

Research Article

Investigating Impact of AI-Powered Educational Platforms on Medical Students' Learning Outcomes, Knowledge Retention, and Academic Performance

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Abstract

Background: Artificial Intelligence (AI) is transforming medical education by offering personalized learning experiences and improving educational outcomes. Initially conceptualized in the mid-20th century, AI's role in medicine has expanded with advancements in deep learning, enabling its application in both clinical and educational settings. Despite its growing use, research on AI's impact on medical students' academic performance remains limited.

Objectives: To investigate AI-powered educational platforms impact on medical students' learning outcomes, knowledge retention and overall academic performance.

Methods: Ethical approval was obtained from the Institutional Review Board (IRB). A cross-sectional online survey of MBBS students (years 1-5) was conducted. Data were collected from June 1–30, 2024. The questionnaire included demographics, AI usage patterns, and Likert-scale items assessing perceived effects of AI on learning and academic performance (N = 114 respondents).

Results: Among respondents, 65.8% frequently use Chat-bots like Chat-GPT, 11.4% use language translation tools, and 20% use other AI applications. Satisfaction with AI tools varied, with 52.6% moderately satisfied and 8.8% highly satisfied regarding their impact on learning and academic performance. A statistically significant association (p-value = .021) was found between AI usage and improved academic outcomes. The study reveals that frequent use of AI tools is linked to significant improvements in managing academic tasks, productivity, assessment accuracy, and creative thinking.

Conclusion: AI use was associated with improved self-reported learning outcomes and academic performance among this sample of medical students. Findings suggest potential benefits of AI-based learning supports, but limitations (cross-sectional design, self-report measures, single institution) preclude causal inference. Further longitudinal and objective-outcome research is recommended.

Keywords: Artificial intelligence, Medical education, AI Tools, Medical Students

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Introduction

Artificial Intelligence (AI) refers to computational systems that perform tasks typically requiring human intelligence, including natural language processing, pattern recognition, and decision support.¹ AI applications are increasingly used in medical education to provide personalized learning, automated feedback, and decision-

support tools. Early AI work began in the mid-20th century, and advances in machine learning and deep learning have expanded AI's capabilities in clinical and educational contexts. In Pakistan, adoption of AI tools among medical students is growing, particularly at major institutions like King Edward Medical University and Aga Khan University. We are entering a new era in medicine where AI may be used in clinical practice through risk assessment models, increasing workflow efficiency and diagnostic accuracy. AI systems are now able to analyze complex algorithms and learn on their own.²

AI-based educational technologies such as Intelligent Tutoring Systems (ITS), adaptive learning platforms, and automated assessment tools offer opportunities for



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individualized instruction, scalable feedback, and more efficient assessment processes. These capabilities may help address resource constraints of teachers and support diverse learner needs.^{3,4}

To improve learning outcomes, students have the benefit of acquiring new study strategies from "smart mentors" and "asynchronous learning" in addition to teachers who can utilize "smart systems" to help assess, analyze data, improve learning progress, and develop new teaching methodologies. The intersection of AI and education has the potential to reshape pedagogical approaches resultantly Information technology has lately been concentrated on using AI in the field of education.⁵

Integration of artificial intelligence in medical education is the need of the hour. The volume of information to be grasped by medical students is immense, and their ability to retain and apply this knowledge is very significant in their role as healthcare practitioners. Empirical evidence on how AI use affects learning outcomes and academic performance remains limited and needs to be further explored.

A survey has been done in Pakistan regarding the attitude of medical students toward AI.⁶ To our knowledge, there's no study regarding the effect of AI on overall academic outcomes. The current study appeared to be the first survey conducted to determine the efficacy of AI in learning outcomes, knowledge retention, and academic performance.

Methods

This is a cross-sectional, non-experimental study conducted at King Edward Medical University Lahore. MBBS students (years 1–5) enrolled at King Edward Medical University who provided informed consent. Students from allied health sciences and those unwilling to provide consent were excluded. The sample was selected based on convenient sampling technique.

A sample size of 114 students was estimated by using 95% confidence level, 5% absolute precision with an expected %age response rate of 92% (AI in higher education a predictive model, <https://doi.org/10.3390/educsci13100990>).

$$n = Z^2 \cdot p \cdot q / d^2$$

Z 1- α /2 = confidence level= 95% p= prevalence =92% q= 1-p d= absolute precision =5%

Data was collected using a questionnaire adapted from Pacheco-Mendoza et al. (2023) distributed through online platforms.

Data was collected from June 1-30 June 2024. The data was analyzed using the Statistical Package for the Social Sciences (SPSS).

This questionnaire consists of demographic items and multiple-choice questions based on a Likert scale. The questionnaire comprises three sections: demographics, knowledge of AI, and factors affecting academic performance.

Results

Out of total 114 responders; 40 (35.1%) were male and 74 (64.9%) were female. The age range of most responders is 21 to 22 years old, with the 21-year-old group having the largest frequency (36.0 %). Chi-square analysis demonstrated that, at the 0.05 significance level, a p-value of 0.021 indicates a statistically significant association between the use of AI tools and overall improvement in academic performance and learning outcomes.

Among the 114 respondents; 65.8% of them use chatbots (like ChatGPT) more frequently than any other AI application, 11.4% use language translation tools, 20% answers are from AI tools other than ChatGPT and Language Translational tools which include Machine learning application, research tools and virtual assistants

Table 1: The frequency of different AI tools used by respondents.

| | Frequency | Percent | Valid Percent | Cumulati ve Percent |
|----------------------------|-----------|---------|---------------|---------------------|
| Valid No | 3 | 2.6 | 2.6 | 2.6 |
| Chatbots (Chatgpt) | 75 | 65.8 | 65.8 | 68.4 |
| Language translation tools | 13 | 11.4 | 11.4 | 79.8 |
| Others | 23 | 20.2 | 20.2 | 100 |
| Total | 114 | 100 | 100 | |

while 2.6% said they didn't use any of the AI tools. Other technologies are less popular, and chatbots are clearly preferred in this distribution.

A cut-off value of 70 was considered, and respondents whose score was above 70 (based on the combined score of all questions regarding improvement in academic learning via AI tools; strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1 for each question) were categorized as having improvement in learning outcomes and overall academic performance, while respondents scoring below 70 were categorized as not improved. The score of each respondent was then compared with their frequency of AI tool usage categorized as 'rarely' or 'often', and the results were

assessed using the Chi-square test. The resulting p-value of 0.021 confirms a statistically significant association between frequency of AI tool usage and improvement in learning outcomes and overall academic performance.

A total of 31.6% were neutral 52.6% are moderately satisfied while 8.8% are highly satisfied with the use of AI tools in improving learning effectiveness and enhancement in academic performance. When it comes to using of AI tools, 34 respondents who often used AI for educational and learning activities are content with the usage of AI tools and have seen significant improvement in Academic –related information ,managing academic matters more quickly, increase in productivity regarding academic difficulties ,in getting expected information,

Table 2: Chi-square tests were used to examine the association between the frequency of AI tool usage and improvements in learning outcomes as well as overall academic performance.

| Chi-Square Tests | | | | | |
|--|--------------------|----|----------------------|----------------------|----------------------|
| | Value | df | Asymp Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
| Pearson Chi-Square | 5.366 ^a | 1 | 0.021 | | |
| Continuity Correction^b | 4.517 | 1 | 0.034 | | |
| Likelihood Ratio | 5.450 | 1 | 0.020 | | |
| Fisher's Exact Test | | | | 0.023 | 0.016 |
| Linear-by-Linear Association | 5.319 | 1 | 0.021 | | |
| N of Valid Cases | 114 | | | | |
| a. 0 cells (.0% have expected count less than 5. The minimum expected count is 21.06. b. Computed only for 2x2 table. | | | | | |

increase in effectiveness of assessments and quizzes ,in creating content relevant to learning and research, increase in confidence regarding accuracy and relevance of educational content ,in overall learning effectiveness ,in adopting unique and new learning and research methods and in creative thinking about learning practices compared to 15 respondents who rarely used AI tools for educational and learning activities. When it comes to using of AI tools, more respondents use it "rarely" (34) than "often" (31) who are dissatisfied and have not seen

any significant improvement in academic related information, managing academic matters more quickly, increase in productivity regarding academic difficulties, in getting expected information, increase in effectiveness of assessments and quizzes, in creating content relevant to learning and research, increase in confidence regarding accuracy and relevance of educational content, in overall learning effectiveness, in adopting unique and new learning and research methods and in creative thinking about learning activities.



Figure 1: Satisfaction level of rarely and often AI users.

Discussion

The primary objective of this research was to generate empirical evidence regarding the actual impact of AI-powered learning tools on medical students' academic performance. In an era of rapidly advancing technology, it is critical to determine whether such tools genuinely enhance learning or potentially hinder academic development.

This study contributes to the growing body of literature on educational technology by demonstrating that AI-assisted learning platforms are associated with improved learning outcomes and enhanced knowledge retention among medical students. The findings suggest that AI can serve as a valuable adjunct to traditional teaching methods.

The findings led to the rejection of the null hypothesis, indicating that AI-integrated learning approaches are associated with improved academic success compared to traditional learning methods. This supports the alternative hypothesis and strengthens the credibility of the study outcomes.

The observed consistency between the study results and the proposed hypotheses reinforces the reliability of the findings. Students who actively utilized AI-based tools demonstrated superior academic performance compared to those who did not, suggesting that AI integration can positively influence learning efficiency and comprehension.

These findings align with previous studies by Baker et al.

and Siemens which emphasized the role of AI in providing personalized learning experiences and adaptive feedback.^{7,8} Additionally, research has shown that AI tools can enhance motivation, simplify complex information, and improve language comprehension.¹⁷⁻¹⁹

However, contrasting evidence exists in the literature. Studies such as that by Weck et al. report potential negative impacts of generative AI on examination performance, suggesting that excessive reliance on AI may reduce independent cognitive processing.¹⁶ These conflicting findings highlight the importance of balanced and guided AI usage.

Other studies conducted in Saudi Arabia and Latin America demonstrate that AI-based platforms foster critical thinking, creativity, and collaborative learning.^{9,12} Similarly, research by Stowell et al. suggests that students often prefer digital assistance over direct faculty interaction, particularly in student-centered learning environments.¹⁰

The present study supports educational theories such as constructivism and cognitivism, which emphasize personalized, interactive learning. From a practical perspective, the findings underscore the potential of AI tools to enhance medical education by improving knowledge retention, academic engagement, and overall performance.

Nevertheless, further longitudinal studies are required to evaluate the long-term impact of AI integration and to develop ethical frameworks that ensure academic integrity. Understanding how AI can be equitably implemented

across diverse educational settings remains an important area for future research.

Conclusion

The study demonstrates a positive association between AI utilization and academic performance among medical students. AI-powered tools have the potential to enhance comprehension, productivity, and overall learning outcomes. Nonetheless, strategic integration, faculty oversight, and ethical guidelines are essential to maximize benefits while minimizing academic dependency. Future longitudinal studies are recommended to evaluate long-term educational impact.

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Ethical approval: Obtained from IRB of King Edward Medical University.

Authors Contribution:

FR: Involved in conceptualization of study.

FL, HI: Involved in manuscript writing.

HFK, IAH, IH: Involved in data collection.

References

- Toosi AN, Bottino AG, Saboury B, Siegel E, Rahmim A. A brief history of artificial intelligence: How to prevent another winter (a critical review). *PET Clin.* 2021;16(4):449–69.
- Kaul V, Enslin S, Gross SA. History of artificial intelligence in medicine. *Gastrointest Endosc.* 2020;92(4):807–12.
- Zhai X, Chu X, Chai CS, Jong MSY, Istenic A, Spector M, et al. A review of artificial intelligence (AI) in education from 2010 to 2020. *Complexity.* 2021;2021:8812542.
- Owan VJ, Abang KB, Idika DO, Etta EO, Bassey BA. Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eur J Math Sci Technol Educ.* 2023;19(8):em2307.
- Tsai CC, Cheng YM, Tsai YS, Lou SJ. Impacts of AIoT implementation course on the learning outcomes of senior high school students. *Educ Sci.* 2021;11(2):82.
- Abid S, Awan B, Ismail T, Sarwar N, Sarwar G, Tariq M. Artificial intelligence: Medical students' attitude in District Peshawar, Pakistan. *Pak J Public Health.* 2019;9(1):19–21.
- Berland M, Baker RS, Blikstein P. Educational data mining and learning analytics: Applications to constructionist research. *Technol Knowl Learn.* 2014;19(1–2):205–20.
- Commonwealth of Learning. Open educational resources: Innovation, research and practice. Vancouver: COL; 2013 [cited 2024 Aug 2]. Available from: <https://oasis.col.org/handle/11599/486>
- Alfalah AA. Factors influencing students' adoption and use of mobile learning management systems: A quantitative study of Saudi Arabia. *Int J Inf Manag Data Insights.* 2023;3(1):100143.
- Stowell JR, Oldham T, Bennett D. Using student response systems (“clickers”) to combat conformity and shyness. *Teach Psychol.* 2010;37(2):135–40.
- Chen HL, Widarso GV, Sutrisno H. A chatbot for learning Chinese: Learning achievement and technology acceptance. *J Educ Comput Res.* 2020;58(6):1161–89.
- Pacheco-Mendoza S, Guevara C, Mayorga-Albán A, Fernández-Escobar J. Artificial intelligence in higher education: A predictive model for academic performance. *Educ Sci.* 2023;13(10):990.
- Shinogaya K. Learning strategies: Review from the perspective of the relation between learning phases. *Jpn J Educ Psychol.* 2012;60(1):92–105.
- Zamora-Antuñano MA, Barros-Baertl R, Tovar-Luna B, González-Gutiérrez CA, Méndez-Lozano NE, Cruz-Pérez MÁ. Use of augmented reality to strengthen competence in data analysis and problem solving in engineering students. *Educ Sci.* 2022;12(11):755.
- Araiza M, García-Leal M. Impact of an LMS platform on the academic performance of postgraduate students: A data analytics study. *Int J Technol Learn.* 2021;28(1):75–91.
- Wecks JO, Voshaar J, Plate BJ, Zimmermann J. Generative AI usage and academic performance. *arXiv; 2024* [cited 2024 May 4]. Available from: <https://arxiv.org/abs/2404.19699>
- Pavlik JV. Collaborating with ChatGPT: Implications of generative artificial intelligence for journalism and media education. *Journal Mass Commun Educ.* 2023;78(1):84–93.
- Fauzi F, Tuhuteru L, Sampe F, Abu A, Hatta HR. Analysing the role of ChatGPT in improving student productivity in higher education. *J Educ.* 2023;5(4):14886–91.
- Sullivan M, Kelly A, McLaughlan P. ChatGPT in higher education: Considerations for academic integrity and student learning. *Journal of Applied*

- Learning & Teaching 2023 Mar 21;6(1):31-40
20. Rasul T. The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning & Teaching*. 2023;6(1):41-56
 21. Sein-Echaluze ML, Fidalgo-Blanco Á, García-Peñalvo FJ. Teaching innovation as a faculty mission. In: *Proceedings of the IV International Conference on Learning, Innovation and Competitiveness (CINAIC)2018*; 2018;803-813.