

USE OF ARTIFICIAL INTELLIGENCE-ASSISTED LEARNING TOOLS AND THEIR IMPACT ON ACADEMIC PERFORMANCE AND LEARNING SATISFACTION AMONG MEDICAL STUDENTS

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ABSTRACT

Background: Medical students are starting to embrace the use of artificial intelligence-enhanced learning tools to aid in their academic endeavors (concept understanding, revision, and exam preparation). Although they are on the increase in use, there is little evidence on their effects on academic performance and learning satisfaction among undergraduate medical students.

Objectives: To assess AI-aided learning tools as well as to establish the relationship between these tools and academic performance and student satisfaction with the learning process among medical students.

Methods: This analytic study was a cross-sectional study that was carried out at Liaquat University of Medical and Health Sciences, Jamshoro in the period January 2025 to July 2025 on 90 undergraduate medical students attending an MBBS program. The non-probability convenience sampling method was employed to select the participants. The structured self-administered questionnaire was used to collect data based on demographic characteristics, academic performance, frequency and purpose of AI tool use, perceived usefulness, and learning satisfaction. A composite score was used to measure learning satisfaction in terms of a Likert-scale.

Results: 58.9% of the students claimed to use artificial intelligent-assisted learning tools frequently. It also showed higher academic performance between frequent users (75.06±8.51%) and occasional users (71.54±7.03%) and non-users (65.91±6.74%) (p=0.002). The weighted score of learning satisfaction was also significantly high among frequent users (31.62±4.72) than other groups (p < 0.001). It was observed that there was positive correlation between perceived usefulness of AI tools and academic performance (r = 0.39), as well as learning satisfaction (r = 0.64).

Conclusion: There is a positive correlation between AI-assisted learning tools and academic performance and the level of learning satisfaction among medical students. They can make modern medical education better through responsible and guided integration.

Keywords: Artificial intelligence; Medical education; Academic performance; Learning satisfaction; Medical students; Digital learning

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INTRODUCTION

Medical training has been acknowledged as one of the most academically rigorous and intellectual professional

training programs.¹ Graduating medical students are supposed to learn and memorize a large amount of theoretical material, synthesize the basic sciences and

clinical thought, keep up with ever growing amounts of medical knowledge and achieve consistency in written, practical and clinical examinations. This very high-intensive learning place usually exposes students to a high level of academic pressure and has raised the demand of more effective, flexible, and learner-focused educational approaches. To overcome these obstacles, students are resorting more to digital and technology-based learning systems to enhance their comprehension, save time, and increase the level of academic productivity.²

In the last ten years, the swift development of the digital education sector has significantly changed the learning experience in the tertiary education, including medical education.³ The internet lectures, learning management systems, electronic libraries, education videos, virtual dissection, simulation and self-assessment programs have all become part and parcel of contemporary medical education. In more recent times, the educational technology has taken a new form in the form of artificial intelligence (AI)-assisted learning tools. Students in various academic fields such as medicine are now using these tools in explaining concepts, summarizing difficult subjects, preparing exams, organizing notes, generating questions and to facilitate writing of academic papers.⁴

Artificial intelligence is defined as the computer-based systems that are capable of simulating some of the elements of human intelligence such as language comprehension, pattern recognition, problem-solving, content creation and adaptive response.⁵ As applied to education, AI-assisted learning tools encompass conversational AI tools, intelligent tutoring, intelligent summarizers, adaptive quiz generators, flashcard generators, writing assistant, and other computer-based solutions that can provide personalized or task-intensive educational support. In comparison to the old non-interactive learning materials, these solutions are interactive and may be instantaneous, thus students are able to clarify their questions, simplify challenging ideas, create revision materials, and get personalized learning support in real time.⁶

AI-assisted learning is especially relevant to medical education due to its volume, complexity, and interdisciplinary character of the curriculum.⁷ Medical students are expected to learn at the same time the molecular processes, the physiological processes, the pathological process, the pharmacological process, the diagnostic reasoning, and the clinical management. AI technology can already be of significant value in terms of education, since it can simplify complex material to absorb, shorten the amount of time required to re-read (or rewrite) certain parts of a text, enhance access to information, and aid self-directed learning in a highly demanding academic setting. To a lot of students, they can also be used as secondary academic friends who are accessible outside the classroom and can be used to help in revision and clarification which is repetitive.⁸

AI-assisted learning tools have one of the largest theoretical benefits in that they facilitate personalized learning.⁹ Classroom instruction is usually generalized and this might not be of equal use to all students. There might be those students who need to be explained, interpreted in simplified ways, find analogies and structured summaries in order to reach the bottom of challenging concepts. Potentially, AI-based tools can fill this gap by providing customized responses to the question that the learner is asking or the academic requirement. It will perhaps be particularly helpful in topics that are generally viewed by medical students as challenging, like anatomy, physiology, biochemistry, pathology, pharmacology and clinical medicine. Repeated questioning and direct explanation can assist the AI tools to enhance concept retention, academic confidence, and perceived learning efficiency.¹⁰

Besides the possible consequences of knowledge acquisition, AI-assisted learning tools can also have an impact on the general experience of learning and satisfaction among students.¹¹ Another dimension of medical education that has not been well studied is learning satisfaction. It represents the way students evaluate the usefulness, ease, interest and efficiency of their learning process. It is possible to have a student who performed reasonably well in examinations yet felt confused, inefficient, stressed, dissatisfied, or low in confidence when studying. Thus, it is equally as significant to find out what students think about their learning process as it is with examining performance associated with the learning process. Assuming that AI-helped tools can decrease study load, enhance its understanding and revision efficiency, it can have a beneficial impact on not only academic performance but also student dissatisfaction and confidence.¹²

Simultaneously, there are a number of valuable academic and ethical issues that have been brought up as a result of the growing application of artificial intelligence in education.¹³ Even though such tools can bring about convenience and accessibility, they can also create some problems associated with overdependence, passive learning, decreased critical thinking, incorrect content creation, shallow learning, and inadequate use of academic tools. These issues are particularly critical in the field of medical education as the future professionals are required to form the skills of independent reasoning, evidence-based judgment, and professional accountability. Uncontrolled use of AI-generated content without checking can harm deep learning and analytical thinking unless it is used in a responsible manner. Therefore, the educational purpose of AI cannot be considered unconditionally positive without the critical analysis of academic purpose.¹⁴

The other issue that cannot be ignored is that learning aids with the use of AI are being adopted by learners at a very high rate compared to the pace at which learning systems are adjusting to it.¹⁵ Already, AI tools are

informally used by students within a wide range of medical colleges to revise, assist with assignments, clarify concepts, and prepare exams, but the institutional advice on how and why this should be done is scarce. This brings a significant disconnection of practice and policy of students. It is thus necessary that medical educators, curriculum planners, and policymakers understand the manner in which these tools are currently being applied in actual academic contexts, and whether or not their application can be linked to any academic and experiential outcomes.¹⁶

Academic performance is one of the most well accepted measures of educational achievement among the medical students.¹⁷ It not only indicates examination success but also consistency of learning, interaction with the content of a course, and success of study strategies. Nevertheless, the quality of the learning experience cannot be wholly determined by academic performance. That is why the consideration of learning satisfaction and academic performance gives a more detailed idea of the educational effect of AI-assisted learning instruments. These outcomes can be evaluated dualistically to identify whether the use of AI is convenient or meaningfully has a positive impact on academic functioning and more satisfying learning experience.¹⁸

Although AI-assisted educational platforms have become increasingly popular, the empirical evidence of their academic effects is still limited, particularly among the students of undergraduate level of medical education, which could be rather poorly organized in developing educational environments and be more student-oriented in terms of technological integration.¹⁹ The bulk of the existing evidence has been dedicated to the topic of technological acceptance, digital preparedness, or overall understanding of AI instead of its real-life connection with academic performance and student satisfaction. The absence of locally relevant educational evidence complicates the issue because it is hard to tell whether the use of AI-assisted learning is actually enhancing student learning or simply a fad in the academic sphere.²⁰

With this context, the current research was designed to determine the application of learning aids using artificial intelligence among undergraduate medical students and determine its effects on academic results and learning satisfaction. This research will provide valuable evidence to the emerging body of research on AI in medical education and contribute to the optimal, efficient, and responsible adoption of emerging learning technologies in academia by analyzing the trend of AI utilization and its links to education.

MATERIALS AND METHODS

The study was an analytical cross-sectional study that was carried out at Liaquat University of Medical and Health Sciences, Jamshoro from January 2025 to July 2025 on 90 undergraduate medical students to observe the application

of artificial intelligence-based learning tools and to find out their relation with academic performance and their level of satisfaction with learning. The sampling process involved a non-probability convenience method because the students that were present and willing to take part within the time frame of the study were approached to be included in the sample. The first year to final year MBBS students were held eligible so that the students who were in both pre-clinical and clinical academic stages could be assigned.

The students who were currently pursuing the MBBS program and had successfully finished at least one of the academic terms or semesters were the participants who were required to give informed consent. Students of both genders were represented. Students that were not present at the time of data collection, those who refused to participate, and students who provided incomplete and inconsistent questionnaire responses were not included. Students with no knowledge of digital educational tools were also locked out since the research had a specific objective of studying the application and effects of AI-assisted learning tools in academic practice.

The structured self-administered questionnaire that was created during the review of the available literature sources relating to digital learning, educational technology, academic performance, and student satisfaction within higher education and medical education was used to collect data. The survey was conducted using the English language since this is the common language used in medical colleges. Prior to actual data collection, the instrument was pilot tested to a limited group of students to determine the clarity and relevance, understanding and consistency in responses to minor adjustment was done where it was necessary to enhance word usage and comprehension. The questionnaire was divided into a number of sections. The first part documented the demographic and academic backgrounds, such as age, sex, year of school, and self-reported recent academic achievement. The academic performance was measured either based on the latest percentage of the students in their professional examination or based on internal assessment performance or cumulative academic score as it was available and was reported consistently by the students. To affect a measure of analytical content, academic performance was measured in terms of a continuous measure and categorized variable.

The second part evaluated the application of learning tools based on artificial intelligence application. Students were requested to answer questions regarding whether they used AI-based learning applications like conversational AI applications, intelligent tutoring applications, summarization applications, question-generation applications, writing assistants, concept-explanation applications, and AI-aided revision applications. Data was gathered on the type of AI tool, duration of use, frequency of use and the intended educational purpose. The key

educational needs investigated were concept clarification, summarization of lectures, exam preparation, supporting assignments, note taking, SBAs/BCQs practice and independent revision. The students were classified into non users, occasional and frequent based on the frequency of use.

The third part assessed the perceived teaching usefulness of AI-assisted learning tools. Students were asked to answer statements on whether these tools assisted them to understand more challenging concepts, saved time, more time spent on revision, extremely confident in their examinations, simplified academic work, and helped them organize better the study materials. The responses were measured through a 5-point Likert scale, which was strongly disagree, weakly disagree, indifferent, strongly agree, and weakly agree.

The fourth part measured the satisfaction of learning. This area covered the utterances concerning the contentment with the learning experience, simplicity, trust in the preparation of the topics, presumed academic convenience, involvement with study content, and general satisfaction with AI-aided learning approaches. The composite learning satisfaction score was obtained by adding the answers to the Likert-scale items in question. The increased scores of total measures showed increased learning satisfaction. All data were typed into and analyzed in SPSS-26. One way analysis of variance (ANOVA) was employed where there was more than two groups. The statistical significance of a p-value of below 0.05 was taken into account during the analysis.

RESULTS

The mean age was 21.34±1.82 years. Forty one (45.6%) were men and 49 (54.4%) women. All the academic years were represented, with the best number being third year

MBBS (24.4%), then fourth year (22.2%), final year (18.9%), second year (18.9%), and first year MBBS (15.6%). As per academic performance, the average recent academic score of the study population was 72.86 with a standard deviation of 8.94. The majority of students acknowledged that they actively use digital academic tools, and a significant percentage of students explicitly cited the usage of AI-assisted learning tools as one of their typical study habits. The trend of the use of AI-assisted learning tools indicated that 58.9% of the students were frequent users, 28.9% were occasional users, and only 12.2% were non-users. In response to the question about

the primary goal of using AI-assisted learning tools, concept clarification (76.7%), exam preparation (68.9%), lecture or topic summarization (62.2%), SBAs/BCQs practice (54.4%), and assignment support (47.8%) responded the most frequently. Quite a significant percentage also indicated the use of AI tools to write brief notes and rewrite large subjects more effectively (Table 1).

The students who more often used the AI-assisted learning tools displayed significantly improved academic indicators as compared to the students who used them less or not at all. Mean academic score was 65.91 ± 6.74 percent of the non-users, 71.54±7.03 percent of occasional users, and 75.06±8.51 of frequent users and the difference was statistically significant between the three groups (p=0.002). The same case was evident with learning satisfaction. The average score of learning satisfaction of the non-users was 21.45±3.10, 26.88±3.94 and 31.62±4.72, and the difference between these categories was highly significant (p<0.001). These findings indicate that the more individuals used AI-facilitated learning materials, the higher their grades and the higher their satisfaction with the educational process were (Table 2).

Table 1: Baseline characteristics and pattern of AI-assisted learning tool use among medical students (n=90)

Variable	Category	No.	%
Age (years)		21.34±1.82	
Gender	Male	41	45.6
	Female	49	54.4
Academic year	First year MBBS	14	15.6
	Second year MBBS	17	18.9
	Third year MBBS	22	24.4
	Fourth year MBBS	20	22.2
	Final year MBBS	17	18.9
AI-assisted learning tool use*	Non-user	11	12.2
	Occasional user	26	28.9
	Frequent user	53	58.9
Main purpose of AI use	Concept clarification	69	76.7
	Exam preparation	62	68.9
	Lecture/topic summarization	56	62.2
	SBAs/BCQs practice	49	54.4
	Assignment support	43	47.8
	Note making/revision planning	39	43.3
Mean academic score (%)		72.86±8.94	
Learning satisfaction score		29.07±5.28	

*Multiple responses were allowed

Table 2: Comparison of academic performance and learning satisfaction according to frequency of AI-assisted learning tool use apply by ANOVA

AI use category	No.	Mean academic score (%)	Mean learning satisfaction score	p-value
Non-user	11	65.91±6.74	21.45±3.10	0.002
Occasional user	26	71.54±7.03	26.88±3.94	
Frequent user	53	75.06±8.51	31.62±4.72	

Table 3: Association between academic performance category and AI-assisted learning tool use

Academic performance category	Non-user	Occasional user	Frequent user	Total	p-value
<65%	5 (45.5%)	8 (30.8%)	6 (11.3%)	19 (21.1%)	0.004
65–74%	4 (36.4%)	12 (46.2%)	20 (37.7%)	36 (40%)	
≥75%	2 (18.1%)	6 (23%)	27 (50.9%)	35 (38.9%)	
Total	11 (100%)	26 (100%)	53 (100%)	90 (100%)	

It was observed that students who showed high academic performance ($\geq 75\%$) had higher chances of being frequent users of AI-assisted learning tools. Out of 35 students in high-performance category, 27 (77.1%) students were frequent users of AI, with only 2 (5.7%) students being non-users. However, non-users and occasional users were relatively more prevalent among the students with lower academic performance (below 65%). This correlation between the classification of AI use and the classification of academic performance was found to have statistically significant value ($p = 0.004$), which means that more actively students used AI-based learning were more likely to fall into the higher category of academic performance. Both the male and the female students were equally engaged in the AI-assisted learning tools, with the latter showing a little more overall satisfaction with learning. The average score of the learning satisfaction of female students was 30.12 ± 5.16 , whereas the average score of learning satisfaction of male students is 27.83 ± 5.01 . Nevertheless, the tendency of correlation between the use of AI and academic achievement was positive in both sexes. Female students had higher chances of using AI tools in explaining concepts, simplifying notes, and planning revision as opposed to male students who had higher chances of using the tools in SBAs/BCQs practice and support of assignment. Although these were insignificant differences in the preferences of the usage, AI-assisted learning seemed to have the same educational value across the sexes (Table 3).

DISCUSSION

The results of the present study showed that AI-aided learning tools were popular among medical students, and positively correlated with the improved academic success and increased learning satisfaction. Students with increased use of AI-supported educational tools attained higher mean academic performance scores, and were more satisfied with their experience of learning, compared to those who averagely or never used the educational tools. These results indicate that AI-based learning items are

gradually becoming an important additional part of contemporary medical education.

The high percentage of students who used AI-assisted tools in the study to facilitate academic activities was also one of the crucial findings. The participation of over fifty percent of the participants to be regular users and a few percent indicated their total lack of using these tools. This trend is an indicator of a distinct change in the student learning habits, as AI is no longer a novelty and has turned into a working learning support. The popularity of tools that can help to understand concepts within a short period of time, summarize a long topic, create questions, and aid in a revision is not surprising in the context of medical education when students have to handle large amounts of information. The increasing adoption of AI devices could be an indicator of the case that students require efficiency, individualization, and immediate academic assistance in an extremely rigorous curriculum.⁴

Another common application of AI-assisted tools in the study was concept clarification followed by exam preparation, lecture summarization and SBAs/BCQs practice. This is an educative value since these are areas that the medical students tend to struggle with. Students are expected to spend a lot of time memorizing in medical education and also acquire knowledge on how to learn with minimal cognitive load and yet not to have to trade learning. AI technologies are seen to be fulfilling this role by assisting students in disaggregating complicated subjects into easier explanations and by helping students to better plan and edit information. This implies that students not only rely on AI due to convenience, they are using it to tackle academic problems practically.⁶

The major result of the current investigation was that the use of AI-assisted learning tools is closely related to academic results. Students who utilized these tools often had better mean scores in academics than infrequent users and non-users. This can imply that AI-based learning, applied properly, can help achieve better academic results. The relationship can be explained in a number of ways. First, AI tools can enhance efficiency as students need not waste a lot of time searching in a variety of resources to obtain quick explanations. Secondly, they can strengthen repetition and reinforcement, which are vital in

memorization in the medical subjects. Third, they can enhance academic confidence through enabling students to go on with the asking of questions without a second thought hence fostering more active self-directed learning.⁸

Nevertheless, the strong correlation between academics and the use of AI is to be understood, however, with critical thinking.⁹ There is a possibility that already academically motivated, more organized, and digitally adaptive students can find it easier to apply AI tools to their advantage. That is, the usage of AI might contribute to an academic improvement, but it also might be more prevalent among the students who already have good learning behaviors. Thus, the current results are promising, but it does not mean that the use of AI can automatically lead to a high level of academic performance in all students. Instead, AI-assisted learning seems to work most effectively as a helpful educational support as a part of an already active and intentional learning process.¹⁰

The current study was found the good positive correlation between the use of AI-assisted learning tools and learning satisfaction. The students that were more inclined to use AI tools were much more satisfied with their learning process. This is a critical discovery as learning satisfaction is frequently ignored in medical education studies although it is closely related to motivation, confidence, academic perseverance, and psychological wellbeing. The training of the medical students is very hectic and complicated and usually leads to decreased satisfaction, anger, and frustration among medical students. As long as AI-assisted tools can make the process of studying easier, more digestible, and less time-consuming, it can be assumed that they can decrease academic stress and enhance the educational experience.¹²

The interactive and responsive character of the artificial intelligence can explain the observed rise in the level of satisfaction with learning among the people who use such tools.¹³ AI-assisted tools can make the learning experience more of a conversation and more adaptive as opposed to a static text book or one-way lecture presentation. Based on the personal needs of students, they can request repetition, simplification, examples, summaries, or other explanations. This malleability can enhance a perceived ability to control the learning process, which is a significant source of satisfaction. The fact that students can get personalized academic assistance can significantly influence student confidence and engagement in medical education, where students can find large volumes of information, much of which is highly technical, overwhelming to comprehend.¹⁴

It was also revealed in the current study that students in senior-year seemed to use AI-assisted learning tools more often than junior students. It is not surprising that this observation is made since students in later years of medical training tend to receive more integrated, more clinically oriented, and conceptually challenging content. They also face growing pressure to be ready to take professional

examination, viva, ward-based, and clinical reasoning. The AI-aided tools could prove especially efficient in this context in terms of quick revision, organizing the idea overview, and connecting the fundamentals of the sciences and clinical knowledge. This is an indicator that AI tools might become more useful with the complexity of academics.¹⁶

The gender-wise analysis of the present research indicated that AI-assisted learning was beneficial to both male and female students; still, female students scored slightly higher in terms of their learning satisfaction. Although it did not form the main subject of the research, this difference could suggest that there are slight variations in the learning styles, studying methods, or the use of digital learning materials. Women students in the study were found to make more use of AI tools in explaining and structured revision, whilst men students indicated slightly more use of AI tools in SBAs/BCQs practice and assignments. Such differences can be due to different study styles as opposed to different educational values. Notably, the general positive tendency of AI-based learning was not different in both genders.¹⁸

The up-positive associations between the perceived usefulness of AI, academic performance, and learning satisfaction support the empowerment of the educational value of the research results further. Students that felt that AI tools were useful in understanding, revision and organization of the academic tasks were also likely to perform better and express satisfaction. This is an indication that the scholarly contribution of AI tools cannot just be quantified by performance, but it also creates a close connection between student perception and acceptability to education. Effective and positively received tools in the educational practice are more susceptible to be adopted in a sustainable manner and become a habitual part of the learning behavior.²⁰

Regardless of the described positive results, another factor that should not be overlooked is the growing popularity of AI-based learning tools in the medical field.¹ Overdependence is one of the significant issues. When students use AI generated summaries or explanations too much without having to critically read primary learning material, there is the risk of superficial learning instead of deep learning. Medical education involves analytical thinking, interpretation, integration and clinical judgment, which rely on active thinking. Thus, AI might be effective though it is not to be substituted with fundamental academic work, studying textbooks, instructor help, and evidence-based thinking.²

The other issue is associated with the quality and credibility of education provided by AI.³ An AI technology may create convincing, well-constructed answers, yet they are not necessarily true, meaningful, and conforming to established medical instructional guidelines. Inaccurate explanations, missing clinical reasoning or simplified summaries have the potential to mislead the students

unless they are verified. The problem has special significance in the field of medicine where misguided knowledge may have a negative influence on not only the achievements in the exams but the subsequent clinical interpretation and professional growth. Thus, AI tools should be seen as additional educational resources of students but not as infallible sources.⁴

Under the academic policy aspect, this study has shown that AI-assisted learning needs to be integrated into medical education in a guided and ethical manner.⁵ Instead of dismissing or deterring the use of AI in general, medical colleges might find it beneficial to create formal academic advice on how apprentices can be responsible about these tools. This can involve educating students on how to check AI generated information, the difference between acceptable academic support and academic dishonesty, and to apply AI to facilitate, and not to supplant, independent thinking and learning based on evidence. It is also necessary to provide faculty development and make them aware of the impact that AI has on student learning so that they can change the teaching approaches.⁶

The current research has a number of strengths. It deals with a very topical and fast changing educational problem in the framework of undergraduate medical education. It not only assesses the prevalence of the use of AI-assisted learning tools but also evaluates their utilization in a practical relationship with academic performance and learning satisfaction, which gives a wider view of education. Furthermore, the study sample of students representing various academic years ensured the inclusion of patterns in the medical training in various levels. Nevertheless, some limitations are also to be considered. To begin with, the research was cross-sectional in nature thus restricting the causal relationship that could have been drawn. Even though the frequency of AI use correlated with the improved academic performance and satisfaction, it cannot be concluded that the use of AI directly provoked the improvements. Second, the sample size was also rather small and was based on one institution, which might restrict the generalizability. Third, other data, such as academic performance and the use of AI behavior, were self-reported, and thus, can fall victim to the bias of recollection or reporting. Fourth, the research failed to make a distinction between the quality and the poor quality of AI platform and the precision of certain tools which were utilized by students.

CONCLUSION

The application of learning devices assisted by artificial intelligence is common in undergraduate medical students and it has a positive correlation with academic and learning satisfaction. Those students using AI-assisted tools with more frequency showed higher academic performance and more satisfaction with their learning experience than those who used it rarely and at all. Concept clarification, exam preparation, summarization of

lectures, and revision support were the most prevalent educational uses of AI, and it is important to note that AI is likely to aid in the management of the academic needs of medical education.

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