INTEGRATION: Journal of Multidisciplinary Studies
ISSN 3123-6928 (online)
Vol. 1 Iss. 2 Pg. 508-527
https://ejournal.scmdigi.id/index.php/integration

ChatGPT in education: a systematic literature review of pedagogical applications, benefits, challenges, and future directions

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DOI: https://doi.org/10.65881/integration.v1i2.166

ARTICLE INFO

History:
Received: 07-23-2026
Revised: 07-28-2026
Accepted: 07-29-2026
Published: 08-04-2026

Keywords:
chatgpt in education; generative ai; pedagogical applications; educational technology; systematic literature review.

ABSTRACT

Purpose: to systematically review the existing literature on the use of ChatGPT in education by examining its pedagogical applications, educational benefits, ethical challenges, and future research directions.
Method: this study used a systematic literature review (SLR) based on PRISMA guidelines. A total of 25 articles published between 2023 and 2026 were analyzed to identify the applications, benefits, challenges, and future directions of ChatGPT in education.
Findings: ChatGPT supports education through personalized learning, tutoring, feedback, teaching assistance, and research support. However, challenges remain regarding academic integrity, information accuracy, privacy, and ethical implementation. Future research should focus on effective and responsible AI integration in education.
Implications: this study highlights the importance of integrating ChatGPT in education through evidence-based pedagogical strategies, AI literacy development, and ethical governance to maximize its benefits while minimizing potential risks.
Originality: this study provides an original synthesis of recent research on ChatGPT in education by identifying emerging applications, pedagogical benefits, ethical challenges, and future research directions through a systematic review framework.

Introduction

The rapid advancement of artificial intelligence (AI), particularly generative artificial intelligence (GenAI), has fundamentally transformed numerous aspects of society, including education (Samala et al., 2025). Unlike conventional AI systems that primarily perform analytical tasks, GenAI enables the generation of human-like text, images, code, and other forms of digital content, thereby creating new opportunities for

teaching, learning, and knowledge creation (Yang et al., 2025). Among recent GenAI innovations, ChatGPT, developed by OpenAI, has attracted unprecedented global attention (Sedkaoui & Benaichouba, 2026). Since its public release in late 2022, ChatGPT has become one of the fastest-growing AI applications worldwide and has been increasingly adopted across educational institutions as a tool for learning support, instructional material development, assessment design, academic writing, and research assistance (Gill et al., 2024; Grassini, 2023). This rapid diffusion has positioned ChatGPT as one of the most influential emerging technologies shaping the future of education.

The widespread adoption of ChatGPT has introduced a significant paradigm shift in educational practices (Munaye et al., 2025). Rather than functioning solely as an information retrieval system, ChatGPT increasingly serves as an intelligent learning companion capable of facilitating personalized learning experiences, providing immediate feedback, explaining complex concepts, supporting collaborative learning, and enhancing students' academic writing and problem-solving skills (Baidoo-Anu & Ansah, 2023; Bettayeb et al., 2024; Karakose & Tülübaş, 2023). For educators, ChatGPT offers opportunities to improve instructional efficiency by assisting in lesson planning, developing teaching materials, generating assessment items, designing grading rubrics, and producing multimedia learning resources (Gill et al., 2024). Consequently, educational institutions worldwide have begun exploring the integration of ChatGPT into both face-to-face and online learning environments as part of broader digital transformation initiatives.

Despite these promising opportunities, integrating ChatGPT into education has also raised substantial academic and practical concerns. Existing studies have highlighted various challenges associated with its implementation, including academic dishonesty, plagiarism, overreliance on AI-generated content, hallucinated or inaccurate information, algorithmic bias, privacy and data security issues, and the potential decline of students' critical thinking and independent learning skills when AI is used without appropriate pedagogical supervision (Grassini, 2023; Rahman & Watanobe, 2023; Trust et al., 2023). Furthermore, the successful implementation of ChatGPT depends on institutional readiness, digital infrastructure, AI literacy, ethical governance, and educational policies, all of which vary considerably across countries and educational systems (Bencsik et al., 2026; Nazeer et al., 2026). These challenges demonstrate that integrating ChatGPT into education is not merely a technological issue but also a pedagogical, ethical, organizational, and policy-related concern.

The growing interest in ChatGPT has resulted in an exponential increase in scholarly publications examining its educational applications. Previous studies have investigated diverse aspects of ChatGPT, including its pedagogical benefits (Baidoo-Anu & Ansah, 2023), responsible implementation strategies (Halaweh, 2023), technology acceptance in higher education (Almogren et al., 2024), public concerns expressed through social media discourse (Li et al., 2024), applications in primary education (Uğraş et al., 2024), inquiry-based learning in STEAM education (Jiang et al., 2026), and its transformative effects on modern education (Gill et al., 2024). In parallel, several literature reviews have synthesized evidence regarding ChatGPT in education, including rapid reviews (Lo, 2023), reviews of educational benefits and risks (Sok & Heng, 2023), and systematic reviews focusing on empirical evidence, opportunities, challenges, and future directions (Albadarin et al., 2024; Munaye et al., 2025). These studies collectively demonstrate the growing recognition of ChatGPT as an emerging educational technology with significant pedagogical implications.

However, despite the increasing body of literature, several important research gaps remain. First, many existing reviews concentrate on a limited dimension of ChatGPT, such as academic integrity, user perceptions, technology acceptance, higher education, or STEAM learning, without providing an integrated understanding of its educational applications across different educational levels, learning contexts, and pedagogical perspectives (Albadarin et al., 2024; Lo, 2023; Munaye et al., 2025). Second, the exceptionally rapid growth of publications since 2023 has produced numerous new empirical findings that have not yet been comprehensively synthesized into a unified body of knowledge. Third, previous reviews have generally discussed opportunities and challenges separately, with limited attention to how pedagogical applications, educational benefits, implementation challenges, ethical concerns, and future research directions collectively shape the evolving landscape of ChatGPT in education. These limitations indicate the need for an updated and comprehensive systematic literature review that integrates recent evidence to provide a holistic understanding of ChatGPT's role in educational practice.

Accordingly, the novelty of this study lies in its comprehensive synthesis of the most recent scholarly evidence concerning ChatGPT in education by integrating four interrelated dimensions within a single analytical framework: (1) pedagogical applications of ChatGPT across educational contexts; (2) educational and pedagogical benefits; (3) implementation challenges and ethical considerations; and (4) future research directions. Unlike previous reviews that primarily focused on specific educational sectors or individual aspects of ChatGPT, this study provides a broader and more integrated perspective that reflects the rapidly evolving research landscape and identifies emerging trends that may inform future educational research and practice.

This study is grounded in the theoretical perspective of AI-supported learning and technology integration in education, which conceptualizes AI as an educational technology capable of enhancing teaching effectiveness, learning engagement, and knowledge construction when implemented within appropriate pedagogical frameworks (Adiguzel et al., 2023). Consistent with responsible AI implementation strategies proposed by Halaweh (2023), the educational value of ChatGPT depends not only on its technological capabilities but also on educators' pedagogical competence, institutional governance, ethical considerations, and learners' AI literacy. Therefore, understanding ChatGPT requires an integrated perspective that combines technological innovation with pedagogical principles and responsible educational practices.

Based on these considerations, this study aims to conduct a systematic literature review (SLR) of contemporary scholarly publications concerning the use of ChatGPT in education. Specifically, the review seeks to: (1) identify the major pedagogical applications of ChatGPT in educational settings; (2) synthesize the educational benefits reported in empirical studies; (3) examine the challenges, limitations, and ethical issues associated with its implementation; and (4) identify emerging research gaps and propose future research directions for advancing knowledge in this rapidly developing field. Conducting this review is particularly important because ChatGPT has become one of the most disruptive educational technologies in recent years, while scholarly understanding of its pedagogical implications continues to evolve rapidly. A comprehensive synthesis of current evidence is essential for informing educators, researchers, institutional leaders, and policymakers regarding the effective, ethical, and sustainable integration of AI into education. By consolidating fragmented findings from diverse educational contexts, this review provides a clearer understanding of the current state of knowledge and highlights priorities for future investigation.

The findings of this study are expected to contribute both theoretically and practically. From a theoretical perspective, this review enriches the literature on AI integration in education by providing an updated conceptual synthesis of ChatGPT's pedagogical applications, benefits, challenges, and future research agenda. From a practical perspective, the findings offer evidence-based recommendations for educators, curriculum developers, higher education institutions, and policymakers to design responsible AI implementation strategies, develop institutional guidelines, enhance AI literacy, and foster sustainable educational innovation. Ultimately, this study provides a comprehensive knowledge base that supports the effective and ethical adoption of ChatGPT in contemporary education while identifying critical directions for future scholarly inquiry.

Method

This study employed a systematic literature review (SLR) to comprehensively synthesize existing research on the application of ChatGPT in education. The review followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, which provide a transparent and rigorous framework for identifying, screening, evaluating, and synthesizing relevant literature. The PRISMA protocol enhances the reliability, reproducibility, and methodological quality of systematic reviews by ensuring that the study selection process is conducted in a structured and unbiased manner. The literature search was conducted using international scholarly databases that index peer-reviewed publications relevant to education and artificial intelligence. The search focused on studies published between 2022 and 2026, reflecting the period following the public release of ChatGPT. Keywords related to ChatGPT, generative artificial intelligence, artificial intelligence, education, teaching, learning, and higher education were combined using Boolean operators to maximize the retrieval of relevant studies. Duplicate records identified across databases were removed before the screening process.

The article selection process followed the four stages recommended by the PRISMA framework. The first stage, Identification, involved retrieving all potentially relevant studies from the selected databases using predefined search strategies. The second stage, Screening, consisted of reviewing titles, abstracts, and keywords to eliminate studies that were clearly unrelated to the research objectives. The third stage, Eligibility, involved a full-text assessment of the remaining articles to determine whether they satisfied the predetermined inclusion and exclusion criteria. Finally, during the Included stage, studies meeting all eligibility requirements were selected for qualitative synthesis and in-depth analysis. The inclusion criteria were established to ensure the quality and relevance of the reviewed literature. Eligible studies were required to: (1) be published in reputable international peer-reviewed journals; (2) explicitly examine the use of ChatGPT in educational contexts; (3) provide full-text access; (4) employ either empirical or conceptual research approaches; and (5) be published between 2022 and 2026. Studies discussing artificial intelligence in general without specifically addressing ChatGPT, conference abstracts, editorials, opinion pieces, commentaries, and publications lacking sufficient methodological information were excluded from the review.

Following the systematic selection process, 25 journal articles met all inclusion criteria and were included in the final review. These studies represented diverse educational contexts, research methodologies, and disciplinary perspectives, providing a comprehensive foundation for synthesizing current knowledge on ChatGPT in

education. Data analysis was conducted using thematic synthesis, a qualitative synthesis approach that enables the identification and integration of recurring themes across multiple studies. Initially, key findings from each article were extracted and coded according to the study objectives. Similar codes were subsequently grouped into broader thematic categories representing major pedagogical applications, educational benefits, implementation challenges, ethical issues, and future research directions. Finally, a cross-study synthesis was performed to identify recurring patterns, similarities, differences, and emerging research trends, thereby providing a comprehensive understanding of the current state of knowledge regarding the implementation of ChatGPT in education.

Results and discussion

Characteristics of the reviewed studies

Following the identification, screening, eligibility assessment, and final selection procedures based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, a total of 25 peer-reviewed studies were included in this systematic literature review. The characteristics of the selected studies were analyzed to provide an overview of the current state of research on ChatGPT in education, including publication trends, research methodologies, publication outlets, and the primary research focus. Examining these characteristics provides an important foundation for understanding how the field has evolved and informs the thematic synthesis presented in the subsequent sections.

Table 1 summarizes the characteristics of the selected studies. Overall, the reviewed literature demonstrates considerable methodological diversity, including systematic literature reviews, traditional literature reviews, conceptual papers, quantitative studies, qualitative case studies, mixed-methods research, bibliometric analyses, social media analytics, and machine learning-based investigations. This methodological variation reflects the rapid evolution of ChatGPT research from conceptual exploration toward empirical validation and practical implementation.

Table 1 characteristics of reviewed articles

Nu.	Author (Year)	Journal	Research approach	Research focus
1	Adiguzel et al. (2023)	Contemporary Educational Technology	Literature review	Transformative potential, educational benefits, and ethical challenges of ChatGPT
2	Baidoo-Anu & Ansah (2023)	Journal of AI	Exploratory literature review	Benefits and limitations of ChatGPT in teaching and learning
3	Gill et al. (2024)	Internet of Things and Cyber-Physical Systems	Conceptual paper	Transformative effects of ChatGPT on modern education
4	Almogren et al. (2024)	Heliyon	Quantitative (SEM)	Factors influencing ChatGPT acceptance in higher education
5	Bettayeb et al. (2024)	Frontiers in Education	Systematic literature review	Educational impacts, student engagement, and ethical issues
6	Uğraş et al. (2024)	Sustainability	Qualitative case study	Teachers' perceptions of ChatGPT in primary education
7	Li et al. (2024)	Education and Information Technologies	Social media analysis (BERT & SNA)	Public concerns regarding ChatGPT in education

Nu.	Author (Year)	Journal	Research approach	Research focus
8	Chinonso et al. (2023)	Global Academic Journal of Humanities and Social Sciences	Literature review	Opportunities and challenges of ChatGPT for teaching and research
9	Rejeb et al. (2024)	International Journal of Management Education	Web mining & machine learning	Public perceptions of ChatGPT in education
10	Trust et al. (2023)	Journal of Technology and Teacher Education	Conceptual paper	Opportunities and challenges in teacher education
11	Loos et al. (2023)	Societies	Reflective study	Reflection capabilities of ChatGPT and educational implications
12	Karakose & Tülübaş (2023)	Educational Process: International Journal	Argumentative literature review	Educational implications and policy perspectives
13	Munaye et al. (2025)	Algorithms	Systematic literature review	Opportunities, challenges, and future directions
14	Albadarin et al. (2024)	Discover Education	Systematic literature review	Empirical evidence of ChatGPT in education
15	Halaweh (2023)	Contemporary Educational Technology	Conceptual paper	Responsible implementation strategies
16	Sok & Heng (2023)	Cambodian Journal of Educational Research	Literature review	Benefits and risks of ChatGPT
17	Lo (2023)	Education Sciences	Literature review	Opportunities and consequences of ChatGPT
18	Rahman & Watanobe (2023)	Applied Sciences	Mixed methods (Experiment & Survey)	Opportunities, threats, and implementation strategies
19	Memarian & Doleck (2023)	Computers in Human Behavior: Artificial Humans	Systematic review	Research methods, potentials, and limitations
20	Grassini (2023)	Education Sciences	Rapid literature review	Early educational impacts of ChatGPT
21	Jiang et al. (2026)	International Journal of STEM Education	Systematic review	Inquiry-based learning in STEAM education
22	Gallart et al. (2026)	EURASIA Journal of Mathematics, Science and Technology Education	Mixed methods	ChatGPT use among pre-service mathematics teachers
23	Madzík et al. (2026)	Journal of Innovation & Knowledge	Bibliometric analysis & topic modeling	ChatGPT for innovation and knowledge development
24	Bencsik et al. (2026)	Social Sciences & Humanities Open	Quantitative (PLS-SEM, regression, cluster analysis)	Digital access and inequality in higher education
25	Nazeer et al. (2026)	Sustainable Development	Qualitative (thematic interviews)	Institutional perspectives and SDGs in higher education

Source: secondary data, processed

The temporal distribution of publications reveals a rapidly expanding research landscape. Most studies (52%) were published in 2023, immediately following the public release of ChatGPT, indicating a strong initial scholarly response to the emergence of generative artificial intelligence in education. During this early stage, research primarily concentrated on conceptual discussions, theoretical implications, educational opportunities, and ethical concerns. In contrast, studies published between 2024 and 2026 increasingly adopted empirical methodologies to investigate user acceptance, pedagogical effectiveness, technology integration, and institutional readiness. This shift suggests that the research field is transitioning from exploratory discourse toward evidence-based educational practice.

The reviewed studies also demonstrate an evolution in research focus. Initial publications mainly examined the transformative potential of ChatGPT, emphasizing its educational benefits alongside concerns regarding academic integrity and ethical implications. More recent investigations have expanded this perspective by exploring specific educational contexts such as teacher education, inquiry-based learning, STEAM education, digital equity, and sustainable education. Furthermore, several studies have examined factors influencing ChatGPT adoption, including technological acceptance, digital literacy, institutional policies, and pedagogical design. Collectively, the reviewed literature can be synthesized into four overarching research themes: (1) pedagogical applications of ChatGPT, (2) pedagogical benefits for teaching and learning, (3) ethical challenges and implementation barriers, and (4) future research directions. These themes provide the analytical framework for the subsequent synthesis and discussion.

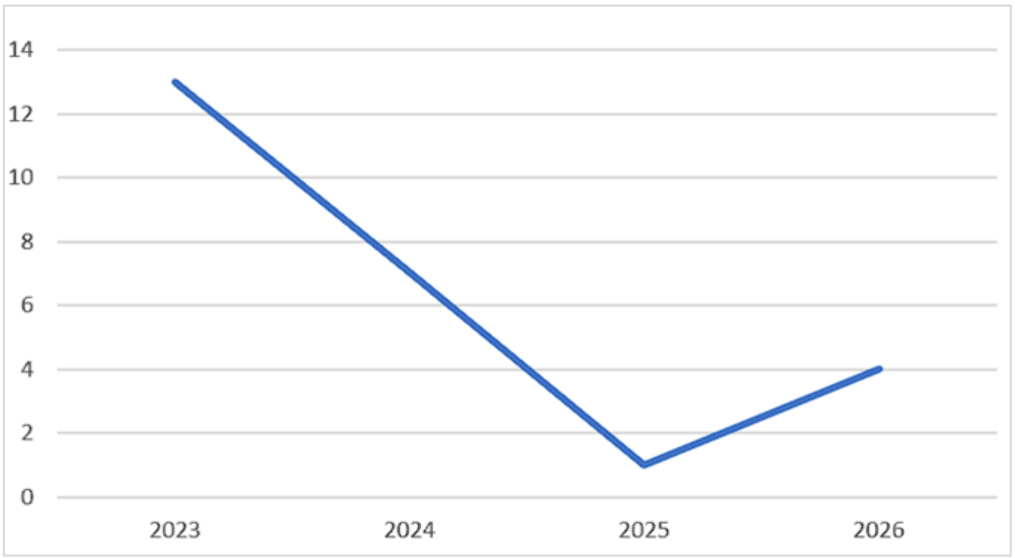

Figure 1 distribution of reviewed publications by year
Source: secondary data, processed

As illustrated in Figure 1, research output increased sharply in 2023, accounting for 13 of the 25 included studies (52%). This surge reflects the immediate academic interest generated by the release of ChatGPT in late 2022 and the growing recognition of generative AI as a disruptive educational technology. Although the number of publications decreased to seven studies (28%) in 2024, the nature of the research changed considerably. Rather than focusing on theoretical discussions, researchers increasingly employed quantitative, qualitative, and mixed-methods approaches to evaluate learning effectiveness, technology acceptance, and classroom implementation.

Only one study (4%) published in 2025 satisfied the inclusion criteria, whereas four studies (16%) published in 2026 were identified. Despite the relatively smaller number of publications, these recent studies address more specialized issues, including AI-supported inquiry-based learning, teacher professional development, digital inequality, and sustainable educational development. This pattern indicates that ChatGPT research is entering a more mature stage characterized by context-specific investigations, stronger empirical evidence, and greater attention to long-term educational implications. Overall, the publication trend suggests that research on ChatGPT in education is progressing from conceptual exploration toward rigorous empirical evaluation. Future studies are expected to place greater emphasis on longitudinal learning outcomes, pedagogical innovation, institutional governance, and responsible AI implementation in educational settings.

Pedagogical applications of ChatGPT

The synthesis of the 25 reviewed studies indicates that ChatGPT has been integrated into a wide range of educational activities, extending beyond its initial role as a conversational assistant. The applications identified in the literature demonstrate that ChatGPT functions as an artificial intelligence-supported learning partner, assisting both learners and educators in instructional, assessment, research, and administrative activities. As summarized in Table 2, the applications of ChatGPT can be categorized into twelve major areas, ranging from direct learning support to broader institutional and educational development initiatives.

Table 2 pedagogical applications of ChatGPT in education

Nu.	Pedagogical application	Description	Supporting studies
1	Virtual tutor	Provides explanations, answers questions, and supports independent learning.	1, 2, 3, 5, 12, 14, 18, 20, 21
2	Personalized learning	Adapts learning materials, difficulty levels, and feedback according to learners' needs.	2, 5, 12, 13, 14, 19, 21
3	Instructional material development	Assists teachers in preparing lesson plans, modules, teaching materials, and presentations.	3, 10, 12, 14, 15, 18
4	Assessment design	Generates quizzes, examinations, formative assessments, and grading rubrics.	2, 12, 14, 16, 18
5	Automated feedback	Provides immediate feedback, corrections, and recommendations for students' work.	2, 5, 12, 14, 18, 21
6	Academic writing support	Assists with essay writing, paraphrasing, grammar checking, literature organization, and initial referencing.	14, 16, 18, 19, 20
7	Language learning	Supports vocabulary development, grammar, translation, conversational practice, and writing skills.	5, 14, 18
8	Programming education	Assists in coding, debugging, algorithm explanation, and programming exercises.	3, 18, 20
9	Critical thinking development	Facilitates brainstorming, discussion, reflection, argumentation, and problem-solving activities.	5, 11, 12, 21, 22
10	Research support	Supports idea generation, literature synthesis, research planning, and preliminary data interpretation.	8, 16, 18, 23
11	Teacher education	Assists pre-service teachers in lesson planning, instructional design, and teaching simulations.	10, 22
12	Sustainable Education (SDGs)	Supports inclusive education, equitable learning opportunities, and SDG 4 implementation.	6, 24, 25

Source: secondary data, processed

Among the identified applications, the most frequently reported use of ChatGPT is as a virtual tutor. Several studies indicate that ChatGPT can explain complex concepts, answer learner questions, generate examples, and support independent learning activities. Unlike conventional digital learning resources, conversational AI enables interactive and adaptive dialogue, allowing learners to seek clarification based on their individual needs. This capability positions ChatGPT as a potential supplement to traditional teaching approaches, particularly in environments where learners require additional academic support beyond scheduled classroom interactions. Another prominent application is personalized learning, where ChatGPT is used to adapt explanations, learning materials, and feedback according to learners' knowledge levels, preferences, and learning progress. The reviewed studies suggest that generative AI can contribute to more learner-centered educational practices by enabling customized learning experiences. However, the effectiveness of personalization depends strongly on the quality of prompts, learners' AI literacy, and teachers' ability to integrate ChatGPT outputs into appropriate pedagogical frameworks.

ChatGPT is also increasingly utilized as a teaching support tool for educators. The reviewed literature highlights its potential in preparing instructional materials, developing lesson plans, creating learning activities, generating assessment items, and designing evaluation rubrics. These applications demonstrate that ChatGPT may improve teacher efficiency by reducing time-consuming preparation tasks and allowing educators to allocate more attention to instructional design and learner interaction. Nevertheless, the reviewed studies emphasize that AI-generated materials require professional evaluation from teachers to ensure accuracy, curriculum alignment, and pedagogical appropriateness. Beyond instructional preparation, ChatGPT has been applied in assessment and feedback processes. The technology can assist in generating quizzes, formative assessments, and automated feedback on student responses. Rapid feedback provision is considered one of the major advantages of ChatGPT because it enables learners to identify weaknesses and improve their understanding more efficiently. However, concerns remain regarding the reliability of automated evaluations, particularly for complex tasks requiring contextual interpretation, creativity, and higher-order reasoning.

The reviewed studies further demonstrate ChatGPT's expanding role in academic writing, language learning, programming education, and research activities. In academic writing contexts, ChatGPT supports brainstorming, outlining, paraphrasing, grammar improvement, and initial literature synthesis. In language education, it facilitates conversational practice, vocabulary development, translation, and writing improvement. Similarly, in programming education, ChatGPT assists learners by explaining algorithms, generating code examples, and supporting debugging processes. These applications suggest that ChatGPT can serve as a versatile learning companion across different disciplines. Recent studies published between 2025 and 2026 indicate a broader transformation in ChatGPT's role within educational ecosystems. Rather than being limited to individual learning assistance, ChatGPT has increasingly been examined in relation to teacher education, inquiry-based learning, STEAM education, educational research, and sustainable development initiatives. For example, emerging research investigates how future teachers can utilize ChatGPT to develop pedagogical competence and how AI-supported learning environments can contribute to inclusive and equitable education.

Overall, the findings demonstrate that ChatGPT has evolved from a general-purpose conversational tool into a multifunctional educational technology capable of

supporting learning, teaching, assessment, and research activities. However, the reviewed studies consistently emphasize that the educational value of ChatGPT does not arise solely from technological capabilities but from the quality of its pedagogical integration. Effective implementation requires alignment between AI tools, instructional objectives, teacher expertise, and institutional policies. Therefore, future educational practices should focus not only on expanding ChatGPT adoption but also on developing evidence-based strategies that ensure meaningful, ethical, and learning-oriented use of generative AI.

Pedagogical benefits of ChatGPT

The synthesis of the reviewed studies indicates that ChatGPT provides substantial pedagogical opportunities by enhancing the flexibility, accessibility, and efficiency of teaching and learning processes. Across the 25 included studies, ChatGPT was consistently identified as a technology that can support learner-centered education through personalized assistance, immediate feedback, increased engagement, and the development of higher-order cognitive skills. However, the reviewed literature also suggests that these benefits depend heavily on appropriate pedagogical integration, teacher mediation, and responsible use by learners. Table 3 presents the major pedagogical benefits of ChatGPT identified from the reviewed studies.

Table 3 pedagogical benefits of ChatGPT in education

Nu.	Pedagogical benefit	Description	Supporting studies
1	Personalized Learning	Adapts learning materials, difficulty levels, and feedback according to learners' abilities, needs, and learning preferences.	2, 5, 12, 13, 14, 19, 20, 21
2	Enhanced Student Engagement	Promotes active participation, motivation, curiosity, and sustained learning through interactive conversations.	2, 5, 9, 13, 14, 21
3	Immediate Feedback	Provides timely feedback, corrections, and recommendations during formative learning activities.	2, 5, 12, 14, 18, 20
4	Support for Self-Directed Learning	Enables students to learn independently through explanations, discussions, and practice activities beyond classroom instruction.	1, 3, 12, 14, 19, 20
5	Development of Critical Thinking and Problem-Solving	Facilitates discussion, reflection, brainstorming, argumentation, and higher-order thinking activities.	5, 11, 12, 21, 22
6	Creativity Enhancement	Supports idea generation, project development, creative writing, and innovative problem solving.	10, 12, 17, 18
7	Academic Writing Improvement	Assists learners in essay writing, paraphrasing, grammar refinement, editing, and academic communication.	14, 16, 18, 19, 20
8	Improved Teaching Efficiency	Assists educators in lesson planning, instructional material preparation, assessment development, and administrative tasks.	3, 10, 12, 14, 15
9	Inclusive Learning	Expands access to educational resources and supports differentiated instruction for diverse learners.	12, 24, 25
10	AI and Digital Literacy Development	Promotes responsible, productive, and critical use of AI technologies within twenty-first-century education.	1, 10, 15, 17, 24, 25

Source: secondary data, processed

The most frequently reported benefit of ChatGPT is its ability to facilitate personalized learning. Several studies indicate that ChatGPT can adapt explanations, examples, learning materials, and feedback according to individual learner characteristics, including prior knowledge, learning pace, and specific difficulties. This capability supports a shift from standardized instructional approaches toward more adaptive learning environments. By allowing learners to request clarification, alternative explanations, or additional examples, ChatGPT can provide individualized academic support that is difficult to achieve in traditional classroom settings with limited instructional time. In addition to personalization, ChatGPT contributes to increased student engagement and learning motivation through interactive conversational experiences. Unlike static learning resources, ChatGPT enables continuous dialogue, allowing students to actively participate in knowledge construction through questioning, exploration, and reflection. The reviewed studies suggest that this interactive feature may increase curiosity, confidence, and willingness to engage with learning materials. Nevertheless, engagement generated through AI interaction should be carefully managed to ensure that students remain cognitively active rather than becoming passive recipients of AI-generated responses.

Another significant pedagogical advantage is the provision of rapid and continuous feedback. Traditional assessment processes often involve delays between student performance and teacher responses, which may reduce opportunities for immediate improvement. ChatGPT can provide instant explanations, suggestions, and corrective feedback, supporting formative assessment practices. This function is particularly valuable in large-scale learning environments where educators may face challenges in providing timely feedback to all students. However, the reviewed studies emphasize that AI-generated feedback should complement rather than replace teacher evaluation, particularly for complex assignments requiring contextual judgment. The reviewed literature also highlights ChatGPT's contribution to self-directed learning and learner autonomy. By providing access to explanations, examples, and learning support at any time, ChatGPT enables students to continue learning beyond formal classroom boundaries. This feature is particularly relevant in contemporary education, where lifelong learning and independent knowledge acquisition are increasingly important. However, effective self-directed learning requires adequate AI literacy, as learners must be able to evaluate, question, and verify AI-generated information rather than accepting responses without critical examination.

Beyond supporting basic learning activities, ChatGPT has been associated with the development of critical thinking, problem-solving, and creativity. Several studies indicate that ChatGPT can facilitate brainstorming, case analysis, argument development, and reflective activities when used through carefully designed learning tasks. Rather than replacing students' cognitive processes, ChatGPT can function as a cognitive partner that stimulates inquiry and encourages learners to explore multiple perspectives. This finding challenges the assumption that generative AI necessarily reduces intellectual effort; instead, its educational impact depends largely on how learning activities are structured. ChatGPT also provides benefits for teachers and educational institutions by improving instructional efficiency. The reviewed studies report that educators can use ChatGPT to accelerate the preparation of teaching materials, assessment instruments, classroom activities, and administrative documents. Such support may reduce teachers' workload and allow greater focus on mentoring, classroom interaction, and pedagogical decision-making. However, professional

expertise remains essential because teachers must validate AI-generated content and ensure alignment with educational objectives and curriculum requirements.

Furthermore, the reviewed studies identify ChatGPT as a contributor to digital literacy and AI literacy development. As artificial intelligence becomes increasingly embedded in professional and academic environments, the ability to use, evaluate, and critically interpret AI technologies represents an important 21st-century competency. Integrating ChatGPT into education provides opportunities for students and teachers to develop responsible AI practices, including understanding AI limitations, evaluating information quality, and applying ethical principles in technology use. Despite these benefits, the literature indicates that ChatGPT should not be viewed as an autonomous replacement for educators. The effectiveness of AI-supported learning depends on the interaction between technological capabilities and human pedagogical expertise. Teachers remain central in designing meaningful learning experiences, guiding students' cognitive processes, and ensuring ethical technology use. Therefore, the greatest pedagogical value of ChatGPT lies in its role as a human–AI collaborative learning tool that enhances, rather than substitutes, the instructional role of educators.

Overall, the findings demonstrate that ChatGPT has considerable potential to support transformative educational practices by enabling personalized learning, improving feedback mechanisms, strengthening learner autonomy, and enhancing teaching efficiency. Nevertheless, realizing these benefits requires a balanced implementation approach that combines technological innovation with sound pedagogical principles, teacher competence, and responsible AI governance. Future research should therefore continue investigating not only whether ChatGPT improves educational outcomes but also under what conditions and instructional designs its benefits can be maximized.

Challenges and ethical issues in the use of ChatGPT in education

Although ChatGPT offers substantial opportunities for improving educational practices, the reviewed studies consistently emphasize that its implementation also introduces complex challenges related to academic integrity, information reliability, data security, equity, and governance. The integration of generative artificial intelligence into education requires careful consideration because technological advancement does not automatically guarantee positive educational outcomes. Instead, the impact of ChatGPT depends on how the technology is regulated, implemented, and integrated into pedagogical practices. Table 4 summarizes the major challenges and ethical issues identified across the reviewed studies.

Table 4 challenges and ethical issues in the use of ChatGPT in education

Nu.	Challenge/ethical issue	Description	Supporting studies
1	Academic Integrity	ChatGPT may facilitate plagiarism, academic dishonesty, and completion of assignments without meaningful learning processes.	1, 3, 5, 7, 9, 13, 14, 16, 18, 19, 20
2	Information Accuracy and Hallucination	ChatGPT may generate inaccurate, fabricated, biased, or unsupported information.	2, 3, 6, 13, 16, 18, 19, 20
3	Excessive Dependence on AI	Overuse may reduce independent thinking, creativity, problem-solving abilities, and learner autonomy.	10, 12, 14, 17, 18, 19, 21
4	Algorithmic Bias	AI outputs may reflect biases embedded in training data, including cultural, linguistic, gender, or social biases.	2, 5, 7, 9, 13, 24

Nu.	Challenge/ethical issue	Description	Supporting studies
5	Privacy and Data Security	Use of ChatGPT raises concerns regarding personal data protection, confidentiality, and information security.	2, 7, 9, 13, 24, 25
6	Lack of Transparency	Users have limited understanding of AI decision processes, data sources, and mechanisms behind generated responses.	9, 11, 13, 15, 17
7	Digital Inequality	Unequal access to devices, internet connectivity, and AI literacy creates disparities in AI adoption.	24, 25
8	Teacher and Institutional Readiness	Educators and institutions may lack sufficient competencies, policies, and guidelines for responsible AI integration.	10, 12, 14, 15, 25
9	Assessment Validity	AI-assisted assignments challenge traditional assessment methods and verification of students' authentic work.	3, 10, 12, 14, 20
10	AI Regulation and Governance	Educational institutions require ethical frameworks, policies, and governance mechanisms for responsible AI use.	1, 5, 9, 13, 15, 24, 25

Source: secondary data, processed

Among the identified challenges, academic integrity represents the most frequently discussed concern in the reviewed literature. Several studies highlight that ChatGPT may facilitate plagiarism, unauthorized assistance, and the submission of AI-generated work as students' original contributions. The ability of generative AI to produce coherent essays, reports, and academic responses makes it difficult for educators to distinguish between authentic student work and AI-assisted outputs. This issue challenges conventional assessment practices that rely heavily on written assignments as indicators of individual knowledge and competence. Consequently, the reviewed studies emphasize the need to redesign assessment strategies toward more authentic approaches, including project-based assessment, oral examination, reflective tasks, and process-oriented evaluation. Another major concern is the accuracy and reliability of information generated by ChatGPT. Although ChatGPT can provide fluent and convincing responses, it may produce inaccurate information, fabricated references, or misleading explanations, commonly referred to as AI hallucinations. This limitation is particularly critical in educational contexts because learners may assume that AI-generated responses are always correct. The reviewed studies therefore emphasize the importance of developing students' critical evaluation skills and ensuring that AI outputs are verified against reliable academic sources. Rather than replacing knowledge validation processes, ChatGPT should be positioned as a supporting tool that requires human judgment and verification.

The literature also identifies the risk of overdependence on artificial intelligence, particularly among learners who may rely excessively on ChatGPT for problem-solving, writing, or information retrieval. Excessive dependence may reduce opportunities for independent reasoning, creativity, and the development of fundamental academic skills. Several studies argue that inappropriate use of ChatGPT may shift students from active knowledge construction toward passive consumption of AI-generated answers. Therefore, effective implementation requires instructional strategies that encourage students to use ChatGPT as a cognitive support tool while maintaining active engagement in reasoning, reflection, and problem-solving activities. A further ethical issue concerns algorithmic bias and lack of transparency. Since ChatGPT generates

responses based on patterns learned from large-scale training datasets, its outputs may reflect existing biases related to culture, language, gender, or social perspectives. In educational environments, such biases may influence learning experiences and potentially reinforce unequal representation of knowledge. Additionally, the limited transparency of generative AI systems makes it difficult for users to understand the sources, reasoning processes, and decision mechanisms behind generated responses. These limitations highlight the importance of AI literacy, transparency mechanisms, and continuous evaluation of AI systems used in education.

Privacy and data security are also significant concerns identified in the reviewed studies. The use of ChatGPT may involve submitting personal information, student work, institutional documents, or other sensitive data to external AI platforms. Without appropriate safeguards, this practice may create risks related to data ownership, confidentiality, and unauthorized use of information. Therefore, educational institutions need clear policies regarding acceptable data usage, privacy protection, and responsible interaction with AI systems. The reviewed literature further emphasizes the challenge of digital inequality and unequal access to AI technologies. Although ChatGPT has the potential to expand learning opportunities, differences in internet availability, technological infrastructure, device ownership, and digital literacy may prevent some learners and institutions from benefiting equally. This issue is particularly relevant in developing educational contexts where technological access remains uneven. Consequently, the integration of ChatGPT should be accompanied by strategies that promote digital inclusion and ensure that AI adoption does not widen existing educational disparities.

Another important barrier is the readiness of teachers and educational institutions. Many studies indicate that educators need additional competencies to integrate ChatGPT effectively into teaching practices. Challenges include limited understanding of AI capabilities, uncertainty regarding appropriate classroom applications, and the absence of institutional guidelines. Without adequate professional development and policy support, ChatGPT adoption may remain fragmented and ineffective. Teacher preparation programs and institutional training initiatives are therefore essential components of responsible AI implementation. The reviewed studies also highlight challenges related to assessment validity and AI governance. The availability of generative AI tools requires educational institutions to reconsider traditional approaches to evaluating student achievement. Assessment methods must increasingly focus on creativity, critical thinking, application, and learning processes rather than solely on final written outputs. At the institutional level, clear regulations, ethical frameworks, and governance mechanisms are required to define appropriate AI usage, establish accountability, and protect educational values.

Overall, the findings indicate that the challenges associated with ChatGPT are not solely technological but also pedagogical, ethical, and institutional. While ChatGPT can enhance educational opportunities, uncontrolled implementation may negatively affect academic integrity, learner autonomy, and educational equity. Therefore, successful adoption requires a comprehensive approach involving AI literacy development, teacher training, ethical guidelines, data protection measures, and redesigned assessment systems. The future of ChatGPT in education will depend not only on improving AI capabilities but also on establishing responsible human-centered frameworks that ensure artificial intelligence contributes positively to learning outcomes.

Future research agenda for ChatGPT in education

The synthesis of the 25 reviewed studies indicates that research on ChatGPT in education remains in a developmental stage and requires stronger empirical evidence to understand its long-term educational implications. While existing studies have successfully identified potential benefits, applications, and challenges associated with generative AI, several important research gaps remain. Future investigations should move beyond exploratory discussions and focus on developing evidence-based frameworks that explain how, when, and under what conditions ChatGPT can effectively support meaningful learning outcomes. Table 5 summarizes the major research directions identified from the reviewed literature.

Table 5 future research agenda for ChatGPT in education

Nu.	Future research direction	Description	Supporting studies
1	Long-Term Impact Evaluation	Investigating the long-term effects of ChatGPT use on learning outcomes, knowledge retention, critical thinking, creativity, and learner competencies.	1, 5, 13, 14, 19, 20
2	Development of AI-Based Pedagogical Models	Designing and testing instructional models integrating ChatGPT with approaches such as blended learning, flipped learning, project-based learning, and inquiry-based learning.	3, 10, 12, 15, 21
3	Academic Integrity and Assessment Design	Developing authentic assessment strategies, plagiarism prevention approaches, and academic policies suitable for generative AI environments.	5, 10, 13, 14, 18, 20
4	AI Literacy Development for Teachers and Students	Examining strategies to improve AI literacy, digital competence, ethical awareness, and readiness for responsible AI adoption.	6, 10, 15, 17, 24, 25
5	AI Ethics, Regulation, and Governance	Establishing ethical frameworks, institutional guidelines, and governance mechanisms that ensure transparent, fair, and accountable AI use.	1, 5, 13, 15, 24, 25
6	Effectiveness Across Educational Levels and Disciplines	Examining ChatGPT implementation in different educational levels and subject areas, including STEM, languages, social sciences, and humanities.	5, 14, 21, 22
7	AI-Based Personalized Learning Systems	Developing adaptive learning environments that use ChatGPT to customize learning materials, activities, and assessments.	2, 5, 13, 19, 21
8	Human–AI Collaboration in Education	Investigating how ChatGPT can support teachers and learners while maintaining the essential role of human expertise.	3, 10, 11, 15, 17
9	Digital Inequality and Inclusive AI Education	Exploring factors influencing equitable access, technological readiness, and the impact of AI on diverse learner populations.	24, 25
10	Development of Empirical Measurement Instruments	Creating valid and reliable instruments and conducting experimental, longitudinal, mixed-methods, and model-based evaluations of ChatGPT implementation.	4, 14, 18, 22, 23

Source: secondary data, processed

One of the most important research priorities is evaluating long-term educational impacts. Although current studies demonstrate ChatGPT's potential to improve learning support, feedback, and engagement, evidence on its sustained effects on knowledge retention, academic achievement, creativity, critical thinking, and learner development remains limited. Future research should employ longitudinal approaches to examine

whether continuous interaction with generative AI produces lasting improvements in learning outcomes or creates unintended consequences, such as reduced cognitive independence and increased reliance on automated assistance. A second major research direction involves developing and validating AI-integrated pedagogical models. Current literature frequently discusses the potential of ChatGPT in education; however, systematic instructional frameworks for effective implementation remain limited. Future studies should investigate how ChatGPT can be integrated into established pedagogical approaches, including blended learning, flipped classrooms, project-based learning, collaborative learning, and inquiry-based learning. Such research should focus not only on whether ChatGPT is used but also on how instructional design, teacher facilitation, and learner interaction influence educational effectiveness.

Another critical area concerns academic integrity and assessment redesign. The emergence of generative AI challenges traditional assessment approaches that emphasize final products rather than learning processes. Future research should explore innovative assessment models that maintain academic authenticity while recognizing the legitimate role of AI assistance. Potential directions include process-based assessment, AI-supported reflective tasks, oral defense mechanisms, authentic performance assessments, and frameworks for evaluating students' ability to use AI-generated information critically. Developing reliable assessment strategies will be essential for maintaining educational standards in the era of generative AI. The reviewed studies also highlight the importance of investigating AI literacy among teachers and students. Effective ChatGPT implementation requires users to understand both its capabilities and limitations. Future research should examine strategies for developing AI literacy, including teacher professional development programs, curriculum integration, ethical AI education, and competency frameworks. Particular attention should be given to preparing educators because teachers play a central role in transforming technological capabilities into meaningful learning experiences.

In addition, further investigation is needed into ethical governance, institutional policies, and regulatory frameworks. Existing studies highlight concerns about privacy, transparency, bias, and responsible AI use, yet practical governance models for educational institutions remain insufficiently developed. Future research should examine how schools and universities can establish effective AI policies, including guidelines for acceptable use, data protection mechanisms, transparency requirements, and accountability structures. Comparative studies across different educational systems may provide valuable insights into developing adaptable governance frameworks. Another important research direction is examining the effectiveness of ChatGPT across different educational levels and disciplines. Current evidence remains uneven, with many studies concentrated in higher education and general learning contexts. Future research should expand investigations across primary education, secondary education, vocational training, and diverse academic disciplines, including science, technology, engineering, mathematics (STEM), languages, social sciences, and humanities. Such research would help determine whether ChatGPT provides similar benefits across different learner characteristics and disciplinary requirements.

The reviewed literature also identifies the need for further exploration of AI-supported personalization and human–AI collaboration. Although ChatGPT has demonstrated potential as an adaptive learning assistant, more research is required to understand how AI systems can complement rather than replace teachers. Future studies should investigate optimal models of human–AI collaboration, where educators maintain pedagogical authority while leveraging AI capabilities to enhance instructional

quality, learner support, and educational decision-making. Furthermore, future research should address digital inequality and inclusive education. While ChatGPT may expand access to educational resources, unequal access to digital infrastructure, internet connectivity, and AI literacy may limit its benefits for disadvantaged learners. Research should therefore examine strategies for ensuring equitable AI adoption, particularly in under-resourced educational environments. Studies focusing on accessibility, affordability, and inclusive design will be important to ensure that generative AI contributes to reducing rather than increasing educational disparities.

Finally, there is a need for more rigorous empirical research methodologies and measurement instruments. Many existing studies are conceptual or review-based, while fewer employ experimental designs, longitudinal methods, mixed-methods approaches, or validated measurement models. Future research should develop reliable instruments to evaluate AI acceptance, learning outcomes, teacher readiness, ethical awareness, and pedagogical effectiveness. Advanced analytical approaches, including structural equation modeling, learning analytics, and bibliometric methods, may provide deeper insights into the complex relationship between AI adoption and educational transformation. Overall, the future research agenda suggests that the next phase of ChatGPT studies in education should prioritize evidence-based, ethical, and context-sensitive approaches. The field should move beyond questions of whether ChatGPT can be used in education toward more critical questions regarding how it can be implemented responsibly, how its effectiveness can be measured, and how human expertise can be preserved within AI-enhanced learning environments. By addressing these research priorities, future studies can contribute to the development of educational systems that are adaptive, inclusive, and sustainable while maximizing the benefits of generative artificial intelligence.

Conclusions

This systematic literature review examined 25 peer-reviewed studies to synthesize the current state of research on the application of ChatGPT in education, including its implementation, pedagogical benefits, challenges, and future research directions. The findings indicate that ChatGPT has rapidly evolved from a general conversational AI tool into a multifunctional educational assistant that supports various learning and teaching activities, including virtual tutoring, personalized learning, instructional material development, assessment support, academic writing assistance, programming education, research support, and teacher professional development. The reviewed studies demonstrate that ChatGPT offers significant pedagogical potential by enhancing learner engagement, providing immediate feedback, supporting independent learning, promoting critical thinking and creativity, and improving teacher efficiency. However, the findings also reveal several critical challenges, particularly related to academic integrity, inaccurate information generation, algorithmic bias, data privacy, digital inequality, teacher readiness, and the need for effective AI governance.

This study contributes to the growing body of knowledge on generative artificial intelligence in education by synthesizing current research trends and identifying key patterns in ChatGPT adoption across educational contexts. The review highlights that the successful integration of ChatGPT depends not only on technological capabilities but also on appropriate pedagogical design, AI literacy, institutional readiness, and ethical frameworks. These findings provide valuable implications for educators, researchers, policymakers, and educational institutions in developing responsible strategies for AI implementation. Nevertheless, this study has several limitations. The review was based

on a limited number of 25 selected articles that met the predefined inclusion criteria, which may not fully represent the rapidly expanding body of literature on ChatGPT in education. In addition, the diversity of research methodologies, educational contexts, and analytical approaches among the reviewed studies may limit direct comparison and generalization of findings. Furthermore, because ChatGPT is a rapidly evolving technology, some emerging applications and long-term impacts may not yet be fully captured in the existing literature.

Future research should address these limitations by conducting more longitudinal, experimental, and multi-context studies to evaluate the sustained impact of ChatGPT on learning outcomes, cognitive development, teacher practices, and educational equity. Further investigations are needed to develop and validate pedagogical models that integrate ChatGPT effectively, establish reliable assessment approaches in AI-supported learning environments, and examine strategies for strengthening AI literacy among teachers and students. Research should also explore human–AI collaboration models, ethical governance frameworks, and inclusive implementation strategies to ensure that generative AI contributes to equitable and sustainable educational transformation. By addressing these research gaps, future studies can provide stronger empirical foundations for maximizing the educational benefits of ChatGPT while minimizing potential risks associated with its adoption.

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