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THE ROLE OF AI IN EDUCATION: ADVANCES, OPPORTUNITIES, AND CHALLENGES

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ABSTRACT

Generative AI has the potential to revolutionize education through personalized learning, content generation, tutoring and research assistance along with providing fast assessment methods. This review aims to analyze the role of generative AI in transforming education via adaptive platforms, machine learning and Natural Language Processing (NLP) models. The analysis examines the role of AI in enhancing the user experience, customized education and automation of educational materials. Further discussions involve the role of AI in bridging the educational gap, improving learning and accessibility. AI is already playing an important role in enhancing access to education for underserved communities and students with disabilities. AI-based learning and tutoring applications are bridging the gaps for such communities. The integration of AI in education has given us unprecedented opportunities and sparked a paradigm shift in learning and teaching. But despite all these advantages, AI also presents a complex set of challenges. These challenges involve ethical concerns, bias, data privacy and security risks. AI-based education can also undermine academic integrity due to issues such as plagiarism, misinformation, reliability and accuracy of information. The review further explores the strategies to overcome these issues and the future direction of AI by developing such frameworks to balance automation with critical human oversight. This ensures the smooth integration of AI with educational tools to maximize the benefits for students and teachers while mitigating the associated risks.

KEYWORDS: 21st century abilities; Ethical Concerns; Generative AI; Natural Language Processing (NLP); Personalized Learning.

1. INTRODUCTION

Generative AI uses machine and deep learning models to generate outputs including texts, pictures and even music. The new data in generative AI is generated based on these learning models and vast datasets fed to them. Some of the important AI models include Generative

Adversarial Network (GAN) used for image generation, Recurrent Neural Network (RNN) for language processing, Transformer for generating content and text, and Variational Autoregressive Encoder for music generation (Koç et al., 2025). These generative AI models can mimic human behavior and reasoning to generate content by giving appropriate prompts.

Moreover, AI can easily perform monogamous and repetitive tasks in educational settings such as editing, curriculum designing, data analysis etc (Anderson-Coto, 2024). Some of the most common generative AI models include OpenAI's chat GPT (Bengesi et al., 2024), Meta's LLaMA (Corchado et al., 2023), Google's Brad (Giannakopoulos et al., 2023), Microsoft's Co-pilot (Mathisen, 2024) and X's Grok (Jamal, 2024). These models use deep learning and transformer architecture to generate output that can be highly helpful for educational purposes. Google is believed to be a pioneer in introducing transformer neural network architecture in 2017 (Rothman, 2021), but Chat GPT took the lead by releasing its model to the public in 2022 with a simple interface. Chat GPT has shown us the true potential and capabilities of AI and how we can use these powerful models to transform our lives.

The user base of Chat GPT increased to 1 million within 5 days of the release and the total number reached up to 100 million users just in two months (Caelen & Blete, 2024). Generative Artificial Intelligence (AI) has revolutionized various sectors with constant innovations. The field of education is also transforming due to these powerful AI technologies which have its own set of opportunities, challenges and complexities (Yu, 2024). Generative AI is revolutionizing education with constant improvements and better integration to streamline different learning aspects and outcomes. Generative AI in education has significantly evolved over the past few years as the early technologies focused more on rule-based and adaptive learning that is designed according to the progress of the student (Hwang et al., 2020).

Some of the early learning and tutoring AI models include Carnegie Learning MATHia (Almoubayyed et al.) and Watson Education by IBM (Rajeshwari & Krishna Prasad, 2020). Due to constant innovations, generative AI has taken a more active role in education by performing functions such as automatic grading, tutoring, content and visual creation, and even speech and text recognition. Now, AI can grade assignments, quizzes and even papers which can reduce the workload of educators significantly. The same AI can also design customized educational plans based on the performance of students and can focus on areas that require more attention (Mittal et al., 2024).

Similarly, virtual AI chatbots can explain any complex concept in simpler terms to make it easy to understand (Grudin & Jacques, 2019). Content creation has never been that easy with AI writing lectures, taking notes and even making quizzes. AI comes with some handy features such as speech to text converter, making it easy to effectively take notes during lectures or can be used as a translator to understand different languages. The use of AI in education is not free from challenges and controversies.

Different research studies have pointed out issues such as plagiarism, biases, false data and even academic misconduct. Some students may start to be overly dependent on these AI tools which can hinder their critical thinking ability, cognitive skills and development of soft skills. These sets of challenges are part of a wider debate on the adoption of AI in educational settings which requires further research (Ahmad et al., 2023). Most of the review papers have briefly discussed the role of AI in education and how it can transform the future of education.

This review paper aims to analyze the role of generative AI in education and how AI is transforming education. The analysis revolves around the role of AI in enhancing the user experience, customized education and automation of educational materials. Further discussions involve the role of AI in bridging the educational gap, improving learning and accessibility. Some of the critical challenges related to AI such as AI dependency, bias, data privacy and the potential impact of AI on critical thinking ability are also discussed.

This review article also aims to develop a framework for the ethical and responsible implementation of AI in different education fields. This review presents a structured analysis of the impact of AI on education to offer deep insights into the transformative potential and the challenges and complexities that must be addressed for responsible implementation. The review follows a systematic methodology to review the available information by

qualitatively analyzing the existing literature that helps to identify the gaps, opportunities and challenges faced by generative AI. AI helps various aspects of learning and teaching, but it is important to mention some significant challenges. AI-based tools enable personalized learning, automate educational content, and provide multimodal and immersive education.

However the excessive use of AI has already raised red flags, and some educational institutes have gone as far as completely banning AI for any activities to preserve traditional teaching and learning methodologies. But the inclusion of AI in teaching and learning can enhance the learning experience. Although the benefits of AI are immense, challenges such as data privacy, algorithmic biases of AI tools and ethical implications are worth noting too. The limitations of AI must be analyzed critically while addressing the risks related to integration with education (Kayyali, 2024).

2. BIBLIOGRAPHIC ANALYSIS

This review paper uses a bibliometric approach to analyze the role and contribution of generative AI in education and research. The data is sourced from databases such as Web of Science (WoS) Core Collection which is regarded as the most used bibliographic database by Clarivate Analytics. The search analysis includes querying all fields with the following string ("Generative AI" OR "Generative Artificial Intelligence" AND "Education") across the WoS Core Collection with no time restrictions.

The data was analyzed up to March 17, 2025. Only publications in the English language are used in this analysis and the search was limited to journal publications including research articles, conference papers, books, book chapters, and review papers. This resulted in a dataset of 2,366 documents from 1,000 sources, authored by 8,079 researchers with an annual growth rate of 180.59% and an average of 6.272 citations per document. Web of Science was preferred over alternatives like Scopus or Google Scholar due to much better search functionality, and consistent metadata.

This ensured high-quality data to analyze trends and their impact even with certain limitations due to non-indexed literature (Mongeon & Paul-Hus, 2016). The analysis used two of the most specialized tools: Bibliometrix in R Studio and VOSviewer (Oyewola & Dada, 2022). Bibliometrix is generally used for thematic mapping, factorial analysis, word cloud generation and collaborative world maps to reveal different research themes and global networks. VOSviewer facilitates the co-occurrence analysis, network visualization, cluster analysis, overlay visualization, mapping keyword associations, author collaborations, and temporal trends across the dataset.

This analysis used 1,409 articles and 412 proceedings papers. With an average document age of 0.902 years, highlighting the rapid evolution of generative AI in education. These tools provide a robust framework to uncover the intellectual structure and dynamic developments within the field (Arruda et al., 2022). The methodology and framework for bibliographic analysis are shown in figure 1.

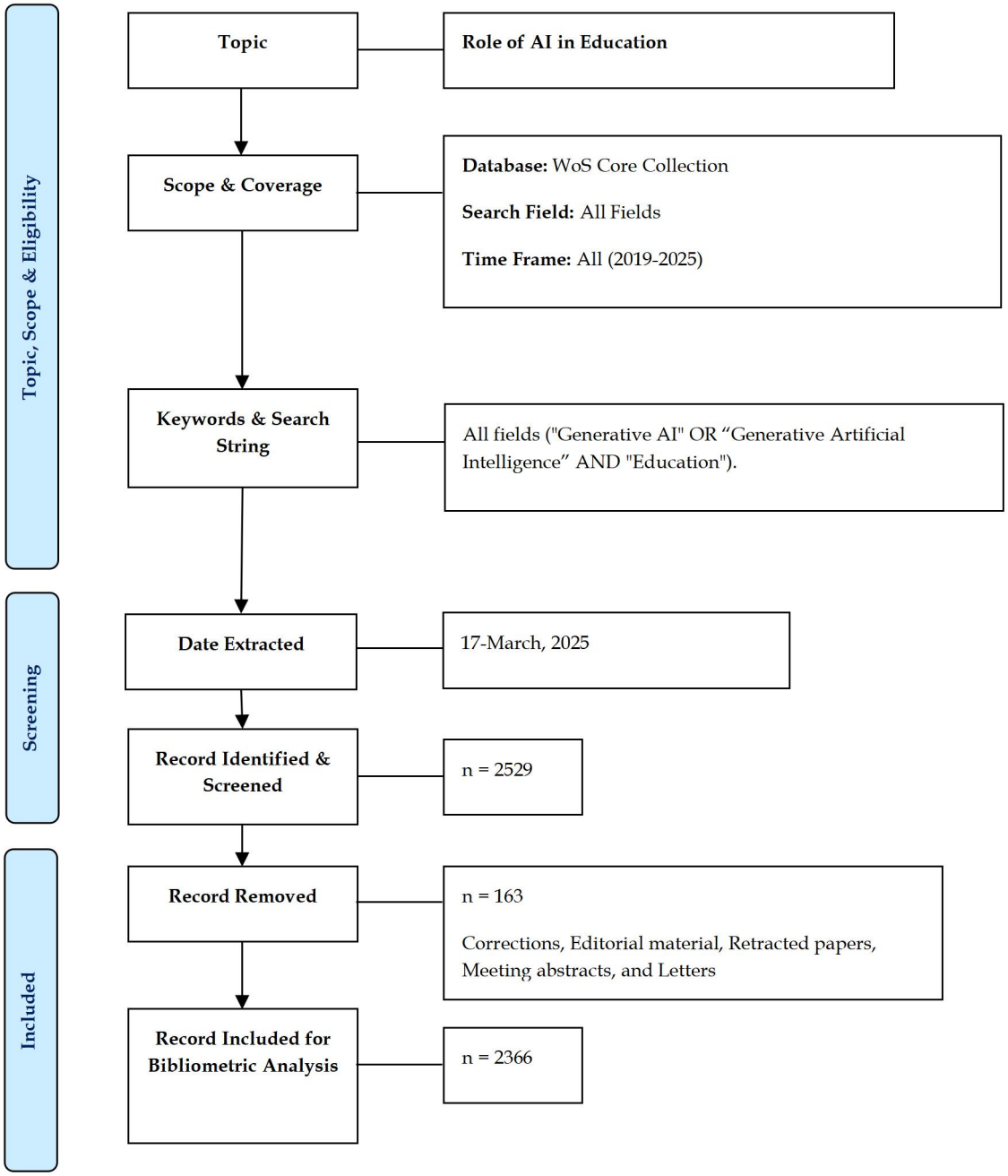

Figure 1: Framework and Methodology of Bibliographic Analysis.

Network visualization and cluster analysis are shown in Figures 2 and 3. The VOSviewer co-occurrence analysis has shown the keywords used in network visualization. These keywords represent a thematic focus for Generative AI in education. These keywords include elements such as academic writing, assessment, curriculum, critical thinking, and student engagement. Similarly, the keywords highlight the integration of AI tools like ChatGPT into essential teaching and learning practices. Keywords also focused on topics such as mental health, digital health, and health literacy and relating them with education and well-being. These keywords also address the factors which influence the acceptance of AI technologies such as gender considerations, intrinsic motivation, and trust.

Furthermore, more keywords covered topics such as collaborative learning, personalized learning, and intelligent tutoring systems which emphasize the role of AI in revolutionizing educational methodologies. Areas like computational modeling, deep learning, and prompt engineering, reflecting the technical aspects of AI integration, large language models (LLMs), machine learning, and

educational innovation are also included in keyword analysis to highlight various cutting-edge technologies for modern education. In the end, the keywords related to academic integrity, AI ethics, and challenges are also included. The keyword analysis and network visualization show a comprehensive landscape not only reflects technological advancements but also the human-centered factors involved in integrating Generative AI into educational systems.

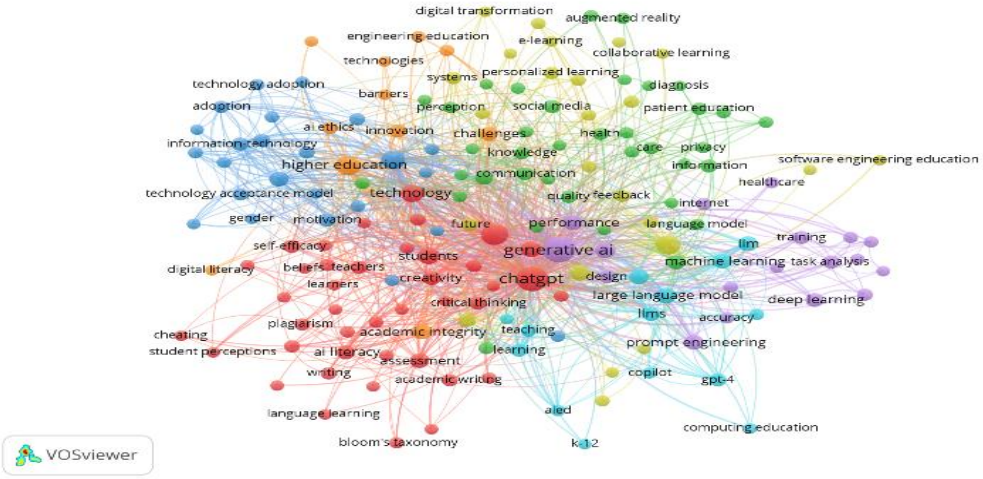

Figure 1: Keyword Analysis and Network Visualization.

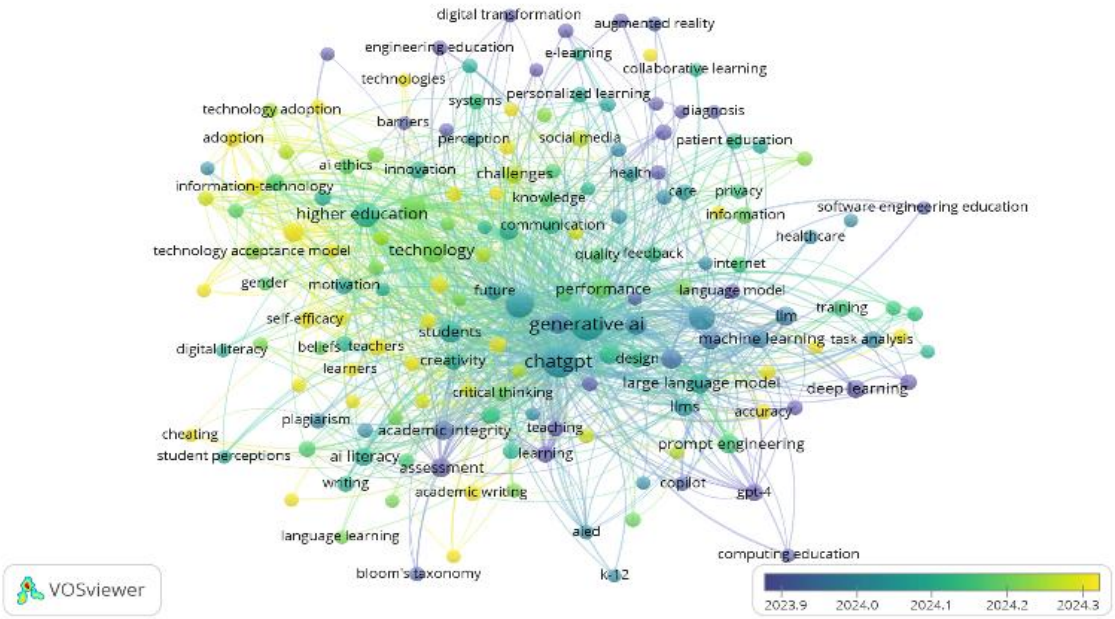

Figure 2: Keyword Analysis and Network Visualization.

3. GENERATIVE AI FOR EDUCATION

As already discussed earlier, generative AI enables personalized learning experiences by automating the content creation, helping with tedious tasks, development of new assessment methods, and AI-powered tutors. Generative AI is based on deep learning models, reinforcement learning and Natural Language Processing (NLP) for adaptive learning experiences with the ability to produce high-quality educational content. These developments are discussed in detail in this section (Obaid et al., 2023).

3.1. Personalized Learning with AI

Personalized learning allows the adaptive learning path by catering for the needs of individual students. Personalized AI learning models are highly student-centric and driven by data analytics for complete synchronization with the pace of students, knowledge gaps and cognitive abilities. These models leverage NLP and deep learning to design student-centric and interactive learning experience (Gm et al., 2024). The learning path is designed based on the strengths, weaknesses, and performance of students through adaptive AI algorithms which adjust the learning materials according to their needs. AI-based personal learning uses real-time data analytics to design strategies and learning plans based on the progress of students (Castro et al., 2024). The practical implementation of AI for such tasks is adopted by DreamBox (Palaniappan & Jain, 2025), Carnegie Learning and Knewton which uses AI algorithms to actively track the real-time progress of students and refine the content accordingly (Rajput, 2025). AI models are used by these platforms to predict learning outcomes by analyzing the performance of students by identifying learning patterns. Similarly, these AI models help identify struggling students and adjust the teaching plan accordingly by including additional problem-solving questions and quizzes. These models adjust the difficulty level of the education based on past performance. Another important aspect of personalized learning is the access of teachers to the performance dashboard, showing the progress trends which enable them to make data-driven decisions and make necessary adjustments (Song et al., 2024).

According to Yilmaz and Yilmaz (Yilmaz & Yilmaz, 2023), Chat GPT can significantly improve the programming skills, computational skills, and motivation to programming in comparison to those without using Chat GPT. The study revealed that AI improved critical thinking, confidence and debugging programs in different programming languages. Even with all these advantages, the study also points towards some of the shortcomings of AI for such tasks including lethargy, laziness and generation of incorrection information.

3.2. AI-Generated Educational Content

Generative AI adds value to education by creating content, books, summaries and interactive learning materials. This content helps educators to improve their efficiency and provide students with diverse learning resources. AI helps to reduce the manual workload for teachers to shift the focus to more productive tasks (Pesovski et al., 2024). AI models such as Chat GPT, Claudia, Grok, Co-pilot etc are capable of generating high-quality educational materials and explaining complex concepts in simpler terms while acting as a learning support guide. AI is assisting in designing more structured content, assignments and papers to improve learning efficiency (Misanchuk & Hyzyk, 2024). Platforms like ScribeSense are using these models to make educational courses more interactive as well as generation of problem sets, quizzes and self-assessment modules. Moreover, AI helps the students to generate the key takeaways and summaries from lengthy papers, books and lectures and enhance self-directed learning by facilitating inquiry-based education through natural language interactions (Olatunde-Aiyedun et al., 2024).

3.3. The Role of AI in Teaching

Teaching methods and strategies are dependent on the learning outcomes and subject matter. It is not always easy to design courses and implement learning strategies following the needs of the students. Some other factors that come into play include the total number of students, availability of resources and teacher's experience. AI can do a good job in preparing teaching materials, functioning as on-demand tutor, and answering questions. AI can create lectures, teaching strategies, outlines and syllabuses for different courses to aid the teaching and delivering lectures more efficiently. The ability of these AI tools to act as virtual teachers can be beneficial when the questions are answered in simpler terms and multiple languages for a wide range of students (Alam, 2021). Some platforms such as Codex and ScribeSense are already using these AI tools for automated content creation.

One of the advantages of AI tutors is available 24/7 to students, which allows students to learn at their own pace and revisit any concept at any suitable time. AI teachers can provide highly customized and targeted practice questions and learning materials. But these AI chatbots or tutors have certain shortcomings including a lack of critical thinking and reasoning which are only possible with human teachers (Pedro et al., 2019). Apps such as Duolingo reinforce learning using NLP for a personalized learning experience (Kong et al., 2024). Socratic by Google allows students to upload pictures of assignment problems and then explain the solution step-by-step (Orynbassarova & Porta, 2024). Similarly, Squirrel AI uses some of the most sophisticated adaptive learning models to improve student engagement and tailor teaching

strategies (S. Wang et al., 2023).

Whalen et al. (Whalen & Mouza, 2023) analyzed the role Chat GPT can play in aiding teachers. The analysis after various prompts to Chat GPT revealed some of the advantages teachers can get. Chat GPT can provide general teaching support, aid in the assessment of students, improve teaching methodologies, and improve communication among teachers, parents and students. Figure 4 shows the role of AI in teaching.

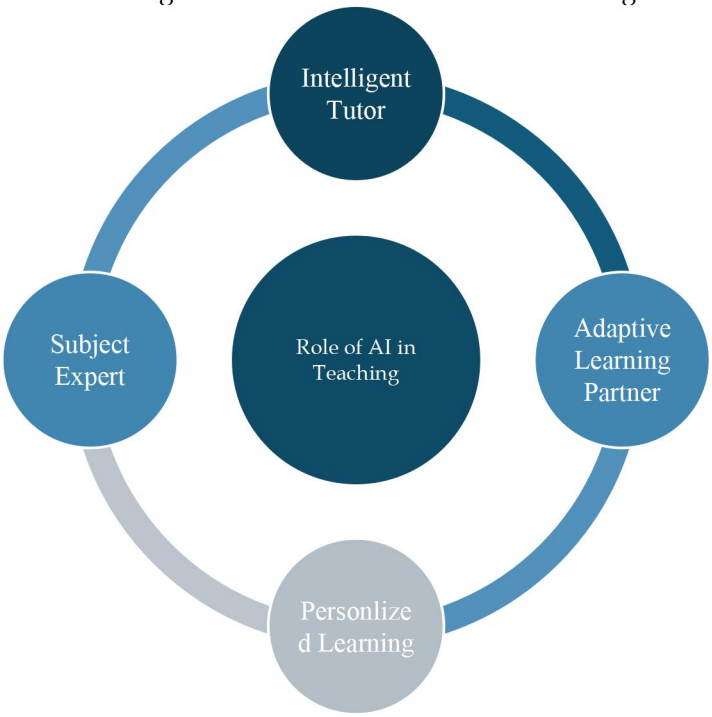

Figure 4: Different Roles of AI in Teaching.

3.4. AI in Assessment and Feedback

Assessment and feedback mechanisms are important to identify learning gaps, evaluate comprehension skills and redesign instructional strategies for students. AI-driven tools ease the assessment process in education and grade tests, quizzes and assignments in a highly efficient manner. AI tools maintain a high level of consistency and objectivity while grading and evaluating. AI tools also provide detailed feedback for each student based on performance and can give insights into the overall performance of the class by providing data analytics. The historical performance data is used to generate adaptive quizzes and assignments. Teachers can use this feedback to create competency-based assessments tailored to the needs of students (Srinivasa et al., 2022). Platforms such as Turnitin and Grammarly are already using AI-based NLP techniques to improve sentence structuring, linguistic accuracy, and coherence by generating detailed feedback for insights into students' performance. The performance assessment is carried out by qualitative analysis of student writing through contextual relevance and argument structure. The feedback generated offers personalized suggestions that help to iteratively improve the composition, writing and analytical skills of students (Raheem et al., 2023). Some peer-reviewed journals are in the process of implementing AI-driven feedback systems to assist the researcher in collaborative learning by providing detailed critiques of the papers submitted.

3.5. AI Immersive Education and Multimodal Learning

Multimodal learning AI incorporates Virtual Reality (VR), Augmented Reality (AR) and gamification for the creation of engaging educational materials. Through AR and VR, students can virtually visit different places and laboratories and even perform virtual experimentation in a stimulated environment. The aim of using VR and AR is to engage multiple sensory modalities to enhance knowledge retention and conceptual understanding among students (AlGerafi et al., 2023). AR-related applications can help in virtual learning by overlaying the digital content over actual objects such as in the study of anatomy for medical students. The students can view other complex diagrams for visual reinforcement. Researchers can run simulations by

mimicking real-world conditions to save time and resources. Google provides a VR environment using Google Expeditions and Labster which offers scientific and historic immersive explorations, and students can view molecular structures or even do space exploration (Geroimenko, 2023).

4. OPPORTUNITIES OF GENERATIVE AI IN EDUCATION

Generative AI presents tremendous opportunities for students and teachers while bridging the knowledge gaps for underserved communities and enhancing access to education. AI can impart a culture of innovation, lifelong learning, and research and development.

4.1. Enhancing Accessibility and Inclusion

One of the most prominent advantages of AI in education is making the learning process more inclusive. AI can cater for students with diverse learning needs, even those with disabilities and language barriers. Some of the AI-based technologies that are helpful for such students include Speech to Text and Text to Speech technologies. Google's Live and Microsoft's Seeing AI can transcribe in real-time by providing speech analysis and transcription. This helps make the educational materials more accessible to the communities and students with special needs such as hearing and visual impairment. Similarly, tools such as JAWS (Job Access with Speech) and Kurzweil 3000 use AI to convert text-based information into audio while providing detailed descriptions for visually impaired students. The same is the case with neurodivergent students, neurodivergent are those having autism or dyslexia. AI-based tools provide customized interfaces for such students to provide a well-structured pathway for learning based on their cognitive abilities.

4.2. AI-based Translation Tools

AI tools have this incredible ability to translate text into different languages in real-time that can be used for multilingual education. Platforms like DeepL and Google Translate can translate content, speech, text and even lectures into various languages to enable seamless multilingual education. Moreover, AI can also be used to generate subtitles and captions that can enhance the learning experience for non-native speakers and students with hearing impairments. Language apps like Rosetta and Duolingo are already adopting AI to provide customized lessons and increase the difficulty level based on the progress of everyone.

4.3. Bridging Educational Gaps in Underserved Communities

AI-based education can provide cost-effective and scalable education solutions that can help to eradicate the disparities among the underserved communities by providing remote and resourceful learning opportunities. Applications can be designed that can give access to educational content offline without the need for internet connectively, making them perfect for highly remote communities and resolving the issues of accessibility for remote communities. Famous education platforms such as Khan Academy and Kolibri are already working in this direction. Similarly, virtual AI-based tutors can be helpful for those areas which lack the required teachers. These chatbots can clear the concepts and offer simple explanations for complex concepts. AI can help to improve low literacy rates by facilitating education for such areas through interactive learning strategies. Some of the other benefits of AI that we have already discussed in detail include curriculum designing, personalized learning plans, content generation and predictive analytics.

4.4. Transforming Higher Education and Research

AI-based tools have contributed to transforming higher education and research by improving academic writing, literature review and even data analytics for various topics (Alqahtani et al., 2023). Platforms such as Semantic AI tools such as Elicit are known to gather the key findings and data from thousands of research and review papers (Fenske & Otts, 2024). Citation tools such as Endnote and Zotero are employing AI to save time by automating the citation process in paper writing. Chat GPT and Grammarly use AI to help students refine academic writing and give suggestions to improve the writing process (Rashidov, 2024). Tha data processing capability of AI is unmatched with tools like MATLAB AI and IBM Watson, enhancing efficiency by visualization, automated data analytics and pattern recognition (Sridhar, 2024). Machine learning can be used by researchers to formulate and test the hypotheses and even identify the correlations between complex datasets by predicting the outcomes (Guryanova et al., 2020). AI-based simulation and modeling can help accelerate research in the fields of sciences and engineering (H. Wang et al., 2023).

Xing (Xing, 2024) used chat GPT for data analytics and statistics. The findings revealed Chat GPT as a valuable tool to implement analytical

methods and solve conceptual problems. These functionalities of Chat GPT improve the learning pathway for data analytics by making it simple and accessible to the students.

4.5. Professional Development

AI can play a significant role in professional and skill development in this era of ever-changing job markets and technologies. Coursera and LinkedIn are leveraging AI to create customized learning pathways for different professionals based on their performance and career goals. AI is helping to filter the market trends in job markets and suggests suitable skill development pathways and professional courses. Moreover, AI can generate interactive corporate training sessions for professional development. Companies and organizations can use AI to track the performance of employees and can design training courses accordingly (Swargiary, 2024). Table 1 shows different AI applications and tools and summarizes technical details.

Table 1: AI Applications and AI Tools

AI Applications	AI Tools	Technical Details	References
AI-based educational content	Quizlet, Chat GPT, Claude, Co-pilot, ScribeSense, OpenAI Codex	Structured content in the form of textbooks, summaries, flashcards, quizzes and lectures is generated through natural learning models. Generation of interactive course materials, syllabus and lectures.	(Cambaz, 2023; Diwan et al., 2023; Korda et al., 2024; Murtaza et al., 2022; Sayed et al., 2023)
AI-based personal learning	EdTech Analytics, DreamBox, Carnegie	The learning pathway for students is adjusted according to their performance. Personalized learning pathways are designed after analyzing the learning behavior.	(Palaniappan & Jain, 2025; Silva et al., 2024)
AI-based Tutors and Chatbots	Duolingo, Squirrel AI	Availability of on-demand assistance with any educational queries 24/7. These tutors and chatbots lack cognitive ability like human beings.	(Rajput, 2025; Vijay et al.)
AI-based Research and Higher Education	Semantic Scholar, Scite, MATLAB AI, IBM Watson	Trend and hypothesis analysis, predictive and statistical modeling.	(Sridhar, 2024)
AI-based Professional Development	AI-based LMS platforms, Coursera AI, LinkedIn	AI-based courses for professional development, course recommendation, adaptive professional learning, and skills learning pathways.	(Swargiary, 2024)

5. CHALLENGES AND ETHICAL CONCERNS

5.1. Ethical Concerns & Bias in AI-Generated Content

The massive proliferation of Artificial Intelligence (AI) in academia has brought various technical challenges. One major concern is the potential for biased content, as AI systems often rely on existing pedagogical content and can perpetuate and intensify biases present in the training datasets (López-Meneses et al., 2025). This can lead to unfair or discriminatory results, ultimately resulting in educational content that contains factual inaccuracies and exacerbates existing biases. Research reports have revealed various types of biases in AI-generated content, Denny et al. (Denny et al., 2023) compared the quality of content created by LLM with the content generated by students. The result reported that LLMs generated content resemble with human created content. However, human generated content has greater variability in length and specific composition of the content, underlining the need to further exploring the Al generated learning material on education. Moreover, the technical demands of AI systems pose an additional challenge. The maintaining and updating these complex AI systems requires significant technical and computational expertise, posing a substantial obstacle for many educational institutions. The finding suggests more advanced AI solutions that can accommodate diverse educational contexts (Yadav, 2024). Fang et al. (Fang et al., 2024) conducted a study examining bias in AI-generated content using unbiased material as a baseline. Their findings revealed that all large language models (LLMs) produced biased content, revealing significant gender and racial biases. Notably, ChatGPT demonstrating the lowest level of bias, and was only model to decline to generate content with biased prompts. Furthermore, studies have showed AI-generated content commonly reinforces cultural and linguistic biases, Cao et al. (Cao et al., 2023) reported AI systems represent significant cultural biases, defaulting the American culture and norm even when these systems operated in non-western language and less adaptive to diverse cultural contexts. Nwosu et al. (Oni) found that AI models give preference to worldwide influential languages and cultures, potentially marginalize the rich cultural and linguistic diversity of Nigeria.

5.2. Plagiarism, Academic Integrity, and AI Misuse

Education assisted-Al tools enhance learning and teaching practices by promoting engagement, collaboration, approachability and accessing information. However, their intentional misuse in academic cheating raises growing concerns to standards of academic Integrity (Agha, 2025), which is the cornerstone of educational excellence characterizing the principles of honesty, fairness, and trust (Tripathi & Thakar, 2024). Various advanced AI tool include ChatGPT (Rafiq & Qurat-ul-Ain, 2025), Automatic Article Generator (Abd-Elaal et al., 2022), Article Forge (Alam, 2024) Wordvice and Jasper (Bahari, 2024) use to analyze the data, generate automatic graphs and drafting the manuscript that is closely mimic human writing making it increasingly challenging to detect and potentially deceiving readers. Although AI detection software use like Turnitin and ZeroGPT adopted in universities but concerns persist regarding their efficiency and the ethical allegations (Rafiq & Qurat-ul-Ain, 2025). Weber et al. (Weber-Wulff et al., 2023) performed a comprehensive research on the detection of AI generating writing, revealing that accurate detection is not feasible. Their research produced false positive and false negative results, suggesting that a reassessment of academic assessment strategies is necessary, rather than relying solely on AI detection tools. Kim et al. (Kim, 2024) reported the risk of plagiarism in academic research fabricated by the use of AI. The findings suggest the comparative analysis to evaluate the accuracy of the AI-generated content in academic articles writing. Similar studies reported the academic misconduct plagiarism, in higher education due to easy access to information, student frequently copy and post content from different sources lacking proper citation, resulting in plagiarism (Crawford et al., 2023; King & ChatGpt, 2023; Perkins, 2023; Sullivan et al., 2023). According to Golding et al. (Golding et al., 2024) research, a majority of the college student use AI application for assisgnment task completion and percieved its use as chaeting. A similar case study by Shepherd et al. (Shepherd, 2025) investigated the vulnerability of AI misuse in assessment among the students enrolled in a cyber-security education at a prestigious university of UK Russell Group. The findings indicate that assignments like individual project-based work and report writing from home, were more likely to AI application misuse for task completion. Research recommends that institutions promote AI-resistant assignment formats and raise awareness among students about the ethical use of AI tools. Khatri et al. performed comprehensive

research and reported that Artificial intelligence (AI) has the potential to enhance learning and teaching experiences in higher education by improving productivity, inclusivity, and accessibility. However, its integration must be carefully optimizes to address ethical concerns, ensure academic integrity, and mitigate potential risks, while promoting responsible and equitable use (Khatri & Karki, 2023).

5.3. Reliability and Accuracy of AI-Generated Information

The capability of AI applications to generate smooth and consistent content across various topics, including education and research articles that open new opportunities of content generation. However, the increasing dependence on AI in scientific communication, raises the critical questions regarding the accuracy, quality and reliability of AI-generated content (Maurya & Maurya, 2024). Panda et al. (Panda & Kaur, 2024) studies showed scientific writing particularly medical writing (Ahn, 2024) where accuracy and precision are significant AI models showed notable limitations to reach desired level of accuracy in term of credible source of citations, frequently fabricating misinformation and representing distorting references. Manian et al. (Manian et al., 2024) examine the reliability of information generated by ChatGPT, comparing the result with human perceived information. The findings presented a great difference in information created by AI as compared to human generated responses. More than one third of responses created by ChatGPT were low quality or inferior to their human-generated counterparts. For this problem specific term such as 'hallucination,' 'sequitur,' or 'unrelated response' (Østergaard & Nielbo, 2023) are used to describe the tendency of AI language models that provide irrelevant information (Janéafik & Dusek, 2024). Ashktorab et al. (Ashktorab et al., 2024) reported that large data set lead to 'hallucination, in AI-generated content, that negative impact the data quality, misleading our entirely fabricated information reduce the trust on AI generated content decision making analysis and compromise the its overall effectiveness. The consequences of this imitation are more critical in educational and medical contexts where it's very difficult to distinguish between correct and incorrect information (Janéafik & Dusek, 2024; Manian et al., 2024). Jho et al. (Jho, 2024) explored the impact of AI-generated hallucinations on physics education, the findings revealed that it can undermine the accuracy of information and hinder effective student assessment, feedback, and support processes. Kamel et al. (Kamel, 2024) conducted comprehensive survey in university community and find that 57.1% of respondents encounter AI hallucinations. The most prevalent type of hallucinations was misinformation that 51.6% followed by 28.8% omissions and fabricated information (22.3%). The result revealed that high frequency of AI hallucinations causes' significant challenges particular in academic setting where accurate and complete information is crucial and suggest that student, researcher and faculty recognised limits of AI.

5.4. Teacher Roles and Job Displacement Concerns

The growing integration of AI in education, including virtual learning and automated assessment, raises professional concerns among educators, such as job insecurity and the potential displacement of traditional teaching roles. Alarcon et al. (Alarcón et al., 2025) perform thematic analysis to identify the intensity of concerns, associated with increasing AI integration in teaching and learning environment. The result revealed high level of social and functional concerns among the educators, including potential disruptions to traditional learning systems, information inaccuracies, and changes to their roles and responsibilities. According to the analyses of Kumar, et al. (Kumar et al., 2022) the potential impact of AI to substitute teachers in Indian education as it could provide interactive instruction to student, evaluate their assessment and personalized feedback. While the result indicates that AI enhance the efficiency of education by collaborative approach with traditional teaching methods, but AI cannot completely replace the role of teacher. Due to the emotional and psychological support that teachers provide, which is essential for creating a successful classroom management. Similarly Nikitina et al. (Nikitina & Ishchenko, 2024) reported that tutors resists to adopting AI in teaching activities from concerns about job insecurity and insufficient training to use AI efficiently. Recently Kim et al. (Kim & Lee, 2025) examine the influences of AI-related job insecurity on employee attitudes and workplace environment. The author studies the behaviors of 392 employees from South Korean and finding indicates that fear of job loss negatively affects the productivity, engagement and self-confidence at workplace. Hopcan et al. (Hopcan et al., 2024) teachers from diverse disciplines are willing to adopt AI, but they express anxiety about the potential consequences for their careers and

social life. Research of Jabali et al. (Jabali et al., 2025) revealed that nearly 70% of respondents showed anxiety how AI would affect their roles as teachers in academic settings about the role of teachers due to adoption of AI in academic process. Furthermore, the study showed concerns regarding the autonomy of teachers, as well as the ethical implications of supplementing teachers with AI. Similar result reported by Melweth et al. (Melweth et al., 2024) that deprived of well-planned, human centered AI integration strategy in education may be perceived as a threat to the teaching profession, rather than an enhancement. The above-mentioned studies collectively emphasize that AI integration in education necessitates human oversight and collaboration. While human-AI collaboration can enhance educational efficiency, balanced and effective policies are crucial. Figure 5 shows different concerns and challenges related to AI in education.

5.5. Data Privacy and Security Risks

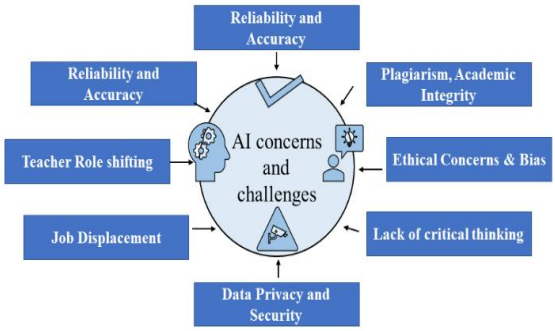

Figure 5: Different Concerns and Challenges Related to AI.

Another significant concern related to AI-powered applications in education is the risk of data privacy and student security breaches (Huang, 2023). AI tools utilize vast amounts of student data, including confidential and personal details, biometric information, academic records, and engagement patterns, to assess performance, provide personalized feedback, and enhance learning outcomes. Though, efficient handling of confidential data raises anxiety about ownership and data security, as the absence of a robust data protection policy increases the risk of misuse of sensitive information (Huang, 2023; Kamenskih, 2022). The other concern surrounding AI applications in education is the potential for unauthorized the other concern from AI applications in education is the unauthorize exploitation of personal information and potential risk of data leakages from the complex architecture of large AI datasets (Piri, 2024). For instance, Paludi et al. (Paludi, 2024) investigate the digital literacy issues like data confidentiality and personal information management. The findings suggest that privacy protection is a complex issue, influenced by factors such as AI system design, individual behaviors, and the subjective perspectives of teachers and students. Educational institutions need to establish operational procedures, follow data protection laws such as GDPR, and offer training courses to teachers and students to protect privacy and personal data effectively. The finding of Kokolakis, et al. (Kokolakis, 2017) revealed that privacy is primary concern in digital time on the other hand people reveal their personal information for very small rewards raising doubts about their concern for privacy. Another comprehensive study reported that the training of Large Language Models (LLMs) on massive datasets with sensitive information creates data privacy concerns, emphasizing the need for updated legislation to tackle the challenges posed by AI in protecting sensitive information (Piri, 2024).

5.6. Lack of Critical Thinking using AI

The cognitive and social impacts of AI are a significant worry for users, as research has shown that teachers are deeply concerned about the potential consequences of AI adoption in education, including the loss of critical thinking, creativity, and emotional intelligence (Alarcón et al., 2025). For example, Abbas et al. (Abbas et al., 2024) investigated the effects of ChatGPT on university students and found that its use was associated with memory loss and academic procrastination, result of this study supported by additional research (Chan, 2023; Yilmaz & Yilmaz, 2023). Gerlich et al. (Gerlich, 2025) conducted a thorough investigation on the effects of AI tool usage on cognitive abilities, surveying and interviewing 666 individuals with varied academic and age-related profiles. The findings showed that frequent AI tool use was linked to poorer cognitive skill development, particularly critical thinking in younger participants. To address this concern, the study suggests that policymakers, faculty members and technologists must work collectively to promote critical thinking growth and balance AI benefits with cognitive skill development (Gerlich, 2025). Further studies reported that AI higher levels of AI use and internet engagement reduced the growth of verbal intelligence and impaired brain tissue maturation (Takeuchi et al., 2018). Similarly, another

investigation showed that a mere six weeks of heavy online engagement led to substantial declines in self-control and decision making abilities (Zhou et al., 2019). Furthermore, a study found that people often turn to computers to answer difficult questions and instead of enhancing the memory they recall the source from where they get information (Sparrow et al., 2011). According to Kim et al. (Kim et al., 2023) unbalanced reliance on AI for academic writing assistance can have a detrimental effect on analytical thinking skills that is vital for problem solving and decision making. Other studies showed that AI have potential to improve cognitive capabilities of critical analysis for this educator should adopt an approach that encourages active learning, depth of understanding, and critical evaluation of AI-powered chatbot information (Danry, 2023; Suriano et al., 2025). Additionally, another serious concerns towards creativity and originality as the AI technology using existing dataset and provide predefined solutions that discourage brainstorming of student and reduced creative exploration. The finding suggests that there should be balance in use AI systems in education to encourage innovation and originality in education (Al-Zahrani, 2024). The quantitatively investigate by Niloy et al. (Niloy et al., 2024) involving 600 students from 10 universities found that the use of AI tools in education has a detrimental effect on creative writing skills of university students. Very recent research findings by Luckin et al. (Luckin, 2025) showed that cultivating critical thinking and creativity in education requires a harmonious blend of AI technology and human interaction. This literature review about the AI use in education reported here conclude that efficient use of AI tools in education can spark the performance of the tutor and learner but at the same time it poses various threat to integrity of educational standards. To mitigate these risks, institutions should embrace the technology and design new policies for optimistic use of AI in assessment, assignment and contextual communications.

5.7. Future Directions and Recommendations

5.7.1. Future Research Areas

The integration of AI with socioemotional learning (SEL) in education holds immense potential for faculty, learner and society, through enhanced self-regulation, self-awareness, interpersonal skill, and supporting teachers in providing personalized guidance, enlightening teaching methods resulting and enhanced academic achievement (Adeli; Shi, 2025). For example, research by Zong et al. (Zong & Yang, 2025) revealed that tailored education according to the social and emotional need of learner lead to boosts student engagement, improved well-being, and better academic outcomes. Similarly, Banu, et al. (Banu) the integration of AI with SEL can be a beneficial educational approach, as adaptive learning and personalization feedback enable AI systems to deliver customized emotional support and learning experiences for students. As long as, it is operating under human oversight and robust security measures. Sethi et al. (Sethi & Jain, 2024) very comprehensively compiled the 487 articles from dataset Web of Science, result described the ongoing research on AI integration improving the socio-emotional learning in education settings. The findings reported various AI technologies like virtual reality apps (Hamzah et al., 2023; Zhang et al., 2023), wearable devices (Ba & Hu, 2023; Micheal et al., 2024), social chatbots (Xiao et al., 2024; Yin et al., 2024), sentiment analysis (Shaik et al., 2023; Zhou & Ye, 2023), and gamification techniques (Fedorova et al., 2023) can support social-emotional learning. These AI techniques provide engaging activities like exercises, emotional regulation training, interactive games, reward systems, and biofeedback mechanisms. While these techniques hold immense promise for improving education, but their adoption is hindered by limitations such as data security risks, privacy concerns, and issues with integrity and emotional authenticity. To address these limitations the development process of AI-SEL system should incorporate diverse expertise and perspectives through interdisciplinary collaborations among ethicists, computer scientists, educators, and psychologists. AI alone is not enough to tackle complex objectives, instead advanced hybrid intelligence systems should be developed with a collaborative approach of machines and humans to get superior results in socio-technically, and both co-evolve and improve over time (Dellermann et al., 2021). Hybrid intelligence systems aim to overcome the current limitations of AI models by developing capabilities for real-time two-way conversations, enabling AI to understand human input, adjust responses, and provide more accurate and relevant information. Human-internalized AI models are being researched to create hybrid intelligence systems that boost human learning and competence, using AI as a collaborative tool to enhance human performance (Cukurova, 2025). Fragiadakis, et al. (Fragiadakis et al., 2024) adopted mixed-methods evaluation techniques to address critical gap in assessing methodologies of hybrid intelligence

systems which pose significant evaluation challenges in both quantitative and qualitative metrics across a variety of sectors due to their complex, constantly evolving, and reciprocal interaction between AI and human. The findings proposed framework provides a structured evaluation approach, breaking down assessments into smaller components, and enabling flexible evaluation of hybrid intelligence systems across diverse contexts. Future work should focus on experimentally validating hybrid intelligence systems through software implementation to harness their full potential in real-world scenarios. Various other types of hybrid intelligence systems along with application and limitation described in Table 2.

Table 2: Various Types of Hybrid Intelligence System.

Types	Working principle	Challenges	Ref.
Collaborative Filtering Models	Combine human and AI input, provide Personalized learning recommendation	Cold start, Privacy, Flaw, Data sparsity	(Feixiang, 2024; Feng, 2024)
Hybrid tutoring Systems	Integrate human teacher with AI system, provide interactive and adaptive learning	Equitable access, Ethical concerns	(Liu et al., 2025; Sleeman, 1984)
Cognitive human AI interaction	Human cognition inspired AI architecture, enable problem solving, expand engagement	Human factor, Bias, Complex integration	(Salas-Guerra, 2025; Tzirides et al.)
Augmented decision making	Integrate human judgment and AI system to create effective and accurate decisions	Trust, transparency, data availability	(Li & Yin, 2024; Noti et al., 2025)
Explainable AI models	AI system design to provide explainable insights into assessment, learning pathway	Technical debt, complexity of models	(Liu et al., 2024; Manna & Sett, 2024)

5.8. Policy and Regulatory Considerations

Artificial Intelligence (AI) is revolutionizing the global landscape, particularly in education, in unprecedented ways. However, the consequences of AI are complex, bringing both benefits and potential harms that can be widespread and devastating. Ethical concerns related to AI are shared by developers, designers, professionals, and end-users. As a result, it is essential to examine current guidelines, educate future professionals on the importance of responsible AI development, and systematically integrate AI ethics into the curriculum to achieve positive outcomes and reduce negative impacts (Borenstein & Howard, 2021; Pedro et al., 2019). Greater than 100 AI ethics codes, policies, and frameworks have been developed through joint efforts of government and non-governmental entities (Gianni et al., 2022; Jobin et al., 2019; Schiff et al., 2021). In 2021, various nations released AI policies across multiple sectors. A comprehensive analysis of 24 AI policy plans by Schiff et al. (Schiff, 2022) revealed that education was rarely discussed in these conversations. Very recently Ghimire et al. (Ghimire & Edwards, 2024) have surveyed 102 vice-presidents of academic affairs and high school principals to examine AI policies in educational settings. The findings revealed significant policy gap in most institutions, high schools were found to be less receptive to adopting guidelines for AI tool usage, in contrast to higher education institutions. The author emphasizes the urgent need of developing effective and flexible policies to ensure safe data use and prevent plagiarism in educational contexts.

Software companies and technological firms like Google (Pichai, 2018), Microsoft (Adetayo et al., 2024), Amazon (Gulson et al., 2021) and many universities (Brabet, 2024; Williams et al., 2024; Wilson, 2025) are working to develop and design frameworks to address the arising ethical concerns of AI in education. The guiding framework of these companies and universities include strategic direction like transparency, data privacy, accountability, security, fairness and safety to maximise the positive use of AI in education. The team of researcher in (Bentley et al., 2023) proposed a comprehensive framework for responsible and ethical integration of AI tools in teaching and learning in educational institutions. Very recently with the collaboration of public and private sectors, National Institute of Standard and Technology (NIST) developed a set of seven flexible principles under the name "AI Risk Management Framework". The document design comprehensive guideline to manage AI risk that impact organizations, individuals and environment and finally conclude that AI responsible practice prioritize social responsibility, human centricity and sustainability (Tabassi, 2023). Moorhouse, et al. (Moorhouse et al., 2023) conducted a detailed review of AI policies and guidelines of 50 world leading higher education institutions. The findings revealed that 50% of the institutions prepared guidelines that are mainly consists of academic integrity, engagement protocols for student and advice on assessment design and these principles are accessible publicly. The findings suggest that higher educational

institutions are actively embrace AI tools in learning and develop corresponding protocols and principles to support their effective implementation in education sector. Atkinson et al. (Atkinson-Toal & Guo, 2024) conduct analysis of AI policies specific to learning and teaching across various universities of UK and find that policy enforcement mechanisms, learning and teaching initiatives and comprehensiveness fluctuates significantly demonstrating their priorities. The research reveals that institutions have different approaches to integrate AI in learning some universities are ready to explore its potential benefits while the others have limited guidance and support.

The research reports suggested that educational institutions should prioritize critical thinking strategies to develop uniform comprehensive AI policies and codes in institutions, ensuring equitable access to AI driven learning experiences which required serious efforts to effectively integrate AI in education sectors.

5.9. The Road Ahead: The Role of AI in Education over the Next Decade

The integration of AI among the educator and learner has increased dramatically between elementary and higher education over the last fifteen years. A comprehensive review of data from 1976 to 2024 by Che et al, (Che Ghazali et al., 2025) showed that AI use in education grow significantly, led by United States and China, emphasizing the importance of AI technologies in education. As AI has potential to enhance quality of education by active management of human and providing personalize learning experiences however how to integrate AI effectively in education sector remain key challenge (Elbek, 2024; Pedro et al., 2019). Popular educational AI tools Robots include Lego Mindstorms and AI tutoring platform have been in use since 18980s, but the recent convergence of Natural Language Processing (NLP) and Machine Learning (ML) has revolutionise the education system in various ways, like enable the teacher to handle class size, harnessing large datasets for learning analytics and providing personalized instruction to individual teaching and learning styles. The adoption of AI at all level is slow due to limited budget, lack of concrete evidence for effective learning, and limited accessibility of ethical regulatory frameworks (Elbek, 2024; Stone et al., 2022). However, it is expected that over next fifteen years the use of AI technologies will become increasingly prevalent in educational settings and home over the next fifteen years, although it is unlikely to fully replace human teaching (Stone et al., 2022). The study of Baig et al. (Baig, 2024) reveals that AI technologies are set to transform higher education in developing countries by reinventing traditional teaching methods due to exceptional quality of AI to digest and analyze the vast datasets. The AI application like research assistance, predictive analytics, automated grading etc. stressing its potential to revolutionize educational practices by enabling restructuring administrative tasks, enhancing learner comprehension and engagement. Predictive analytics harnesses vast datasets to detect early warning signs of student underperformance or dropout, enabling educators to provide target support and interventions that boost retention rates and academic outcomes (Baig, 2024). AI has the ability to solve the exiting gaps of quality education, reduced educational inequality in developing countries. Additionally, AI power accessible tool will improve the learning of student with language barriers, disabilities, and as well as those from low income and minority communities (Rasheed et al., 2025). The widespread adoption of AI poses also challenges like data privacy, ethical consideration, intellectual property, digital divide and algorithmic biases. The successful integration requires a balance approach that prioritizes ethical guideline, and foster collaboration between student, faculty, institutions, and stakeholder (Baig, 2024; Trehan, 2025).

6. CONCLUSION

AI is transforming the educational sector by changing the way knowledge is created, delivered and assessed. AI-based educational tools are making wonders through personalized learning, content generation, automated assessment, and AI-driven chatbots and tutors that not only enhance the accessibility to education but also improve the engagement and efficiency. AI-based tools serve the underserved communities, help in teaching, research and professional development. This shows the transformative potential of AI in making education more inclusive, scalable, and tailored to individual needs.

While AI- powered education offers tremendous potential. It is important to address the associated challenges, including ethical concerns, bias, plagiarism, academic integrity, reliability, and data privacy risks. Furthermore, the over reliance on AI may hinder critical thinking skills. To overcome these limitations human supervised hybrid intelligence systems are recommended. Although framework and codes of ethics are being developed,

further research is necessary to create a comprehensive and uniform approach. A balanced approach must be followed to maximize the benefits of AI in education. There should be interdisciplinary collaboration between educators, AI developers and policy maker to ensure the best outcomes that are human-centric, innovative with highest possible academic integrity. As AI continues to transform the education landscape, institutions must adopt a balanced approach, integrating AI technologies while upholding core values and prioritizing ethical consideration.

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