

INTEGRATING GENERATIVE AI IN EDUCATION- PROMISES AND CHALLENGES FOR FUTURE

Nidhi Chopra, Lyallpur Khalsa College Technical Campus. Jalandhar
Ramandeep Singh Deol, Lyallpur Khalsa College Technical Campus.
Jalandhar

Pooja Dhand, Lyallpur Khalsa College Technical Campus
Rameshwer Singh, Lyallpur Khalsa College Technical Campus

ABSTRACT

Generative artificial intelligence popularly known as GenAI have recently emerged as a hot topic of discussion now a days amongst various communities in the society like teachers, researchers, learners, practitioners and educators etc. This has divided the stakeholders into two categories. One group favoring the notion highlights the potential of using these tools to enhance the teaching & learning while other group raising concerns about the ethics and potential misuse of these tools. This paper primarily focuses on the exponential increase in the role of such tools in current scenario and challenges associated with it that needs immediate attention.

INTRODUCTION

One of the most interesting advances worthwhile discussing in Artificial Intelligence is Generative AI applications. Now a days, the internet and podcasts are flooded with Gen AI tools and its use in education, learning & research. These applications are capable of not only creating a fresh content in the form of text but also provide diverse range of functions like spanning of images and even music. The popularity of these applications is increasing by leaps and bounds providing various organizations an opportunity to explore new and better. Some of such applications available are:

ChatGPT, GitHub Copilot, Jasper AI, Midjourney, Code generators, Video generators, Audio generators, Image generators, Microsoft Copilot, Gemini, Runway, Meta AI etc.

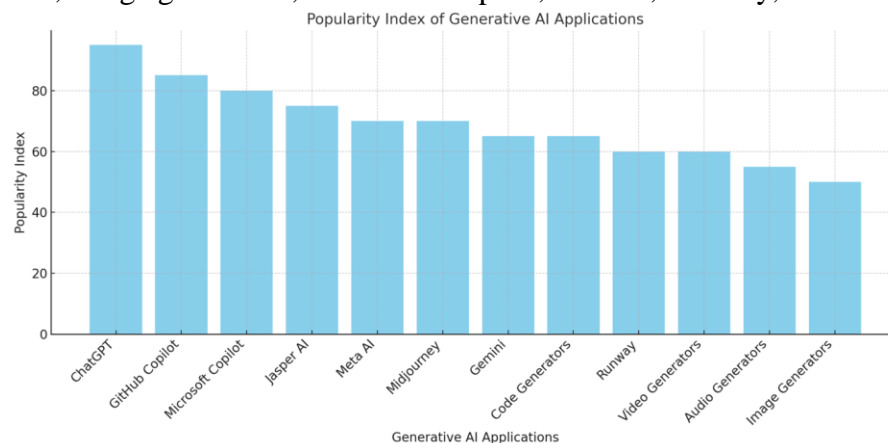


FIGURE 1
POPULARITY INDEX OF GENERATIVE AI APPLICATIONS

The above Figure 1, is a bar chart titled "Popularity Index of Generative AI Applications." It compares the popularity of various generative AI applications based on their popularity index. The applications listed on the x-axis include ChatGPT, GitHub (2023) Copilot, Microsoft Copilot, Jasper AI, Meta AI, MidJourney, Gemini, Code Generators, Runway, Video Generators, Audio Generators, and Image Generators.

The y-axis represents the popularity index, with values ranging from 0 to 100. The chart highlights ChatGPT as the most popular application, followed by GitHub Copilot and Microsoft Copilot. Other applications have slightly lower popularity indices but are closely grouped in comparison.

The range of features provided by such applications are not only limited to creating the course content but also provide tailor made strategies to learners based on his learning data and behavior pattern. This provides the learners with adapting the difficulty of the course and enhancing the effectiveness in learning process. Additionally, such tools also offer educators with an efficient, accurate, and impartial assessment services by automating the grading of assignments and a feedback mechanism to improve the teaching – learning process.

Stakeholders of Generative AI in the field of Education

The revolution brought by Generative AIs in the field of education is worth considering. The stakeholders in this regard can be categorized as mentors mean the one who are either teachers or tutors. Mentees are the one who are learning from the content and are students and tutees. Peer Learners are the group who are working on the same problem or project as a team. Domain experts are the one who are continuously creating the content according to the new researches in the particular domain. Academic Administrators are the one who are responsible for evaluating the outcome of the teaching – learning process Table 1.

Table 1 STAKEHOLDERS OF GENERATIVE AI IN THE FIELD OF EDUCATION	
Mentors	Enhancing Mentor's ability to teach in more interactive manner by demonstrations. Providing adaptive teaching and learning strategies that can be tailor made as per the demand of mentees. Supporting mentor's own personal and professional growth.
Mentees	Self-paced learning environment with increased adaptability and interactivity motivates the mentees for deep learning and understanding of concepts. Mentees can be given assignments based on their individual performance & competence. Query handling through various Chat bots provide assistance round the clock.
Peer Learners	Providing collaborative learning environment at far flung places. Teammates can also evaluate or guide each other on various topics
Domain Experts	Academicians working as an expert can collect & analyze data of learners in order to have better strategies. Large Language Models (LLM) and other content creation applications assist the experts for preparing their content in easier and better manner.
Academic Administrators	Helping the mentor in predicting & evaluating the performance of the mentor. Providing convenient & customized services for the assessment of the learners. Supporting educational decision making with relevant evidences.

REVIEW OF LITERATURE

Noroozi et al. (2024) investigate the integration of Generative AI (GenAI) tools, particularly ChatGPT, in educational settings. They compile findings from seventeen studies, highlighting GenAI's potential to enhance educational outcomes, personalized feedback, and engagement. However, they caution about privacy concerns, biases, and accuracy issues. The paper advocates for ethical guidelines and human oversight. Future research is recommended to focus on the long-term effects, ethical frameworks, and adaptability of GenAI in diverse educational contexts. (Noroozi, 2024)

Wu (2023) examines the integration of ChatGPT and other GenAI tools into education. While the paper highlights the transformative potential of GenAI in enhancing learning, it also addresses challenges such as ethical concerns and impacts on critical thinking skills. Wu emphasizes aligning GenAI integration with educational theories and practices for its effective use (Wu, 2023)

Hwang and Chen (2023) discuss the emerging role of Generative AI (GAI) applications, such as ChatGPT, in education. The paper explores concerns over misuse and the challenges of effectively integrating GAI in educational settings. The authors suggest shifting from a traditional "search" mindset to "programming prompts" for deeper learning and encourage research on GAI's potential for meaningful educational outcomes. (Garcia and Romero, 2024)

Su and Yang (2023) propose a theoretical framework, "IDEE," for applying ChatGPT and generative AI in education. They emphasize defining educational outcomes, ensuring ethical considerations, and evaluating effectiveness. The study highlights benefits such as personalized learning and quick feedback but also addresses challenges like the untested effectiveness and data quality limitations of the technology. (Hwang et al., 2023)

Giannakos et al. (2024) explore the promise and challenges of generative AI in education, particularly focusing on large language models (LLMs). While recognizing GenAI's potential in enhancing learning design, feedback, and assessment, they emphasize limitations and risks, including ethical concerns. They call for careful, evidence-based integration, stressing the need for human-centric design in educational contexts. (Giannakos, 2024)

Sharples (2023) discusses the potential of social generative AI in education, focusing on the interaction between humans and AI in the learning process. While suggesting AI could serve as mentors and guides, Sharples highlights the ethical challenges and stresses the importance of respecting human expertise and ensuring ethical operation. (Sharples, 2023)

Zhou and Yu (2024) investigate the role of AI in personalized education, emphasizing AI tools that adapt learning experiences to individual needs. They highlight AI's potential to track student progress and offer personalized feedback but caution about data privacy and the need for teacher involvement in guiding AI-powered learning. (Zhou and Yu, 2024)

Williams (2024) evaluates the impact of generative AI models like GPT on teaching and learning, particularly in fostering critical thinking and problem-solving skills. The paper also examines the challenges of ensuring the ethical use of AI and creating guidelines for its responsible application in classrooms. (Williams, 2024)

Lee and Tan (2023) provide an evaluation of AI in higher education, focusing on generative AI's role in personalized learning, content creation, and automated grading. They stress the importance of training educators to effectively integrate AI tools into their teaching practices (Lee and Tan, 2023).

Martin and Zhang (2024) explore how generative AI tools can prepare students for future challenges in the workforce by enhancing creativity, collaboration, and problem-solving skills.

They advocate for curricula that incorporate AI to help students develop skills relevant to the age of automation. (Martin and Zhang, 2024).

Garcia and Romero (2024) critically examine the ethical implications of AI in education, addressing concerns such as AI bias, data privacy, and transparency. The authors argue for the development of ethical frameworks and regulatory policies to ensure the responsible use of AI in educational contexts. (Garcia and Romero, 2024).

Table 2 SUMMARY OF PAPERS ON GENERATIVE AI IN EDUCATION			
S.No	Author(s) & Year	Focus	Key Findings
1	Noroozi et al. (2024)	Generative AI tools in education, challenges, and future research	Personalized feedback, engagement, ethical concerns, human oversight
2	Wu (2023)	Challenges and transformative potential of ChatGPT in education	Transformative potential, impact on critical thinking, implementation strategies
3	Hwang & Chen (2023)	Emerging role of Generative AI in education and learning strategies	Concerns on misuse, research on programming prompts for deeper learning
4	Su & Yang (2023)	Theoretical framework for applying ChatGPT and AI in education	Benefits of personalized learning, challenges in technology effectiveness
5	Giannakos et al. (2024)	Promise and challenges of large language models in education	Enhancement in learning design, feedback, ethical risks, human-centric design
6	Sharples (2023)	Social generative AI in education, ethics, and interaction	Ethical challenges, human-AI interaction, AI as mentors
7	Zhou & Yu (2024)	Personalized education with AI, challenges, and teacher involvement	Personalized learning and feedback, data privacy, teacher involvement
8	Williams (2024)	Impact of generative AI on critical thinking and ethics in teaching	Impact on problem-solving, critical thinking, ethics in AI use
9	Lee & Tan (2023)	AI in higher education, personalized learning, and content creation	Personalized learning, content creation, AI tools for educators
10	Martin & Zhang (2024)	Generative AI in fostering creativity, collaboration, and skills development	AI for creativity and skill development, workforce preparation
11	Garcia & Romero (2024)	Ethical implications of AI in education, bias, and privacy concerns	Ethical frameworks, bias, privacy, transparency issues

The above Table 2, summarizes studies on generative AI in education, focusing on its potential and challenges. Key benefits include personalized learning, creativity, engagement, and critical thinking enhancement. Challenges involve ethical concerns, privacy, bias, and the need for human oversight. Studies highlight the transformative potential of tools like ChatGPT and their role in fostering collaboration and skills development. Effective implementation requires ethical frameworks and teacher involvement.

Brief Overview of Generative AI Tools in Education

Generative AI tools have rapidly gained traction in various fields, including education, where they are transforming how learning content is created, delivered, and interacted with. These tools, such as ChatGPT, Claude, GitHub Copilot, Character.ai, MidJourney, and DALL-E 2, provide innovative solutions for personalized learning, creative content generation, coding assistance, and more. Here's a brief overview of each of these technologies and their role in education:

ChatGPT

ChatGPT is a conversational AI developed by OpenAI (2023a) that can engage in natural language dialogues. It is used widely in education for tutoring, answering student queries, generating text-based content, and providing personalized feedback. ChatGPT can assist with a range of subjects, offering explanations, helping with research, and improving writing skills. Its ability to provide real-time responses makes it a valuable tool for fostering personalized learning.

Claude

Claude is a large language model developed by Anthropic, similar to ChatGPT, but with a focus on safety and ethical considerations. It is designed to be more user-friendly and align with ethical AI standards. Claude is used in education for providing tutoring services, generating creative writing, and supporting complex problem-solving tasks. Its safety features make it an attractive tool for schools and educational institutions looking for ethical AI applications.

GitHub Copilot

GitHub Copilot is an AI-powered code assistant that helps students and professionals write code faster by suggesting code snippets, completing functions, and even detecting bugs. It leverages machine learning models trained on vast amounts of open-source code. In education, GitHub Copilot is used to teach programming by providing instant coding support, guiding students through coding challenges, and promoting learning through real-time feedback.

Character.ai

Character.ai is a conversational AI tool that simulates virtual characters capable of engaging in dynamic dialogues. In education, it is primarily used for role-playing, language learning, and scenario-based simulations. It allows students to interact with simulated characters in realistic contexts, enhancing their language skills, critical thinking, and emotional intelligence through engaging conversations.

MidJourney

MidJourney is an AI tool designed for generating artistic images from textual prompts. It allows users to create highly detailed and creative visual content based on descriptions. In education, MidJourney is used to generate educational illustrations, visual aids, and creative art projects. It enhances visual learning and supports students in creative fields like graphic design, art, and media studies.

DALL-E 2

DALL-E 2, developed by OpenAI (2023b), is an image generation tool that uses AI to create images based on text descriptions. It is widely used for generating educational visuals, such as diagrams, illustrations, and artwork, from written prompts. DALL-E 2 helps students in art and design disciplines visualize complex concepts and serves as an excellent resource for creating custom visuals for study material and presentations.

Applications of These Tools in Education

Personalized Learning: ChatGPT and Claude are used to deliver tailored lessons, offer real-time feedback, and provide additional explanations, enabling a customized learning experience for each student.

Creative Content Generation: MidJourney and DALL-E 2 enhance creative expression by helping students and educators generate images, artwork, and design ideas, which can be used for study aids or creative projects.

Coding Assistance: GitHub Copilot assists students in learning programming languages and solving coding problems by providing suggestions and helping with error resolution, making the learning process more efficient.

Language Learning: Character.ai offers interactive learning experiences by simulating dialogues in different languages, helping students practice their language skills and improve communication abilities.

Critical Thinking and Problem-Solving: Tools like ChatGPT, Claude, and GitHub Copilot foster critical thinking and problem-solving skills by providing students with resources and assistance to explore new topics and concepts in-depth.

These generative AI tools represent a major shift in how technology can support and enhance education, allowing for greater engagement, creativity, and efficiency in the learning process. However, it is crucial to integrate these technologies thoughtfully, addressing ethical concerns such as bias, privacy, and the potential for over-reliance on AI.

Here's a table presenting the key facts and applications of various generative AI tools in education, followed by a bar chart to visualize the prevalence of each tool's application areas.

Table 3 GENERATIVE AI TOOLS AND THEIR APPLICATIONS IN EDUCATION				
Generative AI Tool	Developer	Primary Use in Education	Key Features	Benefits in Education
ChatGPT	OpenAI	Tutoring, personalized feedback, content generation	Natural language processing, conversation-based	Personalized learning, instant feedback, wide subject coverage
Claude	Anthropic	Tutoring, research support, creative writing	Ethical AI, user-friendly, conversational model	Safe, ethical interactions, personalized learning
GitHub Copilot	GitHub	Code writing assistance, debugging, learning programming	Code suggestion, error detection, completion of code	Accelerates coding skills, real-time feedback, supports learning by doing
Character.ai	Character.ai	Role-playing, language learning, simulations	Dynamic character interactions, customizable personalities	Enhances language learning, fosters critical thinking through interactive dialogues
MidJourney	Independent	Visual content generation (art, design, illustrations)	Text-to-image generation	Supports creativity, visual learning, enhances graphic design education
DALL-E 2	OpenAI	Image generation from text, educational visuals	AI-driven image creation, highly customizable	Useful for creating custom visuals, enhances visual learning in creative subjects

The above table 3 demonstrate how generative AI tools can cater to various educational needs, from enhancing creativity and critical thinking to supporting technical learning such as coding. By utilizing these tools, educators can customize their approach, making the learning process more engaging and effective across different subjects and learning environments [11-17].

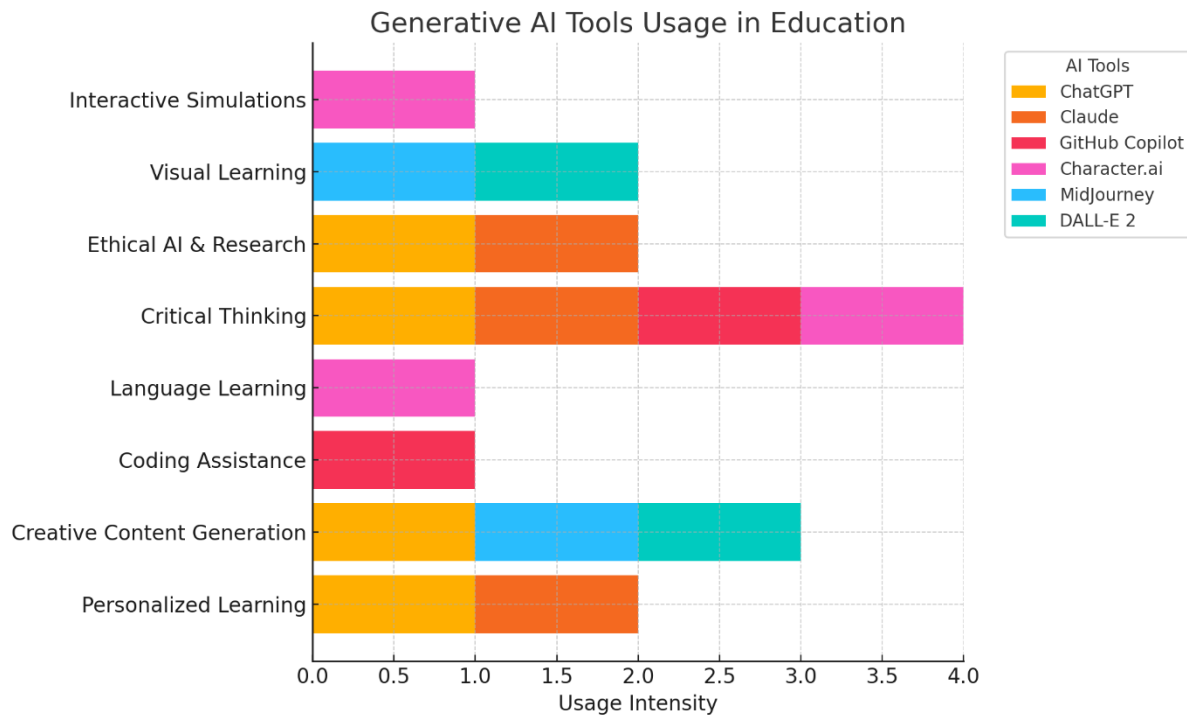


FIGURE 2
GENERATIVE AI TOOLS IN EDUCATION

The bar chart above in figure 2 illustrates the usage intensity of various generative AI tools across different educational applications. Here's a breakdown:

- **ChatGPT:** Primarily used for personalized learning and critical thinking.
- **Claude:** Primarily used for personalized learning and ethical AI research.
- **GitHub Copilot:** Most used for coding assistance and problem-solving.
- **Character.ai:** Most used for creative content generation, language learning, and interactive simulations.
- **MidJourney:** Most used for visual learning and creative content generation.
- **DALL-E 2:** Focused on visual learning and creative content generation.

1. Promises of integrating Gen AI in education

The assimilation of GAI in education has become a topic of considerable interest, opening up plethora of new possibilities and challenges for educational practices. GenAI models, for example, ChatGPT, have been widely explored across different disciplines, opening doors in educating, learning, and examination as discussed below:

a) Customized round the clock learning support

Gen AI tools provide personalized learning support to students either they are looking support for deep understanding of the concepts or solving some problem. Students are using these tools for preparation of assignments or projects, solving any problem in any programming language, preparing presentations or demonstrations, generating important questions from the examination or the interview point of view etc.

Add on, these tools provide tailor made learning resources that suits to the need of individual student. Chat GPT generates short texts based on the keywords entered by the user to help students for memorize the concepts and also generate some lesson plans. This has bring a revolution in the traditional methods of teaching and learning.

b) Content creation support

Gen AI tools & technologies, provide a greater assistance in creating relevant content for the user either on the basis of few keywords or elaborating/summarizing topics. The content can be in the form of essays, assignments, project reports or thesis etc. In some cases it is also useful in generating some new ideas and topics for research and innovation. The tools are equally helpful in providing technical as well as paraphrasing support to the user. It provides an extra ordinary support specially to non-native English-speaking students who are struggling with writing down their ideas in English language. It also helps in retrieval of information or gathering citations. Many budding researchers also use such tools for brainstorming and exploring new ideas and concepts.

c) Analytical & research support to users

The recent advancement in the features of AI tools enables the students and users to acquire, compile and consolidate the required information in desired manner & pattern. Researchers also finding the suitable tools for literature searching, summarizing the content & even generating the hypothesis based on data analysis. AI powered tools & techniques are assisting researchers with a vast pool of data and knowledge enabling them to stay up-to-date with upcoming trends. These applications are worthwhile capable of swiftly & effectively processing large volumes of data and presenting them in dynamic dashboards. Students can directly work on the basis of the preliminary analysis results and can enhance or fine tune according to the dynamic environment.

d) Diverse educational opportunities

Gen AI tools like Large Language Models (LLMs) can produce instructional content and facilitate discussions on diversity. Users from any domain or background can get assistance in understanding complex problems and offering examples of simple code in any programming language. Apart from this, users are also getting support for crafting artworks and handling repetitive tasks. There are various tools which produce images based on a prompt called as text-to-image generation or build multimedia product including slides, audios, and videos. For a fresh designer, it can also provide samples to start with or can also provide opportunity to visualize the stuff.

e) Support for repetitive and non-creative tasks

Gen AI tools not only plays a vital role in creative or analytical tasks but also plays decent role in repetitive and Non-creative tasks which saves a lot of time and efforts of teachers. Checking lengthy essays and commenting on it for improvement is indeed a time consuming and monotonous task. Checking and evaluating assignments is also an important activity that demands time. Such tasks can be effortlessly accomplished by Gen AI tools. Student feedback to improve the teaching – learning process and then mapping students' performance with the outcomes is yet another non-creative but important task which can be handled by AI tools.

Challenges of Integrating Gen AI in Education

Despite having so many advantages of Gen AI tools, users still have concerns have concerns about the challenges and issues related to the extensive use of these tools in the domain of education.

The supporters of GenAI acclaim its capacity to help training for example as far as giving versatile and customized conditions and further developing retention of knowledge, there is a group of stake holders which worries about the moral considerations of GenAI, as well as its likely adverse consequences on evaluation practices, logical uprightness, and students' higher-order thinking abilities.

a) Transparency and accuracy challenges

Undoubtedly Gen AI provide quick and easily understandable responses, but still the accuracy of these results is under question mark. The validity and precision of AI generated information is always a matter of concern for the users. Moreover, many of the users still find difficulty in using such tools for accomplishing their work. They don't find it convenient and transparent to use. The working of machine learning and deep learning algorithms behind the scene is also not clear to the user so as to take the decision whether the information generated is correct or not. Many users don't trust the information generated by AI driven tools.

b) Privacy and ethical challenges

Many of the users raised their concern about the privacy & security of their personal details and information which they provide while using such tools time to time. Moreover, the guidelines pertaining to the ethical use of Gen AI tools is also not clear and followed religiously by the users. This raises an issue related to plagiarism and methods to deal with this serious concern. With the advancement in the technology, it is very difficult to detect that whether the content is AI generated or not. Sometimes, the user is naïve enough to understand that he is either communicating with an AI bot or some other human being.

c) Growth & competence challenges

One of the issues that need immediate attention is that the overuse of AI applications may hamper the holistic growth & development of users. Too much dependency on these tools creates hindrances in the intellectual growth of users. The ability to think analytically can be reduced drastically which will ultimately affect the decision making capacity of the people. According to some of the people, it may have negative impact on the people. As people started relying too much on technology for idea generation they are losing their capacity and willingness to think by themselves which is really adverse and unacceptable in many domains related to art & social science.

d) Job replacement challenges

One of the issues raising issue that is catching attention of all is job replacement. It is being foreseen by many that some jobs will disappear or will drastically reduce in case Gen AI established its place in industry. Many of engineering graduates are really concerned about this issue as there are various platforms that are providing ready to use codes for various problems in all languages. Similarly, the jobs of many analysts may also disappear as there are many applications that are providing readymade dashboards for the same.

e) Policy Matter challenges

At last, there is a need of updated regulatory measures to cover the potential risk caused by the rapid growth of Gen AI applications. There should be implementation of planned strategies and policies to regulate the use at all the levels. A well written procedural guidelines document should be in place that so that no user can misuse the applications.

CONCLUSION

The integration of generative AI tools into education holds significant promise, offering the potential to enhance personalized learning, foster creativity, and support a wide range of educational activities. However, the implementation of these technologies must be approached with caution. Ethical concerns, data privacy issues, and the potential for misuse highlight the need for careful integration and the development of ethical frameworks and guidelines. Future research should focus on the long-term impacts of generative AI on education, its ethical implications, and its adaptability across various educational contexts. By addressing these challenges, generative AI has the potential to revolutionize the way education is delivered, making it more personalized, creative, and efficient.

REFERENCES

- Garcia, P., & Romero, A. (2024). Ethical implications of AI in education: A critical review. *Ethics in Education & Technology*, 18(3), 58-72.
- Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., & Rienties, B. (2024). The promise and challenges of generative AI in education. *Behaviour & Information Technology*, 1-27.
- GitHub. (2023). GitHub Copilot: Your AI pair programmer. Retrieved from <https://copilot.github.com>
- Hwang, G. J., & Chen, N. S. (2023). Editorial position paper. *Educational Technology & Society*, 26(2).
- Lee, J., & Tan, S. (2023). Bridging AI and education: An evaluation of AI applications in higher education. *Higher Education Research & Development*, 42(5), 1120-1134.
- Martin, D., & Zhang, X. (2024). Generative AI in education: Preparing students for future challenges. *Journal of Educational Research & Development*, 10(2), 34-47.
- MidJourney. (2023). Creating visuals with MidJourney. Retrieved from <https://www.midjourney.com>
- Noroozi, O., Soleimani, S., Farrokhnia, M., & Banihashem, S. K. (2024). Generative AI in Education: Pedagogical, Theoretical, and Methodological Perspectives. *International Journal of Technology in Education*, 7(3), 373-385.
- OpenAI. (2023a). ChatGPT: Optimizing language models for dialogue. Retrieved from <https://openai.com/chatgpt>
- OpenAI. (2023b). DALL-E 2: Generating images from text descriptions. Retrieved from <https://openai.com/dall-e-2>
- Sharples, M. (2023). Towards social generative AI for education: theory, practices and ethics. *Learning: Research and Practice*, 9(2), 159-167.
- Su, J., & Yang, W. (2023). Unlocking the power of ChatGPT: A framework for applying generative AI in education. *ECNU Review of Education*, 6(3), 355-366.
- Williams, K. (2024). Teaching and learning with AI: Assessing the impact of generative models in education. *Journal of Modern Education & Technology*, 8(4), 145-157.
- Wu, Y. (2023). Integrating generative AI in education: how ChatGPT brings challenges for future learning and teaching. *Journal of Advanced Research in Education*, 2(4), 6-10.
- Zhou, M., & Yu, Q. (2024). The evolving role of AI in personalized education: Exploring the impact and potential. *Journal of Educational Technology & Innovation*, 15(1), 10-20.

Received: 09-Apr-2025, Manuscript No. AMSJ-25-15845; **Editor assigned:** 10-Apr-2025, PreQC No. AMSJ-25-15845(PQ); **Reviewed:** 20-Apr-2025, QC No. AMSJ-25-15845; **Revised:** 03-May-2025, Manuscript No. AMSJ-25-15845(R); **Published:** 21-May-2025