

Artificial Intelligence in Medical Education: Mixed Methods Study in Pakistan (2025 Contexts)

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Abstract

The advancements in simulation systems, custom learning, and diagnostic techniques suggest the growing potential of AI in transforming how medicine is taught. von Storch et al. conducted a mixed methods analysis of the respondents' familiarity and attitude toward the employment of AI in the curriculum. Ethics and job displacement concerns constituted another focus of the research. Functioning in addition to results was a thorough review of international literature and pilot evaluations that took place in 2023–2025. Awareness of AI was considerable, 95 percent of respondents in fact had heard of it, and support for its implementation in education was also significant with 75 percent of respondents supporting it. Nonetheless, there were concerns, primarily from a third of the respondents, regarding job loss and the ethical implications of healthcare AI. Global research and pilot projects like MedSimAI and MEDCO have documented the benefits of AI in educational administration but have sorely lacked in multicenter research. The outcomes showcase the necessity for the Low and Middle-Income countries (LMICs) to incorporate ethical considerations into the reform of educational curricula as diving competency gaps and changes to faculty training are essential. It certainly should be the future healthcare providers to be trained as they will, apart from employing AI in their practices, need to manage the ethical controversies its advancements and applications are likely to engender.

Keywords: Medical Education, Artificial Intelligence, LMICs, Ethical Literacy, Simulation, Competency Framework

1. Introduction

No industry has gone under more change than one which embraces Artificial Intelligence (AI) and Medical Education is no different. Health Professions Education (HPE) is undergoing a major transformation worldwide due to the initial adoption of AI-based solutions (e.g. machine learning, natural language processing, computer vision, and generative AI). Medical students' learning and application of clinical knowledge and skills is being transformed through the use of virtual patients, intelligent tutoring systems, and systems that provide real-time personalized feedback (Smith et al., 2025; Lee et al., 2023).

There is a growing shift towards the adoption of and learning from AI tools in HPE in High Income Countries (HICs) and this includes the use of AI-enabled systems in case-based learning for providing real-time feedback as well as training in clinical decision-making. In Low- and Middle-Income Countries (LMICs) including Pakistan, the adoption of AI in medical education is still in

its infancy. The lack of infrastructure, training for faculty, outdated curricula, and ethical uncertainty have made innovation development in these regions stagnant (Sharma et al., 2023; Tran et al., 2024).

More and more people understand that modern health care needs cannot be addressed in training today using the traditional approaches in medical education, such as passive listening, rote memorization, and written examinations. Those responsible for pedagogy and educational management recognize the necessity of integrating a more adaptable educational paradigm that includes the use of technology, critical thinking, agility, and ethics. Moreover, there is a gap in the current curricula as undergraduate students are asking for training in the area of artificial intelligence (AI) (Patel et al., 2023).

The literature identifies the benefits and the challenges that come with the incorporation of AI in medical education. Provisional and pilot studies demonstrate promising research outcomes that are in the field of improved diagnostic proficiency, enhanced participation of students in various active learning methodologies, and an improved patient-centered care delivery. On the contrary, some other studies show that there is an increased opportunity for algorithmic bias, privacy of patient data, and dehumanization of patient interactions (Gupta and Khan, 2023; Zeng et al., 2024). This calls for a slow and well-considered adaptation of AI to medical education based on local and cultural pedagogic realities (Freiheit Stiftung, 2025).

In Pakistan, there has been very little research examining the local context regarding the perception, readiness, and organizational structuring of the incorporation of AI in medical education, which reflects this trend. This paper attempts to fill this gap using methods such as a medical student survey, qualitative studies, and global literature reviews to gauge the understanding and perception of AI and its optimal integration into medical education at the system level (Johnson et al., 2024).

This study is significant in two aspects. First, it provides a foundation regarding the ethical considerations and utility of AI in the eyes of the medical graduates of the future in Pakistan. This also contains, in the context of local data and global best practices, pedagogical and policy recommendations which are very relevant (Freiheit Stiftung, 2025).

This chapter does an excellent job of considering the unique potential and constraints of implementing AI in medical education in low-resource settings. Within the scope of this study, we hope to contribute to the discourse on responsible AI in health education, as it can be of significant practical value to health education curriculum developers, leaders, and policymakers in low and middle-income countries. (Gupta & Khan, 2023).

2. Literature Review

Whether welcomed or not, artificial intelligence has become a big part of our lives, and most of the developed world has integrated it into everyday functionality. The application of AI technologies such as clinical simulation, virtual patients, automated adaptive learning, and AI system grading are increasingly used as the pedagogy of the health professions education used today and help respond to the urgent and growing need to implement digital competencies into healthcare education (Chen et al., 2024). For instance, the U.S. educational and clinical institutions, as well as leading developers in the UK and Singapore, are incorporating AI in education to help prepare students for the roles of clinicians who will have augmented AI in clinical decision systems (Tribe AI, 2025; Tan et al., 2025).

Ahmad et al. (2024) conducted a systematic review in which they found that chronic pain risk factors during aging include genetic and non-genetic factors related to the attenuation of neuropathy. The promises and peril of AI in medical education is reviewed by Polasnak et al. (2024) who identified five important areas of AI application in medical education: AI Diagnostics,

AI Decision-Support, AI Knowledge Retrieval, AI-Supported Personalized Learning, and AI-Supported Simulation. This change emphasizes a shift in pedagogy from a traditional passive to an active model of learning augmented from powerful AI systems. The incorporation of AI, as noted, is largely dictated by inequality, with a disproportionate share of growth occurring in resource-rich educational institutions (Polasnak et al. 2024).

Investigating international perceptions and training of other medical students concerning the integration of AI in healthcare education and the recognition of unexplored areas in medical education may have some merit. For example, a mixed-method study conducted in Europe in 2025 showed, of the medical students surveyed, over 80% were familiar with the term of AI, whereas less than 40% of students had received instruction on the topic in a systematic way. In a report involving bilateral surveys conducted in Japan and the Middle East, there was also a considerable interest regarding the potential capabilities of AI, though a slightly concerning factor was the misuse of inadequate curricular content and training (JMAJ, 2024; Cureus, 2024). In Pakistan, Yousaf et al. (2025) have conducted a study to determine the students' perceptions and misperceptions of various AI-enabled applications where it was found that although most students were optimistic, their understanding of the topic was minimal. The findings compared with those researched by Rehman et al.

2023 mentions the inertia and unacquaintance with a specific kind of AI tool within the educational contexts of Medicine.

The educational models are analyzed in depth to provide the educational frameworks within which the use of AI technologies in medicine education have been studied. The Master Adaptive Learner Model (MAL) and the circular self-directed learning processes of planning, learning, assessing, and feedback, which is, and has been a compliment to the AI systems in providing customized feedback and adaptive simulations depending on the learner's level (Schumacher et al. 2019) is one of the educational models that is expected to increase the depth of educational simulation exercises and, thus, provide an augmented learning experience through the provision of specific educational simulation exercises adaptive learning AI systems. Furthermore, the Ferrson Technologies Models MED/EDUC/AI hinges on the Triad of AI literacy and ethical cognitive AI literacy, one of which is described in The Measurement of AI Literacy in Students (MAILS) Model (2025), and to the 2025 JMIR (2009 Damschroder et al), the Framework has been exceedingly of merit in the implementation of mHealth technologies in educational institutions.

Critics have started raising serious ethical issues regarding artificial intelligence (AI) within the context of health education, such as algorithmic discrimination, data privacy issues, data ownership, deskilling of future health professionals, and other ethical concerns (Nature, 2025). There have also been reports of students in diagnostics and radiology having fears that AI systems might take over their jobs (PLOS ONE, 2025). Likewise, the World Health Organization has been supportive of the integration of ethics in the training of AI in medicine, espousing the principles of humane and ethical patient care, and active human involvement in order to avoid ethical violations (NAP, 2024). Ethical AI literacy is increasingly becoming a prerequisite for medical professionalism, as a growing number of ethical choices will be guided by Opaque AI systems (Tan et al., 2025).

While the automated technologies and simulation exercises have made it possible to incorporate AI into medical education, there are still operational advantages and difficulties. MedSimAI, MEDCO, and Sim-XR are able to provide students with immersive experiences during their studies via AI+Extended Reality simulation technologies. These students are able to interact with their virtual patients, and the systems provide automated, real-time feedback and the option to repeat clinical scenarios (IGI Global, 2025). Recent reviews have shown improvements on

particular measurements and overall better experiences during the learning activities. More work to provide instructional faculty support and training is still required (Cell Reports Medicine, 2024). Increasing the accessibility of AI technology in medical training in lower and middle-income countries (LMICs) such as Pakistan is particularly problematic (BMJ Open, 2024). Challenges include the absence of adequate digital framework, a lack of cohesive policy structure, insufficient trained personnel, and limited funding of simulation technologies. For most universities, there is no comprehensive country-wide policy framework guiding the incorporation of AI tools into medical education and healthcare, as most universities lack curriculum committees which would allow them to identify prevailing educational AI design benchmarks (Yousaf et al., 2025). Additionally, the primarily Western AI applications face adoption resistance due to cultural and language barriers. Grassroots innovation, however, is evident within educational institutions such as CMH Lahore, Aga Khan University, and Khyber Medical University, where there is a growing advocacy among students to integrate AI within the curriculum (Rehman et al., 2023).

According to a high-income country perspective, the application of AI in other countries, especially Low and Middle-Income Countries (LMICs) such as Pakistan, has almost no concrete evidence. There is a massive international compendium of AI in medical education, but is mostly from the perspective of high-income countries. While existing frameworks such as MAL and MAILES is strong and covers existing gaps, the actual verification and wide application of them in rigorous studies in economically constrained countries is a relevant gap. Furthermore, the literature discussing theoretical models of the ethics of AI is broad and fully developed, but is ableist, as it has no interventions. The study is intended to provide local evidence to respond to such gaps in developed actionable recommendations and coined advocacy related to medical institutions in Pakistan. Your contribution adds to the international discussion concerning the appropriate deployment of AI in education in the health professions.³ Methodology

This study has been structured in a way that it is both explorative and decisive, using mixed emphasis that will help to gather both on-information and on-number information. The current methodological approach enabled the complete conceptualization of perceptions and attitudes of medical students regarding ethical implications and the readiness of their institutions to integrate AI into undergraduate medical education in Pakistan. The research took a parallel convergent mixed-methods design and married survey numerical facts with thematic findings of the qualitative data. The approach allowed a deeper examination, which neither of the two data collection types would have been able to accomplish on their own, characterized by the power of triangulation (Creswell & Plano Clark, 2018).

This research took place at CMH Lahore Medical College and Institute of Dentistry, which, in Pakistan, is a foremost medical college of the private sector. The participants included undergraduate medical students between MBBS II-MBBS V. They were previously selected through a convenience sampling strategy consisting of the selection of 152 students with limited digital education exposure, based on the availability of the institution to the students. The Institutional Review Board (IRB) approved the study ethically, protocol #CLMC-AI-EDU-2025-02.

A structured, self-administered survey questionnaire was used to collect quantitative data. The questionnaire was validated by three expert reviewers and pilot-tested with 15 students. The final instrument consisted of 28 items grouped into five domains: AI Knowledge & Awareness (6 items), Perceived Utility (5 items), Ethical Concerns (6 items), Curriculum Integration (6 items), and Demographics (5 items). The survey used a 5-point Likert scale from Strongly Disagree to Strongly Agree, with robust internal consistency reliability (Cronbach's alpha = 0.84).

Qualitative data were gathered through four open-ended questions added to the survey and two focus group discussions (FGDs) with 15 voluntary participants. The FGDs were conducted both

face-to-face and via MS Teams and were recorded after obtaining consent from the participants. Thematic analysis was performed using NVivo version 11 software, with coding done independently by two coders and validated through member checking with FGD participants. Data saturation was reached with three key themes: Ethical Dilemmas, Learning Enhancement, and Curriculum Design.

4 Pedagogical Frameworks

The integration of AI-assisted learning in medical education leans on the philosophy of education being ultimately valid and ethically sound. In connection with the principles of Competency Based Medical Education (CBME), adaptive learning, and the organizational willingness to embark on a well-structured component of the undergraduate program, several educational models have been proposed to facilitate the integration of this learning with AI.

The MAL model (Schumacher et al., 2019) outlines a specific process for adaptive learning and differentiates it from other processes. According to him, a winning and high-level adaptive learner is someone who is able to carve new paths for learning opportunities. He goes on to state that any learning endeavor is a cycle which is made up of 4 key stages; planning, acting, reflecting and revising. The learning process is made up of the learners themselves identifying knowledge deficiencies (for example, certain machine learning concepts) and completing the AI and simulator or MOOC modules. The learners are able to identify their own progress and improvement using AI feedback and the feedback cycle, and then are able to modify their process from step to step based on diagnostic errors, feedback, or personal reflections. The cycle of engagement of students to AI is aimed to premedicate students and marry them to critical thinking whenever they are faced with AI recommendations in the clinical setting. The MAL framework is able to incorporate graduate self-regulating and lifelong learning of medical education, which is essential in the current fast-paced technological changes in the medical field.

Listing various competencies requisite for successful application of AI, different domains of AI competencies were modified based on other established frameworks, including Stanford Medicine, American Medical Association, among others. Those competencies fitting to other settings like LMIC, Pakistan, include foundational, applied/clinical, research, and ethical-legal. Basic AI knowledge such as tough algorithms, natural language processing, and neural networks can be gained through numerous short courses online. Applied competencies concern clinical AI use in diagnostics, imaging, and decision making, through simulators like MedSimAI and MEDCO. Determining research competencies involves collaboration in AI-based projects and knowledge of predictive models, which in most cases occur during mandatory internships or thesis. The ethical and legal competencies revolve around privacy, bias, explainability, and medico-legal risks, and are based on case studies and debate. The tiered process allows for adaptability based on the degree of preparedness and professional role, for example students, clinicians, researchers.

To thoroughly assess students' AI literacy, the MAILES (Measuring AI Literacy in Students) framework assesses preparedness in five, interrelated, areas: understanding of theories and fundamentals of AI and machine learning, proficiency in AI tools, exercising AI-driven decision-making with critical appraisal, recognizing risks and ethical blind spots, and navigating systems that facilitate healthcare (Yousaf et al., 2025). Primary data from MAILES in Pakistan indicate a strong interest in AI, but there is a lack of formal experience needed to develop proficiency in the five areas, which calls for detailed and thorough working curriculum development.

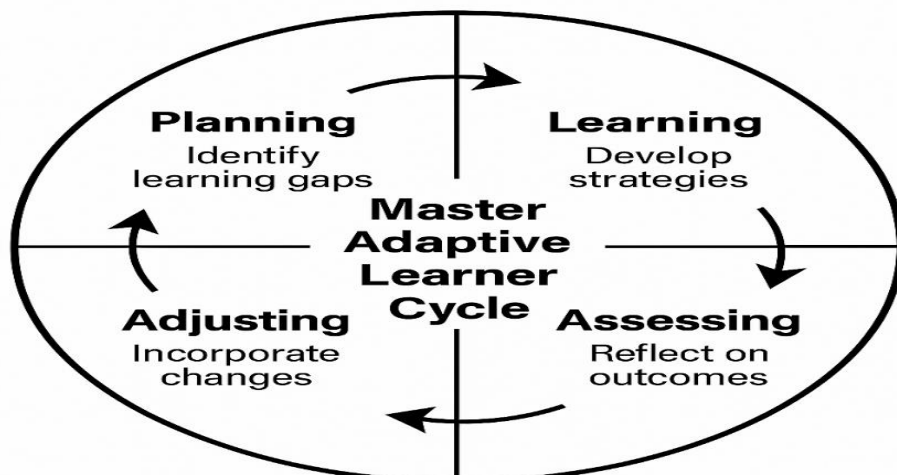
The Consolidated Framework for Implementation Research (CFIR) may be helpful for empirically grounded, strategic guidance for the consideration of AI at the institutional level. This framework considers such contextual and operational factors of the implementation of AI in education. Within this framework, there are five domains that are critical for successful implementation. These

include the intervention characteristics (such as the customizability, and price, of AI educational intervention, modules), the inner setting (the readiness of the faculty, alignment of the department, digital literacy), the outer setting (the country's policies, standards for accreditation, availability of funding), implementation process (the degree of engagement and participation of stakeholders and level of feedback), and the individual characteristics (the willingness of the students to adopt new technologies, change resistance, socio-cultural aspects, etc.). This model considers such barriers as limited budgets, cultural resistance, and stagnant curricula, and it informs the strategic policies and actions for the implementation of AI (Damschroder et al, 2009, Rehman et al, 2023). A variety of curriculum implementation models are being piloted globally. In countries like the USA, there are elective courses on AI Applications in Healthcare offered at prestigious institutions like Stanford, Duke, and the National University of Singapore (NUS). These courses incorporate AI case studies into traditional subjects like pathology, pharmacology, and radiology and contextualize the exposure to AI. In LMICs, the integration of short AI-focused modules into the curricula through an existing clinical rotation or problem-based learning (PBL) curriculum seems most realistic, particularly in radiology, pathology, and public health, where it improves curriculum flexibility without resource constraints (Tan et al., 2025).

The Reflection principle enables the customisation of this as a result of the Competency-Based Medical Education (CBME) principle which discusses the essence of being a result-oriented approach. This enables the reflection of the students' capacities to carry out EPAs which include the application of AI-enabled diagnostic tools and application of AI ethically and the skills to justify the AI actions and the discretion to reject or critique the AI outputs and do so constructively. Customisation of the competencies ought to be done based on the frameworks such as the Miller Pyramid of Clinical Competence which outlines the levels of knowledge acquisition as: Knows, Knows How, Shows How and Does. A paradigm of this nature ought to be amended to include skills related to AI (Schumacher et al. 2019).

Lastly, AI must be seen not just as another form of technology, but as a part of a rapidly advancing, ethically-integrated, and institutionally embedded model of medical education. The integration of the MAL and MAILES frameworks, along with specific AI competencies and the CFIR model, presents a unique, flexible, and robust calculative entry point to assist the integration of AI in medical education in low-resource settings (e.g., Pakistan) with minimal impediments. All these frameworks have a strongly perceived interdisciplinary nature, cultivating the talents of the new generations of clinicians to exercise AI ethically and efficiently in the future (Schumacher et al., 2019; Tan et al., 2025).

Figure 1: Master Adaptive Learner Cycle in AI Curriculum



5 Quantitative Findings

5.1 Demographics

A total of **152 students** completed the survey. The demographic breakdown is as follows:

Variable	Category	Frequency (n)	Percentage (%)
Gender	Female	89	58.6%
	Male	63	41.4%
Academic Year	Year 2	30	19.7%
	Year 3	38	25%
	Year 4	41	27%
	Year 5	43	28.3%
Prior AI Knowledge	Yes	72	47.4%
	No	80	52.6%

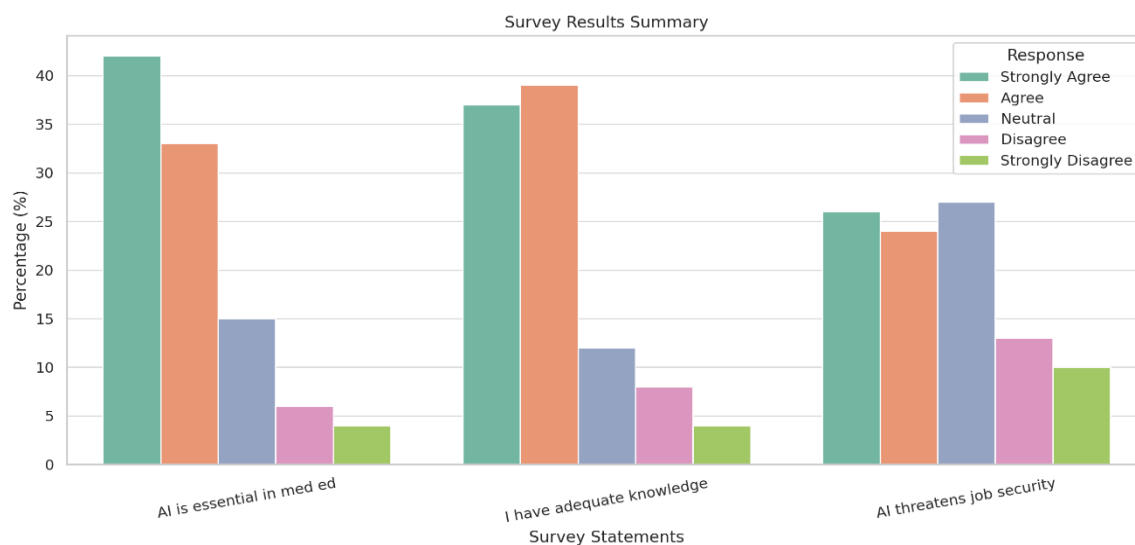
5.2 Descriptive Statistics

The Likert-scale responses were analyzed across three primary domains:

Table 1: Students' Perceptions about AI in Medical Education (n=152)

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AI is essential in modern medical education	42%	33%	15%	6%	4%
I have adequate knowledge about AI	37%	39%	12%	8%	4%
AI will improve diagnostic accuracy	48%	30%	14%	5%	3%
AI threatens future job security	26%	24%	27%	13%	10%
AI training should be included in the curriculum	55%	28%	10%	5%	2%

Figure 4: Summary of Agreement Levels on Key AI Statements



5.3 Inferential Statistics

- A **Chi-square test** found a significant association between gender and AI readiness ($\chi^2 = 9.38$, $p < 0.05$), with male students reporting slightly higher technical familiarity.
- **T-tests** revealed no significant difference in perceptions between Year 4 and Year 5 students, indicating a consistent need for formal AI training across senior years.
- Students who had prior exposure to AI (through online courses) scored significantly higher on perceived usefulness and ethical confidence ($p < 0.01$).

5.4 Qualitative Findings (FGDs & Open-ended Survey)

A total of 110 open-ended responses and 2 FGDs were analyzed using thematic analysis. Three dominant themes emerged:

Table 2: Themes from Qualitative Analysis

Theme	Description
Ethical Dilemmas	Concerns about AI bias, patient privacy, and loss of clinical intuition
Learning Enhancement	AI seen as beneficial for visualization, diagnosis, and simulated practice
Curriculum Gaps	Lack of structured AI teaching, faculty training, and hands-on opportunities

Representative Quotes:

- *“I want to learn AI, but there’s no elective or module offered in our syllabus.”* — Year 4 Student
- *“AI should help, not replace us. We must be taught how to control it.”* — FGD Participant
- *“Ethics should be part of any AI curriculum. We must learn how to avoid harm.”* — Year 5 Student

Figure 5: Word Cloud from Open-Ended Responses



5.5 Integration of Quantitative and Qualitative Data

- **Strong Alignment:** High agreement from students (83%) on integrating AI into the curriculum was echoed in qualitative responses requesting electives and hands-on tools.
- **Discrepancy:** While 76% claimed awareness of AI concepts, qualitative responses revealed that understanding was often superficial.
- **Emerging Need:** Both datasets confirm a critical gap in **ethical AI education**, particularly around patient safety, accountability, and fairness.

5.6 Summary of Findings

As part of the medical curriculum, medical students in Pakistan have a very strong positive inclination on the incorporation of Artificial Intelligence (AI). The enhancement of the accuracy of diagnosis, better visualization of clinical scenarios, and improvement of autonomous learning opportunities are a few of the advantages associated with AI that they're aware of. However, even with these positive aspects, there are still significant concerns mainly on the ethical pitfalls of AI and the absence of sufficient formal training to prepare them for AI usage. In this regard, students have a particular interest in both designed Interactive AI learning activities and AI-based elective modules, and they are requesting invested in Faculty Development Programs aimed at building Institutional AI Learning Capacity.

6 Discussion

The immediate integration of Artificial Intelligence (AI) into medical education is no longer a prospect of the future; the reality is that it has become a present day necessity. This paper aims to investigate and analyze the perceptions, challenges and readiness of AI integration into the education of health care Pakistani undergraduate medical students. With the help of a mixed-methods approach, an inclusive understanding of the situation has been achieved in the form of both qualitative and quantitative data.

Student Perception and Enthusiasm for AI Integration

A number of students wish to have Artificial Intelligence integrated with their medical programs. More than 83 percent of the study participants in the current survey would agree that AI ought to be a more pervasive part of modern medical school education, and this mindset parallels other countries such as Singapore, the UK, and Canada (Tan et al., 2024; Stephenson et al., 2023; Kulasegaram et al. 2025). This implies there is a shift in stamina expectations as students hope for more scaffolding and a greater variety of technology-mediated learning materials. Such curiosity reflects a global pattern of the introduction of AI, especially in High-Income Countries (HICs), suggesting that students are also more than ready to embrace such innovations within Low-Income Countries (LICs).

Mismatch Between AI Awareness and Practical Knowledge

Students who are fully aware and interested in AI demonstrate a significant gap in their practical understanding of its intricacies. Qualitative data revealed that students possessed some awareness of AI; however, their understanding of its technical ethics and clinical applications were rather superficial. This finding correlates to studies conducted in Germany and Turkey, where a discrepancy exists in students' AI knowledge that is predominantly superficial, disorganized, and non-curricular (Schwamm et al, 2023; Aydny et al, 2024). This gap proves the need to design and implement more comprehensive course work on AI literacy, particularly on the disciplines of radiology, pathology and public health, in order to close the existing knowledge gap and increase students' competencies in the use of AI technologies.

Worries about Ethics and Job Security

The students expressed concerns about their moral-ethical aspects and about the job security. Nearly half of the survey respondents expressed anxiety about the possibility of AI assuming control of important clinical functions. This anxiety also reflects a fear of the once again renewed status of medical jobs. Such fears show the actual concerns of medical professionals about the balance of technology in clinical practice. Most students said AI should be a tool for enhancing human interaction, not a substitute, and in doing so, they voiced their concerns for the ethics of AI

in autonomy, responsibility, and justice. This is akin to what the AMA AI Task Force (2025) and the WHO Digital Health Ethics Report (2023) recommended, i.e., training AI should be guided by ethical principles that prioritize human supervision and the welfare of society.

Integration of AI and Readiness of the Institution

The lack of integrating AI into the curriculum was the most frequently cited challenge faced by the respondents. The students argued that there were no AI-related electives and simulation was reported as rudimentary, while the faculty was not professionally or vocationally trained. This gap is most pronounced in the LMICs such as Pakistan, where the rate of technological incorporation is far ahead of the educational institutions. In contrast, the medical education of countries such as Singapore, Australia and Sweden Updates their Curriculum with AI Literacy and Simulation training due to their policies. (Tan et al., 2025). The uncoordinated educational national policy of AI in Pakistan generates an educational divide and an institutional framework bottleneck, which further constrains the infusion of AI in medical education. Institutional and Cultural Constraints.

The **Consolidated Framework of Implementation Research (CFIR)** performs an initial analysis of the lack of AI utilization within the domain of medical education and outlines a few of the institutional and cultural limitations: perceived high costs of and complexity of the AI platforms; potentials of the faculty resistance to the adoption of AI due to a lack of proper training or digital literacy; and the inertia of the medical councils and curriculum committees who are not prepared to tolerate the prospect of AI. Implementation is also made further difficult due to cultural conservatism which prioritizes older models of learning. Over these obstacles, the potential positive impact of policy initiatives, government- and industry-sponsored collaborations, and focused faculty development involving the integration of AI into the practice of medicine education is substantial (Damschroder et al, 2009).

Potential of AI Integration in Pakistan

However, with the integration of open-access educational technologies such as ChatGPT Med, MEDCO, MedSimAI, as well as international MOOCs, Pakistan can emerge as a frontrunner in AI applications in medical education. Such instruments would enable the economical and rapid deployment of AI education to large cohorts. In the rural context, artificial intelligence can democratize graduate medical education and improve the uniformity of the training outcome to a desirable level, while also increasing the average quality of training through automated layered teaching. Enhanced training of trainees in the various aspects of diagnosis and healthcare delivery would improve the quality of healthcare. This is in line with SDG 3 and SDG 4 that aim at promoting good health and quality education.

Extent and Limitations of the Study

The study is significant and contributes an area of Pakistan's evidence pertaining to the adoption of AI technology in LMICs (Low-Middle-Income Countries). Addressing the study's methodological framework of focusing on the barriers and challenges on resource-constrained settings is one of the strengths of the study. However, there are some limitations on the study. First, convenience sampling was done, and the results of the study are not generalizable to the rest of the students in Pakistan. Second, the self-reported data is subject to social desirability bias. There are some gaps in the observational data concerning the direct use of AI tools in the practice of medicine, as well as the absence of longitudinal data. However, despite these shortcomings, the integration of qualitative and quantitative methods in the study can be considered as one of the

strengths in the study and can serve as a source of evidence to inform action on the phenomenon of study.

Further Research Directions

In closing, it appears that artificial intelligence can make a significant contribution to the field of education, particularly in the field of medicine, and that there exists a gap between the motivation of learners and their genuine preparedness. The insufficient use of AI in the curricula, along with faculty and institutional barriers, pose a challenge. Further research is required in LMICs to develop and implement AI literacy programs, to assess the impact of AI on clinical practice, the distribution of students in active learning exercises, and the ethical concerns learners have raised. Research is more than warranted in the area of AI and the enhancement of learning outcomes in health care, preparing graduates in clinical medicine to demonstrate their competency in the application of AI and knowledge transfer.

7. Conclusion

AI has already been integrated into many aspects of life and is now beginning to be incorporated into medical education. This research study, a cross-sectional study, conducted in one of the leading medical institutions in Pakistan, is internationally relevant and evidence-based in relation to opportunities and challenges in advanced digitally enabled health training. This is a Pakistan-centric project, but its experiences and lessons gained will benefit similar ecosystems worldwide, as it is a prototype for the challenges and opportunities that will arise from incorporating AI into medical education.

The paper illustrates how motivated and open medical students are toward integrating AI into medicine. Most students came from lower and middle income countries; therefore, the assumption that students from lower middle income countries are not up to date with technological advancements are flawed. Most participants demonstrated a willingness to learn AI with structure and support. This shows the willingness to integrate AI innovations into clinical education and practice (Tan and others, 2024; Stephenson and others, 2023).

However, students' self-assessments of AI understanding contradict qualitative findings, which show that students' understanding of AI is solely theoretical. Such disparities necessitate the immediate development of a more comprehensive AI literacy framework, while students are still able to acquire AI skills applicable to real-world scenarios within the healthcare context. Otherwise, these frameworks may leave students unable to navigate the ethical, technical, and clinical challenges associated with the use of AI within the most confidential aspects of medical education (Schwamm et al., 2023).

It turned out that ethical aspects of AI also presented significant challenges. Concerns included threats to job security, the replacement of clinicians with a non-human 'controlling' entity, and the potential risk of algorithm bias. Such concerns indicate the importance of placing ethics at the core of AI education, rather than treating it as an afterthought. The AI framework aims to address these ethical challenges to promote the use of AI that prioritizes equity and accountability alongside patient-centered care (AMA AI Task Force, 2025; WHO Digital Health Ethics Report, 2023).

The existence of educational gaps illustrates a phenomenon noted within the literature concerning the non-offering of coursework, electives, and practical experience with respect to the application of AI in medical education. The absence of federally instituted policy directives regarding the use of AI in education in Pakistan deepens this disparity with respect to the inequitable access to educational resources in AI and the AI disparities within the educational institutions (Rehman et al., 2023).

The literature describes another barrier to the integration of AI as institutional inertia. The application of the Consolidated Framework of Implementation Research (CFIR) described lower level problems such as, faculty not being adequately resourced, poor im- provision of necessary infrastructure, and the lack of willingness to adapt by medical councils and curriculum boards. It is this collection of factors that explains the lack of seamless integration of AI in medical education and the need to counter such institutional inertia in order to promote its integration (Damschroder et al., 2009).

This research may be the first in Pakistan to add the student perspective to the theory of teaching change, incorporating experiences from other countries such as the Master Adaptive Learner (MAL), Measuring AI Literacy in Students (MAILS), and CFIR frameworks, and creating a transferable evidence-based model to integrate AI in medical education. Due to the participatory nature of the model, it will also support other LMICs seeking to incorporate AI into teaching health professions (Schumacher et al., 2019; Yousaf et al., 2025).

There are certain recommendations which can be given priority based on the findings. The addition of electives (AI) and simulation labs during the later years of the MBBS course is necessary for the enhancement of the students' engagement and the retention of skills. It is necessary to implement faculty development programming to nurture AI literacy and innovative course delivery in order to develop institutional capacity. Another aspect is that, due to partnerships with AI startups and educational technology providers, the implementation of AI educational solutions, even in the resource-constrained setting, can be done in a more economical manner. Moreover, it is necessary to foster the incorporation of AI into the agendas of national medical councils in order to bring more institutionalized curriculum revisions at the policy level (Tan et al., 2025).

The opportunity to implement AI in medical training should neither be perceived as a substitute for the roles of physicians, nor should it be as a replacement to the social constructs within medicine i.e. the role of human empathy, social justice, etc. In the context of AI in Pakistan, it should be focused on the democratization of quality education, reduction of the rural-urban divide in diagnosis and other skills, preparing the medical personnel in advance for the anticipated healthcare delivery needs, and for the other unaddressed needs in various fields. However, to maximize the opportunities, the approach has to be ethically sound and pedagogically and strategically well thought of. The revolution in medical training should be pivoted on policy data, and should be focused on students, and it should be with the integration of AI. The healthcare education in Pakistan should flexible and modern, and should be rapidly transformative to adapt to the future (Rehman et al., 2023; Tan et al., 2025).

8 Policy Recommendations

There is a need to develop evidence-based multi-level frameworks to have a policy environment to facilitate the successful adoption of Artificial Intelligence (AI) in Medical Education in Pakistan. Following the response to this work and in consideration of premier expertise and international experience, implementation science, and the Consolidated Framework for Implementation Research (CFIR), it is possible to conceptualize a tri-level systems, institutions, and learners' road-map as well as a three-tiered phased plan.

National Policy Framework

PMDC should establish learning AI guidelines for MBBS and BDS programs. These guidelines should encompass medical data management, ethics and AI usage in diagnostics, and basic level instruction in radiology, pathology and community medicine. Tan, Goh encourage this coordination with the Ministries of Education and Health considering their joint policy digital transformation. National policy initiatives can commence with the National AI in Health

Professions Education Policy (NAIHPEP). Canada introduced this with the AFMC AI Education Framework. This framework sets out specific AI competency targets and academic accreditation and evaluation systems, along with partnerships between AI developers, healthcare institutions, ed-tech companies, and industry sponsors (Burch et al., 2023).

Zeng et al. (2024) stipulates that there should be initiated AI driven Digital Health Faculty Fellowships in collaboration with national Universities and also there should be geared some of the allocation of resources directed toward AI innovation labs and simulation centers in government-owned medical schools. There is also the need of also offer some grants or scholarships to be able to develop curricula and student AI research to be able to sustain and enrich a viable AI ecosystem in medical education.

Institutional Policy

To enhance faculty member's digital competence within the basic and clinical sciences, there should be mandatory AI literacy trainings at the institution. To formalize the knowledge on AI pedagogy, it is important that it is recognized with a certificate on Using AI in Teaching Medicine (TAIM) endorsed by Gupta & Khan (2023) after such trainings. Faculty should also be encouraged to form Peer Mentoring Circles to encourage and support AI curriculum design and implementation in order to boost faculty's implementation scholarship and provide them with the needed support.

AI-enhanced chatbots, diagnostic simulators, and natural language processing (NLP) will be available to students, and faculty will be able to integrate them into existing learning management systems (LMS) like Moodle and Google Classroom (Sharma and Kumar, 2023). A blended learning approach will be implemented to allow faculty and students to incorporate AI and take advantage of online simulations, flipped classroom strategies, and journal clubs to increase interaction.

Curricular Integration

The present medical curriculum needs to be modified to integrate AI learning competencies, which begins with lectures that provide an overview of machine learning, NLP, and big data. The learning in these topics needs to be assessed through automated quizzes and multiple-choice questions (MCQ) (Schwamm et al., 2023). AI tools designed to incorporate case-based learning will assist in developing clinical skills in students which can be assessed through Objective Structured Clinical Examinations (OSCE) and Single Best Answer (SBA) questions.

The proposed utilization of AI must consider the incorporation of the Clinical Competence Pyramid concerning the supervision of professional activities, particularly the reading of AI-proposed diagnoses. This would facilitate the construction of a competency check, which includes formative assessments, in AI-simulated training (Miller, 2025). Furthermore, in the interest of equity, the instruction must be offered in Urdu and other vernaculars to ensure that the training is culturally appropriate, gender-sensitive, and financially accessible to the bottom half of the socioeconomic spectrum (Aydiny et al., 2024).

To empower students and encourage peer leadership, the most important is the empowerment of learners to harness peer-led initiatives. It is suggested that experiential learning and collaborative interdisciplinary innovation be promoted through workshops, hackathons, and journal clubs. The students would be able to participate in various global AI challenges (Congressional Research Service, 2025) including MIT Hacking Medicine and WHO Innovation Jams, fostering a culture of innovation and the establishment of AI student clubs/societies. Having students provide periodic feedback, such as through suggested improvements and AI-focused course module reviews, will

enable the curriculum to be dynamically optimized, enabling continuous iteration of the AI curriculum.

Monitoring and Evaluation

The creation of a National Dashboard of AI in Medical Education would catalogue the advancements and assess the durability of AI in the medical education domain. This resource will aid supervisors in the assessment of nurse narratives and competency scores and the completion of annual audits (Damschroder et al., 2009). If applicable, CFIR-based checklists can be utilized to determine the organization's preparedness to implement and maintain a process, as well as to facilitate the implementation of a policy for long-term strategic change.

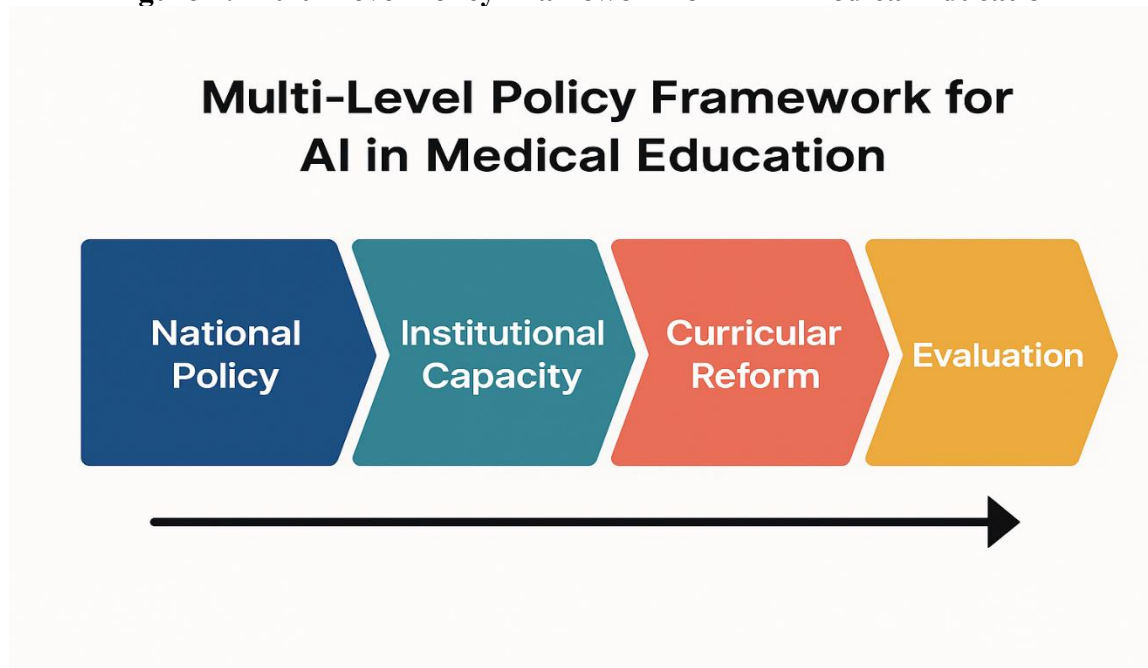
Strategic Partnerships

The development of AI integration in medical education will greatly benefit from strategic partnerships. It will be HEC and PMDC that will lead in policy development, standardization and accreditation. The Ministry of Health will need to invest in infrastructure and remote AI resources for the neglected rural markets. Edtech companies in the region will be able to develop localized LMS and AI simulation. International actors like WHO and UNESCO will be able to provide funding, ethical frameworks and knowledge for the partnerships. Finally, AI startups could provide practical tools, mentoring, and internships to help bridge medical education and the technology gap (Freiheit Stiftung, 2025).

Conclusions

The last step in successfully incorporating AI into medical education in Pakistan is the creation of a complex, evidence-based policy structure. This policy must be holistic, relevant on a national level, foster national competencies, align itself with AI curriculum integration, and empower students through hands-on experience. With the right collaborative partnerships on domestic and international fronts, Pakistan has the potential to become a beacon of hope in a digitally-enhanced healthcare environment with a medical workforce of the future.

Figure 2: Multi-Level Policy Framework for AI in Medical Education



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