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From Models to Impact: A Systematic Review of Generative Artificial Intelligence in Education

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***Abstract*: Generative Artificial Intelligence (GenAI) is increasingly influencing educational systems by enabling personalized learning, automated content generation, adaptive assessment, and intelligent tutoring. Despite its rapid advancement and growing adoption, the effective and responsible integration of GenAI in education remains a challenge due to ethical concerns, limited empirical validation, and issues related to user trust. This paper presents a systematic review and analysis of existing literature to examine the pedagogical potential, ethical risks, and trust-related challenges associated with GenAI-enabled educational environments. It further analyzes global and Indian adoption trends to highlight domain-wise and regional variations in GenAI usage. By identifying key research gaps in current studies, the paper emphasizes the need for integrated, trust-aware, and ethically aligned approaches. The study contributes by synthesizing insights from prior research and proposing directions for the sustainable and responsible deployment of Generative AI in education.**

***Keywords*: Generative AI, GenAI, Education, Ethical challenges, User trust, LLM.**

1. Introduction

The rapid advancement of Generative Artificial Intelligence (GenAI) has introduced a paradigm shift in the way digital systems create, interpret, and personalize content. Unlike traditional artificial intelligence approaches that rely primarily on predefined rules or discriminative models, GenAI leverages large-scale generative models to produce human-like text, images, and interactive responses. In recent years, these capabilities have positioned GenAI as a transformative force across multiple domains, with education emerging as one of the most promising yet challenging application areas.

Recent studies [1]-[6] highlight the potential of GenAI to support educational transformation through personalized learning pathways, automated content generation, adaptive assessment, and intelligent tutoring systems. Conceptual frameworks envision GenAI as a key enabler of inclusive, student-centered, and future-ready education systems. However, despite this growing optimism, the integration of GenAI into real-world educational environments remains at an early stage, with limited empirical evidence validating its pedagogical effectiveness and sustainability.

Existing literature [1]-[6] also emphasizes critical challenges associated with GenAI adoption in education. Ethical risks such as algorithmic bias, misinformation, lack of transparency, and misuse of large language models raise serious concerns regarding trust, accountability, and academic integrity. Furthermore, empirical studies on user perception indicate that learners and educators may exhibit reduced trust in AI-generated content, which can directly influence learning outcomes and acceptance of GenAI-driven systems. These concerns underscore the necessity of designing GenAI solutions that are not only technologically advanced but also ethically responsible and trust-aware.

While prior research provides valuable insights into the capabilities, risks, and perceptions of Generative AI, a clear research gap persists. Current studies are largely fragmented, focusing either on conceptual visions, isolated classroom applications, ethical critiques, or general trust frameworks. There is a lack of integrated approaches that systematically evaluate GenAI in educational contexts while simultaneously addressing ethical considerations and user trust. Bridging this gap is essential for the development of robust, reliable, and learner-centric GenAI-enabled educational systems.

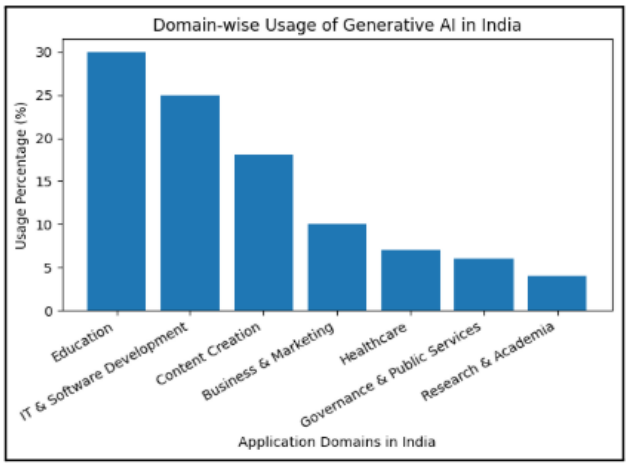

Fig. 1. Domain-wise usage of Generative AI in India

Figure 1 illustrates the domain-wise distribution of Generative AI usage in India. Education emerges as the leading application domain, reflecting the increasing adoption of GenAI for personalized learning, content generation, and academic support. This is followed by IT and software

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Table 1
Comparative overview of Generative Artificial Intelligence development and adoption across different countries

Country/ Region	Approx. No. of Major GenAI Models	Dominant Model Types	Primary Application Areas	Adoption Level
United States	20+ large-scale models	LLMs, Multimodal Models	Education, research, content creation, and healthcare	Very High
China	15+ domestic models	LLMs, Vision–Language Models	Education, government services, and language processing	High
European Union	8–10 collaborative models	Multilingual LLMs	Education, policy research, ethics-focused AI	Medium–High
United Kingdom	5–7 models	LLMs, EdTech-focused AI	Higher education, academic research	Medium
India	5–6 emerging models	LLMs, Indic-language models	Education, governance, skill development	Medium
Japan	4–5 models	Multimodal and robotics-integrated GenAI	Education, automation, robotics	Medium
South Korea	3–4 models	LLMs	Education, digital learning platforms	Medium
Canada	3–5 models	Research oriented LLMs	Academia, scientific research	Medium

development, where Generative AI is extensively used for code generation, testing, and automation. Content creation also shows significant usage, driven by digital media, marketing, and multilingual content needs. Moderate adoption is observed in business and marketing as well as healthcare, while governance and public services are gradually integrating GenAI for citizen services and decision support. Research and academia currently exhibit comparatively lower usage, indicating substantial potential for future growth. Overall, the trend highlights India's strong emphasis on education and technology-driven GenAI applications.

Despite the rapid advancement of Generative Artificial Intelligence and its growing adoption in educational contexts, its effective and responsible integration remains a significant challenge. Existing studies primarily focus on conceptual frameworks, isolated classroom applications, or high-level ethical discussions, without offering a unified approach that combines pedagogical effectiveness, ethical safeguards, and user trust. Furthermore, learners and educators often exhibit scepticism toward AI-generated content due to concerns related to bias, misinformation, transparency, and accountability. The absence of empirically grounded, trust-aware, and ethically aligned GenAI models limits their acceptance and impact in real-world educational environments. Therefore, there is a critical need for a comprehensive approach that systematically evaluates and integrates Generative AI in education while addressing ethical risks and fostering user trust.

This paper aims to examine the integration of Generative Artificial Intelligence in education by evaluating its pedagogical potential, ethical implications, and trust-related challenges. It analyzes current adoption trends with a particular focus on the Indian context and global developments, identifies research gaps through a critical review of existing literature, and assesses key educational applications of GenAI. Furthermore, the study addresses ethical risks and user trust issues influencing acceptance and effectiveness, and proposes a trust-aware and ethically aligned approach to support the responsible deployment of Generative AI in educational environments.

The paper is divided into different sections. The second section shows a comparative overview of Generative Artificial Intelligence development and adoption across different countries and regions. The third section describes the Literature review in the context of Generative AI. The fourth section describes the conclusion and future work.

2. Usage of Generative AI Models Across Countries

Table 1 presents a comparative overview of Generative Artificial Intelligence development and adoption across different countries and regions. It indicates that the United States and China dominate the GenAI landscape, collectively accounting for a substantial proportion of large-scale models, with strong emphasis on large language and multimodal architectures. These models are extensively applied in education, research support, and content generation, reflecting high adoption levels. In contrast, the European Union and the United Kingdom focus on a smaller number of collaborative and regulation-compliant models, prioritizing multilingual support, transparency, and ethical considerations. Emerging economies such as India demonstrate moderate but rapidly growing adoption, particularly through localized and Indic-language generative models aimed at education and governance. Countries such as Japan and South Korea exhibit steady development with a focus on multimodal and domain-specific applications, while Canada's contributions remain primarily research-driven. Overall, the table highlights significant regional variation in model scale, application focus, and adoption intensity, underscoring the influence of technological infrastructure, regulatory frameworks, and educational priorities on the global deployment of Generative AI. The next section describes the literature review conducted in the context of Generative AI.

3. Literature Review

This section shows the recent work done in Generative AI. Sandhu *et al.* [1] present a comprehensive conceptual overview of Generative Artificial Intelligence (GenAI) tools and their anticipated role in shaping education by 2030. The study categorizes GenAI applications such as intelligent tutoring systems, automated assessment, content generation, and personalized learning pathways. It emphasizes inclusivity, accessibility, and adaptive pedagogy as core benefits of GenAI integration in education. While the paper successfully provides a future-oriented vision and structured taxonomy, it remains largely theoretical, lacking empirical validation or measurable learning outcome analysis. This highlights the need for experimental studies evaluating the real-world effectiveness of GenAI-enabled educational systems.

Yu and Guo [2] analyze the transformative potential of GenAI in educational reform by examining its current adoption

Table 2
Comparative analysis of related work on Generative AI

Paper	Primary Focus	Methodology	Key Contributions	Strengths	Limitations or Gaps
[1]	Generative AI in future education	Systematic literature review + conceptual framework	Identifies GenAI tools shaping Education 2030; discusses personalization, inclusivity, assessment, and automation	Holistic education-centric vision; structured taxonomy	No empirical validation; lacks real-world performance metrics
[2]	Educational reform using GenAI	Review-based analysis	Explores opportunities, challenges, and adoption barriers of GenAI in education	Strong policy and reform perspective	Limited technical depth; lacks comparative experiments
[3]	GenAI chatbots in STEM education	Comparative case study	Compares ChatGPT and Bing Chat for chemistry learning support	Practical classroom relevance; tool-level comparison	Small-scale study; limited generalizability
[4]	Ethical risks of LLMs	Critical review	Identifies bias, misinformation, misuse, and societal risks of LLMs	Strong ethical and risk-based analysis	Does not propose concrete mitigation frameworks
[5]	Trust and credibility of GenAI content	Controlled experiments	Demonstrates reduced human trust in AI-generated information	Empirical and statistically validated	Focused on perception, not learning outcomes
[6]	Human–AI trust	Conceptual framework + review	Proposes a foundational trust framework for AI systems	Strong theoretical grounding	Not education-specific; lacks GenAI case studies

status, challenges, and prospects. The paper discusses how GenAI can support curriculum innovation, teacher workload reduction, and student-centred learning environments. It also identifies critical challenges such as ethical concerns, data privacy, and unequal access to AI technologies. Although the study offers valuable insights at the policy and system level, it does not delve into specific model-level implementations or comparative performance analysis, indicating a research gap in technically grounded evaluations of GenAI tools in educational settings.

Santos [3] investigates the use of large language model–based chatbots, specifically ChatGPT and Bing Chat, as cognitive tools to support chemistry education. Through a comparative case study, the paper evaluates how these tools assist learners in problem-solving, conceptual understanding, and reflective thinking. The findings suggest that GenAI chatbots can act as effective "agents to think with," enhancing student engagement. However, the study is limited by its small sample size and domain specificity, which restricts the generalizability of the results across disciplines and educational levels.

Ferrara [4] provides a critical review of the societal, ethical, and technical risks associated with large language models (LLMs). The paper highlights issues such as bias amplification, misinformation generation, lack of transparency, and potential misuse in sensitive domains, including education. While the study offers an in-depth risk taxonomy and raises important ethical concerns, it stops short of proposing concrete mitigation frameworks or governance mechanisms. This underscores the need for responsible AI design models tailored specifically for educational GenAI applications.

Longoni *et al.* [5] empirically examine human trust in AI-generated content through controlled experiments. The study reveals that individuals tend to perceive information produced by generative AI as less credible compared to human-generated content, even when accuracy levels are similar. This finding has significant implications for educational contexts where trust in AI-generated explanations, feedback, and assessments is critical. However, the paper primarily focuses on perception and credibility rather than learning outcomes, leaving scope for education-centric trust evaluation studies.

Lukyanenko *et al.* [6] propose a foundational trust framework for artificial intelligence systems, identifying key dimensions such as transparency, reliability, accountability, and human oversight. Although the paper is not exclusively focused on generative AI or education, it provides a strong theoretical basis for understanding trust in human–AI interaction. The lack of domain-specific case studies and GenAI-oriented validation suggests future research opportunities in adapting this trust framework to educational GenAI systems. Table 2 represents the Comparative Analysis of Related Work on Generative AI. The next section describes the conclusion and the future work.

4. Conclusion and Future Work

Generative Artificial Intelligence has emerged as a transformative technology with significant potential to reshape educational practices through personalization, automation, and adaptive learning support. This paper has examined the current state of GenAI integration in education by synthesizing findings from existing literature, analyzing adoption trends, and identifying critical challenges related to ethics and user trust. The review reveals that while conceptual frameworks and isolated applications demonstrate promising capabilities, empirical validation and integrated implementation strategies remain limited.

Ethical risks such as bias, misinformation, lack of transparency, and concerns regarding academic integrity continue to hinder widespread acceptance of GenAI-driven educational systems. Moreover, issues of trust and credibility play a crucial role in determining user acceptance and learning effectiveness. Addressing these challenges requires a holistic approach that combines pedagogical effectiveness with ethical safeguards and trust-aware system design.

Future research should focus on large-scale empirical studies, domain-specific trust evaluation, and the development of responsible GenAI frameworks tailored to educational contexts. Such efforts are essential to ensure the sustainable, inclusive, and ethical adoption of Generative Artificial Intelligence in education.

References

[1] R. Sandhu, H. K. Channi, D. Ghai, G. S. Cheema, and M. Kaur, "An introduction to generative AI tools for education 2030," in *Advances in Educational Technologies and Instructional Design*, Hershey, PA, USA: IGI Global, 2024, ch. 1.

[2] H. Yu and Y. Guo, "Generative artificial intelligence empowers educational reform: Current status, issues, and prospects," *Frontiers in Education*, vol. 8, Art. no. 1183162, 2023.

[3] R. P. D. Santos, "Enhancing chemistry learning with ChatGPT and Bing Chat as agents to think with: A comparative case study," *arXiv preprint*, arXiv:2305.11890, 2023.

[4] E. Ferrara, "The risks and harms of large language models: A critical review," *arXiv preprint*, arXiv:2403.00025, 2024.

[5] C. Longoni, A. Fradkin, L. Cian, and G. Pennycook, "News from generative artificial intelligence is believed less," in *Proc. ACM Conf. Fairness, Accountability, and Transparency (FAccT)*, New York, NY, USA, 2022, pp. 97–106.

[6] R. Lukyanenko, W. Maass, and V. C. Storey, "Trust in artificial intelligence: From a foundational trust framework to emerging research opportunities," *Electronic Markets*, vol. 32, no. 4, pp. 1993–2020, 2022.