Exploring the Factors of AI- Based Medical Education: A Systematic Literature Review from Foresight and Innovation Perspective in the Gulf Cooperation Council

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ABSTRACT

To explore the integration of Artificial Intelligence (AI) into medical higher education curricula in the Gulf Cooperation Council (GCC) region by identify enablers, barriers, and best practices in medical education in GCC. The study aims to develop a perspective on the future of AI-based learning in GCC medical education system. A foresight study employed methodological triangulation, utilizing systematic literature, causal layered analysis and secondary data analysis. This integrative design enhances credibility, validity and the depth of findings. The study is focus on medical higher education institutions within the Gulf Cooperation Countries (GCC) region. The study employed systematic literature reviews to assess the enablers, barriers, and best practices for AI adoption in medical education. Besides, causal layered analysis and secondary data analysis. The systematic literature review highlights the importance of AI integration in medical education, emphasizing project-based learning, curricular innovation, and ethical considerations. The Gulf Cooperation Council data emphasizes the need for enhanced AI policies. The paper also explores the synergy between societal, educational, and technical dimensions in education and the potential disruptive innovation in medical education due to AI's revolutionary capacity to redefine a new paradigm in medical education. The incorporation of artificial intelligence into medical education in the Gulf Cooperation Council (GCC) necessitates a comprehensive strategy that merges technological advancement, ethical consideration, and inclusive structures to prepare future healthcare practitioners for disruptive innovations in medical education.

Keywords: Medical Education, Artificial Intelligence, Foresight, Disruptive Innovation, Causal Layered Analysis.

INTRODUCTION

Is Artificial Intelligence (AI) merely a global trend, or is it a transformative force reshaping the future of education and healthcare? AI, both as a technological tool and a cultural force, is penetrating a wide range of disciplines, including higher education, as well as both private and public sector domains. The origin of AI can be traced back to the early 1950s, when John McCarthy coined the term "artificial intelligence" to describe a computer capable of performing cognitive functions like those of humans such as conversing, analyzing, acquiring knowledge, and solving problems[1]. Like previous waves of technological innovation since the 17th century, AI is emerging as a disruptive force that will redefine human progress[2]. Globally, AI-based applications are now widely used in education, healthcare, and business. To keep pace with rapid technological change, it is necessary for education systems to mainstream AI in learning to unlock new possibilities through access to big data and improved learning outcomes[3].

Yet despite this global momentum, the integration of AI into medical education in the Gulf Cooperation Council (GCC) remains limited and fragmented. Institutions in the region face challenges such as the absence of strategic frameworks, inadequate digital infrastructure, ethical concerns, and a lack of empirical studies specific to the GCC context. These gaps hinder the potential of AI to enhance medical training and prepare healthcare professionals for an increasingly technology-driven environment. In the field of medical education, organizations are actively seeking to improve service quality, system efficiency, and instructional models. The rapid growth of medical innovations in recent decades has made it difficult for the medical community to keep pace with change. AI can support healthcare professionals by collecting and analyzing data, enhancing decision-making, and simplifying diagnosis and treatment processes[4].

Previous studies have explored the integration of AI in medical education globally, with a focus on curriculum design, technology adaptation, ethics, and interdisciplinary collaboration. However, most of this research is theoretical or conducted outside the GCC, offering limited evidence or strategic foresight within the region. A comprehensive understanding of the enablers, barriers, and best practices for AI adoption in the medical education systems of the GCC is still missing.

Integrating AI into medical curricula is critical for delivering new avenues in learning, diagnosis, and treatment. This study aims to explore the integration of AI into medical higher education within the GCC region by examining current models of AI-based learning and innovative curricula, and by identifying key enablers, barriers, and best practices through a foresight and innovation perspective.

The primary research question is what approaches can be employed to incorporate AI into innovative curriculum to revolutionize medical higher education in the GCC region from a foresight perspective?

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The sub-questions in this research are:

1. What are the enablers for the successful integration of AI in Medical Education Curricula in the GCC region?
2. What are the barriers to employing AI in Medical Education Curricula in the GCC region?
3. What are the global best practices that can be adopted to AI driven curricula in Medical Education in the GCC region?

The questions will constitute a foundation for analyzing literature to evaluate the innovative curriculum in medical higher education within the GCC, focusing on the role of artificial intelligence.

METHODOLOGY

This study employs methodological triangulation utilizing systematic literature review, causal layered analysis, and secondary data. The research strategy based on based on articles were identified by titles, abstracts and keyword relevant to research objective. The key words were Curriculum, Medical Education, Artificial Intelligence and Innovation. The Systematic Literature Review (SLR) was in accordance with the Preferred Reporting Items for Systematic Review criteria as shown in Figure 1 below. The research was sourced from four academic databases: Scopus, ScienceDirect, PubMed and Google Scholar in English during the period 2020–2024. The inclusion criteria are peer-reviewed scientific publications, journals, and open access. Furthermore, the exclusion criteria are conference proceedings, master's thesis, doctorate dissertations, textbooks, and unpublished research papers. The selection process initially yielded 143 publications were found using keyword searches based on journal titles, abstracts, keywords, and subjects in the evaluation phase. Out of those, 60 papers were chosen considering the significant relation with the research questions and objectives.

Table 1, we illustrate the thematic domains of the reviewed papers, focusing on the enablers of AI adoption in medical education, the barriers to AI adoption in medical education, and the best practices for AI adoption in medical education.

Causal Layered Analysis (CLA) is introduced as methodology for futures research and comprises four levels: litany, social causes, discourse/worldview, and myth/metaphor. The objective is to perform research that bridges these analytical layers, encompassing diverse epistemologies [5]. Secondary data refers to information collected by individuals or organizations for various objectives. The secondary data include the Global Innovation Index (GII) from 2020 to 2024, the Sustainable Development Goals (SDGs) for 2024, key performance indicators (KPI), and AI strategies in Gulf Cooperation Council Countries.

Thematic Analysis and Key Findings

The integration of Artificial Intelligence (AI) into medical education curricula has been extensively explored, with the literature identifying key enablers, barriers, and best practices. Curriculum Development and Technological Integration are enlisted as two key thematic codes for enabling AI adoption in medical education. Barriers of AI integration

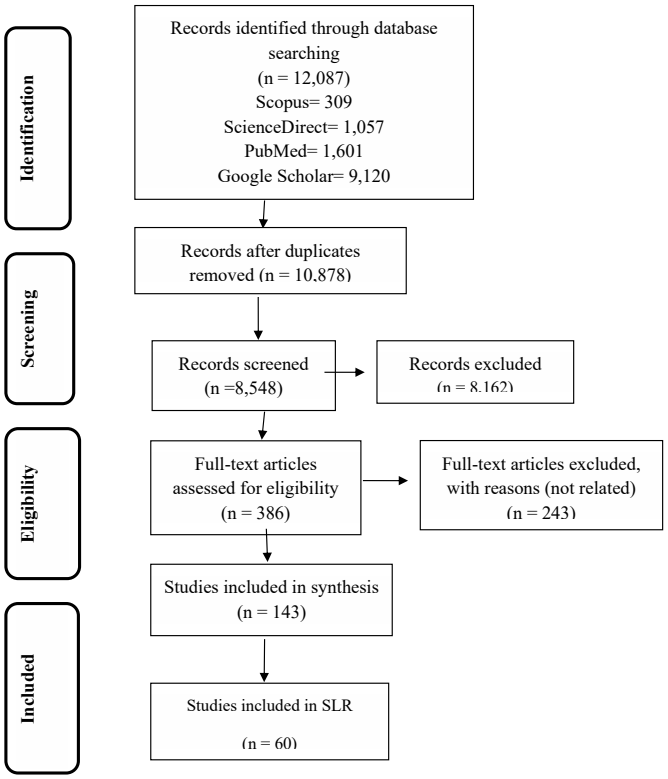

Figure 1. Flow diagram for systematic literature review following PRISMA guidelines

in Medical Education Curricula include ethical and legal concerns, faculty and Medical Students' preparedness, curriculum limitations and technological infrastructure. Best practices for integrating AI into medical education curricula include Curriculum Design and Delivery, Technology Adaptation in Medical Education, Ethics and Critical Thinking, Interdisciplinary Collaboration and Case-based Learning. These key thematic codes provide a foundation for understanding the opportunities and challenges of AI adoption in medical education.

SYSTEMATIC LITERATURE REVIEW

Enablers of AI integration in Medical Education Curricula

A total of two thematic codes related to the enablers of AI adoption in medical education (n=21) were identified and discussed in the literature. Each thematic code is outlined in the subsequent section, including examples sourced from the studies. Table 2 provides an overview of the enablers of AI adoption in medical education. After thorough analysis of each study, enablers had been identified for addressing the research questions. The first thematic code, Curriculum Development (n=13), highlights its role as an enabler of AI adoption in medical education. The second thematic code is Technological Integration (n=8).

Curriculum creation is essential for equipping students with AI in healthcare, incorporating multidisciplinary training, modular frameworks, adaptable competency-based curricula, and standardized

Table 1. The thematic domain of articles

Thematic Domains	Number of instances in the literature
Best practices for integrating AI into medical education curricula	22
Enablers of integration AI in medical education curricula	21
Barriers of integration AI in medical education curricula	17
Total	**60**

Table 2. Thematic codes of articles on the enablers of the successful integration of AI in Medical Education Curricula

Number	Thematic Code	Description	Number of Studies
1	Curriculum Development	Studies focused on designing and implementing AI-based curriculums in medical education.	13
2	Technological Integration	Exploration of existing AI technologies and the development of innovative tools to advance medical education.	8
	Total	21	

Table 3. Thematic code of articles on the barriers of AI integration in Medical Education Curricula

Number	Thematic Code	Description	Number of Studies
1	Ethical and Legal Concerns	Issues like data privacy, algorithmic bias, lack of transparency, and accountability hinder trust and responsible	6
2	Faculty and Medical Students Preparedness	Faculty and students lacking training and readiness limits their ability to incorporate AI effectively into teaching	5
3	Curriculum Limitations	Traditional curricula lack AI-specific content, hindering alignment with technological advancements in healthcare.	5
4	Technological Infrastructure	Lack of infrastructure, including AI tools and digital platforms, constrains the successful integration of AI.	1
	Total		17

Table 4. Thematic code of articles on the best practices for integrating AI into Medical Education Curricula

Number	Thematic Code	Description	Number of Studies
1	Curriculum Design and Delivery	Developing iterative, integrated AI modules and spiral curricula to align with existing frameworks.	7
2	Technology Adaptation in Medical Education	Integrating advanced technologies such as virtual reality and online platforms with trendy pedagogical approaches.	6
3	Ethics and Critical Thinking	Emphasis on promoting ethical AI utilization and improving critical thinking in medical practice.	3
4	Interdisciplinary Collaboration	Collaboration among students, such as medical students, data scientists, and engineers.	3
5	Case-Based Learning	Employing AI-driven scenarios for practical and application focused education.	3
	Total	22	

national frameworks. AI-driven multilingual curricula facilitate communication and enhance inclusivity in global healthcare education[6–18]. The integration of technology is essential for enhancing medical education through the use of modern tools and systems. The metaverse offers immersive settings, whereas extended reality technologies cultivate interactive situations. Big data analytics facilitates evidence-based decision-making and enhances educational outcomes. Instruments such as ChatGPT explain complex subjects, encourage active engagement, and personalize educational experiences. The integration of AI technology in educational frameworks, especially in dental education, improves learning experiences, provides customized feedback, and generates unique educational content. These technologies illustrate the transformational capacity of AI in redefining medical education and preparing future healthcare professionals with fundamental competencies[19–26].

Barriers of AI integration in Medical Education Curricula

The literature addressed four thematic codes related to the barriers of AI integration in Medical Education (n=17). Each thematic code is indicated in the subsection that follows, which includes examples gleaned from the research. A brief description of the barriers of integrating AI in medical education is discussed in Table 3. After thorough analysis of each study, barriers were found to address the research question. The first thematic code was Ethical and Legal Concerns (n = 6). The second thematic code was Faculty and Medical Students' Preparedness (n=6). The third thematic code was Curriculum Limitations (n=4) and the last thematic code was Technological Infrastructure (n=1).

The barriers of AI integration in medical education encompass ethical and legal issues, the readiness of staff and students, curriculum constraints, and technological infrastructure. Ethical considerations encompass privacy concerns, possible algorithmic biases, non-transparent decision-making procedures, and the diminishment of human judgment. Large language models (LLMs) like as Med-PaLM and ChatGPT will transform clinical practice and medical education; however, students must undergo AI ethics training to tackle issues of data privacy, transparency, and intellectual property[27–32].

The preparation of faculty and students is a critical issue, characterized by insufficient expertise, restricted resources, data privacy concerns, and staff opposition to change. Institutions need to provide troubleshooting, digital accessibility, skill enhancement, technical assistance, and ongoing response mechanisms. Artificial intelligence possesses the capacity to enhance human health and medical education; yet, instructors and students must be aware of its limitations, including bias, hallucinations, expense, and security concerns[33–38]. Curriculum limitations represent a substantial obstacle, as the majority of physicians feel that the integration of artificial and human intelligence will influence the future of medicine. Integrating AI systems into the curriculum without bypassing instrumentalism is challenging. A balance between AI and body pedagogy is essential for AI education to underscore the significance of engaging with individual patients and the human aspect of medicine[15,39–42]. Technological infrastructure presents a considerable barrier in medical education, with issues such as dependable network systems, suitable platforms, and proficient IT personnel impeding online learning. Addressing these issues is crucial for effective online medical education[43].

Best practices for integrating AI into Medical Education Curricula

A total of five thematic codes related to the best practices of AI driven curricula in Medical Education (n=22) were discussed in the literature. The succeeding section specifies each thematic code, comprising examples acquired from the included studies. Table 4, gives an overview of the best practices for integrating AI into Medical Education Curricula. After analyzing the studies closely, the best practices were chosen to address the research question. The first thematic code was Curriculum Design and Delivery (n = 7). The second thematic code was Technology Adaptation in Medical Education (n=6) followed by Ethics and Critical Thinking (n=3). The fourth thematic code was Interdisciplinary Collaboration (n=3) and the fifth thematic code was Case- based Learning (n=3).

Curriculum design and implementation emphasize the creation of curriculum that cater to varied student backgrounds and interests, including both technical and non-technical pathways[44–50]. Technology integration underscores ongoing education for healthcare professionals, incorporating Virtual Inquiry Systems, advancing Medical Distance Learning, and creating recorded instructional films. ChatGPT is acknowledged as an AI platform that improves medical education curricula, enables personalized learning, and aids in assessment[51–56]. Ethics and critical thinking advocate for a methodical and intentional integration of AI into undergraduate medical education, prioritizing ethical considerations, patient safety, and the genuine requirements of medical training[57–59]. Interdisciplinary collaboration involves developing global relationships and exchange initiatives with institutions to enhance educational experiences and broaden perspectives on AI applications[60–62]. Case-based learning employs real AI applications in clinical contexts, enhancing student engagement with AI as a critical thinking instrument[63–65]. These strategies seek to improve the educational experience and foster a thorough comprehension of AI applications in healthcare.

SECONDARY DATA

The global innovation report from 2020 to 2024 indicates that the United Arab Emirates maintains the highest average score for human capital and research among Gulf Cooperation Council countries, with a five-year average of 53.8, followed by the Kingdom of Saudi Arabia with average 43.84[66–70]. The 2024 Sustainable Development Goals report reveals a moderate increase in the quality of education in the UAE; nonetheless, the remaining GCC faces considerable challenges[71]. The Gulf Cooperation Council (GCC) countries are advancing their AI strategy via initiatives that concentrate on talent development, ethical application, and intersectoral integration. The UAE's AI policy prioritizes AI literacy and implementation via projects such as the Dubai Centre for AI and teacher upskilling programs[72]. Bahrain underscores the ethical application of AI by prioritizing accountability and transparency in procurement[73], whilst Oman is enhancing strategic sectors through its Executive Program for Artificial Intelligence and Advanced Technologies, prioritizing human-centered governance and modernizing educational systems[74].

The GCC's Key Performance Indicators (KPIs) for medical education encompass student outcomes, quality indicators, resource use, and innovation metrics. These KPIs function as benchmarks for assessing innovative medical education curriculum, leveraging research outputs and partnerships, and improving regional collaboration. These KPIs emphasize student outcomes, quality of teaching, program satisfaction, academic achievement, resource allocation, learning measures, sustainability objectives, and innovation indicators. Arabian Gulf University (AGU) strategic plan focus on research and innovation, learning and teaching, infrastructure, human resource, community engagement and governance. While Royal College of Surgeons in Ireland (RCSI) Bahrain strategic plan emphasizes research and innovation, learning and teaching and community involvement. Furthermore, KPI Framework of the King Saud University (KSU) in Riyadh identified technology, infrastructure, and innovation among 18 strategic KPIs. These KPIs serve as criteria for evaluating innovative medical education curriculum, including AI-based instructional tools and research outcomes. The papers underscore the necessity for regional cooperation and ethical artificial intelligence in education. Bahrain's emphasis on ethical AI in education and KSU frameworks may be crucial for developing long-term, scalable solutions. By incorporating these KPIs, projects can evaluate innovative medical education curricula, utilize research outputs and partnerships, and enhance regional collaboration[75–80] .

CAUSAL LAYERED ANALYSIS

Causal Layered Analysis (CLA) is a research approach and theory that was developed in the late 1980s and aims to combine action learning, interpretative, critical, and empiricists research approaches. This approach values and investigates future projections, the interpretations people make of them, the important presumptions made, and the actions and interventions that follows. This application is applicable for both the internal psychological environment as well as the exterior material realm. The value of CLA as a methodology is found in establishing transformational spaces for the investigation and development of potential futures, rather than in forecasting the future. The four layers of CLA are myth/metaphor, discourse/worldview, social/systemic reasons, and the litany[5].

Causal Layered Analysis (CLA) was performed on strategies to enhance AI readiness in the higher education curriculum within the

Table 5. Causal Layered Analysis (CLA) on AI readiness in the higher education curriculum

Layer	Student worldview	Current Reality	Transformed Future
Litany	Personalized Learning	Growing use of AI tools; resistance to change; insufficient technology infrastructure; differing levels of digital literacy among students and faculty	Widespread implementation of personalized learning strategies that effectively utilize AI tools across all institutions.
Social	Social Construction Of Technology (SCOT): Cultural Shift to Foster Integrity	Strategic challenges posed by lack of necessary policies and ethical regulations; operational challenges in adopting AI; financial constraints	Supportive policies and funding mechanisms that encourage AI integration and cultivate a culture of innovation in teaching and learning.
Worldview	Mentalism: Innovative Teaching Approaches	Beliefs that educators must modernize their outdated teaching methods and rigid curriculum	A broad acceptance of innovative, adaptive teaching strategies that emphasize student engagement and effective learning outcomes.
Metaphor	Empowering Educator: AI as an Enhancer of Educational Experiences	Job displacement for teachers and diminished authority in the classroom	A new narrative that frames AI as a collaborative partner in education, enhancing the role of educators rather than replacing them.

GCC, driven by a significant necessity for technology integration and student engagement as shown in Table 5. The litany layer underscores the trends in AI preparedness within higher education, highlighting the transition towards technology-enhanced learning environments. Prominent developments encompass the incorporation of AI, which alters job dynamics, and the necessity for research on AI applications in education. The benefits of AI encompass individualized learning, automated grading, and AI teaching assistants, yet challenges like resistance to change and disparities in digital literacy remain. A demand for the extensive implementation of individualized learning approaches utilizing AI is issued[81–84].

The sociological dimension examines the economic, cultural, political, and historical ramifications of AI in higher education. It examines the ethical dilemmas presented by Generative AI (GenAI) and the necessity for rules to protect academic honesty. A proposed framework for academic integrity encompasses students, instructors, and institutions, along with the obstacles associated with its implementation. The importance of cultural viewpoints on technological acceptance and the need for rules that facilitate AI integration are highlighted[85,86].

The worldview layer analyzes foundational assumptions regarding education and the function of AI. It acknowledges AI's capacity to improve learning results and accessibility, yet observes opposition stemming from misunderstandings regarding educational methodologies. There is a call for creative pedagogical methodologies and adaptable teaching approaches to align with future educational realities. Mentalism is proposed as a method to enhance learning environments by emphasizing cognitive and emotional processes[82,87].

The metaphor layer examines profound narratives related to AI in education, highlighting themes of essential transformation and modified authority. Although AI is regarded as a transformational force, concerns over job displacement for educators and loss of authority are widespread. The narrative promotes the perception of AI as a collaborative partner in education, augmenting rather than supplanting the work of educators[88,89].

DISCUSSION

The systematic literature review identifies themes related to enablers, barriers, and best practices, as seen in Figure 2 below. The adoption of AI in medical education is driven by two key enablers: curriculum development and technological integration. Each enabler provides strategies to prepare students and faculty for the effective integration of AI into healthcare education. Curriculum development focuses on equipping students with essential skills through interdisciplinary training, flexible curricula and competency-based pathways, modular framework and standardized national framework. Multilingual AI-driven curricula further enhance inclusivity by addressing communication barriers and ensuring access for diverse populations. Technological integration involves incorporating tools like AI-based decision-making systems, metaverse, virtual and augmented reality, extended reality technologies, and big data analytics enhancing the educational experience. These technologies simplify complex concepts, promote collaboration, and create interactive environments for practical training. AI tools such as ChatGPT explain complex subjects, encourage active engagement, and personalize learning experiences, demonstrating the transformative capacity of AI in redefining medical education.

The main barriers to integrating AI into medical education include concerns about algorithmic biases, privacy, and the devaluation of human judgment, which are significant ethical challenges. Protecting

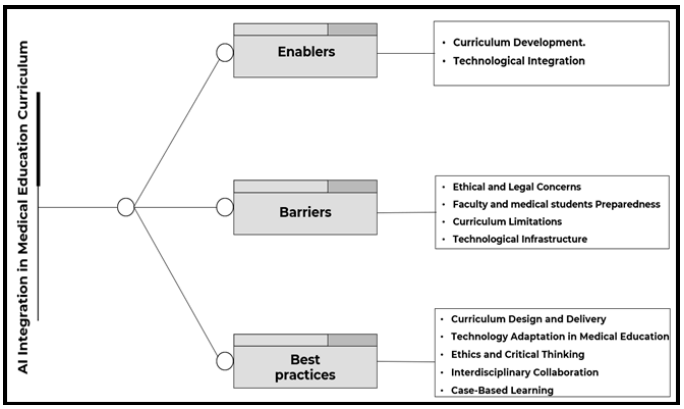

Figure 2. Systematic Literature Review model

private data, ensuring equitable access, and maintaining transparency are key difficulties. Additionally, fostering data confidentiality and accountability requires collaboration among stakeholders to address safety and privacy concerns effectively. Furthermore, there is a need to necessitate formal training and curriculum development to resolve the lack of understanding among medical students and faculty about AI applications in medicine field. In fact, to prepare upcoming healthcare professionals to handle the changing medical technology landscape, institutions must address resource constraints and integrate AI education that strikes a balance between technological advancements and human elements.

The literature on AI-driven curricula in medical education identifies five thematic codes that represent best practices: curriculum design and delivery, technology adaptation, ethics and critical thinking, interdisciplinary collaboration, and case-based learning. Each thematic code highlights essential strategies for integrating AI into medical education effectively. For instance, technology adaptation emphasizes continuous learning and the use of innovative tools like virtual inquiry systems and augmented reality to enhance the educational experience. Curriculum design focuses on accommodating diverse student backgrounds and interests, while ethics and critical thinking stress the importance of a careful and ethical approach to AI implementation. Interdisciplinary collaboration fosters partnerships among various fields to enrich learning experiences, and case-based learning promotes the application of AI in practical clinical scenarios to enhance critical thinking. Overall, these best practices underscore the need for a comprehensive and thoughtful integration of AI in medical education to prepare future healthcare professionals effectively. Overall, a thorough and comprehensive strategy for incorporating AI into medical education is crucial for equipping future healthcare professionals to effectively manage the changing technology environment.

The secondary data in global innovation index from 2020 to 2024 consistently ranked the United Arab Emirates as leading GCC in human capital and research capacity. Achieving an average score of 53.8, reflecting continuous commitment to education, academic research and development and knowledge infrastructure. Followed by Saudi Arabia showed moderate improving performance with average at 43.84, indicating increasing focus on innovation driven human development. The 2024 Sustainable Development Goals (SDGs) report highlights diverse challenges in educational quality within the GCC, noting moderate advancements in the UAE, whereas Saudi Arabia, Oman, Kuwait, and Bahrain encounter considerable challenges.

The GCC countries are actively advancing their Artificial Intelligence (AI) plans, emphasizing talent cultivation and ethical application. The UAE stresses AI literacy with programs such as the Dubai Centre for

AI, whilst Bahrain focuses on the ethical application of AI. Kuwait intends to include AI into its educational system, while Saudi Arabia seeks to train a substantial segment of its workforce in AI skills. Qatar's AI+X initiative emphasizes education and research, whereas Oman aims to enhance its educational institutions with AI.

Key Performance Indicators (KPIs) for medical education in the Gulf Cooperation Council (GCC) prioritize student outcomes, quality metrics, and innovation. These KPIs are crucial for assessing innovative curricula and promoting regional collaboration in ethical AI within education. The focus on ethical AI and sustainable frameworks is essential for creating scalable solutions in medical education throughout the GCC region. For example, medical schools in Kingdom of Bahrain and Kingdom of Saudi Arabia reflect shared commitment to research, innovation and community engagement. Medical schools can ensure alignment with national strategy and global innovation standards through integrating indicators such as AI literacy, clinical performance metrics, program satisfaction rate and ethical compliance. Furthermore, employing regionally specific KPIs encourages collaboration, assures accountability, and facilitates the continuous enhancement of GCC medical schools.

The Causal Layered Analysis (CLA) of AI integration in higher education within the GCC reveals a complex interplay between four layers. The litany layer highlights the shift towards technology-enhanced learning, while the social causes layer highlights the rise of Generative AI (GenAI) and its ethical challenges. The discourse/worldview layer reveals how societal attitudes affect the acceptance of AI in education, with a disconnect between AI's potential benefits and reluctance due to misconceptions. The myth/metaphor layer discusses the need for change and its impact on educators' roles, with the "Discourse of Altered Authority" promoting a shift in perspective from feared job loss to considering AI as a cooperative collaborator. Effective AI integration requires collaboration among all stakeholders, promoting adaptability and ethical responsibility while reshaping perceptions of AI. Supportive social structures and a positive narrative around AI are essential for building trust and encouraging acceptance.

Sohail Inayatullah's push and pull dynamics, combined with the weight of the history framework[90], can significantly improve AI preparedness in higher education across the Gulf Cooperation Council (GCC) by offering a systematic approach for analyzing and strategizing essential measures. The "push of the present" emphasizes technological advances and societal demands as catalysts for transformation, while also acknowledging obstacles such as resistance to change and infrastructural deficiencies that require attention. The "pull of the future" emphasizes hopes for AI-integrated educational systems that foster individualized learning and ethical AI application, urging institutions to establish long-term objectives and develop incentives for alignment. Ultimately, the " weight of the history " underscores the need for GCC institutions to adapt to global transitions toward AI in education, tackling ethical issues and involving stakeholders to alleviate concerns regarding AI's influence on the educational environment. This comprehensive framework seeks to cultivate a culture of innovation and guarantee that educational institutions are equipped for the future of AI in higher education.

The United Nations Environment Programme (UNEP) is executing a strategic foresight program to tackle uncertainty and disruptive change. A Foresight Expert Panel, assembled by UNEP and the International Science Council, created four scenarios capturing potential futures in 2050. The scenarios encompass the sustainability paradox, post-truth division, fortress multipolarity, and global awakening[91].

Upon concluding the causal layered analysis, we formulated the following future scenarios based on UNEP framework. The first scenario is the sustainability paradox which predicts that the future will incorporate AI into education. However, challenges such as inequalities, ethical issues, and unsustainable consumption will drain resources. The second scenario is post-truth division, which anticipates that disinformation pertains to incorrect information, while fragmentation refers to unequal access resulting from split knowledge and resources. The third scenario is fortress multipolarity, which anticipates that institutions have access to AI; yet, innovation and freedom are constrained due to restrictive regulations imposed by authorities. The fourth scenario is a global awakening, which anticipates a dramatic shift in the integration of AI in education, fostering a balanced and inclusive future.

Limitation: The limitation of this study methodological gap which majority of researches is theoretical include systematic literature reviews, narrative analyses and mixed methods. Nevertheless, a clear gap in the execution of experimental studies that explore the impact of AI integrated curriculum on medical students' competency in the GCC. Furthermore, there is deficiency region specific literature about the integration of artificial intelligence into higher education institutions in Gulf Cooperation Countries (GCC).

CONCLUSION

The aim of this study was to examine the integration of AI into medical higher education curricula within the GCC region. The findings highlight that the successful integration of AI requires a comprehensive and balanced strategy that incorporates technological readiness, curricular innovation, and ethical considerations. Institutional readiness emerged as an important factor, emphasizing the need for targeted training, skill development, and infrastructure audits for both the faculty and students. Best practices from the literature advocate for innovative pedagogical approaches, such as case-based learning, interdisciplinary collaboration, and personalized AI-driven instruction, to improve engagement and learning outcomes.

Equally important are the ethical and legal dimensions of AI integration. These include addressing data privacy, transparency, and intellectual property rights, which must be embedded in curriculum development through mandatory training in AI ethics.GCC countries are making progress in their national AI strategies by promoting talent development, policy alignment, and cross-sectoral collaboration. However, disparities remain across the region in digital infrastructure, educational quality, and strategic coherence. A forward-thinking collaborative framework which combines foresight with innovation and regional cooperation will enable the GCC to maximize AI potential for transforming medical education.

Future research should focus on testing and evaluating AI-integrated medical curricula in the GCC to generate empirical evidence of their effectiveness. Supporting the transition from strategic vision to practical implementation requires studies that assess student competencies, faculty preparedness, and ethical considerations in real-world educational settings.

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