RESEARCH PAPER

Systematic Review: Generative Artificial Intelligence (GAI) and Artificial Intelligence (AI) and Learning in Elementary and Secondary Schools

[1]Saira Bano* and [2]Syed Atif Mehdi

1. Research Assistant, Faculty of Information Technology and Computer Science, University of Central Punjab (UCP), Lahore, Punjab, Pakistan
2. PhD Scholar, Faculty of Information Technology and Computer Science, University of Central Punjab (UCP), Lahore, Punjab, Pakistan

*Corresponding Author: saira.bano@ucp.edu.pk

ABSTRACT

This study explores GAI's role in school education and its benefits for learning in elementary and secondary school settings. Education is an essential activity for people, communities, and societies and learning is a process for identifying patterns in the information we receive. Generative Artificial Intelligence (GAI) allows for a personalized approach to learning, increasing engagement and motivation. Some prior studies discuss the use of GAI in academic institutes and its effect on students and teachers. This investigation was performed by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) methodology. It was found that the most popular types of manuscripts used to communicate outcomes were journals and conference articles to answer our defined research questions. This study demonstrates that GAI is a valuable tool that enhances educational practices and learning outcomes but does not improve skills. The findings suggest that further research is essential to obtain more conclusive results and fully understand its impact on teaching and learning processes. The additional investigation helps clarify the potential benefits and limitations in schools.

| **KEYWORDS** | School education, Learning, Artificial Intelligence, Generative AI, |

Introduction

Learning is a process of identifying patterns in the information that we receive. Educators use eight different methods to teach students how to recognize and learn from patterns. Primary education is focused on helping students correctly identify existing knowledge and acquire new information. Knowledge management is concerned with the aspects of learning (Muzaffar, 2020; Sisson & Mazzuchi, 2019). In school education, it is common practice to tailor teaching methods to students; learning styles, are often categorized as auditory, visual, and kinesthetic. The idea behind this approach is that it leads to better learning outcomes. for instance, learners are believed to retain information better when it is presented visually. However, while this approach is widely accepted and effective, studies have questioned its validity, and empirical evidence is lacking. Despite this, a on learning styles suggests that students learn better when taught in a way that suits their learning style (Ali et al., 2022).

Education is an essential activity for people, communities, and societies. It faces possibilities and challenges, including frequent disruptions (Muzaffar, 2016). The growth of digitalization has opened up numerous opportunities. The internet provides a vast amount of information and knowledge for students and teachers with internet access, who can comprehend and use it. However, despite decreasing digital divides, as of 2023,

35.4% of the global population still lacked internet access. By 2023, Generative Artificial Intelligence (GAI) had become widespread and garnered significant media attention, as evidenced by inquiries on major search engines worldwide. GAI has been developed for decades with Machine Learning (ML) techniques as its foundation. In November 2022, OpenAI released ChatGPT-3.5, a generative pre-trained transformer (GPT) AI chatbot, making it accessible to a wider audience with internet connectivity and a smartphone or PC. This chatbot powered by Artificial Intelligence (AI) can respond to user input in a way, that feels natural and informative (Jauhiainen & Guerra, 2023).

GAI provides several benefits, depending on the students' ages. Primary school education can help students learn reading, vocabulary, writing, and counting skills from an early age—advanced themes, such as writing styles, grammar, and text analysis. Large Language Models (LLMs) can help make a difficult, lengthy language easier and more concise. For instance, the app can provide personalized feedback, analyze user needs, and evaluate outcomes. This was discovered through a test in which primary school students polished their language. The LLMs can produce questions and prompts that urge students to think critically about what they read and write. Additionally, they can analyze and comprehend offered information, which enhances students' skills. GAI in secondary school education enables personalized content for students in natural sciences, humanities, and languages, tailored to their abilities and interests. This GAI enables a tailored approach to learning, increasing engagement and motivation. LLMs might create practical challenges and quizzes to help students grasp and contextualize study content. GAI enables thorough performance tracking and tailored programming based on individual student capabilities. This individualized approach reduces anxiety and boredom in class, which can lead to dissatisfaction and dropout rates within the educational system (Kasneci et al., 2023).

A recent research study found that incorporating ChatGPT-3 into educational settings can enhance students' engagement and facilitate their capacity to draw connections between different topics being studied.

With the increasing use of AI technologies, the world is experiencing technological advancement. It has expanded beyond its roots in computer science and is now utilized in various fields such as engineering, commerce, art, and science. As a result, it has started to impact many aspects of human life. To thrive in the digital age, individuals must enhance their AI literacy by acquiring new skills (Yue et al., 2022). It intensely impacts our daily lives, and it is also widely acknowledged that AI is among the most disruptive technologies in history. Contrary to popular belief, AI has raised expectations instead of decreasing them. Although general-purpose AI is still a distant reality, it is currently utilized to solve real-world problems in various applications. Young people must comprehend how AI functions to effectively use new technologies in their daily lives, including learning and social interaction (Casal-Otero et al., 2023).

Literature Review

Several studies highlighted AI's potential to support teachers by automating administrative tasks and providing real-time insights into student performance, thus allowing educators to focus more on instruction. However, the literature also reveals significant challenges, such as ethical concerns regarding data privacy, the need for teacher training AI tools, and the risk of over-reliance on technology that could reduce critical human interaction in learning. As Educational Robotics (ER) and virtual tutors grew in popularity, scholars noted both the promise and limitations of these tools in

fostering engagement and promoting STEM skills (Bano et al., 2023), emphasizing that careful implementation and teacher support are essential for effectively integrating AI in classrooms (Rizvi et al., 2023).AI tools with caution and interact with these GAI technologies creatively and critically. This contrast reflects the broader debate regarding integrated AI technologies in the educational sectors, as stakeholders attempt to weigh the potential benefits and hazards. Existing research on GAI such as ChatGPT has proved its ability to promote learning outcomes comparable to those attained by human instructors, by delivering personalized feedback and instructions. Teachers have been shown to utilize ChatGPT more frequently than students for different purposes, including creating lesson plans, examinations, and example solutions (Elkhodr et al., 2023).

Methodology and Material

We used the Preferred Reporting Items Systematic Reviews and Meta-analysis (PRISMA) (Moher et al., 2009) methodology for this study. This systematic approach provides a robust framework for comprehensively understanding the topic and drawing meaningful conclusions. PRISMA methodology ensures that the study adheres to established standards for a quality review. To gather relevant literature, we utilized three online databases, enriching the breadth and depth of our literature search. Our study was meticulously structured around two specific research questions:

Search Strategy

Initially, we tried searching using the ("Learning GAI" OR "School education") AND ("Learning" OR Artificial Intelligence") AND ("primary OR elementary") AND ("secondary school" OR "middle school") Keywords, on IEEE (Institute of Electrical and Electronics Engineering) Xplore advanced search from November 2022 to October 2024, displayed in Table 1.

Table 1
Search Articles Using the Keywords

Database	Keywords
IEEE Explore	("Learning GAI" OR "School education") AND ("Learning" OR Artificial Intelligence") AND ("primary OR elementary") AND ("secondary school" OR "middle school")
ACM Digital Library	("Learning GAI" OR "School education") AND ("Learning" OR Artificial Intelligence") AND ("primary OR elementary") AND ("secondary school" OR "middle school")
Google Scholar	("Learning GAI" OR "School education") AND ("Learning" OR Artificial Intelligence") AND ("primary OR elementary") AND ("secondary school" OR "middle school")

Finally, we obtained 232 articles from 3 databases, IEEE (Institute of Electrical and Electronics Engineering) Explore, ACM (Association for Computing Machinery) Digital Library, and Google Scholar database. 17 articles were repeated. 42 articles had no full-text availability. There were 173 articles screened by title and abstract and 57 were unrelated to our topic. The 101 articles that have full-text available. Many articles were removed due to other reasons (including books, chapters, dissertations, and reviews), such as higher education, undergraduate and college students learning high school education, the industry needs and involvement analysis, reports, and learning related to disability, gesture, teaching approach, space engineering industrial impact for digitalization, design, and challenges and digital education. However, only 7 articles were suitable for demonstrating the effectiveness of digital learning, as shown in Figure 1.

Inclusive and Exclusive Criteria

We have incorporated articles that cover various aspects, of AI and GAI in school settings. We have excluded books, chapters, dissertations, reviews, and reports on industrial and related to other fields of AI and GAI, particularly those related to high schools and higher education or intended for professional purposes.
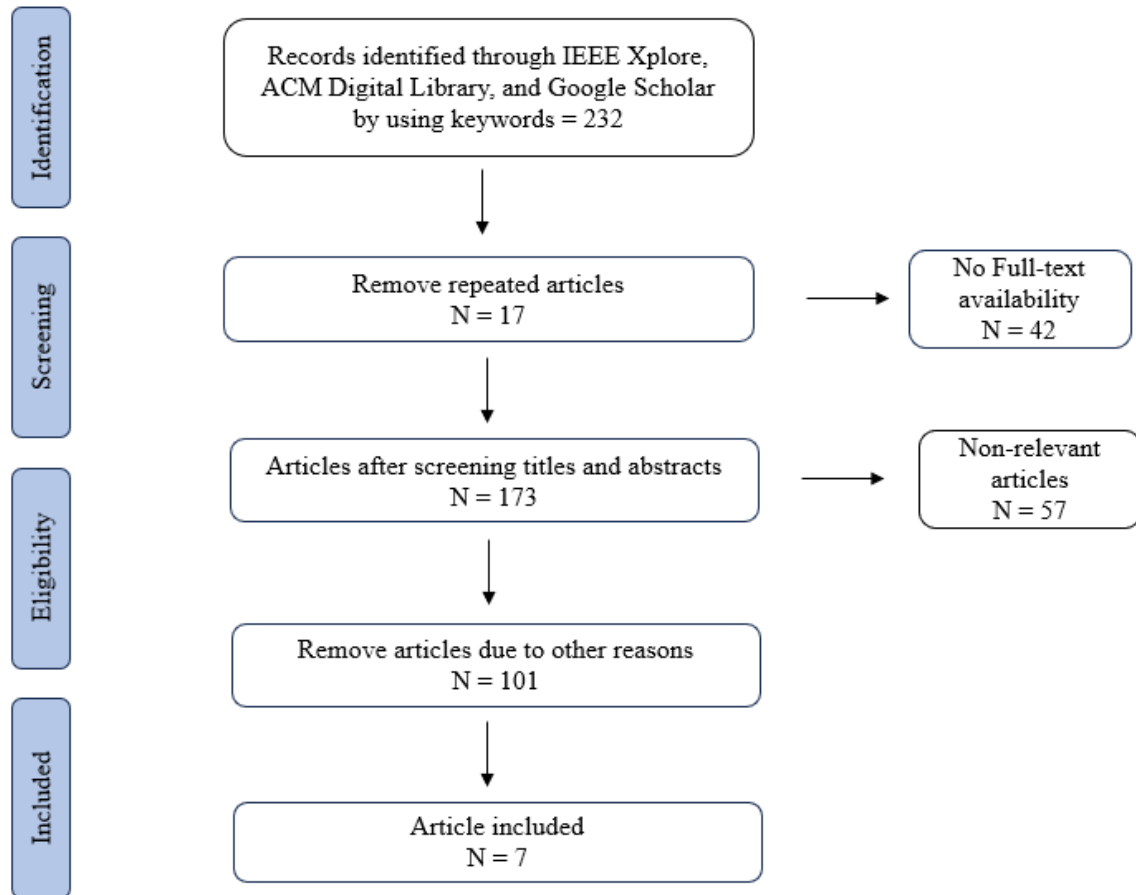

Figure 1
The Flowchart of the PRISMA Methodology

Results and Discussion

This section will discuss the results and answer the two research questions: Is GAI a new assistive tool or does it enhance learning skills in school education? And, what is the effectiveness of AI in elementary and secondary student learning? We also provide additional relevant information.

Artificial Intelligence (AI) and GAI in School Education

Artificial Intelligence (AI) is a computer science field that seeks to create intelligent machines capable of mimicking human behavior and mental processes. Algorithms enable machines to learn from data, make smart decisions, and solve problems. AI can be divided into two categories: narrow AI and generative AI. Narrow AI focuses on specific tasks that a human can do. Narrow AI focuses on specific tasks, such as facial recognition or online, whereas general AI can perform any cognitive task that a human can. GAI algorithms create new content based on real-world data patterns. These models have significant applications in natural language processing, computer vision, and brain imaging. GAI techniques have contributed to the production of high-quality creative work. Visual arts, music, literature, films, and animation are all examples

of media. AI technology is transferred to inventive processes, especially in education. The collaboration, analogies, and scaffolding can help 5th graders understand AI concepts without programming skills. Educational theories like constructivism can provide an optimal learning environment (Relmasira et al., 2023).

Despite their limits, ChatGPT and other generative AI are rapidly transforming education. Some have advocated banning ChatGPT in schools, while others are developing software to detect AI-generated text. Teachers can use strategies to discourage students from using ChatGPT to write essays and assignments. The New York (NYC) Education Department prohibited ChatGPT on school devices and networks, preventing students and teachers from assessing it. Advanced generative AI, such as GTP-5, may outperform current techniques shortly. ChatGPT offers personalized coaching, automated easy gardening, language translation, interactive learning, and adaptive learning, making it a potentially effective tool for improving education (Baidoo-anu & Ansah, Owusu, 2023). Large language models, such as ChatGPT, have the potential to revolutionize teaching and the learning approach. For example, it aids personalized learning, lesson planning, language acquisition, research, and writing. It also helps professional growth, assessment evaluation, and students' familiarity with AI issues. LLMs in education are a promising study field that can improve students' learning and support teachers utilizing these models in education, it's important to exercise caution and understand their limitations and biases. Integrating LLMs into education requires strict privacy, security, environmental, and ethical considerations, as well as continual human supervision and direction (Kasneci et al., 2023).

The 21st century has seen a significant shift in educational techniques, driven by technological advancements like AI. Advancements in ML have enabled advanced digital content generation. GAI is an unsupervised or partially supervised ML system that generates man-made relics using statistics and probabilities. GAI uses Deep Learning (DP) to build artificial relics from digital content, including video, image/graphics, text, audio, and video. Training examples are analyzed to understand patterns and distribution. The literature identifies two important GAI models: GAN and Generative Pre-trained Transformer (GPT). GAN is now the most prevalent GAI technique employed. GAN employs two neural networks, a generator, and a discriminator network (Baidoo-anu & Ansah, Owusu, 2023).

Children's ability to ask curiosity-driven inquiries enhances their learning. Curiosity means the desire to know, or experience that motivates exploratory behavior towards acquiring new knowledge. It is an important aspect that positively affects the individuals' learning experiences and consequences. It indicates that classrooms can foster curiosity by teaching students to be comfortable with ambiguity and ask questions to answer it (Abdelghani et al., 2024).

AI education interventions teach students in grades K-12 AI concepts and applications. Initially, AI was introduced as self-improving autonomous computers that could tackle problems that were reserved to be solved by humans. It is important to note that ML is just one aspect of AI, and the two terms are often confused. ML refers to algorithms that can recognize patterns from vast amounts of data and develop models to forecast (Rizvi et al., 2023). AI has brought about a significant change in various aspects of human life, through its rapid technological advancement. GAI is taking place in many educational fields, particularly, medical and engineering education. The applications of GAI in education are vast and include personalized learning support, evaluation, and intelligent tutoring systems. However, the GAI in education has sparked debates on ethical

concerns, academic integrity, and the potential to transform teaching and learning. As GAI continues to evolve, it is crucial to study its effects, benefits, and limitations to determine its future in education(Bahroun et al., 2023).

By 2023, it will have been three years since the release of the GPT-3 large language model, less than two years since the Codex model, less than a year since the Copilot plug-in for generating code directly within an IDE, five months since the ChatGPT chatbot interface, and one month since their release. A working group was formed when the computing education community was still adjusting to the widespread use of GAI technologies by students and the general public. New models and techniques bring challenges and opportunities, raising important questions about adaptation. How will students' motivation to learn and retention be affected if they can create solutions to programming coursework? (Prather et al., 2023).

GAI a New Assistive Tool or Does it Enhance Learning Skills in School Education

The ChatGPT is a large language model that has the potential to make a significant impact in the field of education. There are several specific ways in which Chat GPT can be used to improve learning and resources that support it. These include personalized tutoring, automated grading, language translation, interactive learning, and adaptive learning. However, it also has some deficiencies, such as lack of personal interaction, limited understanding, bias in training data, lack of creativity, dependency on data, limited ability to personalize instruction, and privacy concerns. Overall, it can be powerful for enhancing teaching and learning. It's important to know its limitations and use it with other teaching methods prioritizing human interaction and understanding (Baidoo-anu & Ansah, Owusu, 2023).

Despite the benefits of GAI technologies such as ChatGPT in an educational context, educators, researchers, and policymakers continue to argue their potential benefits and downsides. This is primarily because, as some teachers have stated, these GAI tools might be exploited by students who want to cheat. Other instructors have expressed worry that AI technologies could misinform students by giving them inaccurate information, prompting calls to ban and restrict their use in school education. ChatGPT supports, on the other hand, believe it provides an opportunity to teach students how to use AI tools with caution and interact with these GAI technologies (Elkhodr et al., 2023).

Education stakeholders share their perspectives on the advantages of using GAI systems for teaching literacy in elementary schools, GAI systems can create customized lesson plans, including mentor texts, that teachers can adjust to each student's needs and skill level. These systems provide relevant and timely feedback for writing assignments and encourage new ideas (Han et al., 2024).

Numerous studies have investigated the potential and challenges of GAI tools in many settings, including education. Several studies have looked into the broader application of AI, highlighting the benefits, drawbacks, and ethical implications of implementing GAI technology in various scenarios. GAI in scientific writing necessitates careful consideration and comprehension. ChatGPT's effectiveness is also being evaluated in other areas (Elkhodr et al., 2023).

The Effectiveness of AI in Elementary and Secondary Students' Learning

AI-powered chatbots like ChatGPT and Bing Chat are increasingly valuable in education and provide unique opportunities for students to address learning challenges. Computing education's future involves the use and impact of GAI and LLM-based tools, adapting teaching methods, and updates to academic integrity policies. It also calls for collaboration to shape computing education for the common good amidst its rapid evolution (Prather et al., 2023). The focus of education has shifted to preparing students for industries that use AI. Research in Science, Technology, Engineering, Arts, and Mathematics (STEAM) education should investigate the impact of thinking. This approach prepares them to adapt to changing job requirements and real-life situations (How & Hung, 2019).

AI belongs to the benefits of advanced technologies such as ML and neural networks to solve problems. It can combine knowledge from various fields, providing an opportunity to enhance children's learning experiences by using multiple technologies simultaneously. Computers interact with children through gesture, touch, and speech, AI enables young learners to access digital content and services. However, there is limited research on how preschool teachers can intentionally improve children's learning using AI technologies. Moreover, there is a lack of studies on teaching AI to young children who don't have prior knowledge of computer programming and robotics. Teaching AI to young learners poses several challenges for early childhood educators. There is a need to figure out how AI is relevant to early childhood learning, identify concepts children can grasp, and engage children in meaningful experiences that help them acquire these core concepts (Yang, 2022).

Technologies are becoming more common and are impacting our daily lives. Educators are realizing the importance of AI education, as it can help students improve literacy, apply knowledge to solve real-life problems, and develop fundamental skills, along with critical and ethical reflection on the role and use of AI in society. It can positively affect the learning outcomes of young learners, motivating them and building positive attitudes. Effective teaching methods, hands-on activities, investigation with other subjects, and addressing misconceptions are ways to promote successful AI education (S. J. Lee & Kwon, 2024). It is critical to create an AI curriculum that appeals to all age groups providing comprehensive information, and develop dynamic and engaging learning materials aligned with K-12 educational objectives. Although difficult it is critical to combine AI academic knowledge with practical experience. Relatively sophisticated topics, such as reinforcement learning, were deemed both difficult and interesting. Similarly, students' interest and perception of AI-powered agents improved after they created them during one of the AI training sessions (Rizvi et al., 2023).

The ChatGPT is a large language model in the educational field. There are several specific ways in which ChatGPT can be used to improve learning and resources that support it. These include personalized tutoring, automated grading, language translation, interactive learning, and adaptive learning. However, it has some edge in education, such as lack of personal interaction, limited understanding, bias in training data, lack of creativity, dependency on data, limited ability to personalize instruction, and privacy concerns. Overall, it can be powerful for enhancing teaching and learning. It's important to note its limitations and use it with other teaching methods that categorize human interaction and understanding. ChatGPT garnered over one million users within just one week of its official launch on November 30, 2022. This GAI tool surprised the global community with its remarkable ability to execute complex tasks. However, the paper also identified some flaws in ChatGPT, such as inaccurate

information. This contrasting situation suggested that policymakers, educators, and technology professionals collaborate and engage in discussions to address these issues (Baidoo-anu & Ansah, Owusu, 2023). The following point indicates that ChatGPT is a tool, but technically it does not support skill enhancement. In the future, it may be possible to enhance skills by adding some new features, creating a few solutions with options, and combining them to solve problems, but currently, it is just a tool. It's important to use it carefully, particularly in scientific fields.

There is a lot of potential to improve how we develop and encourage children's interest in AI. Every topic in AI can be taught at different levels of complexity. One possible solution is to simplify the process by hiding certain actions within a "black box." Previous studies have shown that children can comprehend ML processes with multiple steps, such as data labeling and evaluation. However, learning about just one building block of ML doesn't lead to a complete understanding. Despite the potential of IoT and Robotics to enhance student engagement and teach AI concepts, there remains a dearth of research on technologies in AI educational programs. We must explore and develop strategies for integrating AI education programs that effectively incorporate cutting-edge technologies (Rizvi et al., 2023). It is essential to prepare young learners to become aware citizens and competent workers in the era of AI. To achieve this, workshops can be helpful for middle school students and are crucial for shaping their interest and perspectives on AI and its related careers (I. Lee et al., 2021). .

GAI has ethical and societal implications. It can create Deepfakes and spread misinformation. It is challenging our understanding of AI systems as socio-technical systems. GAI-generated media is easily available on social media platforms, especially among children who may not be aware of its presence. Previous research has highlighted the importance of digital media and AI literacy among children. Therefore, GAI methodologies introducing secondary school students to and encouraging critical discussions about their societal and ethical implications are crucial (S. Ali et al., 2021). Teachers' positivity towards GAI contradicts the current literature on technology integration in instruction. Teachers often hesitate to integrate emerging technologies due to their complexity and breadth and may lack certain competencies such as comfort and open-mindedness (Kaplan-Rakowski et al., 2023).

Conclusion

This study presents a comprehensive review of the latest literature on GAI, focusing on its impact on educational territory. The study delved into the context: of GAI, as a cutting-edge trend in school education. We used the PRISMA methodology to conduct this literature review.

The review included an analysis of 232 articles that discussed the role of GAI as a tool in elementary and secondary education, especially in grades 5 to 8. However, the study emphasized that only a limited number (7 studies) provided an evaluation, which hindered a more comprehensive analysis. The investigation revealed a lack of empirical evidence concerning the use of GAI in elementary and secondary education, and further research is needed in this area.

In this literature review, the defined two research questions were thoroughly addressed with detailed analysis and insight. ChatGPT model that has the potential to impact education. There are several specific ways that ChatGPT can be used to improve learning and the resources that support it. AI-powered chatbots like ChatGPT and Bing Chat are increasingly useful in education and provide special opportunities for students

to address learning challenges. These chatbots offer benefits like interactivity, personalization, and a better understanding of topics and create a comprehension of the principles and concepts of robotics and automation.

It's important to acknowledge that the study was based on 7 articles identified using specific research criteria in three databases. It was noted that using alternative databases may have yielded additional relevant articles. Therefore, the study is best viewed as an initial exploration rather than a comprehensive overview.

Recommendations

The review brought attention to several other significant points. AI is a field of computer science that aims to create intelligent machines that can change human behavior and thinking processes. GAI algorithms generate new content based on real-world data patterns. Its technique has helped produce high-quality creative work. The study also provided insight into the role of GAI as a supportive learning tool, highlighting that its current impact on enhancing skills is limited. It is anticipated that GAI may contribute to skill development in the future. The study showed that at present, it primarily serves as a tool. Educators and stakeholders are actively considering its potential and further investigation is necessary to understand its impact. The study aims to offer valuable guidance to educators and researchers in the field of education.

References

Abdelghani, R., Wang, Y. H., Yuan, X., Wang, T., Lucas, P., Sauzéon, H., & Oudeyer, P. Y. (2024). GPT-3-Driven Pedagogical Agents to Train Children's Curious Question-Asking Skills. *International Journal of Artificial Intelligence in Education*, *34*(2), 483–518. https://doi.org/10.1007/s40593-023-00340-7

Ali, S., DiPaola, D., Lee, I., Sindato, V., Kim, G., Blumofe, R., & Breazeal, C. (2021). Children as creators, thinkers and citizens in an AI-driven future. *Computers and Education: Artificial Intelligence*, 2, 100040. https://doi.org/10.1016/j.caeai.2021.100040

Ali, Z., Mankash, M. A., & Ullah, N. (2022). Journal of Educational Research & Social Sciences Review (JERSSR). *Journal of Education Research & Social Sciences Review*, *2*(3), 45–54.

Bahroun, Z., Anane, C., Ahmed, V., & Zacca, A. (2023). Transforming Education: A Comprehensive Review of Generative Artificial Intelligence in Educational Settings through Bibliometric and Content Analysis. *Sustainability (Switzerland)*, *15*(17). https://doi.org/10.3390/su151712983

Baidoo-anu, D., & Ansah, Owusu, L. (2023). Education in the Era of Generative Artificial Intelligence (AI): Understanding the Potential Benefits of ChatGPT in Promoting Teaching and Learning. *Journal of AI*, *7*(1), 52–62. https://doi.org/10.61969/jai.1337500

Bano, S., Atif, K., & Mehdi, S. A. (2023). Systematic review: Potential effectiveness of educational robotics for 21st century skills development in young learners. *Education and Information Technologies*, 1–19. https://doi.org/10.1007/S10639-023-12233-2/TABLES/2

Casal-Otero, L., Catala, A., Fernández-Morante, C., Taboada, M., Cebreiro, B., & Barro, S. (2023). AI literacy in K-12: a systematic literature review. *International Journal of STEM Education*, *10*(1). https://doi.org/10.1186/s40594-023-00418-7

Elkhodr, M., Gide, E., Wu, R., & Darwish, O. (2023). ICT students' perceptions towards ChatGPT: An experimental reflective lab analysis. *STEM Education*, *3*(2), 70–88. https://doi.org/10.3934/steme.2023006

Han, A., Zhou, X., Cai, Z., Han, S., Ko, R., Corrigan, S., & Peppler, K. (2024). Teachers, Parents, and Students' Perspectives on Integrating Generative AI into Elementary Literacy Education. *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3613904.3642438

How, M. L., & Hung, W. L. D. (2019). Educing AI-thinking in science, technology, engineering, arts, and mathematics (STEAM) education. *Education Sciences*, *9*(3). https://doi.org/10.3390/educsci9030184

Jauhiainen, J. S., & Guerra, A. G. (2023). Generative AI and ChatGPT in School Children's Education: Evidence from a School Lesson. *Sustainability (Switzerland)*, *15*(18), 1–22. https://doi.org/10.3390/su151814025

Kaplan-Rakowski, R., Grotewold, K., Hartwick, P., & Papin, K. (2023). Generative AI and Teachers' Perspectives on Its Implementation in Education. *Journal of Interactive*

Learning Research, *34*(2), 313–338.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*(January). https://doi.org/10.1016/j.lindif.2023.102274

Lee, I., Ali, S., Zhang, H., Dipaola, D., & Breazeal, C. (2021). Developing Middle School Students' AI Literacy. *SIGCSE 2021 - Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, 191–197. https://doi.org/10.1145/3408877.3432513

Lee, S. J., & Kwon, K. (2024). A systematic review of AI education in K-12 classrooms from 2018 to 2023: Topics, strategies, and learning outcomes. *Computers and Education: Artificial Intelligence*, *6*(February), 100211. https://doi.org/10.1016/j.caeai.2024.100211

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Journal of Clinical Epidemiology*, *62*(10), 1006–1012. https://doi.org/10.1016/j.jclinepi.2009.06.005

Muzaffar, M. (2016). *Educational Institutions and Political Awareness in Pakistan: A Case of Punjab*, Unpublished Ph. D Dissertation, International Islamic University Islamabad, Pakistan

Prather, J., Denny, P., Leinonen, J., Becker, B. A., Albluwi, I., Craig, M., Keuning, H., Kiesler, N., Kohn, T., Luxton-Reilly, A., MacNeil, S., Petersen, A., Pettit, R., Reeves, B. N., & Savelka, J. (2023). The Robots are Here: Navigating the Generative AI Revolution in Computing Education. In *ITiCSE-WGR 2023 - Proceedings of the 2023 Working Group Reports on Innovation and Technology in Computer Science Education*. https://doi.org/10.1145/3623762.3633499

Relmasira, S. C., Lai, Y. C., & Donaldson, J. P. (2023). Fostering AI Literacy in Elementary Science, Technology, Engineering, Art, and Mathematics (STEAM) Education in the Age of Generative AI. *Sustainability (Switzerland)*, *15*(18). https://doi.org/10.3390/su151813595

Rizvi, S., Waite, J., & Sentance, S. (2023). Artificial Intelligence teaching and learning in K-12 from 2019 to 2022: A systematic literature review. *Computers and Education: Artificial Intelligence*, 4(January), 100145. https://doi.org/10.1016/j.caeai.2023.100145

Sisson, P. W., & Mazzuchi, T. (2019). Bloom's taxonomy of educational objectives: A template for primary school KM education. *Proceedings of the European Conference on Knowledge Management, ECKM*, *2*(September), 949–957. https://doi.org/10.34190/KM19.059

Yue, M., Jong, M. S. Y., & Dai, Y. (2022). Pedagogical Design of K-12 Artificial Intelligence Education: A Systematic Review. *Sustainability (Switzerland)*, *14*(23), 1–29. https://doi.org/10.3390/su142315620