

Integrating AI Chatbots and Web Content in Teaching and Learning: A Systematic Review of Barriers, Opportunities and Strategies

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Abstract

This review synthesizes research on "Integrating artificial intelligence (AI) Chatbots and Web Content in Teaching and Learning: Technical Implementation, Pedagogical Impact, and Practical Strategies. Explore Barriers, Opportunities, and Strategies in depth." to address fragmented understanding of AI chatbot deployment in education. The review aimed to evaluate technical architectures, assess pedagogical outcomes, identify ethical and institutional barriers, compare implementation strategies, and explore opportunities for personalised learning. A systematic analysis of 44 studies spanning higher education and Science Technology Engineering and Mathematics (STEM) contexts, employing diverse methodologies including experimental designs and systematic reviews, was conducted. Findings reveal that advanced integration approaches, notably Retrieval Augmented Generation combined with Learning Management Systems, enhance contextual accuracy and scalability but face technical complexity and limited large-scale validation. Pedagogically, AI chatbots improve engagement, motivation, and learner autonomy, though evidence is constrained by short-term studies and uneven disciplinary impact. Ethical challenges such as academic integrity, data privacy, and algorithmic bias persist with insufficient institutional safeguards. Implementation success depends on embedding chatbots within existing platforms, iterative development, and educator facilitation, yet adoption is hindered by infrastructure, training deficits, and equity concerns. Opportunities exist to advance self-regulated learning and personalised feedback through adaptive, emotion-aware chatbots, though metacognitive support and multimodal interaction remain underdeveloped. These findings underscore the need for comprehensive frameworks integrating technical, pedagogical, and ethical dimensions to guide scalable, responsible AI chatbot adoption in diverse educational settings.

Keywords

Artificial intelligence chatbot, Web-based learning, Teaching and Learning, AI technologies in classrooms

1. Introduction

Research on integrating AI chatbots and web content in teaching and learning has emerged as a critical area of inquiry due to its potential to transform educational practices through personalised, accessible, and scalable learning support (Emmanouil et al., 2025; Dinesh & Manivel, 2025). The evolution from early computer-assisted language learning to the current deployment of large language models (LLMs) such as ChatGPT and retrieval-augmented generation (RAG) systems marks a significant shift in educational technology (Cohen et al., 2024; Ramadhani & Irawan, 2025). This integration addresses practical challenges like information fragmentation and cognitive overload while promising enhanced learner autonomy and engagement across diverse educational contexts (Márta, 2025; Puertas et al., 2023). With AI chatbots increasingly embedded in Learning Management Systems (LMS), their role in fostering interactive

and adaptive learning environments has gained prominence, underscoring their social and pedagogical significance (Rasanjani & Anuradha, 2024; Brunner et al., 2025).

Despite growing adoption, the integration of AI chatbots with web content in education faces unresolved challenges related to reliability, ethical concerns, and pedagogical effectiveness (Emmanouil et al., 2025; Annamalai, 2025). Current research reveals gaps in longitudinal studies, inclusive assessment frameworks, and the mitigation of AI hallucinations that generate inaccurate information (Al-Shamaileh et al., 2025; Márta, 2025). Controversies persist regarding overreliance on AI, risks to academic integrity, and the balance between technological innovation and traditional teaching methods (Sain et al., 2024; Haidar, 2024). These unresolved issues hinder the full realisation of AI chatbots' potential, with consequences including compromised learning outcomes and institutional unpreparedness (Olugbade, 2025; Joshi, 2025). Addressing these gaps is essential to ensure equitable, effective, and ethical AI integration in education (Sivathanu et al., 2025; Krishnan, 2025).

This review adopts a conceptual framework that situates AI chatbots as pedagogical agents operating within LMS ecosystems, emphasizing their cognitive, constructivist, and adaptive functions (Mungai et al., 2024). It defines key concepts such as generative AI, retrieval-augmented generation, and personalised learning, highlighting their interrelations in enhancing student engagement and academic support (Modran et al., 2024; Farah et al., n.d.). This framework guides the systematic examination of technical implementations, pedagogical impacts, and practical strategies for AI chatbot integration, aligning with constructivist and adaptive learning theories (Bae & Lee, 2025; Yusuf et al., 2025).

The purpose of this systematic review is to synthesize current knowledge on the integration of AI chatbots and web content in teaching and learning, focusing on technical implementation, pedagogical impact, and practical strategies while exploring barriers and opportunities in depth (Emmanouil et al., 2025; Qadir, 2025). By addressing identified gaps, this review contributes to evidence-based decision-making for educators, developers, and policymakers aiming to optimise AI-enhanced educational environments (Kayyali, 2025; Maigari & Kumar, 2024). It offers a comprehensive understanding that balances innovation with ethical and pedagogical considerations, advancing the discourse on AI in education (Wangsa et al., 2024).

This review employs a rigorous methodology encompassing systematic literature searches, inclusion of empirical and theoretical studies, and thematic analysis to organise findings across technical, pedagogical, and practical dimensions (Al-Shamaileh et al., 2025; Qiu et al., 2025). The synthesis is structured to first present technical architectures and implementations, followed by pedagogical outcomes and challenges, and concluding with strategic recommendations for effective AI chatbot integration (Martin et al., 2024). This organisation facilitates a holistic understanding of the multifaceted role of AI chatbots in modern education.

1.1 Statement of Purpose

The objective of this report is to examine the existing research on "Integrating AI Chatbots and Web Content in Teaching and Learning: Technical Implementation, Pedagogical Impact, and Practical Strategies. Explore Barriers, Opportunities, and Strategies in depth." in order to synthesize current knowledge on how AI chatbots, particularly those leveraging large language models, are being technically implemented and pedagogically integrated within educational environments. This review aims to elucidate the multifaceted benefits and challenges associated with chatbot adoption, including ethical considerations, academic integrity, and user acceptance. By critically analysing practical strategies and identifying barriers and opportunities, the report seeks to inform educators, developers, and policymakers on effective approaches to harness AI chatbots and web content integration to enhance teaching and learning outcomes across diverse educational contexts.

1.2 Objectives:

- To evaluate current knowledge on the technical architectures and integration methods of AI chatbots with web-based educational content.
- Benchmarking of existing pedagogical frameworks assessing the impact of AI chatbots on student engagement and learning outcomes.
- Identification and synthesis of barriers, including ethical, technical, and institutional challenges, in deploying AI chatbots in education.

- To compare practical strategies and best practices for implementing AI chatbots within Learning Management Systems and other digital platforms.
- To deconstruct opportunities for enhancing self-regulated learning, personalised feedback, and administrative support through AI chatbot technologies.

2. Methods

The methodology involved transforming an initial broad research query into a set of more focused and structured search queries to guide the literature review. These refined queries were designed to capture multiple dimensions of AI chatbot integration in education, including technical implementation, pedagogical impact, and practical deployment strategies. Table 1 presents the search strategy and Boolean operators employed in formulating the search queries.

Table 1. Search strategy and Boolean logic

Component	Details
Primary Keywords	"AI chatbot" , "educational chatbot" , "conversational AI" , "large language model" , "LLM" , "ChatGPT" , "teaching" , "learning" , "higher education" , "K-12" , "e-learning" , "learning management system" , "LMS" , "Moodle" , "Canvas" , "web content" , "web-based learning" , "student engagement" , "learning outcomes" , "self-regulated learning" , "personalized learning" , "implementation" , "integration" , "evaluation" , "adoption" , "governance" , "ethics"
Boolean Logic String	("AI chatbot" OR "educational chatbot" OR "conversational AI" OR "large language model" OR "LLM" OR "ChatGPT") AND ("teaching" OR "learning" OR "higher education" OR "K-12" OR "e-learning") AND ("learning management system" OR "LMS" OR "Moodle" OR "Canvas" OR "web content" OR "web-based learning") AND ("student engagement" OR "learning outcomes" OR "self-regulated learning" OR "personalized learning") AND ("implementation" OR "integration" OR "evaluation" OR "adoption" OR "governance" OR "ethics")

Further refinement expanded the scope to include strategic design and governance considerations, ensuring that the review addressed not only how chatbots are built and implemented, but also how they are managed and evaluated. This included attention to system architectures, scalability across K-12 and higher education, and the role of chatbots in supporting self-regulated learning (SRL). Ethical and institutional factors such as data privacy, equity, and academic integrity were also incorporated to ensure a comprehensive analysis.

Finally, the queries were structured to capture evaluation frameworks and measurable outcomes, including student engagement and learning gains, as well as teacher-focused dimensions such as professional development. This multi-layered query design enabled a holistic and systematic exploration of the literature, ensuring coverage of technical, pedagogical, ethical, and governance-related aspects of AI chatbot use in education.

Table 2 presents the inclusion and exclusion criteria, structured using the PICO framework, to facilitate the identification of relevant studies and the retrieval of a focused set of candidate papers. Additionally, the inclusion criteria included only English publications with timeframe focusing on recent advancements (2023 – 2026). The exclusion criteria excluded older studies (pre-2015) which were not relevant to modern generative AI or LLM technologies.

Table 2. Inclusion and exclusion criteria

PICO Component	Inclusion Criteria	Exclusion Criteria
P	Students and educators across Higher Education, STEM, and K-12 ecosystems.	Studies entirely outside of an educational setting (e.g., commercial, retail, or industrial chatbots).
I	Deployment of AI chatbots (LLMs/RAG) integrated with web-based content or LMS (Moodle/Canvas).	Non-conversational AI or general educational software without a chatbot interface.

C	Traditional teaching methods, early computer-assisted learning, or comparisons between different AI architectures.	Studies lacking any comparative baseline or context for implementation effectiveness.
O	Technical architectures, pedagogical impact (engagement, self-regulated learning), and institutional governance/ethics.	Papers without primary data, such as editorials, short opinion pieces, or news articles.

Figure 1 presents the PRISMA flow diagram used to guide the study selection process. During this process we found 334 papers from Scopus. Scopus was selected as the primary specifically because it provided interdisciplinary coverage of STEM, Social Sciences, and Humanities, which is critical for a topic that bridges Technical Implementation (Engineering/Computer Science) and Pedagogical Impact (Education). Scopus also provides quality control by primarily indexing high-impact, peer-reviewed journal articles, ensuring that the core of the 334 papers met the baseline for academic rigor. Furthermore, Scopus was selected as the primary bibliometric database because of its extensive citation coverage and advanced citation-tracking functionality. These capabilities enabled both backward citation chaining (reviewing referenced studies) and forward citation chaining (identifying citing studies), which contributed to the identification of an additional 85 potentially relevant records for screening. Citation chaining was employed to enhance the comprehensiveness of the review. Backward citation chaining identified 38 additional studies, comprising 12 records from the reference list of Al-Shamaileh et al. (2025), 10 from Ali et al. (2024), 8 from Bekkar and Chtouki (2024), and 8 from Scopus-derived foundational bibliographies. Forward citation chaining yielded a further 47 records through citation tracking, including 25 records from Google Scholar, 15 from SciSpace, and 7 from ArXiv and Crossref. Collectively, these processes generated 85 additional records that were subsequently screened for inclusion in the review.

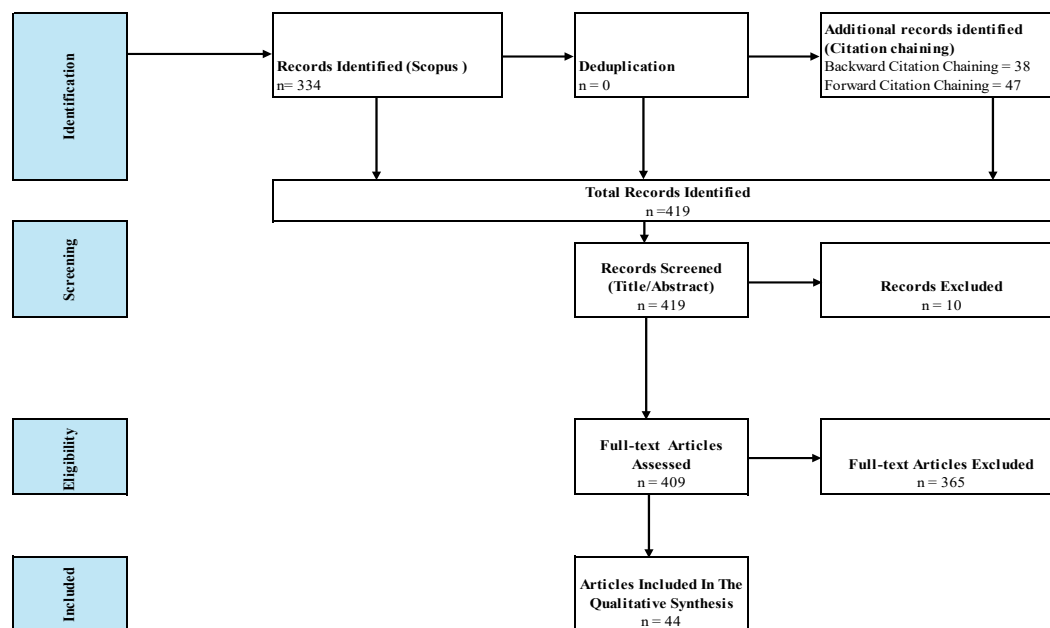


Figure 1. PRISMA

3. Literature

The reviewed studies collectively examine the integration, impact, and implications of AI chatbot technologies in education from multiple perspectives. A substantial group of empirical studies focuses on the implementation of LLM-based and RAG-enhanced chatbots within learning management systems and classroom settings. For instance, Emmanouil et al. (2025), Al-Shamaileh et al. (2025), and Ramadhani and Irawan (2025) investigate how chatbot integration influences learner autonomy, motivation, and user acceptance, while Márta (2025) introduces Dynamic Course Content Integration to improve engagement and reduce hallucinations. Similarly, Mehnen and Pohn (2024), Dinesh and Manivel (2025), and Qadir (2025) explore real-time academic support, content generation, and cross-

disciplinary adaptability, with Qiu et al. (2025) providing robust longitudinal experimental evidence of learning gains. Complementing these are usability and discipline-specific studies such as Sell et al. (2025) and Fekets (2025), which assess productivity, accessibility, and student expectations, alongside pedagogically grounded analyses like Bae and Lee (2025) and Ling and Jan (2025), which emphasize structured interaction and learner autonomy.

Another set of studies concentrates on the technical design and architecture of chatbot systems. These include Puertas et al. (2023) and Rasanjani and Anuradha (2024), who develop LMS-integrated and modular chatbot frameworks for academic support, as well as Martin et al. (2024) and Farah et al. (n.d.), who propose domain-specific and software engineering-oriented conversational agents. More advanced systems are presented by Modran et al. (2024) and Faruqi et al. (2024), which combine LLMs with RAG for adaptive tutoring and real-time assistance, while Dhar and Kalidas (2025) extend this work through emotion-aware, multimodal chatbots. Additional contributions such as Thammeter et al. (2025) and the RAG-based chatbot study (2025) highlight scalable architectures for MOOCs and dynamic question answering, and Gligorea et al. (2025) provide a conceptual systems-level framework for chatbot integration in complex educational environments.

A third cluster of research synthesizes pedagogical outcomes and learning benefits through reviews and theoretical analyses. Studies such as Olugbade (2025), Bekkar and Chtouki (2024), and Labadze and Machaidze (2023) evaluate the effectiveness of chatbots in supporting personalised learning, tutoring, and skill development, while Elkot et al. (2025) and Mungai et al. (2024) emphasize improvements in achievement, engagement, and adaptive learning grounded in cognitive theory. Language-focused applications are explored by Diasamidze and Tedoradze (2024), and Brunner et al. (2025) highlight limitations in fostering metacognitive engagement in MOOC environments, pointing to important gaps in current implementations.

Ethical, policy, and governance considerations form another major theme across the literature. Sain et al. (2024), Ali et al. (2024), and Annamalai (2025) address concerns related to academic integrity, plagiarism, and misuse, while Haidar (2024) and Wangsa et al. (2024) emphasize risks of misinformation, bias, and system reliability. Broader policy and institutional readiness issues are discussed by Joshi (2025), Sivathanu et al. (2025), and Krishnan (2025), who highlight privacy, equity, and the need for governance frameworks, with Bakmeedeniya (2024) further underscoring the practical and ethical challenges educators face when adopting AI tools.

Finally, several studies adopt conceptual, strategic, and future-oriented perspectives on AI chatbot integration. Yusuf et al. (2025) propose frameworks for conversational agent design incorporating personalisation and embodiment, while Kayyali (2025) and Ashfaque et al. (2025) explore broader applications including student wellbeing and immersive AI-driven classrooms. Institutional and collaborative approaches are discussed by Cohen et al. (2024), and practical implementations such as Adesina (2022) demonstrate chatbot use for microlearning and student support services. Forward-looking discussions by Reddy (2025), Maigari and Kumar (2024) study outline emerging trends such as emotional AI, system-wide transformation, and the evolving role of generative AI in higher education. Collectively, these studies provide a comprehensive overview of the technological, pedagogical, ethical, and strategic dimensions shaping the adoption of AI chatbots in education.

4. Results and Discussion

This section maps the research landscape of the literature on Integrating AI Chatbots and Web Content in Teaching and Learning: Technical Implementation, Pedagogical Impact, and Practical Strategies. Explore Barriers, Opportunities, and Strategies in depth. The reviewed studies encompass a broad spectrum of educational levels, disciplines, and geographic contexts, with a strong emphasis on higher education and STEM fields. Methodologies range from systematic reviews and case studies to experimental designs and pilot implementations, highlighting both technical architectures and pedagogical frameworks. This comparative analysis addresses key research questions by synthesising findings on technical integration, pedagogical outcomes, ethical considerations, implementation strategies, and user acceptance, thereby informing best practices and future research directions.

4.1 Technical Integration Approaches:

A synthesis of the reviewed literature indicates that the majority of studies ($n = 30$) focus on the integration of large language models (LLMs) with learning management systems (LMS), frequently enhanced through Retrieval-Augmented Generation (RAG) techniques to improve contextual accuracy and reduce hallucinations (Ramadhani & Irawan, 2025; Márta, 2025). In addition, several studies highlight the importance of dynamic content integration and modular chatbot frameworks in enabling personalised and adaptive learning environments (Puertas et al., 2023;

Rasanjani & Anuradha, 2024; Mungai et al., 2024). More advanced approaches are emerging, including multimodal and emotion-aware chatbots as well as domain-specific conversational agents, reflecting increasing technical sophistication and customisation in educational applications (Martin et al., 2024; Dhar & Kalidas, 2025). Despite these advancements, significant challenges remain, particularly in relation to infrastructure demands, system complexity, and the continuous need for data updates to ensure chatbot relevance and effectiveness over time (Faruqui et al., 2024; Thammeter et al., 2025).

4.2 Pedagogical Impact Measures:

The literature shows that a substantial number of studies ($n = 28$) report positive pedagogical outcomes associated with AI chatbot use, particularly in enhancing personalised learning, student engagement, motivation, and critical thinking skills (Emmanouil et al., 2025; Ling & Jan, 2025; Qiu et al., 2025). Both quantitative and qualitative findings further indicate improvements in academic achievement, self-efficacy, and learner autonomy across a range of disciplines (Elkot et al., 2025; Qadir, 2025; Yakin et al., 2023). However, several studies emphasize that these benefits are not automatic, highlighting the importance of structured guidance and well-designed pedagogical frameworks to maximise the effectiveness of chatbot integration in educational contexts (Bae & Lee, 2025; Ling & Jan, 2025).

4.3 Ethical and Integrity Safeguards:

Reviewed studies indicate that a significant proportion ($n = 25$) identify academic integrity, plagiarism, data privacy, and misinformation as major concerns requiring robust safeguards in the use of AI chatbots in education (Emmanouil et al., 2025; Annamalai, 2025; Haidar, 2024). To address these risks, the literature highlights several mitigation strategies, including the use of plagiarism detection tools, the development of ethical guidelines, ongoing professional development for educators, and the implementation of technical fail-safes to prevent misuse (Sain et al., 2024; Faruqui et al., 2024; Bakmeedeniya, 2024). Beyond these measures, ethical considerations are also extended to broader issues such as inclusivity, equity, and transparency in AI deployment (Joshi, 2025; Sivathanu et al., 2025). However, some studies point out that there is still a limited explicit focus on concrete ethical mechanisms in practice, revealing an important gap in current research (Puertas et al., 2023; Farah et al., 2025).

4.3 Implementation Strategies Effectiveness:

A considerable number of studies ($n = 22$) report successful deployment of AI chatbots within learning management systems such as Moodle and Canvas, with generally positive feedback regarding usability and administrative support (Mehnen & Pohn, 2024; Rasanjani & Anuradha, 2024; Márta, 2025). Many pilot studies and case reports further emphasize the importance of iterative development processes, continuous user feedback, and seamless integration with existing educational workflows to ensure effective implementation (Faruqui et al., 2024; Thammeter et al., 2025; Qadir, 2025). Despite these successes, several challenges persist, including issues related to scalability, infrastructure costs, and the need to adapt chatbot systems for diverse student populations, particularly those with disabilities (Faruqui et al., 2024; Ashfaque et al., 2025). In response, several studies propose structured frameworks for institutional readiness and governance to support responsible, scalable, and sustainable implementation (Joshi, 2025; Krishnan, 2025).

4.4 User Acceptance and Accessibility:

Studies indicate that a large proportion ($n = 30$) report high levels of user satisfaction with AI chatbots in education, particularly due to features such as personalised feedback, and enhanced student engagement (Ramadhani & Irawan, 2025; Márta, 2025; Fekets, 2025). Accessibility is also a key factor in positive user experiences, with studies highlighting the role of multilingual support and emotion-aware interactions in improving inclusivity for diverse learner groups (Mehnen & Pohn, 2024; Dhar & Kalidas, 2025). However, several concerns continue to influence user acceptance, including over-reliance on chatbots, issues related to response accuracy, and limitations in conversational coherence (Ling & Jan, 2025; Fekets, 2025). In addition, educator acceptance is shown to depend heavily on access to professional development opportunities and the degree to which chatbot use aligns with established pedagogical goals (Sain et al., 2024; Mungai et al., 2024).

Figure 2 illustrates a summary bar chart that visualizes the distribution of research themes across the 44 studies, such as technical integration, pedagogical impact, and ethical safeguards. This provides a clear, quantitative overview of the study's findings within the results and discussion section.

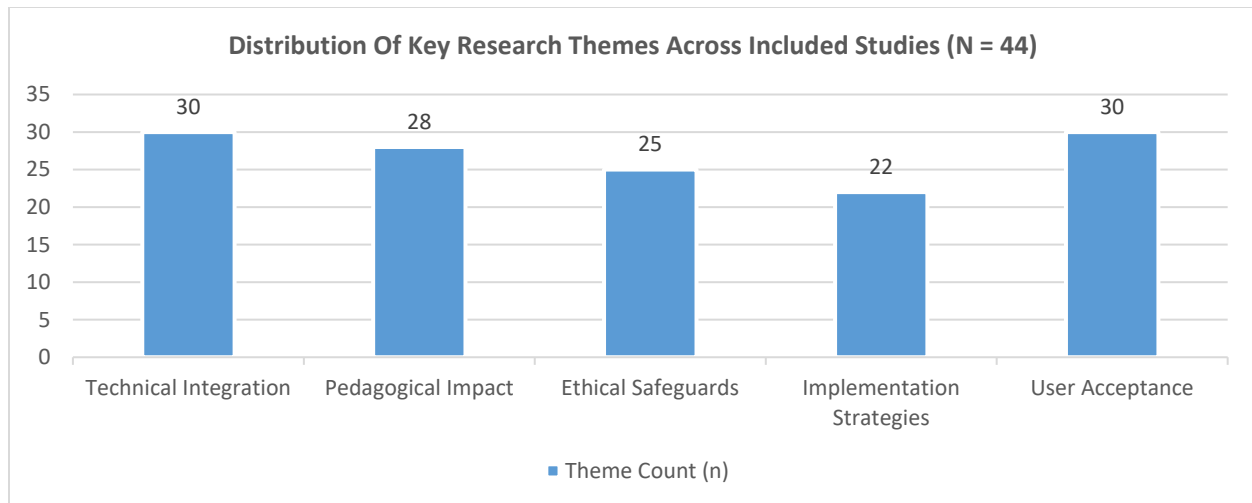


Figure 2. Count of Key Research Themes

4.5 Graphical Results

The data of the depicted graph in Figure 3 is extracted from Scopus. The figure illustrates a clear and rapidly accelerating growth trend in publications on AI chatbots and web-based learning over time.

- Early stage (2009–2017): Research output is extremely limited, with only 0–2 publications per year, indicating that the topic was largely exploratory and peripheral during this period.
- Emergence phase (2018–2021): A gradual increase becomes visible, rising from 1 publication in 2018 to around 22 publications by 2021. This period reflects growing academic interest, likely driven by advances in educational technology, learning management systems, and early conversational agents.
- Pre-ChatGPT surge (2022): A slight dip is observed in 2022 (17 publications), suggesting a transitional phase before widespread adoption of large-scale AI chatbots in education.
- Exponential growth phase (2023–2025): Publications increase dramatically from 89 in 2023 to 162 in 2024, peaking at 274 in 2025. This sharp rise coincides with the mainstream adoption of generative AI chatbots, signalling heightened research attention on opportunities (personalised learning, feedback), barriers (ethics, academic integrity), and implementation strategies.
- Partial decline (2026): The decrease to 72 publications in 2026 likely reflects incomplete indexing or partial-year data, rather than a genuine reduction in research interest.

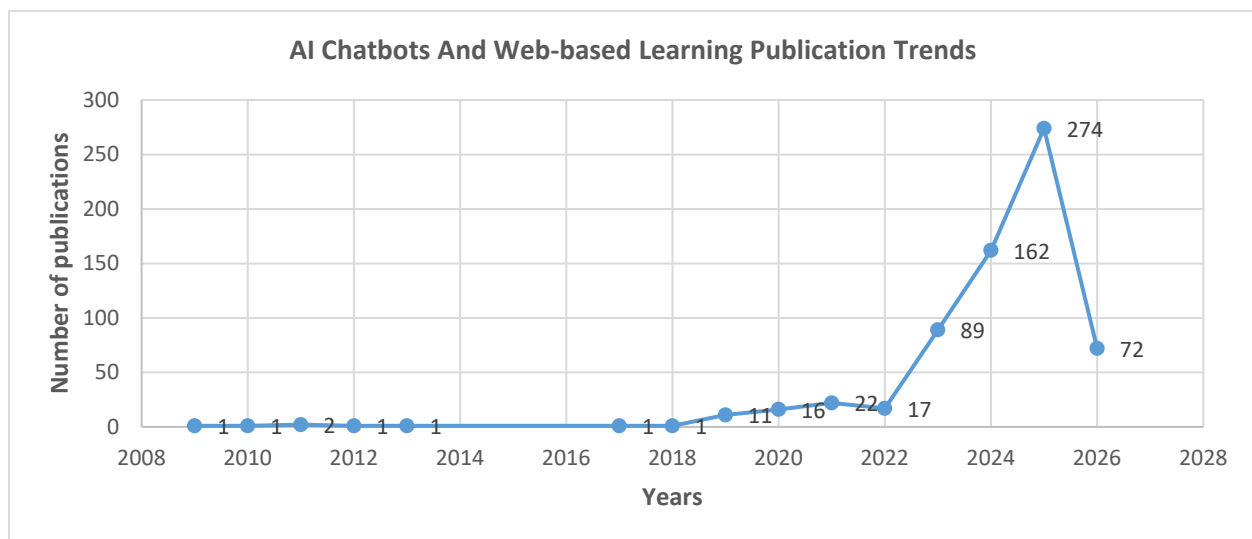


Figure 3. Publication trend (AI chatbots and web-based learning)

5. Conclusion

The collective body of research on integrating AI chatbots and web content in educational settings demonstrates significant potential for enhancing teaching and learning through personalised, adaptive, and accessible learning experiences. Technically, advancements in large language models combined with Retrieval Augmented Generation methods have enabled chatbots to deliver contextually accurate, timely, and relevant responses by dynamically interfacing with Learning Management Systems and course content. Modular and template-based architectures further empower educators to customise chatbot functionalities according to discipline-specific needs, although challenges such as system complexity, maintenance demands, and limited multimodal interaction remain. The predominance of text-based communication limits the richness of chatbot-user interactions, suggesting opportunities for future development in emotion-aware and multimodal AI agents.

Pedagogically, AI chatbots have been shown to improve student engagement, motivation, critical thinking, and self-efficacy across diverse disciplines, particularly in higher education and STEM fields. Their ability to provide 24/7 personalised feedback and scaffold learning supports self-regulated learning and autonomy, aligning well with cognitive, constructivist, and adaptive learning theories. However, the literature highlights a scarcity of longitudinal studies and comprehensive evaluations that confirm sustained learning gains and broad applicability across diverse learner populations. There is also evidence that unstructured or over-reliant use of chatbots may inadvertently diminish critical thinking and deep learning if not integrated within well-defined pedagogical frameworks.

Ethical considerations emerge as a recurrent and critical theme, emphasizing risks related to academic integrity violations, misinformation, data privacy, and algorithmic bias. While many studies call for robust ethical frameworks, policies, and professional development to address these concerns, practical application remains inconsistent and underdeveloped. Institutional readiness is often insufficient, with educators facing resistance, limited training, and infrastructural constraints that impede widespread adoption. Equity issues, including accessibility for marginalised groups and inclusivity in AI design, further complicate implementation and necessitate deliberate governance and policy interventions.

Effective implementation strategies underscore embedding chatbots seamlessly within LMS environments to enhance usability, employing prompt engineering, and fostering human-AI collaboration where educators act as facilitators rather than mere content deliverers. Multilingual and adaptive features contribute positively to accessibility and learner satisfaction. Nevertheless, scalability and sustainability beyond pilot phases require more extensive research and institutional commitment. Opportunities for advancing self-regulated learning and personalisation through AI chatbots remain promising but are currently under-realised, especially in supporting metacognitive skills and emotional engagement.

In sum, the literature reveals a dynamic and evolving landscape where AI chatbots can meaningfully augment educational experiences when technical sophistication, pedagogical alignment, ethical safeguards, and institutional readiness converge. Addressing existing gaps through longitudinal research, inclusive design, and comprehensive policy frameworks will be essential for maximising the transformative potential of AI chatbots integrated with web content in teaching and learning.

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