

ARTIFICIAL INTELLIGENCE'S (AI) EFFECT ON STUDENTS' ACADEMIC PROGRESS

Dr. T. Prabakaran¹, A. Sindhu Devi², Dr. Pandi M.³, Sunil Kumar Mannil⁴, Dr. Ajay Kumar Varshney⁵

¹Associate Professor, Department of Computer Science and Engineering, Joginpally B. R. Engineering College, Moinabad, Hyderabad, Telangana, India. Email: prabaakar.t@gmail.com/drtprabakarancse@jbrec.edu.in

²Department of Computer Science and Business Systems, Jerusalem College of Engineering, Chennai, Tamil Nadu, India. Email: sindhudevivenkadesh24@gmail.com

³Professor, Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam, Tamil Nadu, India. Email: mpandi123@gmail.com

⁴Assistant Professor, Department of English, Central University of Kashmir, Jammu and Kashmir, India. Email: sunilvenkulam@gmail.com

⁵Professor, KL Business School, Koneru Lakshmaiah Education Foundation, Green Fields, Vaddeswaram Campus, Guntur District, Andhra Pradesh, India. Email: varshneyak@rediff.com ORCID: 0000-0002-1191-1016

Corresponding Author: Dr. T. Prabakaran

Abstract: Artificial Intelligence (AI) holds great promise for the education sector, revolutionizing how teaching and learning are experienced, and improving the results for students. The education sector is being transformed by the use of Artificial Intelligence (AI) which is improving both the learning and teaching experience and the outcomes of both students and schools. This study investigates how Artificial Intelligence (AI) influences students' achievements in the context of undergraduate students. A quantitative research design was employed, and a structured questionnaire was used in collecting the data, which included 109 respondents. Data obtained were subjected to statistical treatment namely descriptive statistics, reliability analysis, correlation and regression analysis in SPSS. These results highlight the potential of AI to positively impact students' results and confirm its value in improving the efficiency of learning, accessibility to education, and academic outcomes. The study finds that when used appropriately and responsibly, AI can be a valuable tool in enhancing academic results and suggests that there should be a push for responsible use of AI within the education sector.

Keywords: Artificial Intelligence, AI in Education, Students' Academic Progress, Academic Performance, Higher Education

1. INTRODUCTION

Artificial Intelligence (AI) is the technological capability of machines and computer programs to emulate human intelligence, such as learning, reasoning, problem-solving, decision-making and language understanding. AI technologies are powered by the use of machine learning, natural language processing, and sophisticated algorithms to process information, provide answers to queries, and help users in academic and professional tasks. Over the last few years, the fast development of AI technologies has revolutionized many industries, and education is certainly one of them. ChatGPT, Google Gemini, Microsoft Copilot, Grammarly, and QuillBot are some of the most well-used AI tools by students for a variety of tasks, including writing assignments, research, writing improvement, idea generation, and complex idea comprehension. These advancements have positioned AI as a crucial asset in education, assisting students on their learning path.

AI's role in education has revolutionized the way teaching and learning are conducted, creating smart and personalized learning spaces. Through adaptive learning, intelligent tutoring systems, automated assessment, content recommendation, and virtual academic assistance, AI allows learners to experience personalized learning, thereby



helping them understand and learn more quickly at their own level and speed. AI-powered technologies are gaining traction in educational settings around the globe to boost teaching and learning quality, optimize learning processes, and foster student engagement. Unlike traditional educational methods, AI-driven learning systems can offer instant feedback, ongoing assistance, and customized content, enabling students to consolidate their grasp of academic material and enhance their educational outcomes.

AI tools have transformed academic processes by being widely integrated among students. Students search for information using AI-powered applications, summarize research articles, prepare academic presentations, translate languages, improve their grammar, solve mathematical problems, and receive explanations on difficult topics regularly. The tools save time in accessing information, help students to simplify complex content and allow students to learn outside the classroom. The development and advancement of AI tools will shape the future of education and learning, further defining their role in student education. AI technologies will continue to evolve and play a crucial role in students' learning experiences, both individually and collectively.

Student learning progressions are defined as the ongoing development of learning outcomes, academic achievement, knowledge building, critical thinking, problem solving and student's overall educational performance over time as learning occurs. Typical indicators of academic achievement include higher-order thinking abilities, grade point averages, participation in class, quality of work on assignments, and scores on tests. Academic progress is affected by a range of factors: learning strategies; technological resources; motivation; and educational support systems. The advent of AI-driven education technologies has created new possibilities for improving students' learning outcomes through the quick, personalized academic support offered and the easy access to learning materials.

Overall, with respect to students' academic progress, AI has potential to be very useful in recentering and enhancing personalized learning, improving learning efficiency and offering nearly instant academic support. AI systems process students' learning patterns to offer tailored recommendations, adaptive learning materials, intelligent tutors, and real-time feedback, improving conceptual understanding and students' learning outcomes. AI-powered tools can help students understand complex concepts, practice problem-solving, organize their studies and get support to supplement classroom learning. In conclusion, AI can create a more student-centric learning environment, enhance engagement, and lead to better educational results by providing students with access to high-quality education resources on-demand and off-the-grid.

Although AI in education offers great educational potential, it also comes with its challenges. Students might become disheartened in their abilities to think, create, analyze and solve problems without relying on AI tools. Relying too heavily on AI tools could diminish students' capacities for independent thinking, creativity, analysis, and problem-solving. Plagiarism and academic dishonesty, misinformation, algorithmic bias, and data privacy have become the key ethical problems in the use of AI in education. Moreover, a digital divide in access to digital technology, lack of AI literacy among students and teachers and lack of clear institutional policies may prevent optimal implementation of AI in educational settings. The challenges remind us of the need to encourage responsible and ethical AI use and ensure that AI does not become a substitute for students' learning activities.

Meanwhile, Artificial Intelligence provides several benefits to improve the teaching and learning experience. AI allows for personalized learning experiences by tailoring educational content to students' learning capabilities, preferences, and academic needs. It gives instant feedback, helps accessibility to the learning resources, helps continuous learning, helps academic productivity and helps independent learning. AI can also support educators by automating mundane administrative activities, creating learning materials, tracking student progress, and offering data-driven insights to enhance instruction. These capabilities enhance student engagement, effectiveness of learning and academic achievement.

Based on these developments, the present study examines the effect of Artificial Intelligence (AI) usage on students' academic progress among undergraduate students. The study focuses specifically on the relationship between the use of AI and students' academic progress, as well as the advantages and disadvantages of the use of AI in education. The independent variable is Artificial Intelligence (AI) Usage and the dependent variables are Students'

Academic Progress, Benefits of AI in Learning, and Challenges of AI in Education. The study takes the perspective that increased usage of the AI tools will have a positive impact on students' academic achievement, aiming to enhance the efficiency of student learning and students' learning outcomes, while also taking into account the ethical and practical issues surrounding the use of AI in higher education. This conceptual model offers a theoretical lens to explore how AI affects students' learning using a quantitative statistical approach.

2. LITERATURE REVIEW

Vieriu et,al (2025) The integration of Artificial Intelligence (AI) in education has transformed academic learning, offering both opportunities and challenges for students' development. This study investigates the impact of AI technologies on students' learning processes and academic performance, with a focus on their perceptions and the challenges associated with AI adoption. Conducted at the National University of Science and Technology POLITEHNICA Bucharest, this research involved second-year students who had direct experience with AI-enhanced learning environments. Using purposive sampling, 85 participants were selected to ensure relevance. Data were collected through a structured questionnaire comprising 11 items as follows: seven closed-ended questions assessing perceptions, usage, and the effectiveness of AI tools; and four open-ended questions exploring experiences, expectations, and concerns. Quantitative data were analyzed using frequency and percentage calculations, while qualitative responses were subjected to thematic analysis, incorporating both vertical (individual responses) and horizontal (cross-dataset) approaches to ensure comprehensive theme identification. The findings reveal that AI offers significant benefits, including personalized learning, improved academic outcomes, and enhanced student engagement. However, challenges such as over-reliance on AI, diminished critical thinking skills, data privacy risks, and academic dishonesty were also identified. The study underscores the necessity of a structured framework for AI integration, supported by ethical guidelines, to maximize benefits while mitigating risks. In conclusion, while AI holds immense potential to enhance learning efficiency and academic performance, its successful implementation requires addressing concerns related to accuracy, cognitive disengagement, and ethical implications. A balanced approach is essential to ensure equitable, effective, and responsible learning experiences in AI-enhanced educational environments.

Ayeni et,al (2024) The integration of Artificial Intelligence (AI) in education has ushered in a transformative era, redefining traditional teaching and learning methods. This review explores the multifaceted role of AI in education, with a particular focus on personalized learning and educational technology. The synergy between AI and education promises to address individualized needs, enhance student engagement, and optimize learning outcomes. Personalized learning, enabled by AI algorithms, tailors educational experiences to the unique needs, preferences, and pace of each student. This approach goes beyond a one-size-fits-all model, fostering a more inclusive and effective learning environment. The review delves into the diverse applications of AI-driven personalized learning, ranging from adaptive content delivery and real-time feedback to intelligent tutoring systems. It analyzes the impact of these technologies on student performance, highlighting the potential to narrow educational gaps and cater to diverse learning styles. Educational technology, powered by AI, extends beyond the classroom, encompassing online platforms, virtual reality, and interactive tools. The review explores the integration of AI in curriculum development, content creation, and assessment methods, offering insights into how these technologies augment the teaching and learning experience. Furthermore, the review examines the role of AI in automating administrative tasks, allowing educators to redirect their focus towards personalized instruction. Challenges and ethical considerations associated with the adoption of AI in education are also scrutinized. Privacy concerns, algorithmic biases, and the digital divide are discussed, emphasizing the importance of responsible AI implementation. The review underscores the need for collaborative efforts among educators, policymakers, and technologists to establish ethical guidelines and ensure the equitable distribution of AI-enhanced educational resources. This review provides a comprehensive examination of the evolving landscape of AI in education, with a spotlight on personalized learning and educational technology. As the symbiosis between AI and education continues to evolve, this synthesis of current research and trends aims to guide future developments, fostering an informed and progressive approach to the integration of AI in the educational sphere.

García-Martínez et,al (2023) Artificial intelligence (AI) and computational sciences have aroused a growing interest in education. Despite its relatively recent history, AI is increasingly being introduced into the classroom through different modalities, with the aim of improving student achievement. Thus, the purpose of the research is to analyse, quantitatively and qualitatively, the impact of AI components and computational sciences on student performance. For this purpose, a systematic review and meta-analysis have been carried out in WOS and Scopus databases. After applying the inclusion and exclusion criteria, the sample was set at 25 articles. The results support the positive impact that AI and computational sciences have on student performance, finding a rise in their attitude towards learning and their motivation, especially in the STEM (Science, Technology, Engineering, and Mathematics) areas. Despite the multiple benefits provided, the implementation of these technologies in instructional processes involves a great educational and ethical challenge for teachers in relation to their design and implementation, which requires further analysis from the educational research. These findings are consistent at all educational stages.

Asri et,al (2024) This study investigates the transformative potential of Artificial Intelligence (AI) in higher education, focusing on its impact on student achievement, equity, and systemic educational improvements. It explores how AI facilitates personalized learning, addresses educational disparities, and aligns academic outcomes with societal and workforce demands. A qualitative approach using a Systematic Literature Review (SLR) method was employed to synthesize insights from recent peer-reviewed studies. The research analyzed the integration of AI into higher education, examining pedagogical strategies, systemic challenges, and ethical considerations. The findings reveal that AI significantly enhances student engagement and academic performance by personalizing learning experiences. It also supports educators by automating routine tasks, enabling more focused student interaction. AI can potentially democratize access to quality education, particularly in underserved regions. However, challenges such as resistance to change, technological infrastructure limitations, and ethical concerns related to data privacy and algorithmic bias were identified. The discussion emphasizes the need for ethical frameworks and inclusive policies to ensure effective and responsible AI integration. This study provides practical insights for universities, policymakers, and technology developers. Institutions are encouraged to invest in infrastructure, align curricula with AI advancements, and train educators in AI applications. Policymakers should support digital literacy initiatives and equitable technology access. These measures highlight AI's capacity to create more inclusive, adaptive, and sustainable higher education systems, underscoring its transformative role in modern education.

Akoi, et,al (2025) In this research, we analyze how ChatGPT, an artificial intelligence-based tool, might affect academic outcomes. The chosen title succinctly conveys the central focus of the article, providing a clear and comprehensive overview of the exploration into how ChatGPT, as a representation of artificial intelligence, is influencing students' academic achievement within the context of the evolving educational landscape. The study applied quantitative research method. Incorporating AI-based solutions like ChatGPT has been shown to improve individualized education, according to the study's findings. Ethical issues, including data privacy and bias, are also highlighted as crucial when employing AI-based tools in the classroom. The results demonstrated that artificial intelligence-based tools like ChatGPT could significantly improve teaching and learning. Moreover, it is crucial to make sure that ethical considerations direct the integration and that instructors and educators are given the proper training to use the tools successfully to encourage individualized learning.

- **Research gap**

Existing literature shows that Artificial Intelligence (AI) can significantly enhance students' learning experiences, engagement, and performance by providing personalized learning, intelligent tutoring systems, and AI-driven education tools. Previous research has largely concentrated on the overall advantages and applications of AI in education, ethical implications, and the challenges faced by AI in education, alongside systematic literature reviews and qualitative methods. While there are some empirical research studies that study students' perception and the use of AI, little research has quantitatively investigated the direct link between the use of AI and the students' academic growth by statistical methods such as correlation and regression analysis. In addition, there is a lack of evidence on the amount and type of AI use of undergraduates and on the impact of AI on academic outcomes both positive and negative. Hence, this study fills this void with an empirical study of the influence of the use of Artificial Intelligence

(AI) on students' academic achievements among the undergraduate students; utilizing a structured questionnaire and statistical analysis with SPSS.

3. OBJECTIVES

- To evaluate the impact of Artificial Intelligence (AI) on Students' Academic Performance.
- To measure the extent of Artificial Intelligence (AI) being used by students.
- To discover the merits of Artificial Intelligence (AI) in the learning process.
- To make recommendations for the proper use of Artificial Intelligence (AI) in educational domain.

4. RESEARCH METHODOLOGY

The method used was correlational research design, which was designed to examine how the use of Artificial Intelligence (AI) impacted students' academic achievement among undergraduate students. The study's objective was to identify the relationship between the use of AI and the students' academic development using quantitative analysis. The target users were undergraduate students of various disciplines who are using Artificial Intelligence tools for the purpose of learning.

The instrument of data collection was a structured questionnaire survey which contained the independent variable (IV) section, and dependent variable (DV) section on a 5-point Likert Scale. The items pertaining to the use of Artificial Intelligence (AI) were adapted from the items developed by Mayer, J. (2023). Items from the questionnaire on Students' Academic Progress were adapted from A., & Fernández-Escobar, J. (2023). The following items were taken from M., & Abramowitz, B. and adapted for use in the context of Benefits of AI in Learning. The items reflecting the Challenges of AI in Education were adapted from Mi, W. (2023).

Using an online questionnaire, a total of 115 questionnaires were sent to the undergraduate students. At the end of the data collection period 109 valid questionnaires were retrieved of which 94.78% were suitable for analysis. The data collected were analyzed by the Statistical Package for the Social Sciences (SPSS) Version 29. In this research, the statistical analysis conducted were descriptive demographic analysis, reliability analysis, Pearson correlation analysis and simple linear regression analysis.

Table 1: Questionnaire Design

Variable	No. of Items	Adopted From
Artificial Intelligence (AI) Usage (IV)	9	Mayer, J. (2023)
Students' Academic Progress (DV1)	9	A., & Fernández-Escobar, J. (2023)
Benefits of AI in Learning (DV2)	6	M., & Abramowitz, B. (2023)
Challenges of AI in Education (DV3)	6	Mi, W. (2023)

5. RESULTS

The analysis involves demographic characteristics of the subjects, reliability analysis, correlation analysis, regression model summary and regression coefficient analysis to examine the impact of Artificial Intelligence (AI) on students' academic growth.

Demographic Profile

A demographic analysis of the respondents was conducted using frequency analysis in terms of their gender, age, current CGPA, and how often they used AI for academic work. In total, 109 undergraduate students took part in the study.

Table 2: Demographic Profile of Respondents (N = 109)

Variable	Category	Frequency	Percentage
Gender	Male	31	28.4
	Female	78	71.6
	Total	109	100.0
Age (Years)	18–20	4	3.7
	21–23	84	77.1
	24–26	21	19.2
	Total	109	100.0
Current CGPA	2.01–3.00	14	12.8
	3.01–4.00	95	87.2
	Total	109	100.0
Frequency of AI Usage	Rarely	7	6.4
	Occasionally	41	37.6
	Always	61	56.0
	Total	109	100.0

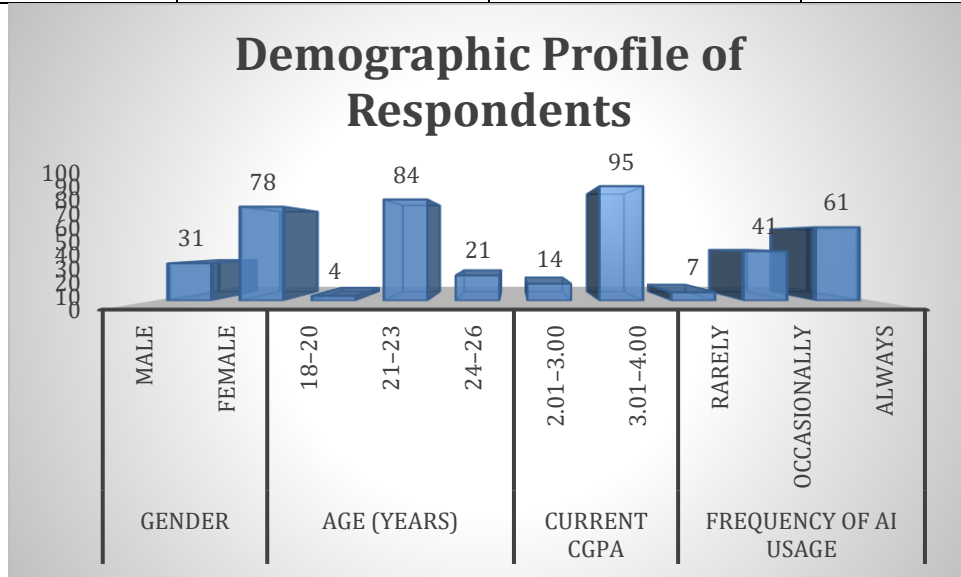
**Figure 1: Demographic Profile of Respondents**

Table 1 shows the demographic profile of the respondents. The majority of respondents were female (78, 71.6%) and 31 (28.4%) were male. As far as age is concerned, majority (84, 77.1%) of the respondents were in the age group of 21-23 years followed by 21 (19.2%) who were 24-26 years old, while 4 (3.7%) were in the age group of 18-20 years. With respect to academic performance, the majority (95; 87.2%) had a CGPA between 3.01 and 4.00, while 14 (12.8%) had a CGPA between 2.01 and 3.00. When asked about the use of AI for studying purposes, 61 students (56.0%) said they always use AI, 41 students (37.6%) said they occasionally use AI and 7 students (6.4%)

said they rarely use AI for studying. This indicates that AI has become a frequently used learning tool among undergraduate students.

Reliability and Correlation Analysis

Cronbach Alpha was used to assess the internal consistency of the measurement scales in this study. Cronbach's Alpha value of > 0.70 is considered as good reliability.

Table 3: Reliability and Correlation Analysis

Variables	Mean	SD	1	2	3	4
1. AI Usage	4.05	0.69	(0.886)			
2. Students' Academic Progress	4.01	0.63	.618**	(0.891)		
3. Benefits of AI	3.89	0.61	.581**	.602**	(0.874)	
4. Challenges of AI	3.14	0.67	-.214*	-.236*	-.198*	(0.852)

The internal consistency is satisfactory for all constructs based on the reliability analysis. The items with the highest Cronbach's Alpha values were the items pertaining to AI Usage (0.886), Students' Academic Progress (0.891), Benefits of AI (0.874), and Challenges of AI (0.852). All the alpha coefficients were found to be above the recommended level of 0.7, thus the measurement instrument was considered reliable. The correlation analysis showed that there was a significant positive relationship between AI Usage and Students' Academic Progress with a correlation coefficient of $r = 0.618$, $p < 0.01$, indicating that with the increase of AI Usage the Academic Progress of students also increased. AI Usage was also moderately positively correlated with the Benefits of AI ($r = 0.581$, $p < 0.01$). A weak negative correlation was found between AI Usage and Challenges of AI ($r = -0.214$, $p < 0.05$): students who use AI more often are less likely to perceive challenges when using AI.

Model Summary of Regression Analysis

Simple linear regression analysis was used in order to explore the effects of AI Usage on Students' Academic Progress.

Table 4: Model Summary of Regression Analysis

Dependent Variable	R ²	Adjusted R ²	F	Sig.
Students' Academic Progress	0.382	0.376	66.143	<0.001

Table shows that 38.2% ($R^2 = 0.382$) of the variation in Students' Academic Progress can be explained by AI Usage. The adjusted R^2 value (0.376) indicates that the regression model is stable. The regression model was statistically significant ($F = 66.143$, $p < 0.001$), and this means that students' academic progress is significantly predicted by AI Usage. The remaining 61.8% of the variance is due to other factors which are not measured in this present study.

Regression Coefficient Analysis

The influence of AI Usage on Students' Academic Progress was done using regression coefficient analysis.

Table 5: Regression Coefficient Analysis

Variables	Standardized Beta	t-value	Sig.
-----------	-------------------	---------	------

AI Usage → Students' Academic Progress	0.618	8.133	<0.001
--	-------	-------	--------

The regression coefficient analysis shows that AI Usage has a significant positive impact on Students' Academic Progress ($\beta = 0.618$, $t = 8.133$, $p < 0.001$). This indicates that more educational progress is happening with the increased adoption of AI tools. The study's results indicate that AI technologies provide aid to students and helps to optimize their learning processes, thereby making educational resources more accessible and improving overall educational results. Hence, the null hypothesis is rejected and it is concluded that AI Usage significantly affects students' academic progress.

6. DISCUSSION

The results of this research show that Artificial Intelligence (AI) has great positive impact on students' academic development. Based on these findings, it is concluded that using AI tools regularly can be beneficial for improving learning efficiency, accessibility to academic materials, and the understanding of course content, which ultimately aids in achieving better academic outcomes. The study also reveals that there are more positive than negative experiences for students in using AI for learning purposes. Thus, it is important that higher educational institutions foster the responsible use of AI by integrating the use of AI-supported learning activities into teaching and assessment as well as by offering training on AI literacy and by establishing clear AI policies that guarantee that AI should be used as a method to support learning and not to replace it. However, there are other factors that could be investigated in future studies to better understand the impact of AI on academic achievement, including digital literacy, autonomy in learning and motivation.

7. CONCLUSION

This study aimed to explore the impact of Artificial Intelligence (AI) on students' academic achievement in university context, specifically focusing on the relationship between the use of AI and academic results of undergraduate students. The results showed that there was a strong positive effect of the use of AI tools in education on students' learning outcomes, suggesting that the more often teachers use the tools created by AI, the better the educational results. The study also shows how AI can help with learning, by making educational content easily accessible, offering personal help, giving immediate feedback, and aiding in grasping academic topics. Some of the implications of using AI, including ethical considerations and reliance on AI, were raised but were perceived as having a lesser impact compared to the educational advantages. The overall results indicate that AI is an effective and valuable learning aid which has a positive impact on the academic development of the students. The research suggests that when AI is used in a responsible and ethical manner within the educational context of higher education, it can enhance the efficiency of learning and academic achievement, and equip students with the necessary digital skills to thrive in the contemporary educational landscape. Thus, the educational institutions must foster AI literacy, set up proper protocols for responsible use of AI, and consider implementing AI-assisted learning techniques to make the most of the educational value of AI while upholding academic integrity and critical thinking.

REFERENCES

1. Akoi, S., Ismael, F., & Naseri, T. (2025). Artificial Intelligence and the Future of Education: The impact of ChatGPT on Students' academic achievement. *QALAAI ZANIST SCIENTIFIC JOURNAL*, 10(1), 1169-1193.
2. Asri, A. (2024). Utilization of artificial intelligence in improving student achievement. *Paradoks: Jurnal Ilmu Ekonomi*, 7(4), 451-465.
3. García-Martínez, I., Fernández-Batanero, J. M., Fernández-Cerero, J., & León, S. P. (2023). Analysing the impact of artificial intelligence and computational sciences on student performance: Systematic review and meta-analysis. *Journal of New Approaches in Educational Research*, 12(1), 171-197.
4. Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalized learning and educational technology. *GSC Advanced Research and Reviews*, 18(2), 261-271.
5. Vieriu, A. M., & Petrea, G. (2025). The impact of artificial intelligence (AI) on students' academic development. *Education Sciences*, 15(3), 343.

6. Von Garrel, J., & Mayer, J. (2023). *Artificial intelligence in studies: Use of ChatGPT and AI-based tools among students in Germany*. Humanities and Social Sciences Communications, 10(1), 1–9.
7. Xu, X., Dugdale, D. M., Wei, X., & Mi, W. (2023). *Leveraging artificial intelligence to predict young learner online learning engagement*. American Journal of Distance Education, 37(3), 185–198.
8. Cheng, L., Umaphathy, K., Rehman, M., Ritzhaupt, A., Antonyan, K., Shidfar, P., Nichols, J., Lee, M., & Abramowitz, B. (2023). *Designing, developing, and validating a measure of undergraduate students' conceptions of artificial intelligence in education*. Journal of Interactive Learning Research, 34(2), 275–311.
9. Pacheco-Mendoza, S., Guevara, C., Mayorga-Albán, A., & Fernández-Escobar, J. (2023). *Artificial intelligence in higher education: A predictive model for academic performance*. Education Sciences, 13(10), 990.
10. Tadese, M., Yeshaneh, A., & Mulu, G. B. (2022). *Determinants of good academic performance among university students in Ethiopia: A cross-sectional study*. BMC Medical Education, 22(1), 395.
11. Tiwari, R. (2023). *The integration of AI and machine learning in education and its potential to personalize and improve student learning experiences*. International Journal of Scientific Research in Engineering and Management, 7.
12. Topal, A. D., Eren, C. D., & Gecer, A. K. (2021). *Chatbot application in a 5th-grade science course*. Education and Information Technologies, 26(5), 6241–6265.
13. Tsai, S. C., Chen, C. H., Shiao, Y. T., Ciou, J. S., & Wu, T. N. (2020). *Precision education with statistical learning and deep learning: A case study in Taiwan*. International Journal of Educational Technology in Higher Education, 17(1).
14. Villegas-Ch, W., Sanchez-Viteri, S., & Roman-Canizares, M. (2021). *Academic activities recommendation system for education in the age of COVID-19*. Informatics, 8(2), Article 29.
15. Von Garrel, J., & Mayer, J. (2023). *Artificial intelligence in studies: Use of ChatGPT and AI-based tools among students in Germany*. Humanities and Social Sciences Communications, 10(1), 1–9.
16. Williamson, B., & Eynon, R. (2020). *Historical threads, missing links, and future directions in AI in education*. Learning, Media and Technology, 45(3), 223–235.
17. Wogu, I. A. P., Misra, S., Olu-Owolabi, E. F., Assibong, P. A., Udoh, O. D., Ogiri, S. O., & Damasevicius, R. (2018). *Artificial intelligence, artificial teachers and the fate of learners in the 21st-century education sector: Implications for theory and practice*. International Journal of Pure and Applied Mathematics, 119(16), 2245–2259.
18. Xia, Q., Chiu, T. K. F., Lee, M., Temitayo, I., Dai, Y., & Chai, C. S. (2022). *A self-determination theory design approach for inclusive and diverse Artificial Intelligence (AI) education*. Computers & Education, 189, 104582.
19. Xu, X., Dugdale, D. M., Wei, X., & Mi, W. (2023). *Leveraging artificial intelligence to predict young learner online learning engagement*. American Journal of Distance Education, 37(3), 185–198.
20. Xu, X., Wang, J., Peng, H., & Wu, R. (2019). *Prediction of academic performance associated with internet usage behaviors using machine learning algorithms*. Computers in Human Behavior, 98, 166–173.
21. Yang, D., Oh, E. S., & Wang, Y. (2020). *Hybrid physical education teaching and curriculum design based on a voice interactive artificial intelligence educational robot*. Sustainability, 12(19), 8000.
22. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). *Systematic review of research on artificial intelligence applications in higher education: Where are the educators?* International Journal of Educational Technology in Higher Education, 16(39), 1–27.