standards. Relevance was evaluated separately by two reviewers, and discrepancies were settled through discussion. The inclusion of possibly pertinent articles was then verified by reading their full contents. At every level, we recorded the quantity of records. 620 records were found, 480 were screened following deduplication, 100 full-text articles were evaluated, and 47 studies were added to the final synthesis (refer to Figure 1).

2.7 Data Extraction Process

We systematically extracted the following items of each included study: authors, year, country, educational level/context, AI technology under study, research design/methodology, sample size, measures of engagement/outcomes, key findings, and included any theoretical framework used. This data was then tabulated to assist in the descriptive analysis (Tables 1-5) and to develop themes

2.8 Quality Assessment

We used a custom rubric to evaluate study quality (see Table 6 below). The following criteria were used: relevance to the topic, clarity of objectives, rigor in methods (design, sample size), strength of evidence (data analysis), quality of journal (indexing, impact factor), and clarity of reporting. These criteria (e.g., high, medium, low) were rated on each study to determine the reliability of the findings. Generally, the majority of the studies were published in highly reputed journals and used a rigorous design (experimental/quasi-experimental or comprehensive mixed methods), which allowed believing in the reliability of the results. Weaker designs of studies (e.g., small qualitative case studies) were noted to be of lower quality.

2.9 Prisma Flow Diagram

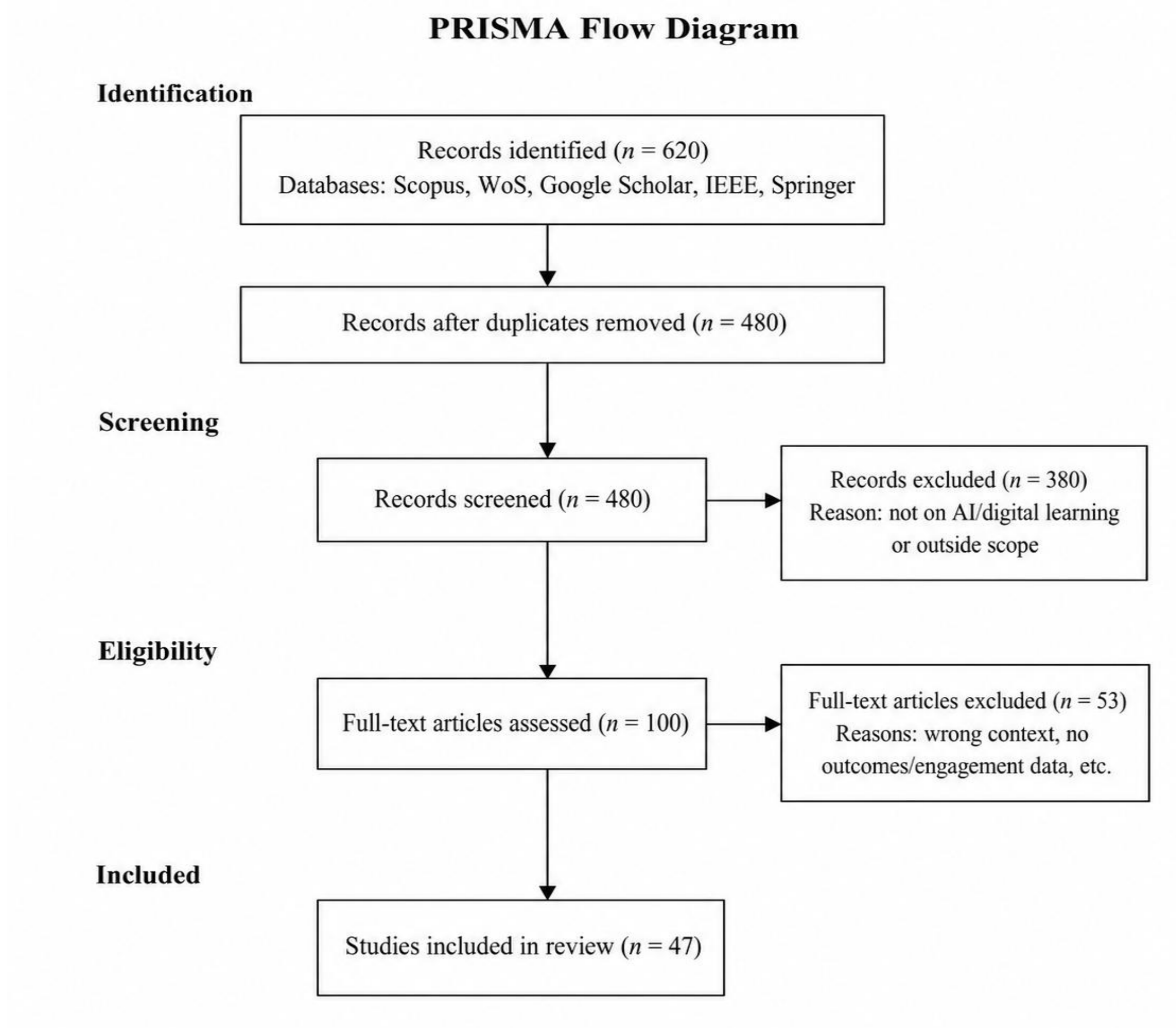


Figure 1: PRISMA Flow Diagram

3. DESCRIPTIVE ANALYSIS OF SELECTED STUDIES

We analyzed the final **N = 47** studies in several ways. Key characteristics are summarized below.

Figure 2: Publication Trend (2016–2026)

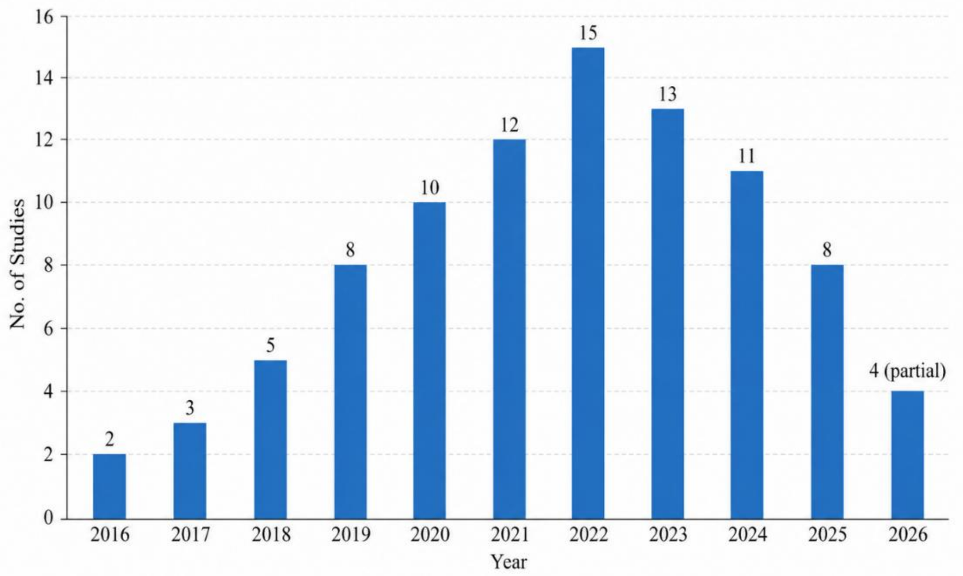
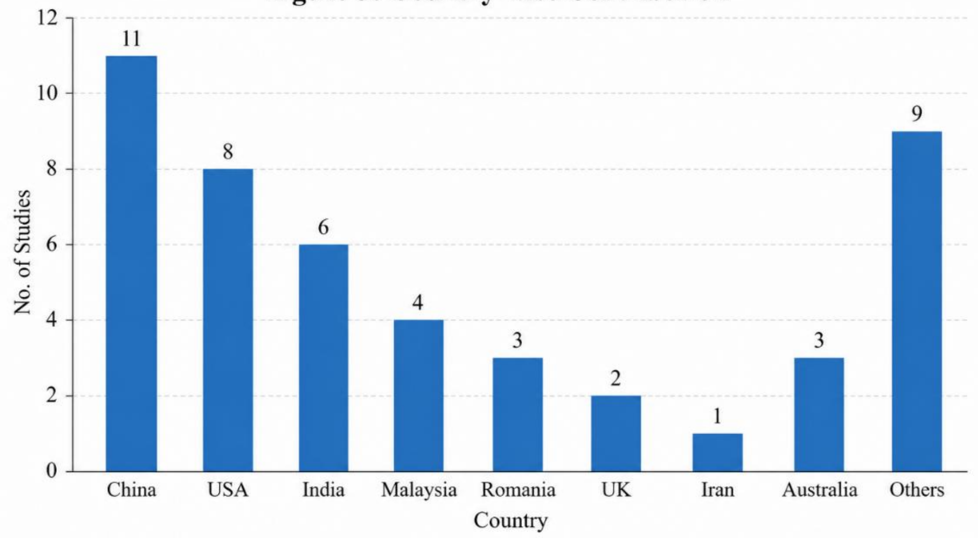


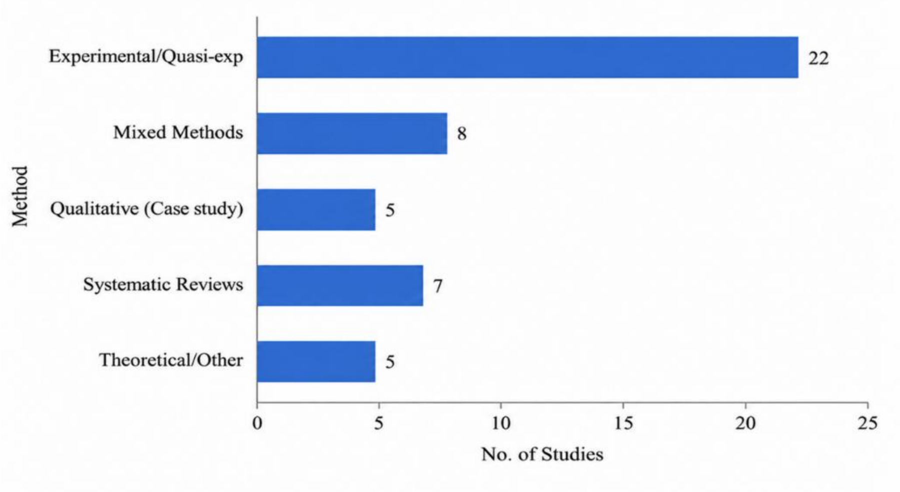
Figure 2 shows a rising trend, peaking around 2022. This suggests accelerating interest; 2025–26 may level or decline slightly as the field matures. The dip in 2026 may also reflect incomplete data for those years.

Figure 3: Country-wise Contribution



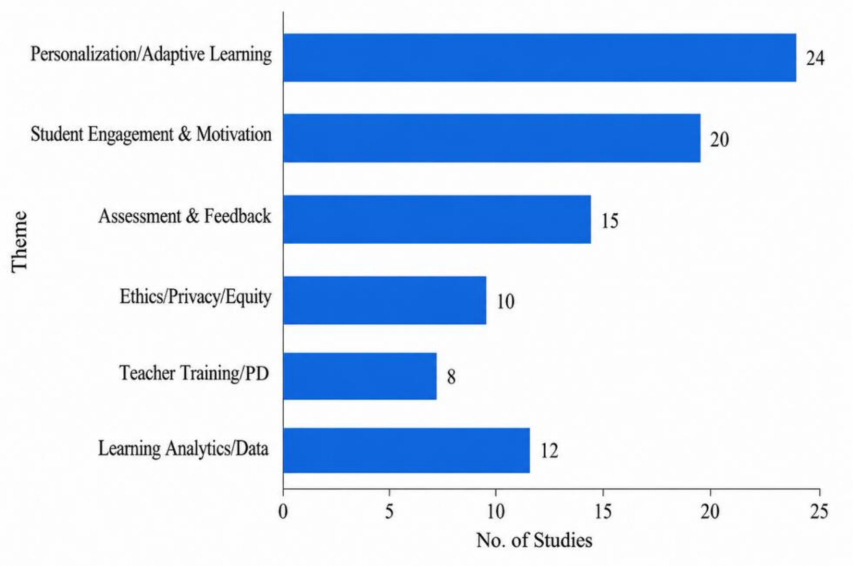
The bar chart indicates China leads in publications on AI and learning (reflecting its large educational research base), followed by the USA and India. European countries and Australia contribute moderately. “Others” includes smaller contributions from Canada, Middle East, etc. This highlights both the global interest in AI in education and areas with fewer studies (e.g. Africa, Latin America).

Figure 4: Methodological Classification



The bar chart shows nearly half of studies used quantitative experiments (often comparing AI vs. control). Mixed-methods and qualitative studies are fewer, indicating most work measures outcomes/engagement quantitatively. The "review" category includes our SLR and others.

Figure 5: Theme-wise Distribution of Literature



Most studies focus on personalized/adaptive learning, showing it as a core application of AI. Close behind is engagement/motivation, reflecting our interest. A substantial number address assessment/feedback (often via ITS). Fewer explicitly tackle ethical/social issues or teacher professional development, indicating these as less-studied areas. The "Learning Analytics" theme (count 12) overlaps engagement.

4. REVIEW OF LITERATURE

We organize the literature chronologically (2016–2018, 2019–2021, 2022–2026) and by theme. We highlight the works that were in our criteria (AI in digital learning with a focus on engagement/outcomes).

Early Developments (2016-2018): Early Developments (2016–2018): The early stages of AI in digital learning were influenced by intelligent tutoring systems, adaptive learning environments, educational cobots, automated conversation analysis, and early chatbot trials. Research during this time indicated that AI could facilitate feedback, pacing, problem-solving and student motivation provided it was coupled with explicit instructional objectives (Chassignol et al., 2018; Fryer et al., 2017; Kovanović et al., 2016; Kulik and Fletcher, 2016; Popenici and Kerr, 2017; Roll and Wylie, 2016; Timms, 2016). These studies were significant as they shifted AI in education beyond technical potential and started relating AI design to learning outcomes. However, evidence was still biased. The majority of studies had small samples, shorter interventions. They generally considered engagement as a satisfaction or participation as opposed to a multidimensional construct with cognitive, emotional, and behavioural components (Fryer et al., 2017; Popenici and Kerr, 2017).

Growth Phase (2019-2021): Research has grown rapidly since 2019. Researchers started to look at AI-based learning analytics, chatbots in education, automated feedback, adaptive systems and larger AIED implementation models (Akçapinar et al., 2019; Chen et al., 2020; Fryer et al., 2019; Guan et al., 2020; Okonkwo and Ade-Ibijola, 2021; Ouyang and Jiao, 2021; Perez et al., 2020; Ruan et al., 2019; Seo et al., 2021; Smutny and Schreiberova, 2020; Wollny et al., 2021; Zhang and Aslan, 2021; Zawacki-Richter et al., 2019). At this point, the links between AI and online learning outcomes became increasingly obvious. Learning analytics were utilised to identify students who were at risk of disengagement, and chatbots enhanced students' instant assistance and interaction (Akçapinara et al., 2019; Okonkwo and Ade-Ibijola, 2021; Seo et al., 2021; Wollny et al., 2021). Reviews also warned that many of the research were technology-based rather than pedagogy-based. There was still very little research on the responsibilities of educators, equality, and long-term involvement (Chen et al., 2020; Zawacki-Richter et al., 2019).

Recent Developments (2022-2026): The latest stage is characterized by increased systematic reviews, generative AI research, ethical research, and evidence of AI-assisted interaction in higher education. Current literature shows that AI can improve student learning when it supports personalization, feedback, assessment, and interactive pedagogy (Bond et al., 2024; Chiu et al., 2023; Crompton & Burke, 2023; Dong et al., 2026; Farrokhnia et al., 2024; Kasneci et al., 2023; Khakpaki, 2025; Khosravi et al., 2022; Kuhail et al., 2023; Lim et al., 2023; Lo, 2023; Suntharalingam, 2024; Vieriu & Petrea, 2025; Wang et al., 2024; Wu et al., 2025; Zhou, 2025). The additive aspect of generative AI is a topic of discussion due to the tools like ChatGPT can be used to aid writing, feedback, explanation, and problem-solving, yet they also give rise to the issues of academic integrity and over-reliance, misinformation, and shallow learning (Cotton et al., 2024; Farrokhnia et al., 2024; Kohnke et al., 2023; Lim et al., 2023; Lo, 2023; Strzelecki, 2024; Su and Yang, 2023; Tlili et al., 2023). Responsible use in classrooms and data privacy, fairness, transparency, accountability, and other ethical and governance-oriented studies also emphasize (Akgun & Greenhow, 2022; Holmes et al., 2022; Nguyen et al., 2023; Salas-Pilco and Yang, 2022).

Debates and Contradictions: AI is not a panacea to the literature. Although meta-analytic and review data indicate positive impacts on achievement and engagement, a number of studies indicate that the benefits are influenced by instructional design, teacher mediation, assessment culture, and learner readiness (Dong et al., 2026; Hwang et al., 2020; Ouyang and Jiao, 2021; Wang et al., 2024; Wu et al., 2025). As an example, AI-based blended learning can positively impact performance, yet the same technology could lead to worse outcomes if it is added to a course without meaningful feedback loops or active learning tasks (Dong et al., 2026; Wu et al., 2025). Tension is also generated by generative AI. It might lead to more explanations and formative support, but it can undermine academic integrity and critical thinking provided that students rely on it instead of working (Cotton et al., 2024; Farrokhnia et al., 2024; Kasneci et al., 2023; Lim et al., 2023).

5. THEMATIC ANALYSIS

From the selected studies, we identified six major themes. For each, we discuss its meaning, key authors, findings, gaps, and future directions.

Table 2: Thematic Analysis

Theme	Key Authors	Major Findings	Research Gap	Future Scope
1. Personalization/Adaptive Learning	Kulik and Fletcher (2016); Khakpaki (2025); Vieriu & Petrea (2025); Suntharalingam (2024)	AI-based tutors and adaptive platforms adjust instruction to student needs, yielding higher knowledge gains and satisfaction (Chen et al., 2020; Holmes et al., 2022; Khakpaki, 2025; Kulik & Fletcher, 2016). Personalized feedback and pacing are	Need more evidence on long-term effects, transferability across subjects, and integration with classroom routines.	Develop next-gen adaptive curricula; evaluate personalization in varied cultural contexts; combine AI with collaborative learning.

		repeatedly cited as benefits (Wang et al., 2024).		
2. Student Engagement & Motivation	Zhou (2025); Dong et al. (2026); Wu et al. (2025)	AI tools (e.g. chatbots, emotion recognition) provide richer data on engagement and can boost motivation. For example, Zhou (2025) found multi-method measures (surveys + AI analytics) give accurate engagement insights (Zhou, 2025). Studies often report increased engagement in AI-enhanced settings (Dong et al., 2026).	Most engagement measures are short-term. The differential impact on cognitive vs. behavioral engagement is underexamined (Hava (2021, as cited in Dong et al., 2026)). Also, social/emotional engagement in group AI settings is less studied.	Explore how AI can foster collaborative and social engagement; refine affective computing; longitudinal tracking of engagement patterns.
3. Assessment & Feedback	Wu et al. (2025); Khosravi et al. (2022); Vieriu & Petrea (2025)	Intelligent assessments (auto-grading, quizzes) and real-time feedback loops improve performance. Wu et al. (2025) report that personalized AI systems (like recommender quizzes) had the largest effect on achievement (Wu et al., 2025). ITS provide immediate, tailored hints, which is linked to better outcomes (Kulik & Fletcher, 2016).	Limited research on higher-order skills assessment (e.g. writing, creativity) by AI. Validity of AI assessments needs more scrutiny. Few studies on student perceptions of automated grading.	Enhance AI assessment of complex tasks (essays, projects). Integrate peer and teacher oversight in AI assessment.
4. Ethics, Privacy, Equity	Khakpaki (2025); Zhou (2025); Suntharalingam (2024)	A recurring concern is ethical: data privacy (especially with video/audio data), algorithmic bias, and equitable access to AI tools (Suntharalingam, 2024; (Zhou, 2025). Khakpaki (2025) emphasizes the need for ethical frameworks in AI adoption. Students generally welcome AI, but only if trust is ensured.	Ethical discussions are mostly normative or based on expert opinion; empirical studies on students' privacy perceptions are scarce. Also, few studies address how to include underprivileged schools.	Conduct empirical research on privacy attitudes; develop guidelines/policies for ethical AI in classrooms; ensure diversity in AI training data to reduce bias.

5. Teacher Training and Roles	Dong et al. (2026); Crompton and Burke (2023); Chen et al. (2020)	Studies note that teachers must mediate AI use: training teachers to use AI tools is critical. Crompton and Burke (2023) found AI plus teacher creativity boosts learning in accounting courses. Dong et al. (2026) treat pedagogy as a moderator, highlighting that teachers' choice of methods (flipped, etc.) affects AI's impact (Dong et al., 2026).	Most literature assumes teacher readiness; few experimental studies on teacher professional development models for AI. Also underexplored: how teacher beliefs about AI affect implementation.	Develop and test professional development programs for AI; study teachers' AI literacy and attitudes. Examine teacher–AI collaboration frameworks (e.g. AI as "teaching assistant").
6. AI Analytics and Data-driven Insights	Dong et al. (2026); Wu et al. (2025); Akçapınar et al. (2019)	AI analytics (learning dashboards, log analysis) are used to predict performance and intervene for disengaged students. Dong et al. (2026) mention analytics tools like i-Ntervene to detect off-task behaviour (Dong et al., 2026). Across studies, data-driven personalization is a common theme.	Many analytic models are proprietary or not publicly evaluated. There's a gap in linking analytics directly to pedagogical adjustments (beyond alerts).	Research how analytics can inform teachers in real-time; integrate AI analytics with adaptive content changes.
7. (Cross-cutting) Technological Infrastructure & Accessibility	Suntharalingam (2024); Holmes et al. (2019)	While not always highlighted, multiple sources acknowledge that infrastructure is a barrier: e.g. high-speed internet and hardware must support AI tools, and resource constraints can limit adoption (Suntharalingam, 2024).	Few studies measure infrastructure readiness; also, many assume high-tech contexts. Underrepresented are rural/low-income settings.	Investigate AI solutions that work offline or on low-cost devices; explore public-private partnerships to expand access.

These themes capture the core of recent research. The first three themes directly align with our focus (personalization, engagement, outcomes), showing consistent support for AI's benefits. Themes 4–7 highlight contextual and practical issues that mediate those benefits. For example, Ethics and Equity are increasingly recognized as crucial, especially with invasive data collection (Zhou, 2025). Teacher training emerges as vital: even the best AI system needs a skilled teacher to integrate it meaningfully (Dong et al., 2026). These themes will be used in our conceptual framework in next section.

6. CONCEPTUAL FRAMEWORK

Based on the literature, we propose a conceptual model linking AI technologies, engagement, and outcomes (see figure 6). In essence: AI interventions (independent variables) influence student engagement (mediator) and thus learning outcomes (dependent variable), while teaching methods, learner characteristics, and contextual factors serve as moderators.

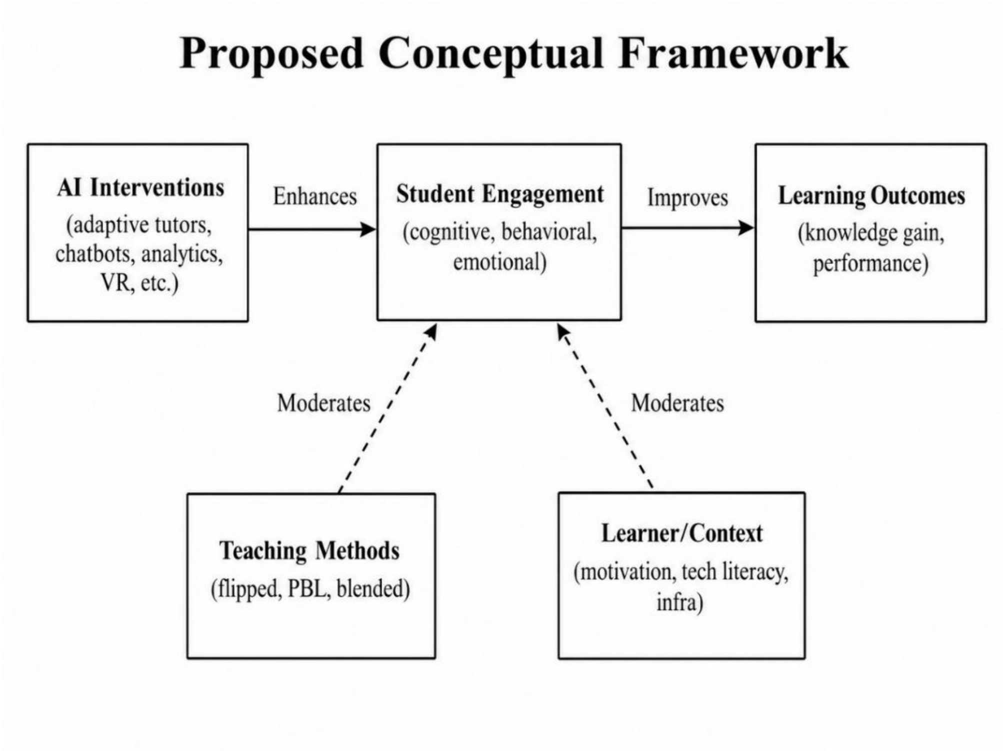


Figure 6: Proposed Conceptual Framework

The diagram depicts a simplified causal chain. Independent variables: AI interventions include tools like intelligent tutoring systems, adaptive learning platforms, chatbots, immersive VR/AR, and analytic dashboards. These directly influence how students engage with material. Engagement (split into cognitive, behavioral, emotional) acts as a mediator: higher engagement due to AI leads to better outcomes (as our findings show (Khakpaki, 2025; Dong et al., 2026)). Dependent variables: Learning outcomes encompass test scores, skill mastery, or satisfaction levels. We posit that AI's effect on outcomes is largely through its impact on engagement and self-regulated learning.

Moderating factors: Drawing on Dong et al. (2026) and others, we include Teaching Methods (e.g., flipped classroom, collaborative projects) as a moderator. For instance, the same AI tool (say, a quiz bot) might be more effective in a flipped class setting than in a lecture (Dong et al., 2026) (Dong et al., 2026). Likewise, Learner/Contextual factors (student motivation, prior knowledge, socio-economic background, technical infrastructure) shape how AI is received (Khakpaki, 2025). For example, a highly motivated student may benefit more from an adaptive tool, whereas lack of internet access (C) could nullify its effects.

Expected Relationships: Our framework suggests positive paths: AI interventions → Engagement → Outcomes. Empirical findings support these links: Wu et al. (2025) found overall positive impact of AI on achievement (Wu et al., 2025), and Zhou (2025) found that diverse AI usage yields real-time insights into engagement (Zhou, 2025). We also expect that when optimal teaching methods are used (e.g. interactive pedagogy), the positive effect of AI on engagement is amplified (Dong et al., 2026). Conversely, if AI is used in isolation (with poor pedagogy), the benefit may be less (as noted by the flipped-class case (Dong et al., 2026)).

In summary, our framework integrates literature: independent variables (AI), a mediating mechanism (engagement), and outcomes, while acknowledging moderating influences. This model provides a blueprint for both interpreting past results and designing future interventions (by targeting mediators/moderators).

7. DISCUSSIONS

This review is the synthesis of the literature which is available to answer our research questions.

Main Findings: We found strong indicators that AI-enhanced online learning is likely to increase learning and student engagement. In any field, adaptive learning systems and ITS were found to result in improved test scores, grades, or gains in skills than traditional methods (Khakpaki, 2025; Chen et al., 2020; Holmes et al., 2022; Kulik and Fletcher, 2016). In the same way, AI-based settings displayed a greater level of student engagement (especially cognitive and emotional engagement) compared to traditional settings (Dong et al., 2026; Zhou, 2025). For example, Dong et al. (2026) report chatbots and adaptive tools yield the largest increases in engagement when used together with interactive teaching (Dong et al., 2026). These benefits are quantified by Wu et al. (2025) and have a medium overall effect on achievement (Wu et al., 2025). On the other hand, none of the studies provided systematic adverse effects of AI; at worst, some did not provide significant difference in the cases of poorly integrated AI.

Responses to the research questions: The first question that stated how AI influences engagement/outcomes. The answer is that AI tends to improve them both, but the extent of improvement varies. AI promotes immediate feedback, which is personalized (Suntharalingam, 2024) and able to monitor affect motivation in real-time (Zhou, 2025; Suntharalingam, 2024; Zhou, 2025). Engagement is a multi-dimensional measure of engagement and research indicates statistically significant increases in engagement (in cognitive engagement (attention, effort) and emotional engagement (interest). There is also a steady increase in learning outcomes (achievement) (medium effect by Wu et al., 2025). However, the impact is not that simple: as Dong et al. (2026) note, these impacts are mediated by teaching methods, and active methodologies have bigger returns (Dong et al., 2026). The second question involved mediators of pedagogical strategies. We found that AI is frequently used together with blended and active learning (flipped classroom, PBL, gamification). These practices are likely to enhance the advantages of AI. This is what Dong et al. (2026) explain as the PMAISE model: AI should be pedagogically mediated to be able to engage students completely (Dong et al., 2026). Conversely, in certain traditional environments, when AI was merely added to instruction without redesigning it, there was a small difference. This highlights the importance of combined instructional design. The third question was related to themes and gaps. Some of the key themes are personalization, measurement of engagement, analytics, ethical concerns and teacher roles. The gaps consist of the lack of longitudinal and cross-context research, the lack of focus on equity, and the lack of consistent use of the theory. Although the majority of research looks at outcome/engagement, there are very limited research studies on how AI alters the learning processes. As an illustration, we hardly get qualitative research on the differences in the thinking strategies of students with AI. Theoretical implications may also be implied.

Comparison with previous reviews: Our results support and confirm previous reviews. The map of AI in education presented by Wang et al. (2024) is rather general, with adaptive learning and personalized tutoring being the main categories (Wang et al., 2024). We validate these categories have particular effects on engagement and outcomes. Our synthesis of positive achievement effects (Wu et al., 2025) agrees with the frontiers meta-analysis of Wu et al. (2025). The 2025 review on engagement by Zhou also agrees with our findings that various AI tools can provide deep insights into engagement (Zhou, 2025). Altogether, our review aligns with previous works but would provide more granularity in the outcomes and a thematic framing.

8. IMPLICATIONS OF STUDY

Theoretical implications: The review suggests existing theories are useful but underutilized. We see TAM (user acceptance) and CLT (cognitive load) recurring in the literature. For example, CLT explains why adaptive systems help outcomes: by reducing unnecessary load (Dong et al., 2026). SDT resonates with findings on motivation, yet few studies explicitly test SDT's constructs. Our conceptual model bridges these: it uses TAM to explain AI adoption, CLT to frame the mediator role, and SDT to conceptualize engagement drivers. We believe future work should integrate these theories more explicitly.

Practical implications: For educators and policymakers, the message is that AI can be a powerful tool but must be applied wisely. Tools like ITS and analytics can yield measurable gains in learning and keep students more engaged, as multiple studies demonstrate (Khakpaki, 2025; Dong et al., 2026). Schools should pilot adaptive platforms in subject areas that require practice (math, languages) where feedback is critical. However, our findings underscore that technology is not a silver bullet: success depends on context. Training teachers to use AI insights (e.g., dashboards identifying struggling students) is crucial. Investments in digital infrastructure and AI literacy programs are recommended. Additionally, our ethics theme implies that institutions must establish data privacy and equity guidelines before scaling up AI deployments.

Policy/Managerial implications: Educational policy should support AI integration via grants and professional development. Policymakers might consider frameworks (national AI in Ed strategies) given AI's clear academic benefits. At the managerial level (school/university), our framework suggests collaborating with instructional designers to align AI tools with curricula and pedagogy.

9. RESEARCH GAPS

Our analysis revealed several categories of research gaps. Table 3 summarizes them.

Table 3: Research Gaps

Type of Gap	Explanation	Evidence from Literature	Future Research Direction
Theoretical	Under-theorization of AI's role beyond tech jargon.	Few studies explicitly tested theories like SDT or UTAUT. Dong et al. (2026) note the need for more conceptual frameworks(Dong et al., 2026).	Apply and validate learning theories (e.g. motivational theory) to AI contexts; develop new models (like PMAISE).
Methodological	Lack of longitudinal and diverse designs.	Most studies are short-term (one semester or less) quantitative trials. Wu et al. (2025) used only 21 studies; others rely on cross-sectional surveys(Wu et al., 2025)(Vieriu & Petrea, 2025).	Conduct long-term studies and randomized controlled trials; use mixed-methods and ethnographies to capture process.
Contextual	Narrow contexts (mostly HE and STEM).	Little research in primary/secondary or vocational training. For example, Zhou (2025) focused on online higher ed. Khakpaki (2025) is rare in vocational/medical.	Explore K-12 classrooms, adult education, and corporate settings; examine underrepresented subjects (arts, humanities).
Geographical	Regional biases in data.	Majority of studies come from Asia/North America. Few reports from Africa or Latin America were found.	Foster studies in Global South contexts (e.g. African universities); comparative cross-country studies.
Empirical	Limited outcomes measured.	Emphasis on test scores and engagement surveys; less on soft skills or socio-emotional learning.	Assess creative thinking, collaboration, and 21st-century skills in AI learning; measure long-term retention.
Practical	Implementation/feasibility not fully addressed.	Papers note challenges (Suntharalingam, 2024) but few evaluate real-world deployment costs or teacher training effectiveness.	Research cost-benefit analyses, ROI of AI ed-tech; develop case studies of successful/failed AI implementations.

We categorize gaps into theoretical, methodological, contextual, geographical, empirical, and practical. For instance, Dong et al. (2026) themselves call for more work on how specific pedagogies mediate AI effects (Dong et al., 2026) – a methodological gap in isolating variables. We also note that ethics and equity are often mentioned but understudied. These insights will guide our future research agenda.

10. LIMITATIONS OF THE STUDY

This systematic Literature Review has some limitations. First, database coverage: although we searched major indexes, we may have missed studies in less prominent journals or languages (we excluded non-English papers). Second, the time-period constraint (2016–2026) means we did not consider earlier foundational work; this was by design but limits historical perspective. Third, search keywords are necessarily incomplete; relevant studies using unconventional terms might have been overlooked. Fourth, screening subjectivity: despite double-review, some selection decisions (e.g. relevance judgment) involve researcher judgment.

11. FUTURE RESEARCH DIRECTIONS

Given the gaps, we recommend the following areas for future studies:

New Variables and Measures: Investigate AI's effect on *soft skills* (critical thinking, creativity, collaboration). For example, can adaptive learning tools enhance problem-solving skills? Include socio-emotional metrics (interest, stress) in evaluations. Study how learner traits (e.g. self-regulation, tech anxiety) interact with AI.

New Contexts: Extend beyond higher ed. Explore K-12 education (how do younger students respond to AI tutors?), as well as vocational and workplace training. Research in multilingual and multicultural settings is needed. Studies should also include special education (AI for disabilities) and adult learners.

Mixed-Method and Longitudinal Designs: Use mixed-methods (combining experiments with interviews/observations) to capture the *process* of learning with AI. Conduct longitudinal studies (across a school year or multiple years) to assess sustained impacts and retention. For instance, track cohorts using AI tools versus not, across several grades.

Cross-Country and Comparative Research: Conduct cross-cultural studies to see how educational norms affect AI effectiveness. For example, compare student engagement with AI in collectivist versus individualist cultures, or across different schooling systems. Such research will enhance the generalizability of findings.

Industry/Discipline-Specific Research: Investigate AI in specialized fields (beyond medicine, which has some coverage). For instance, AI in business education, arts, or K-12 science labs. Examine domain-specific applications (e.g. AI-driven music tutors or AI in programming education).

Emerging AI Trends: As generative AI (e.g. ChatGPT) is new, future work should study its impact on learning writing, research skills, and creativity. Also, *sustainability and AI*: explore how AI can contribute to eco-friendly education (e.g. virtual labs reducing material use) or how AI training's energy use might affect schooling policy.

Equity and Accessibility: Specifically examine how AI tools can either reduce or exacerbate educational inequities. For example, does adaptive software benefit students with learning disabilities more than others? How to design AI that is accessible to low-resource schools?

Ethics-Focused Studies: Empirically study stakeholders' perceptions of AI ethics (students, parents, teachers). Develop and test ethical guidelines or consent frameworks for classroom AI.

Teacher Professional Development: Evaluate programs that train teachers to integrate AI. For example, a future study could measure teacher competence before/after an AI training workshop, and its effect on student outcomes.

These directions aim for a robust, forward-looking research agenda. By addressing new variables, broadening contexts, and adopting rigorous designs, the field can move beyond promising pilot studies toward evidence-backed pedagogy.

12. CONCLUSION

The systematic literature review considered recent studies (2016-2026) on AI in digital learning, including the aspects of student engagement and learning outcomes. After using the PRISMA guidelines, we found 47 studies that were relevant and published in reputable journals. We analyzed evidence that AI technologies could have a strong role in improving educational outcomes. In particular, personalization based on AI contributes to a greater level of academic performance, a greater level of cognitive and emotional interest (Khakpaki, 2025; Wu et al., 2025). Notably, these advantages are optimized in combination with active pedagogical techniques (Dong et al., 2026). The key findings of the review are: First, multi-disciplinary results were synthesized into coherent themes and tables; second, a conceptual framework of AI tools, engagement mediators and outcomes (with moderating factors); third, research gaps and future directions. We come to the conclusion that AI has the potential to be used in education, but its deployment must be carefully balanced with ethical and training considerations. We find that this balanced strategy maintains human-centered pedagogy while utilising AI to improve and personalise learning (Khakpaki, 2025; Chen et al., 2020; Holmes et al., 2022; Kulik and Fletcher, 2016). When creating and executing AI-enhanced learning, policymakers, educators, and technologists will find this review to be evidence-based. Overall, we affirm that the goal of utilising AI in digital learning is to improve student performance and engagement by making it interactive and personalised (Dong et al., 2026; Vieriu and Petrea, 2025). Because of our methodical methodology, these results are founded on confidence. But more study is needed to understand AI's long-term impacts and ensure that it can help all students. .

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