
THE IMPACT OF AI ON CRITICAL THINKING AMONG MEDICAL STUDENTS IN KHYBER PAKHTUNKHWA: A CROSS-SECTIONAL STUDY**Abbas Inayat**

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Abstract:

Artificial Intelligence (AI) is increasingly being utilized in medical education, as learning tools and decision-making tools in the clinic. However, we are not yet certain of its impact on the critical thinking ability of medical students. Although AI has benefits such as improved diagnosis and quicker decision-making, its use is feared to decrease students' ability to problem-solve independently. The study investigates the impact of AI on the critical thinking skills of Khyber Pakhtunkhwa (KPK), Pakistan medical students. Cross-sectional study was conducted among 376 MBBS and BDS medical students of various study years. Data were collected using a structured questionnaire with due consideration of how AI is applied, what the students' perception is about its impact on critical thinking, and how it is applied in practical usage. Statistical analysis was performed with SPSS 26. The results indicated that 33% of the students use AI tools occasionally, 27.1% use them not very often, and 26.9% use them frequently. The most widely used AI tools were diagnostic software (46.5%) and educational chatbots (29.4%). Despite the perception that AI-powered learning benefited them in decision-making and problem-solving, 37.3% were

concerned that overusing AI would reduce the capacity to think autonomously. Nevertheless, 71% had a very positive or quite positive perception of AI use in medical education. AI may be employed to promote critical thinking in medical students if utilized appropriately. Its integration into education should be closely managed to prevent dependency and to ensure that it augments, rather than replaces, traditional approaches to problem-solving. There is much research that needs to be done to verify long-term effects and optimal practices in the integration of AI into medical education.

Keywords: *Artificial Intelligence (AI), Medical Education, Clinic, Thinking Ability, Pakistan Medical Students, Cross-Sectional Study, MBBS and BDS*

Introduction

Application of Artificial Intelligence (AI) in medical education is changing very fast, facilitating learning and decision-making in medicine. However, whether AI has an effect on the critical thinking capacity of medical students is not well studied. Critical thinking is central to medicine's problem-solving and reasoning, but it is feared that if much dependence is placed on AI, it may increase or decrease these capacities. This research investigates the effect of AI on the critical thinking capacity of medical students.

International research indicates both the positive and negative impacts of AI on critical thinking among medical students. Positively, AI has been seen to significantly enhance the accuracy of students in diagnosing patients and the speed of decision-making. For instance, research indicates that AI enables medical students to make accurate diagnoses faster, thus enabling them to make better clinical judgments. Negatively, however, most are concerned that overdependence on such technologies undermines students' capacity to solve problems independently [1] assert that constant use of AI can lead to a decline in critical thinking since students over depend on such mechanisms in decision-making

In Pakistan, early research suggests that AI tools such as virtual patients and diagnostic programs are being incorporated into medical school slowly. But research demonstrates a failure to prioritize learning how these devices shape students' cognitive development causes one to question whether AI is truly enhancing critical thinking or merely providing a crutch that undermines it [3]. More research has established that AI can be used to enhance critical thinking through simulation and tailored feedback. The applications enable students to practice challenging problem-solving exercises without the real-world consequences of clinical practice. More, research has established that AI simulation in health care enables students to make decisions in a risk-free environment, which enhances their critical thinking [4]. Nonetheless, there are concerns that AI can have negative impacts on independent thinking. The application of AI in learning has sparked controversy on whether it hurts or assists in the cultivation of critical thinking, depending on the application. Research establishes that whereas AI can be an efficient learning tool, it ought to be applied cautiously to prevent interfering with students' capacity to think critically.

Briefly, AI is very capable of infusing some elements of medical education with improvements, but how it impacts critical thinking is controversial. It is hoped that this research can contribute to the argument by investigating how AI affects the critical thinking

skills of medical students.

Rationale

This research will fill a growing gap in the literature by demonstrating whether or not AI tools support or impede the critical thinking ability of medical students. The findings will inform course design and application of AI tools for medical education.

Objective

To evaluate the effect of AI on the critical thinking abilities among medical students of KPK.

Operational Definitions

Artificial Intelligence (AI) is when computers do things that usually need human thinking, such as learning, reasoning, and problem-solving.

Critical Thinking: The ability to break down and comprehend a problem so that you can make a decision.

Medical Students: MBBS and BDS students studying in medical colleges of Khyber Pakhtunkhwa.

Methodology

This study focused on medical colleges in Khyber Pakhtunkhwa (KPK). The study had 376 participants. The participants were calculated by using the Open Epi calculator, with 50% prevalence and 95% confidence interval. For participant selection, a convenient sampling strategy was adopted to ease the accessibility within the limit of the capacity of the study.

Inclusion Criteria

- Medical students from 1st to final year enrolled in MBBS and BDS programs.
- Students who provide informed consent.

Exclusion Criteria:

- Students enrolled in programs other than MBBS and BDS.
- Students who do not consent to participate.

Data Collection Tool and Procedure:

A structured questionnaire was employed. It contained questions regarding the application of AI, views on its implications, and a test of critical thinking ability. The questionnaire was administered to shortlisted medical college students, and the data collection process lasted for two months.

Data Analysis:

Data was analyzed using SPSS 26 software and presented in tables, percentages and graphs form to have a clear picture.

Results

We surveyed a total of 376 students, including 223 males and 153 females, enrolled in MBBS and BDS programs. Among them, 295 were MBBS students, and 77 were BDS students. The

participants were aged between 18 and 29 years and included students from first to final year. Detailed information is provided in Tables 1, 2, 3, and 4.

Table 1 Age

		Frequency	Percent
Valid	under 20	62	16.5
	20-24	248	66.0
	25-29	66	17.6
	Total	376	100.0

Table 2 Gender

		Frequency	Percent
Valid	Male	223	59.0
	Female	153	40.7
	Total	375	99.7
Total		376	100.0

Table 3 Field of Study

		Frequency	Percent
Valid	MBBS	295	78.5
	BDS	81	21.5
	Total	376	100
Total		376	100.0

Table 4 Year of study

		Frequency	Percent
Valid	1st year	49	13.0
	2nd year	87	23.1
	3rd year	88	23.4
	4th year	89	23.7
	final year	63	16.8
	Total	376	100.0

Our questionnaire consisted of four sections with a total of 22 questions. The sections focused on the following areas: AI Usage in Medical Education, Perception of AI's Impact on Critical Thinking, Practical Application and Critical Thinking Development, and General Feedback.

AI Usage in Medical Education:

The survey revealed that 33% of students sometimes use AI tools in their studies, while 27.1% use them rarely, and 26.9% use them often. Only 7.7% never use AI tools, and 5.3% always rely on them. Overall, AI usage varies among students, with the majority using it occasionally or frequently. Total responses were 376. Details in Table 5.

Table 5. How frequently do you use AI tools in your studies?

		Frequency	Percent
Valid	Never	29	7.7
	Rarely	102	27.1
	Sometimes	124	33.0
	Often	101	26.9
	Always	20	5.3
	Total	376	100.0

Among the surveyed students, 46.5% most frequently use AI-based diagnostic apps like ChatGPT, followed by 29.4% who prefer educational chatbots. Medical image analysis tools are used by 13.1%, while 11% use virtual patient simulations. Details in table 6.

Table 6. Which AI tool do you use most frequently?

		Frequency	Percent
Valid	AI based diagnostic apps [eg.chatgpt]	174	46.3
	Virtual patient simulations	41	10.9
	Medical image analysis	49	13.0
	Educational chatbots	110	29.3
	Total	374	99.5
Total		376	100.0

The survey showed that 43.9% of students have been using AI tools for 6 months to 1 year, while 27% have used them for 1–2 years. About 23.8% started less than 6 months ago, and 5.3% have been using them for more than 2 years. Details in table 7

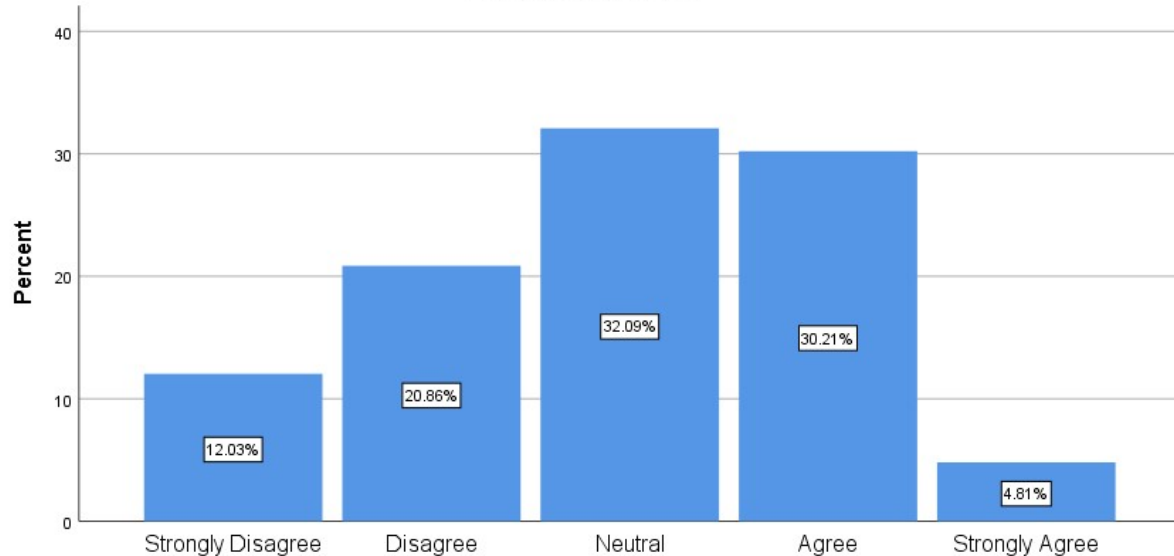
Table 6 How long have been you using AI tools

		Frequency	Percent
Valid	Less than 6 months	89	23.7
	6months -1 year	164	43.6
	1-2years	101	26.9
	More than 2 years	20	5.3
	Total	374	99.5
Missing	System	2	.5
Total		376	100.0

Perception of AI impact on Critical Thinking:

The section on the Perception of AI's Impact on Critical Thinking consisted of questions, with detailed results provided in form of bar charts in following figures as percentages and frequency. Figure 1,2,3,4,5.

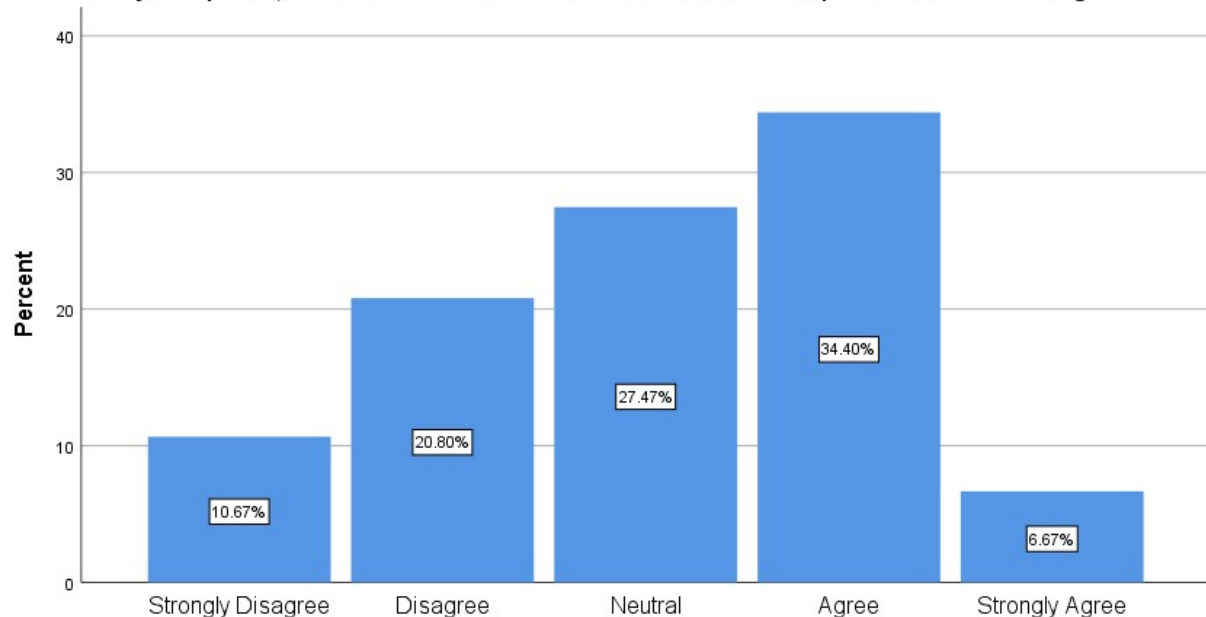
To what extent do you agree with the following statement: "AI tools have improved my ability to think critically in medical scenarios."



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Figure 1

In your opinion, does the use of AI tools reduce the need for independent critical thinking?



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Figure 2

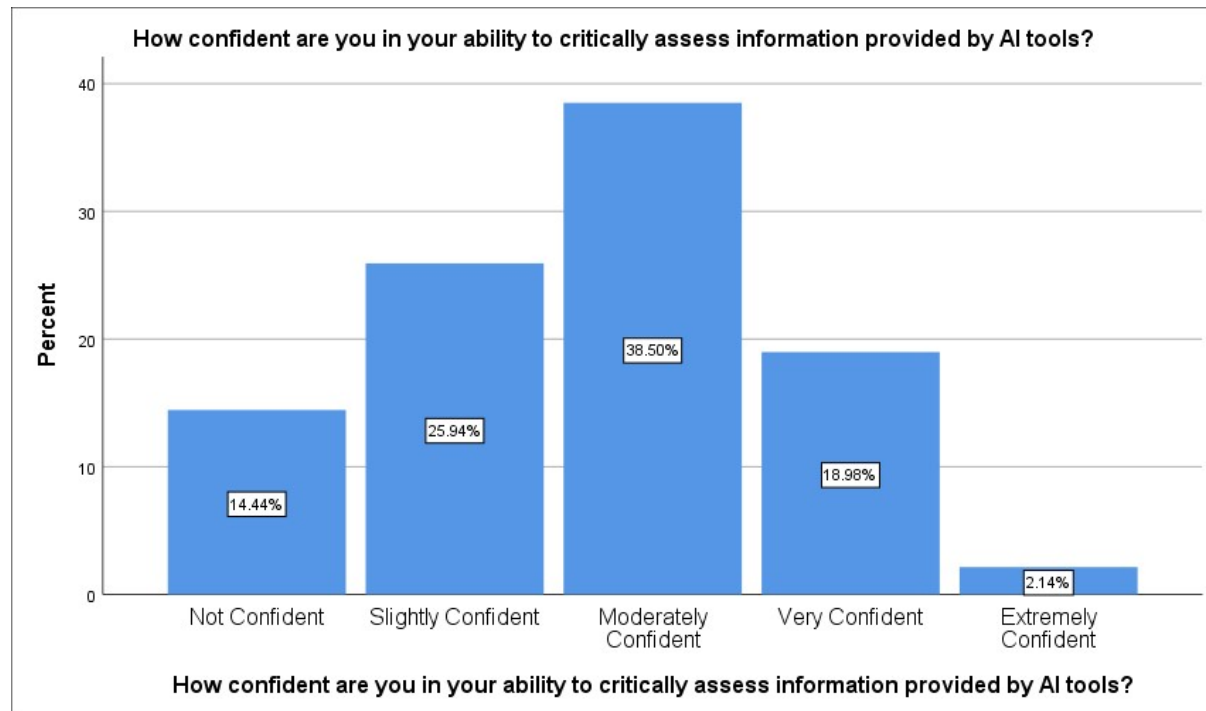


Figure 3

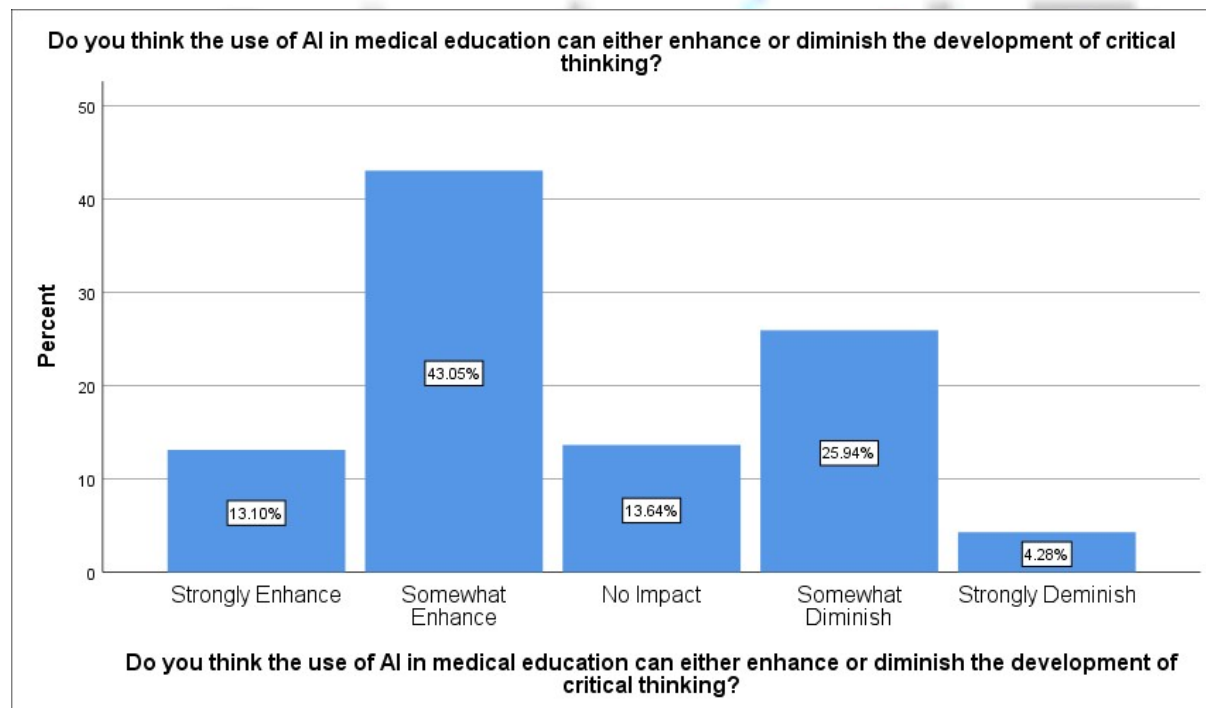


Figure 4

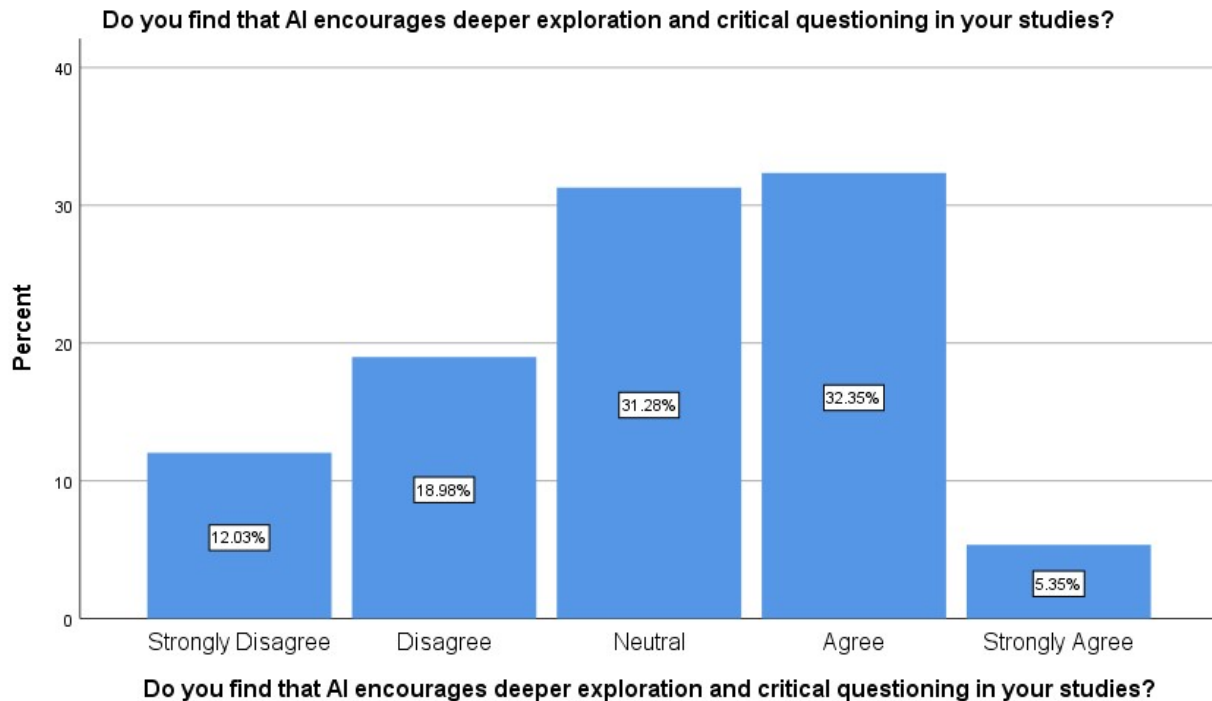


Figure 5

Practical Application and Critical Thinking

The Practical Application and Critical Thinking section included three questions, with detailed results presented in form of bar charts in following figures shown as percentages and frequency. Figure 6,7,8.

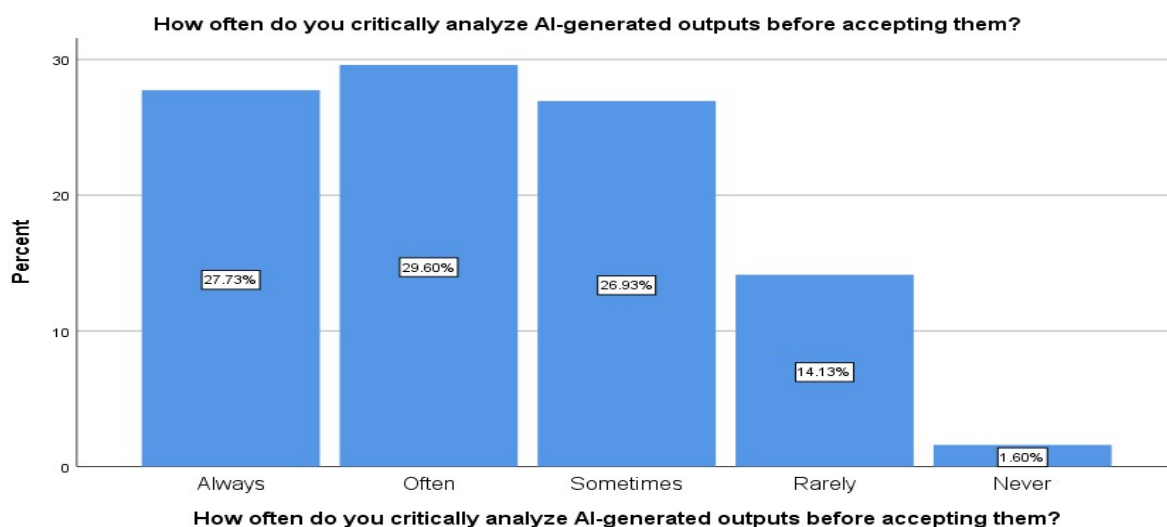


Figure 6

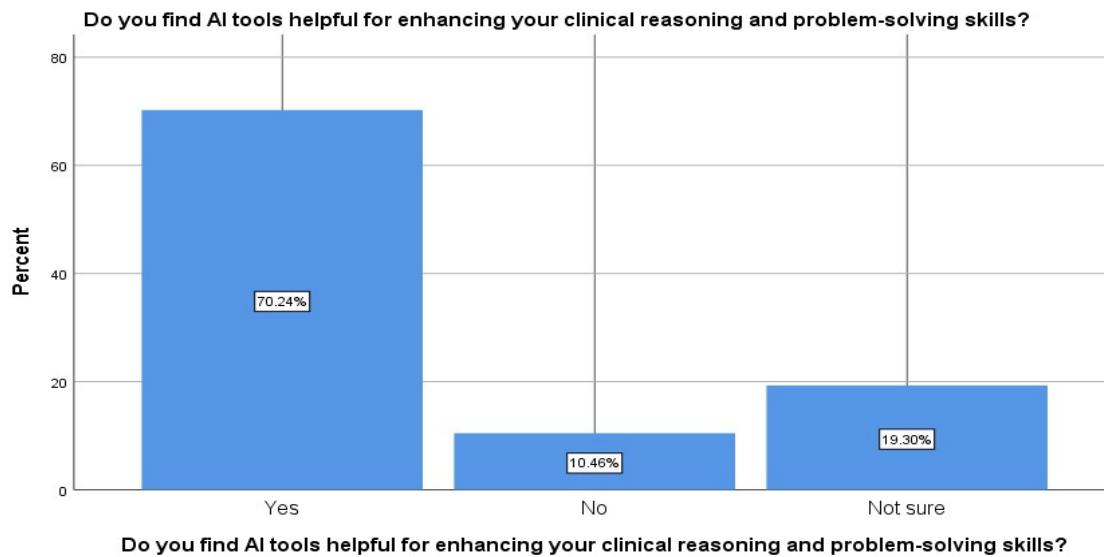


Figure 7

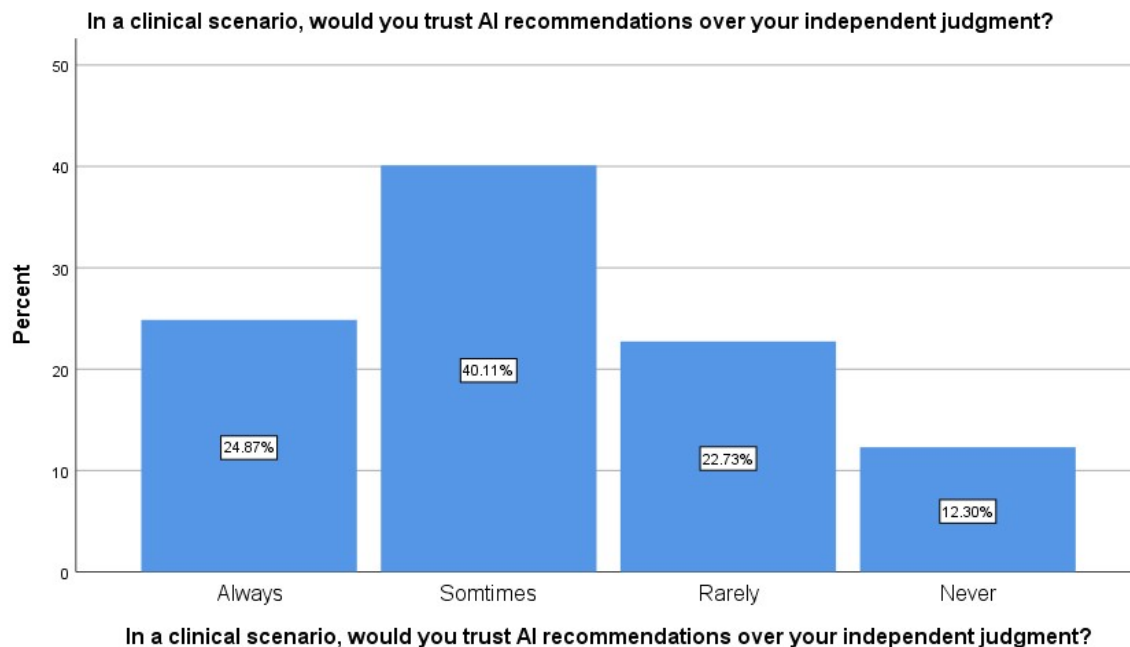


Figure 8

Critical Thinking Development:

The Critical Thinking Development section comprised four questions, with detailed results provided in form of bar charts in following figures shown as percentages and frequency. Figure 9,10,11,12.

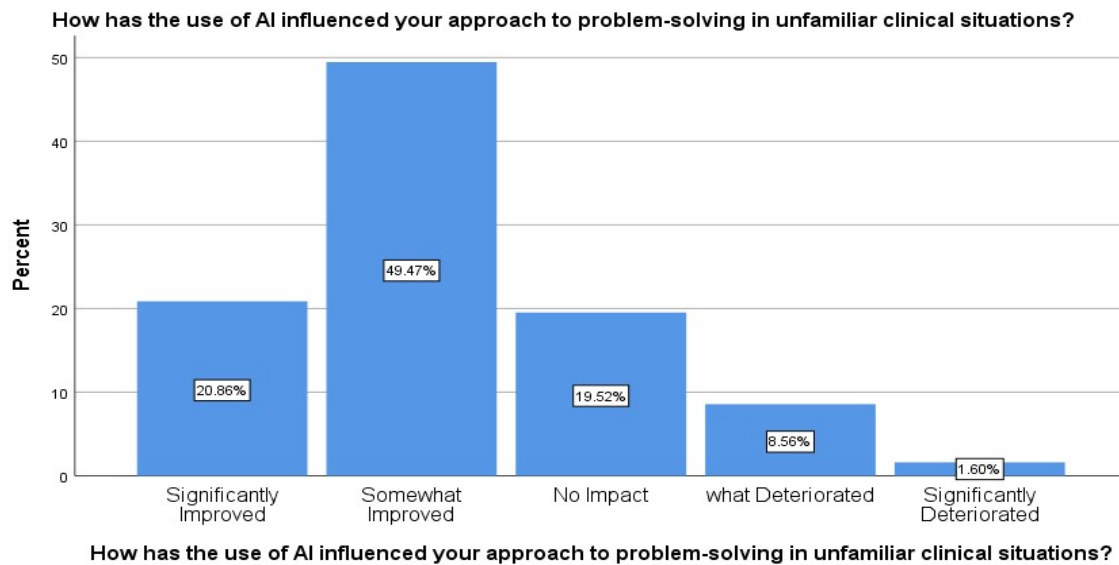


Figure 9

Do you believe that using AI tools has enhanced your ability to challenge assumptions or think critically about medical information?

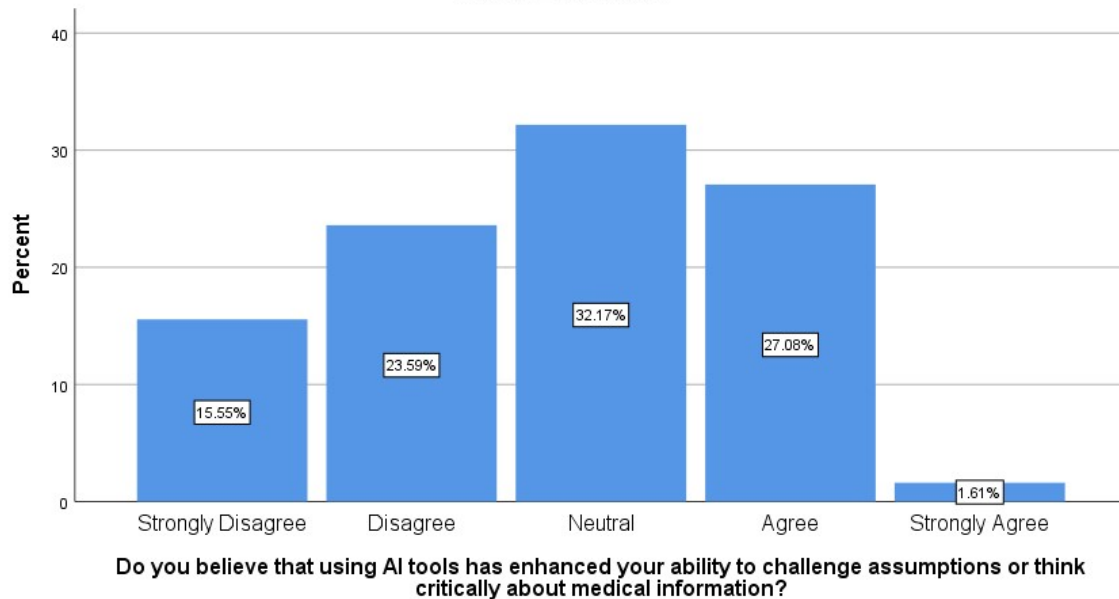
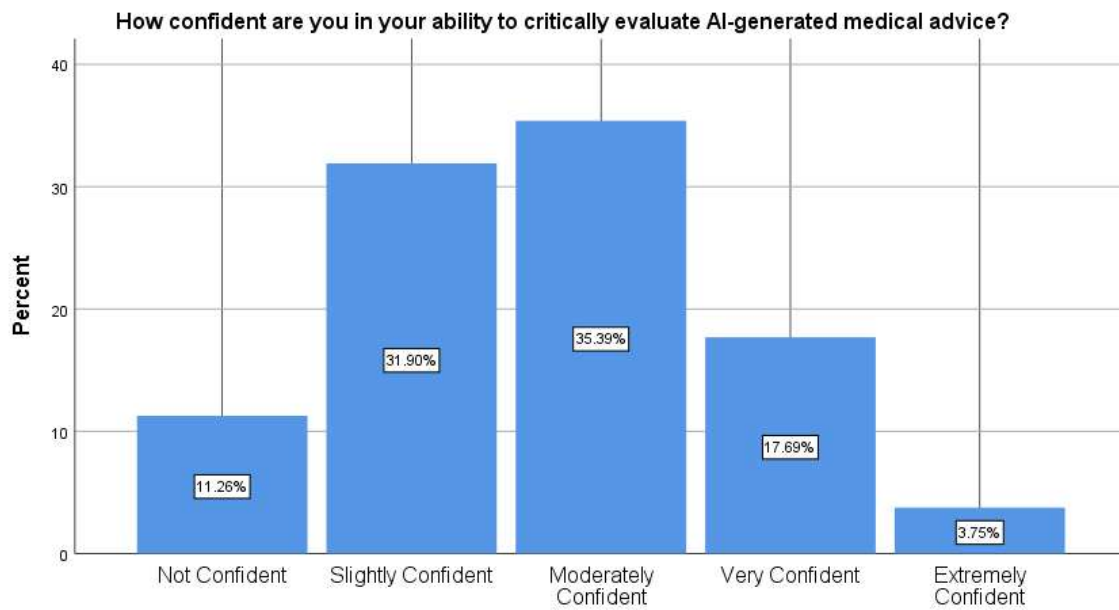
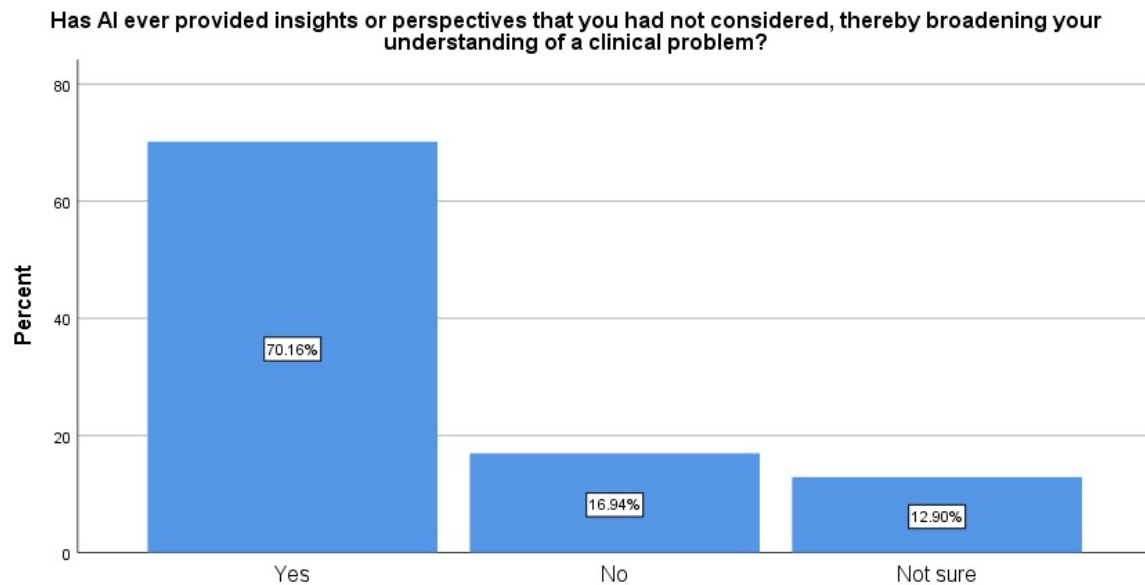


Figure 10



How confident are you in your ability to critically evaluate AI-generated medical advice?

Figure 11



Has AI ever provided insights or perspectives that you had not considered, thereby broadening your understanding of a clinical problem?

Figure 12

The General Feedback section included two questions the details of which are shown in following tables. Table 8,9.

Table 8. Would you recommend the increased use of AI tools in medical education to help develop critical thinking skills in future students?

		Frequency	Percent
Valid	Strongly Disagree	60	16.0
	Disagree	79	21.0
	Neutral	98	26.1
	Agree	121	32.2
	Strongly Agree	18	4.0
	Total	376	100
Total		376	100.0

Table 9. What is your overall opinion on the integration of AI into medical education?

		Frequency	Percent
Valid	Highly Positive	82	21.8
	Positive	183	48.7
	Neutral	81	21.5
	Highly Negative	21	5.6
	Highly Negative	9	1.6
	Total	376	100
Total		376	100.0

Discussion

Application of Artificial Intelligence (AI) in medical education is transforming the learning process of students and the development of their critical thinking ability. This study was conducted to investigate the impact of AI on the problem-solving ability of Khyber Pakhtunkhwa (KPK) medical students and critical thinking.

The research revealed that medical students employ AI tools differently. The majority of the students (33%) employ AI occasionally, while others employ AI regularly (26.9%) or seldom (27.1%). Extremely few (5.3%) always depend on AI. It reflects that students employ AI as a helpful tool but never completely depend on it.

The most used ones are AI diagnostic apps like ChatGPT at 46.5%, educational chatbots at 29.4%, medical image analysis software at 13.1%, and virtual patient simulations at 11%. Diagnostic apps appear to be the most convenient and useful for students, whereas applications like virtual patient simulations, though less used, are a safe place to practice students' decision-making skill.

AI tools offer many benefits for medical students. They help improve diagnostic accuracy, provide personalized feedback, and create simulations for practicing real-world scenarios. Nearly half of the students (43.9%) have been using AI tools for 6 months to a year, showing that these tools are relatively new but already important in their education.

The interactive lessons and simulations provided by AI allow learners to utilize critical thinking and problem-solving skills without ever putting themselves at risk of committing

real-world errors. This way, they truly bridge the theory-practice gap.

Even though it has its benefits, over-reliance on AI is undesirable. About 37.3% of the students indicated their unwillingness to support increased incorporation of AI into medical studies. Some fear that overuse of AI will deter them from independent thinking and problem-solving. Although most of the students (71%) were positive or highly positive towards AI, the mixed reactions show that not all are assured of its goodness.

This work is supported by other studies that suggest that AI can be used to improve as well as degrade critical thinking based on the type of its usage. These results provide new evidence from Pakistan that supports the call for using AI wisely so that it reinforces, instead of degrades, students' problem-solving abilities.

The research emphasizes the importance of a balanced implementation of AI in medical training. AI technology must be utilized by teachers and schools as an aid to learning, and not as a substitute for conventional practice methods. Educating students to utilize AI effectively while developing independent thought is most essential. Accordingly, AI can be a valuable aid to learning, though.

We used a convenience sampling method, which may not be representative of all medical students' varied views. The findings also represent opinions and usage at a point in time. Future studies should explore how AI affects students' critical thinking ability over time and compares findings between institutions to gain an improved overview. Conclusion AI is a very useful tool that can improve the way medical students learn and are taught to think. However, we must employ it in such a manner that fosters independent thought and problem-solving. If we solve problems and utilize AI in medical education in a thoughtful manner, then we can make the students more confident and capable future doctors.

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