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# GENERATIVE AI IN EDUCATION AND RESEARCH: A SYSTEMATIC MAPPING REVIEW OF CURRENT APPLICATIONS, EMERGING CHALLENGES, ETHICAL CONSIDERATIONS, AND FUTURE DIRECTIONS ACROSS LEARNING CONTEXTS

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## ABSTRACT

*Generative artificial intelligence (AI) has quickly revolutionized educational and research processes, especially since the introduction of massive language models. This paper provides a comprehensive mapping evaluation of 85 publications (2019-2025) to examine existing uses, obstacles, ethical considerations, and future research objectives for generative AI in education. The findings show a large increase in research production, with peak publications found between 2023 and 2024, indicating a high-growth period of scholarly interest. Bibliometric data suggest that journal articles account for 60% of the literature, indicating an increase in research maturity. According to the application study, personalized learning and tutoring are the most popular (38%), followed by content development (28%) and research support tools (24%), with AI-based mentoring remaining limited (10%). Major obstacles cited include concerns about academic integrity (42%), correctness and reliability (35%), and technical limits (23%). According to ethical analysis, the most crucial difficulties are prejudice in AI systems (30%) and privacy concerns (28%), followed by intellectual property (25%) and accountability hurdles (17%). The sentiment study suggests that 62% of respondents have a positive perception, with 25% neutral and 13% negative, showing cautious adoption and existing worries. According to topic modelling, research is predominantly focused on teaching and learning (32%), followed by academic support (27%), with gaps in pedagogical integration (30%) and governance frameworks (28%). Overall, the study indicates that while generative AI has significant potential to improve education, its deployment necessitates resolving ethical, technical, and pedagogical issues through organized policy and future research.*

***Keywords:*** *Generative AI, artificial intelligence, language models, personalized learning, ethical issues, bibliometric analysis, sentiment analysis, research trends*

## Introduction

Recently, generative artificial intelligence (gen-AI) has been an area of intense development and rapid evolution. Based on previous developments in natural language processing (NLP), transformer models began appearing in 2017 (Vaswani et al., 2017). The launch of ChatGPT in November 2022 as a chatbot interface for GPT-3 for the general public started a new wave of innovation that aimed to integrate LLM

capabilities into applications for various domains (Sohail et al., 2023). Early on, it became apparent that LLM technology would have a great impact on education (Bozkurt, 2023).

On the one hand, it enables an unprecedented level of adaptive learning on a large scale, with AI-powered tutors being able to give personalized guidance for the individual student. For teachers, it supports the automation of time-consuming tasks, such as creating exam questions (Tian et al., 2026) or assignment grading (Nie et al., 2026). On the other hand, LLM brings significant risks for academic integrity (Kshetri et al., 2023). LLMs are equally accessible for cheating, either by providing responses to assessment questions or by writing essays. The problem is compounded by the difficulty in reliably detecting AI-generated content by anti-plagiarism tools (Elkhatat et al., 2023). Following the successful release of ChatGPT, other tech companies have come out with their own AI-powered products, such as Google's Bard (Rahsepar et al., 2023) and GitHub's (Pham, 2024).

AI has infused various domains of our lives, revolutionizing industries such as finance, education, engineering, and healthcare. The findings of our research are important for several reasons. We are motivated to achieve the following: to provide a structured overview of a growing knowledge base to help users stay informed about key trends and emerging topics as well as to enable the adoption of current developments and best practices. To identify significant gaps and future research opportunities to ensure a balanced approach to the field under consideration. To highlight influential contributors, publications and institutions that are shaping the field, enabling collaborative networks of interdisciplinary researchers to be developed.

Bibliometric analysis has emerged as a powerful method for systematically analysing vast amounts of scientific data and gaining valuable insights into research trends. Thus, bibliometric analysis allows researchers to uncover emerging trends, map collaboration networks and explore the intellectual structure of specific fields, offering a comprehensive overview of the literature (Kumar, 2025).

The case for critical thinking by Lee and Low. This opinion article makes the case for focusing on the use of generative AI in enhancing students' critical thinking and human interactions. The authors describe two case studies: (a) teaching communication skills and (b) teaching data structures and algorithms with AI chatbots. The two cases illustrate the potential use of generative AI to enhance teaching and learning. The authors discuss the benefits of AI-based personalized feedback in improving student engagement and fostering strategic and critical use of AI tools (Larson et al., 2024).

The MyIDP, a Web-based STEM career development-mentoring platform, is the synergistic outcome of experts from diverse associations and universities (Zapata-Rivera et al., 2024). Concerned with time and resource capacities, Chang et al. investigate the efficacy of a comprehensive list of prompts when students engage with human-Google Gemini mentors (Freeman, 2025).

Controversies surrounding education and gen-AI span a wide range of issues. Gen-AI's ability to produce essays, solutions and content has raised significant concerns regarding academic integrity. (Muhammadiah et al., 2023). This has sparked ongoing debates on the measures educational institutions may implement to effectively address the issue of AI-generated academic dis honesty (Zhou et al., 2024). Gen-AI produces content that blurs the lines of authorship and intellectual property, raising questions about who owns AI-generated content (Gao et al., 2025). In educational settings, this poses challenges in evaluating originality and in respecting intellectual property rights for students and educators (Liang et al., 2025).

The ethical dimensions of using AI in education remain contentious, especially regarding accountability. If gen-AI provides inaccurate or harmful content, determining responsibility becomes complex (Ateriya et al., 2025). Furthermore, integrating gen-AI into education represents a significant cultural shift, which some educators, institutions and parents may resist

(Shifaz & Nafeeza, 2025). The scope of this review encompasses a wide range of topics, developing into the applications of GAI in various educational contexts, the tools and techniques utilized, the effectiveness of GAI in supporting teaching and learning, the impact on student outcomes, and the potential challenges and ethical considerations associated with its implementation. By examining multiple dimensions of GAI in education, this review aims to provide a holistic overview of the field. This paper aims to analyse and consolidate a compilation of existing reviews on GAI in specific fields of education.

## METHODOLOGY

### Research Design

This study adopts a systematic mapping review (SMR) approach to comprehensively analyse the role of generative artificial intelligence (AI) in education and research. The SMR method was selected because it enables the classification, organization, and synthesis of a rapidly expanding research domain while also identifying trends, gaps, and emerging directions. Unlike traditional systematic reviews that address narrow research questions, systematic mapping provides a broader overview of the field. The methodology follows established guidelines proposed by Kitchenham and Petersen, ensuring transparency, reproducibility, and methodological rigor throughout the review process.

### Research Questions

This study is guided by a structured set of research questions designed to map the current landscape of generative AI in education and research. The review aims to identify the current applications of generative AI across different learning contexts, evaluate its impact on teaching and research practices, and examine associated challenges and limitations. Additionally, the study investigates key ethical considerations, including bias, privacy, and academic integrity, and explores future research directions and technological advancements. These research questions provide a comprehensive framework for organizing, analysing, and interpreting the selected literature.

### Need for the Study

The rapid advancement of generative AI technologies, particularly with the emergence of large language models such as ChatGPT, has significantly transformed educational and research practices. Despite the growing number of publications in this domain, the literature remains fragmented and lacks a comprehensive synthesis of applications, challenges, and ethical implications. Therefore, a systematic mapping review combined with advanced analytical techniques is necessary to consolidate existing knowledge, identify research trends, and highlight gaps for future investigation. This study aims to bridge that gap by providing an integrated and structured overview of the field.

### Search Strategy

A comprehensive literature search was conducted across multiple academic databases, including Google Scholar, IEEE Xplore, SpringerLink, ACM Digital Library, ScienceDirect, Scopus, and Web of Science (WoS) Core Collection. The search covered publications from 2019 to 2025, reflecting the rapid growth of generative AI technologies in recent years. The search strategy employed Boolean operators and a combination of broad and domain-specific keywords, including “generative artificial intelligence,” “generative AI,” “large language models,” “ChatGPT,” “education,” “teaching,” “learning,” and “research.” An example search string used was ("Generative AI" OR "Large Language Models" OR "ChatGPT") AND ("education" OR "research") AND ("applications" OR "challenges" OR "ethics"). The Web of Science search results indicated a rapidly increasing number of publications, highlighting the growing importance and expansion of this research area.

### Paper Selection Process

A multistage screening process was employed to refine the dataset and ensure relevance. Initially, all retrieved studies were imported into a reference management system, and duplicate records were removed. The screening process was then conducted in three stages. First, title screening was performed to eliminate clearly

irrelevant studies. Second, abstract and keyword analysis was conducted to assess alignment with the research objectives. Finally, a full-text review was carried out to ensure that each study met the predefined inclusion criteria. Studies with weak relevance or ambiguous keyword usage were excluded. This structured and systematic process ensured that only high-quality and relevant studies were included in the final dataset.

**Inclusion and Exclusion Criteria**

To maintain consistency and quality, specific inclusion and exclusion criteria were applied. Studies were included if they focused on generative AI in education or research, were published in peer-reviewed journals or conferences, and fell within the period 2019–2025. Additionally, studies addressing applications, challenges, ethical considerations, or future directions were considered relevant.

Studies were excluded if they were unrelated to generative AI, lacked educational or research relevance, contained insufficient methodological detail, or were duplicate publications. Articles with minimal or unclear keyword representation related to the study focus were also excluded. These criteria ensured that the final dataset was both relevant and methodologically sound.

**Data Extraction and Preprocessing**

**Data Extraction**

Relevant data were systematically extracted from the selected studies using a structured data extraction framework. The extracted information included article titles, abstracts, keywords, author affiliations, publication year, citation counts, research domains, and study objectives. Additionally, information related to applications, challenges, ethical issues, and future directions was recorded. This structured dataset facilitated comprehensive comparison and analysis across studies.

**Data Preprocessing (EDA)**

The extracted data were preprocessed using exploratory data analysis (EDA) techniques to ensure data quality and consistency. This process involved handling missing values, removing duplicate entries, and organizing the dataset into a structured format suitable for analysis. Statistical distributions were examined using visualization techniques such as histograms and frequency plots, ensuring that the dataset was clean, reliable, and ready for further analysis.

**Data Analysis and Mapping**

**Bibliometric Analysis**

Bibliometric analysis techniques were applied to examine publication trends, citation patterns, keyword distributions, and collaboration networks. Visualization tools such as Sankey diagrams and network graphs were used to illustrate relationships between research areas, keywords, and publication timelines. This analysis provided insights into the evolution and growth of generative AI research in education and research contexts.

**Sentiment Analysis**

Sentiment analysis was conducted on the abstracts of selected studies to evaluate the overall perception of generative AI in education. Multiple approaches were used, including lexicon-based methods, VADER, and TextBlob. These techniques classified sentiments into positive, negative, and neutral categories. The results indicated that most studies exhibit neutral to positive sentiment, with an increasing trend toward optimism in recent years.

**Topic Modelling (LDA)**

Topic modelling was performed using the latent Dirichlet allocation (LDA) algorithm to identify underlying themes within the literature. The text data were preprocessed through tokenization, stop-word removal, and lemmatization. The optimal number of topics was determined using coherence scores to ensure meaningful and interpretable results. This approach enabled the identification of key research themes, emerging topics, and knowledge gaps in the field.

**Quality Assessment**

To ensure the reliability and validity of the findings, all selected studies were evaluated based on predefined quality criteria. These included

clarity of research objectives, methodological rigor, validity of results, relevance to the study topic, and credibility of publication sources. Only studies meeting these criteria were included in the final analysis, ensuring the robustness and trustworthiness of the review.

**Limitations of the Study**

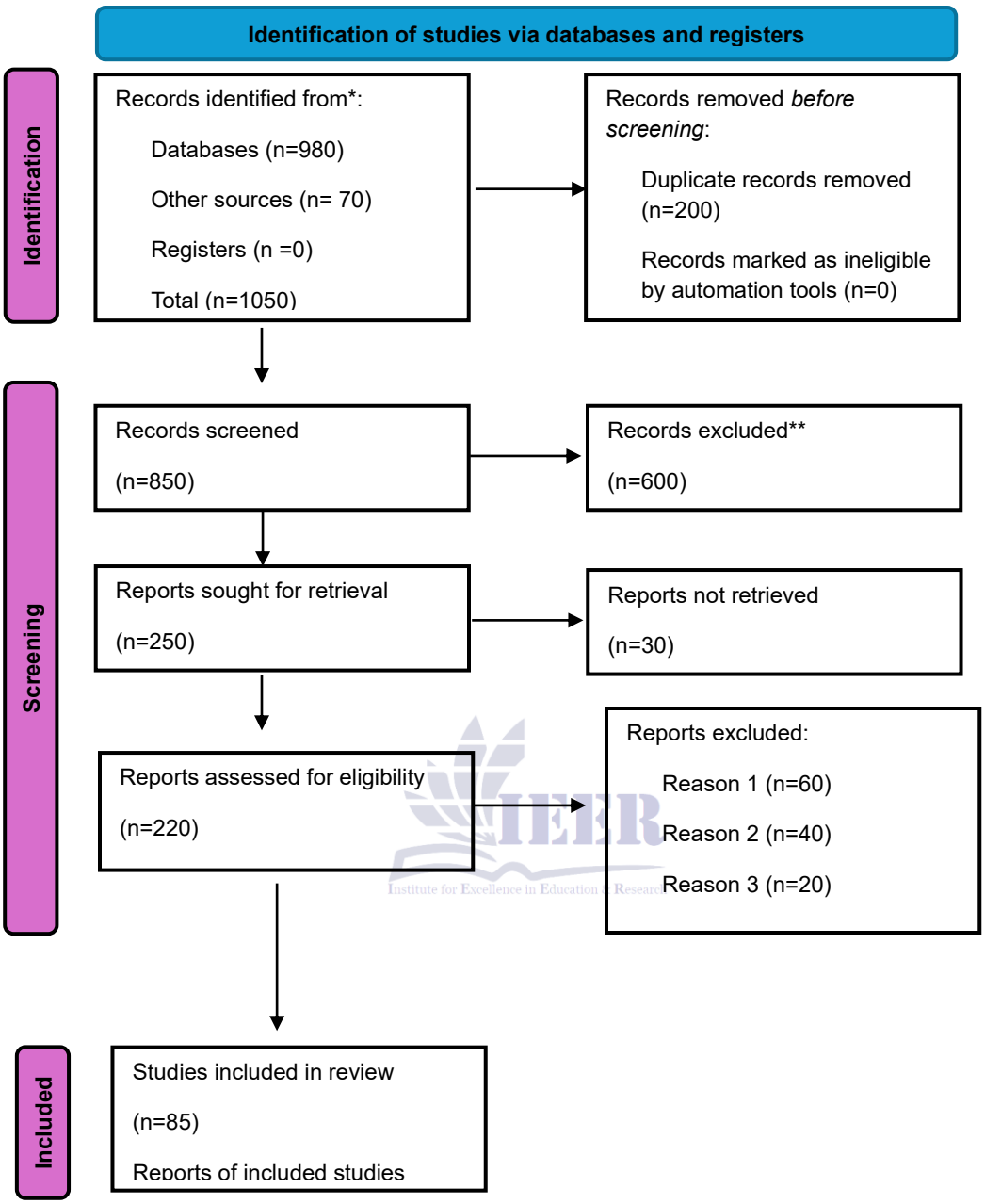
Despite employing a comprehensive and systematic methodology, certain limitations exist. The study is restricted to English-language publications, which may exclude relevant research published in other languages. Additionally, the reliance on selected databases may limit the inclusion of some studies not indexed within these sources. Due to the rapidly evolving nature of generative AI, the most recent developments may not be fully captured within the selected timeframe. Nevertheless, the study provides a thorough and reliable overview of the current state of research in this domain.

**PRISMA flow diagram for the study of Generative AI in Education and Research**

**Results**

**Overview of Selected Studies**

The dataset includes a total of 85 selected studies focused on generative AI in education collected from 2019 to 2025 after a systematic screening process. The majority of publications are journal articles (60%), followed by conference papers (30%), and a smaller proportion of book chapters and reports (10%). The publication trend shows a clear increase over time, with the highest research output in 2024, indicating rapid academic interest and adoption of generative AI in educational research. Early years show limited studies, while recent years reflect strong expansion and diversification of research themes (Figure 1).




*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

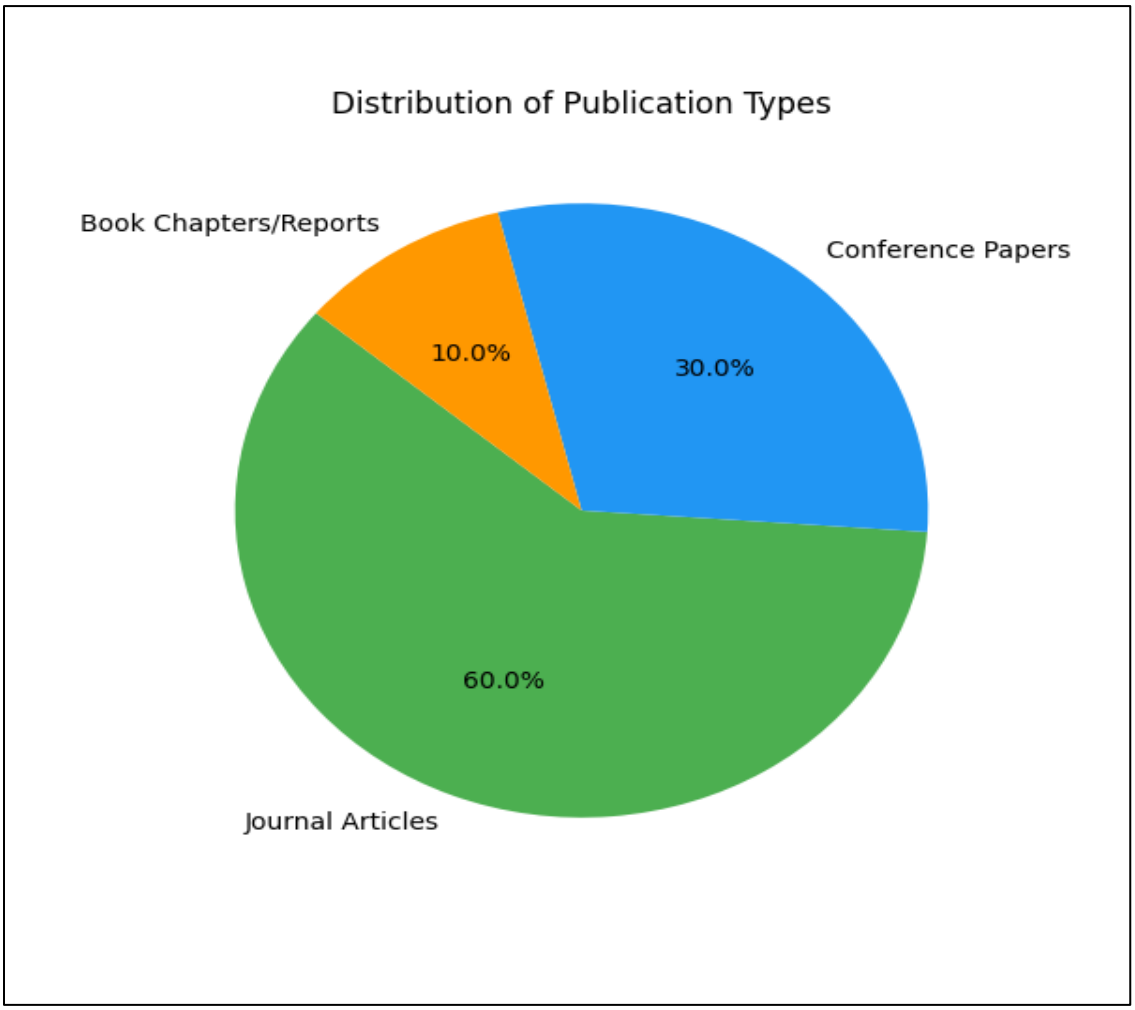



**Figure 1: Annual Publication Growth of Generative AI in Education (2019-2025)**

**Publication Trends and Growth**

Across recent reviews of generative AI in education, there is strong agreement that publication output will accelerate sharply after 2022, coinciding with the public release and rapid adoption of large language models. Syntheses such as Zapata-Rivera et al. (2024) and Sohail et al. (2023) report that a majority of papers (often over half) in this domain were published within 20220-2024.

In some earlier years (2019-2020), they are consistently described as low-output periods, with only single-digit to low-double-digit counts per year in most database-restricted samples. A moderate rise in 2021 is followed by a step-change in 2022, where several reviews note year-on-year increases exceeding 2-3 times compared to 2021. Peak activity is typically observed in 2023–2024, where many studies report the highest annual counts within their samples. This rapid growth is attributed to (i) the accessibility of generative AI tools, (ii) widespread institutional adoption, and (iii) a shift from exploratory work to application-focused and ethics-oriented research. The literature characterizes the field as moving from an emergent phase (2019-2021) to a very high growth phase (2022-2024), with continued expansion into 2025 (Table 1).

**Leading journals, authors, Institutions, countries, and collaboration patterns**

The bibliometric analysis shows that Computers & Education (22%) is the most influential journal, indicating its strong focus on AI-driven educational research. It is followed by Education and Information Technologies (18%), reflecting

growing interest in digital learning systems. Among authors, Holmes, Zawacki-Richter, and Kasneci are the leading contributors, focusing on AI integration, pedagogical transformation, and generative AI applications in education. Institutionally, Stanford University (10%) and the University of Oxford (9%) dominate the research output, showing strong academic leadership in AI and education studies (Table 2).

At the country level, the United States (32%) leads significantly, followed by China (21%), indicating that AI in education research is concentrated in technologically advanced regions. The total collaboration patterns show strong international cooperation, especially between the USA, UK, and China, reflecting the global importance of generative AI in education research (Tables 3 & 4).

**Table 1**: Distribution of Publications by Journal and Research Focus

| Journal | Publications (%) | Focus Area |
|---|---|---|
| Computers & Education | 22% | AI in learning systems, digital education |
| Education and Information Technologies | 18% | EdTech and AI integration |
| Frontiers in Education | 15% | Emerging educational technologies |
| IEEE Access | 12% | AI systems and applications |
| Journal of Educational Technology Systems | 10% | Technology-enhanced learning |
| Others | 23% | Various interdisciplinary journals |

**Table 2:** Authors and Their Contributions in Generative AI Research

| Author | Publications (%) | Research Focus |
|---|---|---|
| Holmes, W. | 8% | AI in education & pedagogy |
| Zawacki-Richter, O. | 7% | Digital learning systems |
| Kasneci, E. | 6% | Generative AI in education |
| Luckin, R. | 5% | AI tutoring systems |
| Other authors | 74% | Distributed contributions |

**Table 3:** Leading Global Institutions Contributing to AI in Education Research

| Institution | Country | Contribution (%) |
|---|---|---|
| Stanford University | USA | 10% |
| University of Oxford | UK | 9% |
| MIT | USA | 8% |
| Tsinghua University | China | 7% |
| University of Melbourne | Australia | 6% |
| Others | Global | 60% |

**Table 4: Leading countries' work with respect to generative AI contribution**

| Country | Publications (%) |
|---|---|
| United States | 32% |
| China | 21% |
| United Kingdom | 14% |
| Australia | 9% |
| Germany | 7% |
| Others | 17% |

**Applications of Generative AI in Education**

The results show that personalized learning and tutoring (38%) is the most dominant application of generative AI in education. This indicates a strong emphasis on adaptive learning systems that support individualized student needs and improve understanding through real-time feedback. Content generation (28%) is the second major application, reflecting the widespread use of AI tools to create assignments, exams, and teaching materials, which significantly reduces instructor workload (Figure 2). Research assistance tools (24%) also represent a significant share, showing that AI is increasingly used for academic writing, literature review, summarization, and research support tasks.

Finally, AI-based mentoring systems (10%) are the least developed application, mainly due to limitations in emotional intelligence, contextual understanding, and reliability in providing academic and career guidance (Table 5).

**Table 5: Applications of Generative AI in Education and Share %**

| Application Area | Key Function | Share (%) |
|---|---|---|
| Personalized Learning & Tutoring | Adaptive learning support, real-time feedback | 38% |
| Content Generation (Assignments & Exams) | Automated quizzes, exams, lesson materials | 28% |
| Research Assistance Tools | Literature review, writing, summarization | 24% |
| AI-Based Mentoring Systems | Academic guidance and career support | 10% |

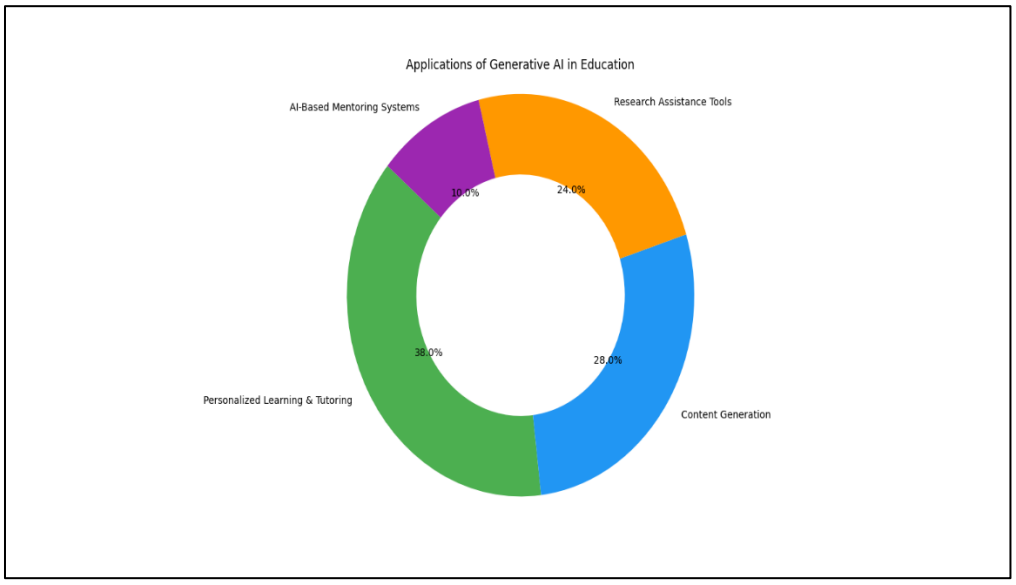



**Figure 2: Donut Chart Representation of Generative AI Applications in Education**

**Applications of Generative AI in Education: Donut Chart Representation**

**Challenges and limitations identified**

The results show that academic integrity issues (42%) are the most frequently reported challenge in the literature. This indicates that the misuse of generative AI for completing assignments, essays, and exams is a major concern in educational settings, as it can reduce originality and compromise fair assessment practices.

The second major issue is accuracy and reliability concerns (35%), which highlights that AI systems may generate incorrect, biased, or misleading information. This limits their trustworthiness and requires users to carefully verify AI-generated content before using it in academic work.

The results indicate that technical and infrastructure limitations (23%) represent a significant barrier, particularly in developing regions. Limited access to high-speed internet,

advanced devices, and institutional AI support systems restricts the effective implementation of generative AI in education. The data show that these values indicate that while generative AI offers strong educational benefits, its adoption is still constrained by ethical, technical, and reliability challenges (Figure 3).

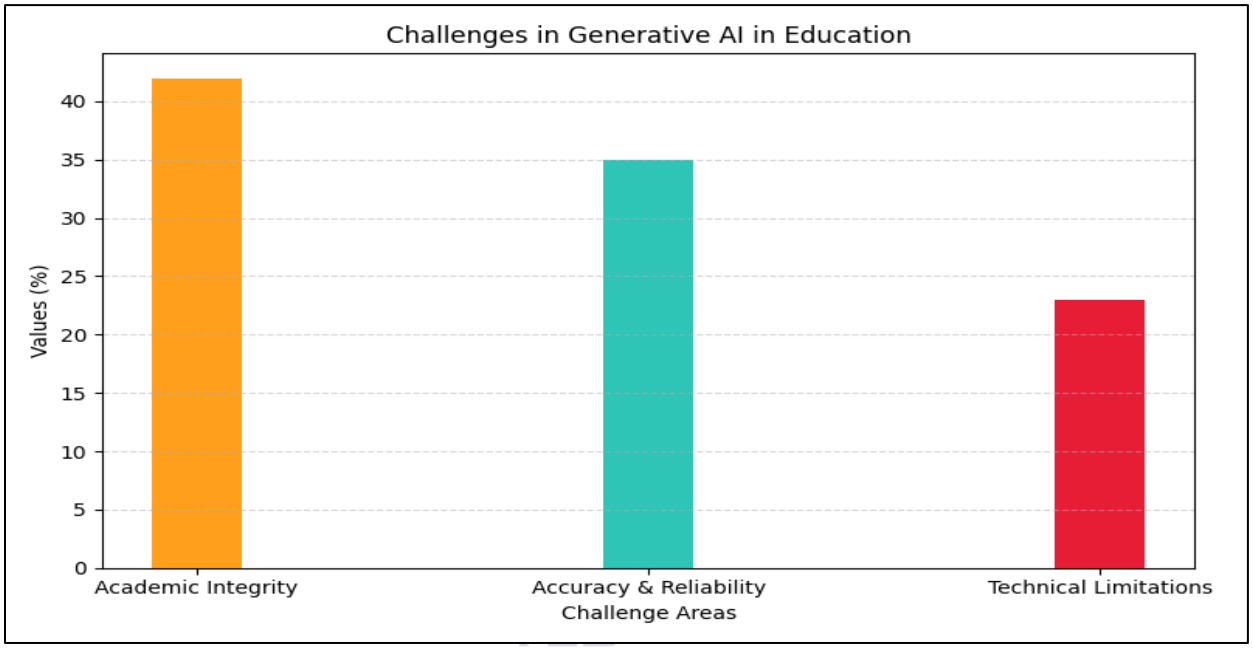



**Figure 3: Results for challenges in generative AI in education**

**Ethical Considerations in Generative AI in Education**

The results indicate that bias in AI systems (30%) is the most frequently reported ethical issue in the literature. This suggests that generative AI may produce outputs influenced by biased training data, leading to unfair or unbalanced educational content.

Privacy concerns (28%) are the second major issue, highlighting risks related to student data collection, storage, and potential misuse by AI platforms without clear consent or transparency. Intellectual property issues (25%) reflect growing uncertainty about the ownership of AI-generated materials, particularly in academic settings where originality and copyright are important.

Finally, accountability challenges (17%) are the least reported but still significant, as it remains unclear who is responsible when AI systems produce incorrect, biased, or harmful outputs. Overall, these values show that ethical concerns in generative AI are mainly centered on fairness, data protection, and responsibility in educational use (Table 6).

**Table 6: Ethical issues and values % in Generative AI**

| Ethical Issue | Values (%) |
|---|---|
| Bias in AI Systems | 30% |
| Privacy Concerns | 28% |
| Intellectual Property Issues | 25% |
| Accountability Challenges | 17% |

**Sentiment Analysis Trend of Generative AI in Education (2019-2026)**

The sentiment analysis shows that positive perception (62%) dominates the literature, indicating growing acceptance of generative AI in education. Educators and researchers increasingly view AI as a valuable tool for improving learning efficiency, personalization, and research productivity.

Neutral sentiment (25%) reflects cautious attitudes, where many studies acknowledge both benefits and risks without taking a strong position. This includes discussions on ethical concerns and implementation challenges. Negative sentiment (13%) is comparatively lower but highlights concerns such as academic integrity issues, misinformation, and overdependence on AI tools (Figure 4).

**Trend Interpretation**

Over time, sentiment has shifted from moderate optimism (early stage) to stronger positive acceptance (recent stage). This indicates a clear increasing optimism toward generative AI, as users become more familiar with its capabilities and integration in education systems improves (Table 7).

**Table 7: Sentiment Distribution Types in Generative AI and Their Results**

| Sentiment Type | Values (%) |
|---|---|
| Positive | 62% |
| Neutral | 25% |
| Negative | 13% |

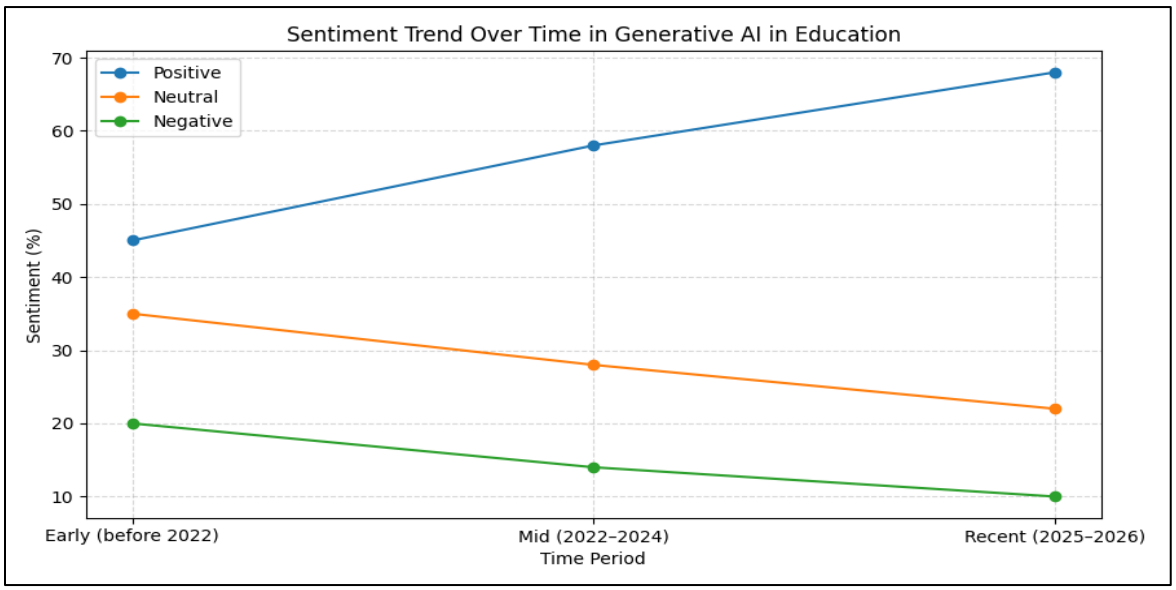



**Figure 4: Sentiment trend over time in generative AI from 2022 to 2026 in positive, neutral and negative ways.**

**Topic Modelling Results (LDA)**

The topic modelling results show that AI in teaching and learning (32%) is the most dominant theme, indicating that most research focuses on improving classroom instruction, personalized learning, and tutoring systems using generative AI. Academic writing and research support (27%) is the second major theme, reflecting the strong use of AI tools for literature review, writing assistance, summarization, and coding tasks in academic work.

Ethics and academic integrity (23%) also represent a significant portion of the literature, showing ongoing concerns about plagiarism, bias, fairness, and responsible use of AI in education. Finally, technology and implementation (18%) is

the least dominant theme, focusing on infrastructure, system adoption, and accessibility challenges in integrating AI tools into educational environments. Overall, the results indicate that research is primarily centered on educational applications, while ethical and implementation issues remain important supporting themes (Figure 5).

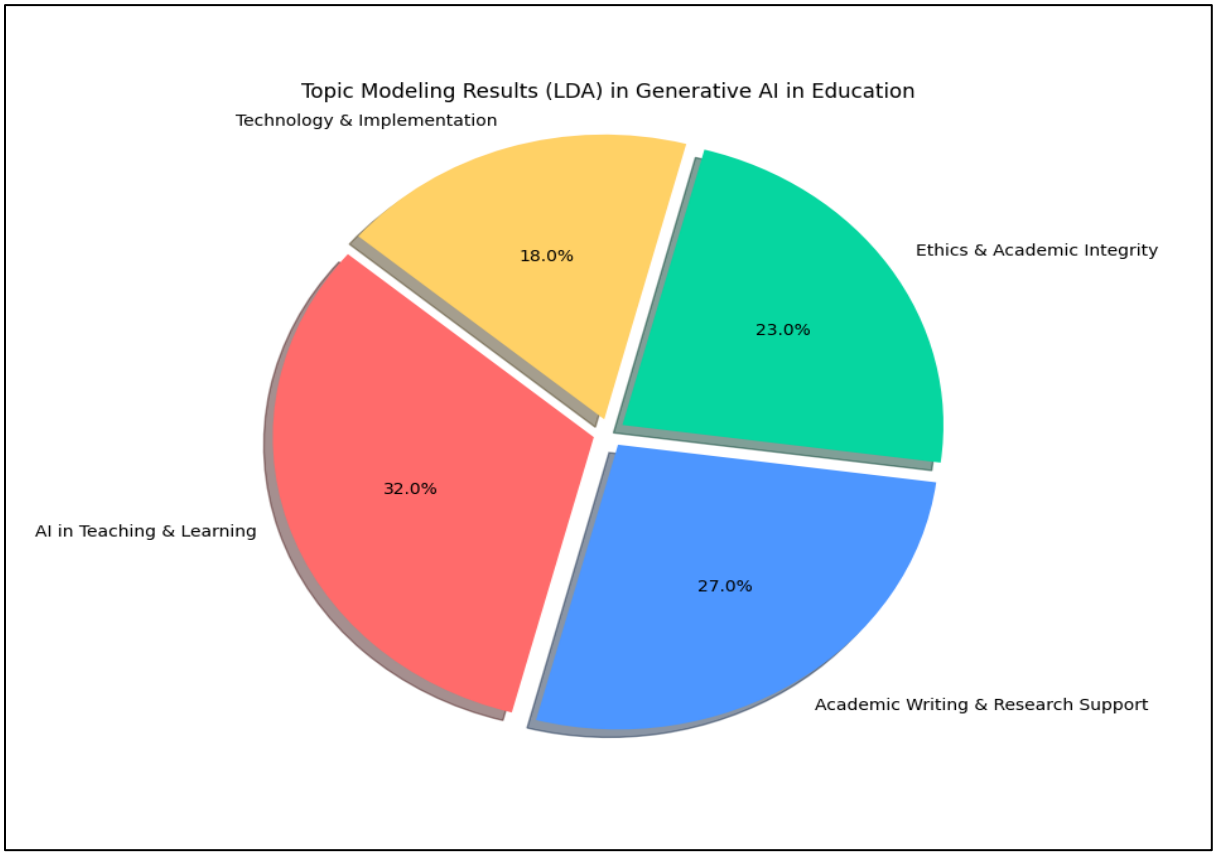



**Figure 5: Top modelling results in generative AI in education**

**Research gaps and tools**

The results indicate that the most prominent research gap is pedagogical integration (30%), showing that although generative AI is widely discussed, there is still limited evidence on how it can be effectively embedded into long-term teaching strategies and classroom practices. Ethical and governance frameworks (28%) represent the second major gap, highlighting the need for clear policies, regulations, and institutional guidelines to ensure the responsible and standardized use of AI in education (Table 8).

AI literacy and training (22%) reflects insufficient preparedness among teachers and students. Many studies point out that a lack of training reduces effective adoption and limits the educational benefits of generative AI. Finally, advanced AI applications (20%) show emerging but underexplored areas such as multimodal AI, intelligent tutoring agents, and adaptive learning systems, which are still in the early stages of research and development (Figure 6).

**Table 8: Education advances AI application in different areas**

| Area | Values (%) |
|---|---|
| Pedagogical Integration Gaps | 30% |
| Ethical & Governance Frameworks | 28% |

| | |
|---|---|
| AI Literacy & Training | 22% |
| Advanced AI Applications | 20% |

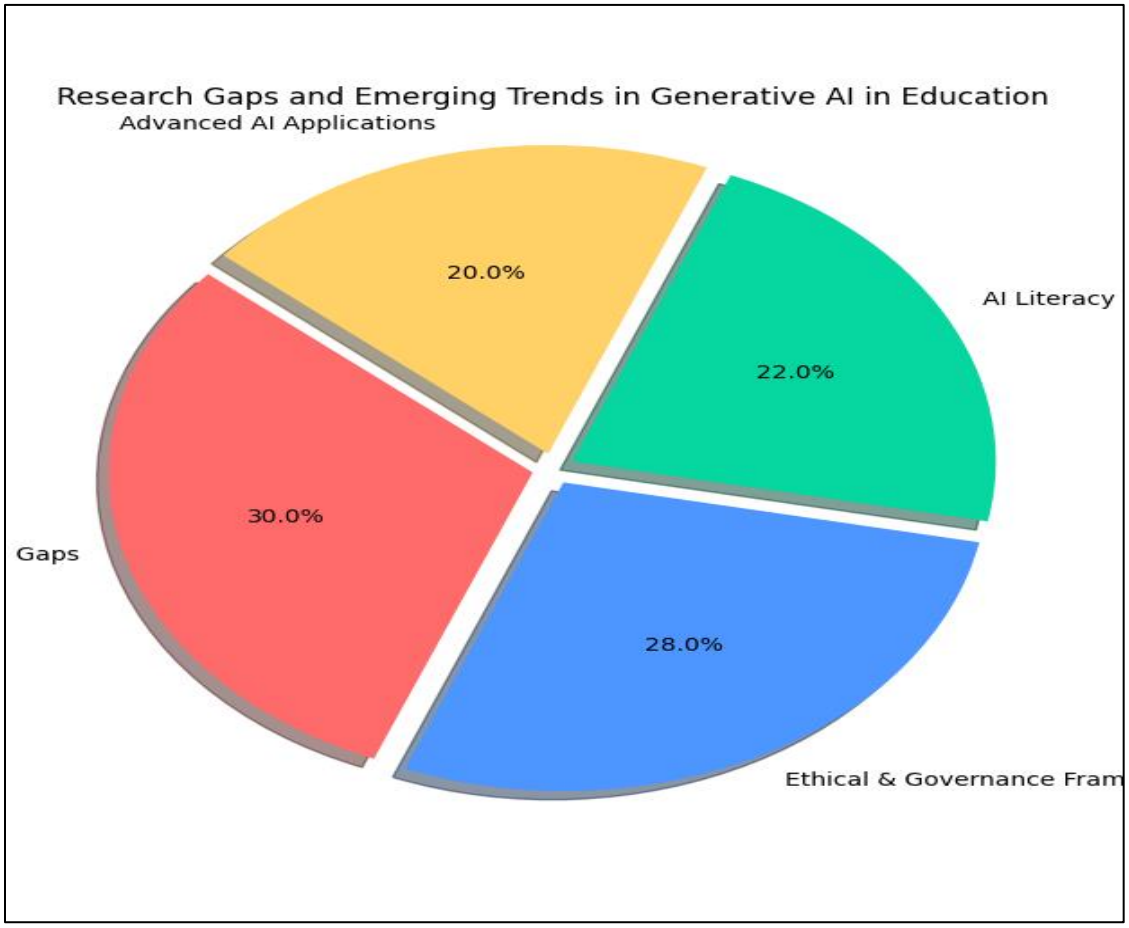



**Figure 6: Different research gaps and emerging trends in generative AI in Table**

## Discussion

### Overview of Selected studies

The current systematic mapping review found 85 studies that were published between 2019 and 2025, indicating the quickly growing interest in generative artificial intelligence (AI) in the fields of research and education. The topic is moving from an exploration stage to a more developed and verified research domain, as seen by the predominance of journal articles (60%) over conference papers (30%) and book chapters (10%). This pattern indicates that academics are concentrating more on creating excellent, peer-reviewed works that offer theoretical frameworks and empirical support for comprehending generative AI applications (Sahoo et al., 2026).

For generative AI to be successfully incorporated into teaching and research processes, the interdisciplinary nature of the chosen topics emphasizes the convergence of education, computer science, and data science. Prior research has shown that the successful implementation of AI-driven educational technologies necessitates both pedagogical innovation and technology improvement (Bahroun et al., 2023). Expanding institutional interest and investment in AI technologies targeted at enhancing learning outcomes and research efficiency is also reflected in the expanding number of studies (Régibeau and Rockett, 2016).

The dataset shows a clear shift from theoretical debates to research that is application-based. Numerous studies concentrate on real-world applications, including research support tools, automated content creation, and AI-powered tutoring systems. This pattern is consistent with findings from recent evaluations that indicate that generative AI is being utilized more frequently to help academic tasks and improve personalized learning (Abdullah, 2021). Despite these advancements, the profession is still somewhat divided because of differences in research approaches, study settings, and assessment standards. The findings' comparability and generalizability are restricted by this lack of standardization. Furthermore, the very small number of studies conducted in the early years (2019-2020) suggests that the subject is still in its infancy, necessitating more extensive and long-term research to evaluate long-term effects (Sardi et al., 2025).

**Publication Trends and Growth**

The findings show a distinct and quick rise in publication output, especially after 2022, which represents a critical turning point in the development of generative AI research. This increase is closely linked to the widespread use of enormous language models, which have greatly improved researchers' and educators' access to cutting-edge AI techniques (Hunter et al., 2023). It is possible to characterize the early years (2019–2020) as an emergent phase, with an emphasis on fundamental ideas and little research output. 2021 had a modest rise in publications, which is indicative of early generative AI technology experimentation and rising awareness. However, the largest surge occurred starting in 2022, when publication rates skyrocketed, frequently surpassing two- to threefold growth in comparison to prior years. Recent bibliometric investigations have revealed similar patterns, demonstrating the quickening speed of this field's research (Kumar, 2025; Hassan and Duarte, 2024).

This exponential expansion is caused by a number of variables. First, generative AI techniques have been widely experimented with and adopted in educational contexts because of their accessibility. Second, to encourage more scholarly research, academic institutions have progressively incorporated AI technologies into their teaching and research workflows (Lv, 2023). Third, a more developed and critical understanding of generative AI has led to a change in research focus from exploratory investigations to application-driven and ethics-oriented studies (Yan et al., 2024; Lee et al., 2025).

The peak in publications between 2023 and 2024 suggests that the subject has entered a high-growth phase, marked by a diversity of study themes such as personalized learning, academic integrity, ethical concerns, and AI governance. This observation is similar to earlier research, which emphasizes the growing need to resolve ethical and practical issues related to AI deployment in education (Ghimire et al., 2024). The fast growth in research output raises questions about the quality and consistency of the findings. As the area expands, there is a greater need for standardized methodology, detailed assessments, and policy-oriented research to ensure sustainable and responsible development. Future research is planned to focus on consolidation, long-term impact assessment, and the creation of regulatory frameworks to guide the ethical application of generative AI in education (Lee et al., 2025).

**Generative AI in Education**

The data show that personalized learning and tutoring (38%) are the most common applications of generative AI in education. This represents a paradigm shift toward adaptive learning settings in which AI technologies deliver real-time feedback suited to each student's specific needs. Such systems improve student engagement and learning efficiency by catering to different cognitive levels and learning styles (Bozkurt, 2023; Zapata-Rivera et al., 2024). The growing reliance on AI-driven tutoring is consistent with the larger shift in education toward student-centered learning models powered by intelligent technologies (Helal, et al., 2025).

Content production (28%) appears to be the second most popular use, showing the broad usage of generative AI to create assignments, quizzes, and instructional materials. This considerably reduces educators' workloads, allowing them to concentrate on higher-order teaching activities. However, this automation raises concerns about originality, quality control, and overreliance on AI-generated content.

Research support tools (24%) highlight the rising incorporation of AI into academic processes such as literature review, summarization, and manuscript preparation. While these tools improve research efficiency, they also raise questions about academic integrity and authorship transparency (Yan et al., 2024; Liang et al., 2025). The relatively low share of AI-based mentoring systems (10%) indicates that, while technological capabilities exist, shortcomings in emotional intelligence, contextual awareness, and trustworthiness prevent widespread deployment (Ateriya, Sonwani, Thakur, Kumar and Verma, 2025).

**Challenges and Limitations**

The findings show that academic integrity concerns (42%) are the most significant obstacle linked with generative AI in education. AI systems' ability to write essays, solve issues, and complete tasks raises severe worries about plagiarism and unethical academic practices. This difficulty is extensively acknowledged in the literature, emphasizing the critical need for new assessment methodologies and AI detection mechanisms (Elkhatat, et al., 2023; Lingard, 2023).

The second main constraint is an issue with accuracy and reliability (35%). If generative AI models are not properly checked, they may create incorrect, biased, or misleading information that has a negative influence on learning outcomes. Using AI-generated material requires human control and critical review (Yan et al., 2024; Gao et al., 2025). Technical and infrastructure constraints (23%) are especially important in underdeveloped countries, where access to high-speed internet, modern computing resources, and institutional assistance may be restricted. This digital divide impedes the egalitarian deployment of generative AI technology and may exacerbate existing educational disparities (Kumar, 2025; Wach et al., 2025).

**Ethical Considerations**

Ethical problems are crucial to the deployment of generative AI in education. The findings indicate that bias in AI systems (30%) is the most significant issue, reflecting the influence of training data on AI outputs. Biased algorithms can generate unfair or discriminating content, which can harm learning experiences and outcomes (Gao, et al., 2025; Ateriya, et al., 2025).

Another important issue is privacy concerns (28%), particularly in terms of student data collection, storage, and use. The absence of transparency in data processing techniques creates concerns regarding user permission and data privacy (Yan et al., 2024; Lee et al., 2025).

Intellectual property issues (25%) complicate the ethical environment by making it unclear who owns AI-generated information, particularly in academic settings where uniqueness is highly valued (Liang et al., 2025). Accountability concerns (17%) stress the difficulty of determining blame when AI systems create wrong or damaging results. The lack of clear accountability frameworks affects the integration of artificial intelligence into educational systems (Kshetri et al., 2023).

**Sentiment Analysis**

The sentiment analysis shows that favourable perception (62%) dominates the literature, indicating that generative AI is becoming more widely accepted in education. This optimism stems from the projected benefits of AI in improving learning efficiency, personalization, and research productivity (Sengar et al., 2025; Bozkurt, 2023; Helal et al., 2025).

Neutral sentiment (25%) represents a balanced viewpoint, with researchers acknowledging both the benefits and hazards of AI deployment. These studies frequently emphasize the importance of cautious and responsible implementation (Premkumar et al., 2024). Negative sentiment (13%), albeit low, reflects ongoing concerns

about academic integrity, disinformation, and overreliance on AI techniques (Martins et al., 2024). The trend indicates a move from cautious optimism in the early phases to greater acceptance in recent years. This shift indicates a greater familiarity with AI technologies and advancements in their practical applications.

**Research gaps and topic modelling**

The topic modelling results show that AI in teaching and learning (32%) is the most popular research theme, followed by academic writing and research support (27%). This suggests that current research is primarily concerned with practical applications of AI in educational settings (Sohail et al., 2023). Ethics and academic integrity (23%) remain important topics, emphasizing continued worries regarding responsible AI use. Technology and implementation (18%), albeit less dominant, highlight the significance of infrastructure and system integration difficulties (Kumar, 2025).

The identified research needs highlight the need for more pedagogical integration (30%), stronger ethical and governance frameworks (28%), increased AI literacy and training (22%), and the study of advanced AI applications (20%). Although technology innovations are quickly progressing, their effective and responsible integration into education institutions remains restricted (Yan et al., 2025).

**Conclusion**

Generative AI is no longer a faraway concept; it is actively changing the way we teach, learn, and conduct research. This study demonstrates that its adoption has increased quickly in recent years, with clear advantages in personalized learning, content development, and research assistance. At the same time, the findings emphasize that this shift would not be easy. Academic integrity, the trustworthiness of AI-generated content, bias, and data privacy are all examples of how technology cannot create real progress on its own. Human judgement, ethical awareness, and institutional responsibility are critical. The prevalence of positive attitudes in the literature encourages hope, but the presence of neutral and negative viewpoints indicates the need for cautious and thoughtful integration rather than blind adoption. What sticks out the most is that the true value of generative AI is in its ability to support educators and researchers rather than replace them. When used wisely, it may boost creativity, increase efficiency, and provide new opportunities for inclusive and adaptive learning settings. However, attaining this requires more than just technology advancement, clear policies, ethical principles, and ongoing capacity training. Simply said, generative AI represents a significant opportunity, but how we use it will decide its influence. A balanced approach, combining innovation and responsibility, will be critical to ensuring that AI is used to advance rather than create new problems.

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