"From Tradition to Innovation: The Evolution of Education through Artificial Intelligence".

Georgios Natsiopoulos

Educational Consultant for Science (Physics), Greek Ministry of Education, Eastern Thessaloniki

Abstract
Through the evolution of Artificial Intelligence (AI) it is found that, over the years, it significantly affects various sectors, including education. More specifically, it revolutionizes education by enhancing learning experiences through personalized and adaptive learning approaches that meet students' individual needs and learning styles. Traditional teaching methods differ significantly from AI-based adaptive learning systems, which transform traditional course materials into adaptive learning streams by reformulating, restructuring and enriching content to improve educational outcomes. AI-based tools such as intelligent teaching systems, speech recognition and natural language processing frameworks facilitate real-time feedback and create inclusive learning environments, eliminating barriers for students with disabilities and different learning abilities. Collaborative learning is also enhanced, in the context of AI education, as these technologies promote a more interactive and engaging learning environment. However, integrating AI into education presents multifaceted challenges, including ethical concerns about data privacy, algorithmic bias, and the digital divide, which require careful consideration and strategic management. Despite these challenges, AI-based adaptive learning systems have been shown to significantly improve student outcomes by enabling personalized learning experiences and promoting critical thinking and creativity. The role of teachers is also transforming, as artificial intelligence helps prepare teaching materials, presentation media, and accurate assessments, allowing teachers to focus more on facilitating and guiding student learning than traditional teaching. Future trends in AI education are multifaceted, promising continuous developments and innovations that will further enhance personalized learning and education resources. Overall, thoughtful integration of AI into education has the potential to significantly improve educational outcomes and empower a generation of lifelong learners equipped for the challenges of the 21st century.
Keywords: Artificial intelligence, education, teaching methods, learning tools, innovation.

I. Introduction

The historical development of Artificial Intelligence has been quite recent, with its birth being traced back to the mid-20th century while its roots can be traced back to the 1950s, in McCulloch and Pitts. The idea of artificial intelligence was crystallized by Alan Turing, in his famous work of the 1960s. Although its origins are relatively recent, there are still some influences that have contributed greatly, albeit indirectly, to the conceptualization of artificial intelligence. The genesis of AI can be credited to the contributions of different academic fields, history, art, philosophy, logic, and mathematics (Y. Xu et al., 2021;   Muggleton, n.d.).

Artificial intelligence, too, is perhaps unique among engineering subjects in that it has raised very basic questions about the nature of computing, perception, reasoning, learning, language, action, interaction, consciousness, humanity, life. At the same time, it has contributed substantially to answering these questions in such a way that, in fact, it is sometimes seen as a form of empirical research.

Classic theoretical debates have mainly focused on issues such as whether machines can think, or whether artificial intelligence can solve certain problems such as, for example, "Can a machine manage an unknown x?". Meanwhile, technical artificial intelligence systems have advanced massively and are now visible and perceptible in many aspects of our environment and our daily lives.

The educational landscape is one of the areas that AI has significantly transformed. This is achieved by offering innovative solutions to enhance teaching and learning processes as well as to improve student performance. These developments aim not only to enhance the effectiveness of education systems but also to reduce teachers' workload and provide better learning experiences for students. In addition, AI is revolutionizing education by enhancing learning experiences, transforming teaching methodologies and promoting inclusion, thus preparing students to adapt to the digital age. At the same time, it significantly transforms traditional teaching methods by introducing personalized, adaptive, and more effective learning strategies in various educational areas. Its role, therefore, in education is poised to lead to the next major digital transformation, fundamentally changing the way we teach, learn and evaluate educational outcomes (Onesi-Ozigagun et al., 2024; Harry, 2023).

The paper focuses on models and teaching methods regarding the use of artificial intelligence in education. In fact, it aims to investigate students' academic performance, synthesize and clarify the methodologies and tools of artificial intelligence used in teaching, as well as the findings, consequences and limitations of future research. This comprehensive review highlights the transformative potential of AI in education while acknowledging the need for continuous innovation and improvement.

Teaching methods

Artificial intelligence (AI) significantly enhances personalized learning in education by adapting educational experiences to students' individual needs and abilities. AI-driven adaptive learning systems analyze student performance data to create customized learning methods. In doing so, they ensure that students receive content at their pace and level of understanding, which improves their engagement and academic performance (Ou, 2024; Katiyar et al., 2024).

In addition, AI-powered assessment tools provide real-time feedback and insights into students' level of understanding, moving beyond traditional exams to more dynamic assessment methods. In special education, AI adapts content and resources to meet the specific needs of students with disabilities, promoting inclusion and creating accessible learning environments. Adapted learning methods based on artificial intelligence have also been shown to improve academic achievements, learning attitudes and self-directed learning abilities, enhancing the overall educational process (Owan et al., 2023; Olabisi Oluwakemi Adeleye et al., 2024; Aballa et al., 2024).

The integration of artificial intelligence in education has led to the development of Automated Grading of Learning Systems (AGLS), which not only reduces teachers' workload by providing timely feedback but also encourage students to become self-directed. Recent advances in genetic artificial intelligence technologies, such as large language models, further enhance adaptive learning by offering sophisticated tools that can dynamically adapt educational content based on student performance in real time (Messer et al., 2023; Yan et al., 2024).

The combination of these methods promises to significantly improve educational outcomes by making learning more effective and relevant to each student's unique needs. Thus, adaptive learning through artificial intelligence is not only about personalized education but also about equipping students with the appropriate knowledge and skills in order to navigate and contribute to an increasingly AI-driven world (Katiyar et al., 2024).

Traditional teaching methods and adaptive AI-based learning approaches differ significantly in several key areas, including personalization, feedback, pace, and creation of educational content. Traditional methods often follow a one-size-fits-all model, where the same material is delivered to all students at a standardized pace, but which may fail to meet individual needs and the appropriate learning model.

In contrast, AI-based adaptive learning systems leverage machine learning algorithms and natural language processing to provide personalized learning experiences. These elements can enhance students' participation and motivation while aligning with their interests and goals. Also, they can constantly monitor and adapt to the evolving needs of students. However, the implementation of AI-based adaptive learning also faces challenges such as insufficient training for teachers, limited access to technology and the need for effective content to ensure the success of the system (Banerjee, 2023).

Another method is collaborative learning in education, which harnesses the advantages of AI technologies to improve teaching methodologies and learning experiences. More specifically, a collaborative teaching approach based on artificial intelligence has been proposed in order to provide personalized and practical learning experiences. Thus, the potential of artificial intelligence to innovate in teaching practices related to various disciplines is demonstrated. In addition, the use of artificial intelligence in collaborative activities within e-learning environments can significantly improve learning outcomes and develop soft skills. At the same time, it can help create heterogeneous groups of students, ensuring effective collaboration and thus improving learning and teaching (Olabisi Oluwakemi Adeleye et al., 2024).

Collaborative learning approaches in AI can significantly improve teacher-student interaction in the classroom while leveraging various tools and methodologies based on it. At the same time, artificial intelligence technologies such as ChatGPT can facilitate active learning models, including blended and collaborative learning, thus reshaping teachers' roles from traditional educators to facilitators and advocates of learning. All this enhances, among teachers, confidence and acceptance of learning methods using artificial intelligence. This finding helps teachers understand and use AI knowledge to improve teaching practices and interactions with students (Heathen & Lin, 2024).

Learning tools

AI-based learning tools can modify traditional course materials by rephrasing, restructuring and enriching content in order to use them on various learning platforms. Despite promising developments, challenges remain in improving these tools in order to produce high-quality educational content and ensure their effective implementation in different educational settings. These tools also leverage AI's ability to tailor educational content to students' individual needs, thus promoting a deeper understanding and retention of the material (Triberti et al., 2024; Sani et al., 2024).

Regarding the integration of Virtual Reality (VR) in education, with the help of artificial intelligence, not only enhances academic competence but also significantly improves students' motivation by providing exciting experiential learning experiences. For example, in a biotechnology course, the VR intervention showed higher student engagement and improved learning outcomes compared to traditional methods, as students actively participated in simulated laboratory environments, which increased their curiosity and motivation. In addition, AI-driven VR environments can create high-quality educational content (Z. Xu, 2024; Tene et al., 2024).

The combination of VR and AI not only improves academic proficiency but at the same time enhances critical thinking and problem-solving skills by allowing students to explore and analyze information, independently, in a virtual environment. This innovative approach not only boosts engagement but also improves information retention by offering an immersive and interactive educational experience. Overall, the convergence of artificial intelligence and virtual reality in educational tools has huge potential to transform traditional educational methods and promote deeper understanding and engagement among learners (Z. Xu, 2024).

An additional tool such as gamification incorporates game design elements into educational contexts, making learning more engaging and more interactive. Games also provide students with support tools that improve overall classroom performance, Educational tools linked to the use of games, significantly improve students' learning and academic performance by providing personalized learning methods and adaptive learning scenarios . Artificial intelligence tools such as ChatGPT offer instant feedback and target interactive learning environments that are combined with games to develop advanced problem-solving skills and gain personalized learning experiences (Neerupa et al., 2024; Heathen & Lin, 2024).

Gamification significantly enhances the contribution of AI to education by increasing student participation, motivation and understanding of complex concepts through interactive elements. The hybrid gaming framework, which integrates artificial intelligence, machine learning, and the Adaptive Neuro-Fuzzy Inference System (ANFIS), personalizes the learning experience by monitoring student interactions and performance, thereby allocating rewards, based on progress while promoting a more engaging environment. This approach not only helps to identify students who struggle in some subjects as well as high achievers but also leads to maximizing student success. These gamification strategies, therefore, create a dynamic and effective learning environment that not only enhances the understanding and retention of AI concepts but also prepares students for practical applications in their future careers (Narayanan & Kumaravel, 2024).

Intelligent tutoring systems (ITS) are revolutionizing education by providing personalized and adaptive learning experiences that mimic teachers. These tools enhance autonomous learning for students and at the same time reduce the time teachers spend designing teaching content. For example, MaThia, an AI-based ITS, has shown significant improvements in student performance in math by creating personalized lessons based on students' emotions, progress, and learning preferences. In addition, ITS tools such as live chatbots, adaptive personalized teachers, and image-based learning have transformed traditional education systems, making them more interactive and inclusive, especially for students with learning disabilities. The integration of ITS into educationally oriented games further engages students in a personalized learning system that adapts based on the actions of the game, thus improving educational effectiveness (Ozbey et al., 2023; He, 2024; Hirankerd & Kittisunthonphisarn, 2020;Hare et al., 2023).

Hybrid learning environments such as Smart Groups facilitate collaboration by automating team building. They also support communication between students by proposing collaborative learning patterns, thus ensuring effective coordination between groups Overall, intelligent teaching systems not only enhance the teaching-learning experience but also encourage critical thinking and student participation, paving the way for a more effective educational landscape (Martín et al., 2022).

Integrating AI into education – Benefits and challenges

The integration of AI in education offers many benefits that significantly enhance the learning process, teaching methodologies and administrative processes. AI also supports teachers by automating administrative tasks such as grading, creating interactive lessons and providing real-time feedback. This allows teachers to focus more on facilitating learning and developing critical thinking skills from students.

AI-based adaptive learning systems personalize learning experiences by analyzing student performance data to create customized learning paths. In addition, they ensure that the content of each subject is delivered at the appropriate pace and at the appropriate level of understanding, which improves student participation and academic performance. The meta-analysis of adaptive learning systems combined with artificial intelligence shows a medium to large degree of positive effect on students' cognitive learning outcomes compared to non-adaptive interventions, indicating significant benefits in terms of learning effectiveness (Katiyar et al., 2024).

However, the application of artificial intelligence (AI) in education also presents a multifaceted series of challenges that require careful consideration and strategic management. One of the main challenges is data privacy and security, as educational institutions collect and analyze vast amounts of data related to students, raising concerns about potential abuse and breaches. Moreover, the complexity of AI systems and the difficulty of understanding and interpreting algorithmic results further complicate their adoption, requiring extensive training

and support for teachers. It is therefore appropriate to highlight the need for a balanced approach that integrates artificial intelligence without undermining the human element of teaching. When it comes to updating curricula to include AI disciplines and developing new assessment metrics for adaptive teaching techniques, these are additional obstacles. These issues need to be addressed by policymakers in order to ensure the effective integration of AI into education (Mohammed Elam Physician, 2024).

Despite these challenges, AI is called upon to transform education by enhancing personalised learning, supporting teachers and improving administrative efficiency, provided these issues are addressed with diligence and ethical foresight. Therefore, a collaborative effort between AI developers, educators and policymakers is essential to harness the potential of AI while mitigating its risks and ensuring that AI serves the education community responsibly and fairly.

Future trends in the application of AI in education are multifaceted, reflecting a significant shift towards personalised, attractive and ethical, healthy, learning environments. A prominent trend is the adaptation of artificial intelligence to educational experiences and individual needs of students, enhancing learning outcomes and active student engagement. The potential of AI to revolutionize online learning platforms is important, offering benefits such as quick responses, learning support and smart educational content creation that can transform the way teachers teach, and students learn. However, ethical considerations, including data privacy and bias, remain critical challenges that need to be addressed to ensure the effective and responsible use of AI in education (Katiyar et al., 2024; Sumanth et al., 2024).

II.   Conclusions

The role of teachers, and education in general, is significantly transformed with the integration of artificial intelligence, allowing them to shift from traditional teaching methods to more facilitative and supportive roles. Artificial intelligence technologies, such as intelligent teaching systems, are reshaping teacher-student dynamics, promoting active learning models such as collaborative learning. This change requires professional development and institutional support to help teachers successfully transition into these new roles. Moreover, the role of AI in education is crucial, offering personalized learning and adaptive systems that enhance teachers' readiness for the future based on it. This includes improved accessibility and data-driven decision-making, which are crucial to prepare teachers to meet the demands of modern educational environments.

This development highlights the potential of AI in shaping teachers' personal teaching abilities and enhancing their effectiveness in the classroom. Overall, integrating AI into education not only automates routine tasks but also enables teachers to focus on more meaningful aspects of education, thus enriching the learning process for students.

Further research on the use of AI in education should focus on several key areas to maximise its potential and address existing challenges. In addition, research needs to delve deeper into the ethical aspects of the use of AI, particularly regarding privacy and security, as these are critical issues in the global digital landscape. Further investigation is also needed to balance its benefits with concerns about academic integrity and intellectual development.

By addressing these issues, future research can provide a holistic understanding of the role of AI in education, ensuring that its application improves learning processes while mitigating potential risks.

References

[1].   Aballa, A. N., Ojo, A. O., & Eneh, O. A. (2024). Impact of artificial intelligence in achieving quality education. *In Artificial intelligence and education - Shaping the future of learning* (Working title). IntechOpen. https://doi.org/10.5772/intechopen.1004871

[2].   Banerjee, S. (2023). The evolving role of artificial intelligence in education: The past, present and future. *International Journal of Multidisciplinary Educational Research, 12* (5), Sucharitha Publication. https://doi.org/10.1109/FIE58773.2023.10343378

[3].   *Harry, A. (2023). Role of AI in education. Injuruty: Interdisciplinary Journal and Humanity, 2(3). e-ISSN: 2963-4113, p-ISSN: 2963-3397.* https://injurity.pusatpublikasi.id/index.php/in

[4].   He, W. (2024). Design and Application of Intelligent Teaching System Based on Artificial Intelligence Technology. *International Conference on Distributed Computing and Optimization Techniques, ICDCOT 2024.* https://doi.org/10.1109/ICDCOT61034.2024.10515855

[5].   Heathen, T. S., &; Lin, D. E. (2024). *A Review on the Perks of Using Chatgpt in Education.* https://doi.org/10.20944/preprints202406.1060.v1

[6].   Hirankerd, K., & Kittisunthonphisarn, N. (2020). E-learning management system based on reality technology with AI. *International Journal of Information and Education Technology*, *10*(4), 259–264. https://doi.org/10.18178/ijiet.2020.10.4.1373

[7].   Katiyar, Prof. Dr. N., Awasthi, Mr. V. K., Pratap, Dr. R., Mishra, Mr. K., Shukla, Mr. N., singh, Mr. R., & Tiwari, Dr. M. (2024). Ai-Driven Personalized Learning Systems: Enhancing Educational Effectiveness. *Educational Administration Theory and Practices.* https://doi.org/10.53555/kuey.v30i5.4961

[8].   Martín, A. C., Alario-Hoyos, C., & Delgado Kloos, C. (2022). Smart Groups: A system to orchestrate collaboration in hybrid learning environments. A simulation study. In *Australasian Journal of Educational Technology* (Vol. 38, Issue 6).

[9].   Messer, M., Brown, N. C. C., Kölling, M., & Shi, M. (2023). Machine Learning-Based Automated Grading and Feedback Tools for Programming: A Meta-Analysis. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE, 1*, 491–497. https://doi.org/10.1145/3587102.3588822

[10].   Elam, K. M., (2024). Exploring the Challenges and Future Directions of Big Data and AI in Education. *Journal of Artificial Intelligence General Science (JAIGS) ISSN:3006-4023, 5*(1), 81–93. https://doi.org/10.60087/jaigs.v1i1.173

[11]. Narayanan, K. S., & Kumaravel, A. (2024). Hybrid Gamification and AI Tutoring Framework using Machine Learning and Adaptive Neuro-Fuzzy Inference System. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *42*(2), 221–233. https://doi.org/10.37934/araset.42.2.221233

[12]. Neerupa, C., Naveen Kumar, R., Pavithra, R., & John William, A. (2024). Game on for learning: a holistic exploration of Gamification's impact on student engagement and academic performance in educational environments. *Management Matters*. https://doi.org/10.1108/manm-01-2024-0001

[13]. Olabisi Oluwakemi Adeleye, Chima Abimbola Eden, & Idowu Sulaimon Adeniyi. (2024). Innovative teaching methodologies in the era of artificial intelligence: A review of inclusive educational practices. *World Journal of Advanced Engineering Technology and Sciences*, *11*(2), 069–079. https://doi.org/10.30574/wjaets

[14]. Onesi-Ozigagun, O., Ololade, Y.J., Eyo-Udo, N.L., & Ogundipe, D.O. (2024). Revolutionizing education through AI: A comprehensive review of enhancing learning experiences. *International Journal of Applied Research in Social Sciences, 6*(4), 589–607. https://doi.org/10.51594/ijarss.v6i4.1011

[15]. Ou, S. (2024). Transforming Education: The Evolving Role of Artificial Intelligence in The Students Academic Performance. *International Journal of Education and Humanities*, *13*(2).

[16]. Owan, V. J., Abang, K. B., Idika, D. O., Etta, E. O., & Bassey, B. A. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. In *Eurasia Journal of Mathematics, Science and Technology Education* (Vol. 19, Issue 8). Modestum LTD. https://doi.org/10.29333/ejmste/13428

[17]. Ozbey, A. Y., Shakhzoda Mubinova, Mohamed Abdelgadir, & Merve Kevser Gokgol. (2023). Revolutionizing education: A study on Intelligent Tutoring Systems in U.S education. *London Journal of Social Sciences*, *6*, 152–157. https://doi.org/10.31039/ljss.2023.6.117

[18]. Sani, J., Kamal, M., Biswas, T. K., Chowdhury, S., Roy, S., & Sarwar, S. (2024). Technologies Used in Education. In *IJFMR240322020* (Vol. 6, Issue 3). www.ijfmr.com

[19]. Sumanth, N. S., Priya, S. V., Sankari, M., & Kamatchi, K. S. (2024). AI-Enhanced Learning Assistant Platform. *7th International Conference on Inventive Computation Technologies, ICICT 2024*, 846–852. https://doi.org/10.1109/ICICT60155.2024.10545011

[20]. Tene, T., Guevara, M., Moreano, G., Vera, J., & Gomez, C. V. (2024). The Role of Immersive Virtual Realities: Enhancing Science Learning in Higher Education. *Emerging Science Journal*, *8*(Special Issue), 88–102. https://doi.org/10.28991/ESJ-2024-SIED1-06

[21]. Triberti, S., Di Fuccio, R., Scuotto, C., Marsico, E., & Limone, P. (2024). "Better than my professor?" How to develop artificial intelligence tools for higher education. *Frontiers in Artificial Intelligence*, *7*. https://doi.org/10.3389/frai.2024.1329605

[22]. Xu, Y., Liu, X., Cao, X., Huang, C., Liu, E., Qian, S., Liu, X., Wu, Y., Dong, F., Qiu, C. W., Qiu, J., Hua, K., Su, W., Wu, J., Xu, H., Han, Y., Fu, C., Yin, Z., Liu, M., Zhang, J. (2021). Artificial intelligence: A powerful paradigm for scientific research. In *Innovation* (Vol. 2, Issue 4). Cell Press. https://doi.org/10.1016/j.xinn.2021.100179

[23]. Xu, Z. (2024). AI in education: Enhancing learning experiences and student outcomes. *Applied and Computational Engineering*, *51*(1), 104–111. https://doi.org/10.54254/2755-2721/51/20241187

[24]. Yan, L., Martinez-Maldonado, R., & Gasevic, D. (2024). Generative Artificial Intelligence in Learning Analytics: Contextualising Opportunities and Challenges through the Learning Analytics Cycle. *ACM International Conference Proceeding Series*, 101–111. https://doi.org/10.1145/3636555.3636856