

Integration of AI into teaching methodologies in health training institutions in Tanzania

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Abstract

Purpose – This study investigates the integration of artificial intelligence (AI) into teaching methodologies within health training institutions in Tanzania. It aims to explore expert perspectives on AI's potential benefits, the challenges to its implementation and strategies for successful adoption. The findings contribute to understanding how AI can transform health education in low-resource settings, helping to prepare future healthcare professionals for an evolving healthcare industry.

Design/methodology/approach – The study employed a qualitative, interpretivist research philosophy, utilising a case study design. A sample of 15 experts was selected, including policymakers, health educators and AI technical specialists. Semi-structured interviews provided the primary data, exploring participants' perceptions, challenges and recommendations related to AI integration. Thematic analysis was conducted using constructivism, TPACK and activity theory as guiding frameworks. The study incorporated expert validation and triangulation by consulting subject-matter experts and supporting findings with secondary data, ensuring the reliability and depth of the results.

Findings – The study reveals that AI adoption in Tanzanian health training institutions is in its infancy, with most applications driven by individual initiatives rather than institutional strategies. Key benefits include personalised learning, enhanced remote education opportunities and streamlined administrative processes. However, significant barriers exist, such as insufficient infrastructure, limited technical skills among educators, financial constraints and resistance to technological change. Proposed strategies to address these challenges include developing a clear policy framework, phased implementation, professional development for educators and fostering collaborations with AI providers.

Originality/value – This research provides a novel contribution by focusing on AI integration in health training institutions within a low-resource setting, which remains underexplored in the existing literature. The study offers actionable strategies for overcoming barriers and advancing AI adoption in education by applying established theoretical frameworks to analyse the contextual challenges and opportunities. The findings also serve as a foundation for future research and policy development, supporting the broader goal of improving healthcare education in Tanzania and similar contexts.

Keywords Artificial intelligence, Teaching methodologies, Health training institutions, Education technology

Paper type Research paper

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1. Introduction

Artificial intelligence (AI) is transforming educational practices worldwide. Across various sectors, AI is being integrated into educational systems to personalise learning, automate administrative tasks, and enhance engagement by adapting to individual learner needs (Gligorea *et al.*, 2023). Developed countries have led this transformation by incorporating AI into educational strategies, from adaptive learning systems to AI-powered virtual tutors, revolutionising how students interact with content (Rigley *et al.*, 2023). These technologies promise to address learning gaps and improve inclusivity, allowing educators to provide targeted support to diverse learners.

In low- and middle-income countries, such as Tanzania, the integration of AI into education has been slower (Zawacki-Richter *et al.*, 2019). Tanzania's commitment to advancing digital education is further exemplified by the newly developed national digital education strategy (2024/25–2029/30), which provides a comprehensive framework for integrating ICT across all levels of education (MOE, 2024). This strategy focuses on enhancing teaching and learning outcomes through core pillars such as infrastructure, digital content development, and integrating emerging technologies like AI in education. However, according to the national health policy, health training institutions in Tanzania fall under the regulation and oversight of the MoH, 2003 Ministry of Health (). These institutions, including public and private entities, are crucial in training healthcare professionals such as nurses, clinical officers, and laboratory technicians (Sirili *et al.*, 2023). Accredited by the National Council for Technical and Vocational Education and Training (NACTVET), these institutions ensure that curricula meet national standards and are aligned with the country's healthcare needs (NACTVET, 2022). However, many institutions still face challenges related to infrastructure and the availability of skilled educators, particularly in rural areas, making it difficult to fully capitalise on innovative educational tools in healthcare training.

Health training institutions in Tanzania have yet to fully capitalise on AI's potential to improve education and equip students for the dynamic healthcare environment. Some progress is visible through initiatives like “Twende Digital,” an AI-powered learning platform developed in collaboration with Google, which offers personalised learning, virtual tutors, and adaptive assessments (Tanzania Digest, 2024). Despite these efforts, challenges such as insufficient educators and limited resources hinder widespread AI adoption, especially in rural areas. AI's promise lies in its ability to address these gaps by providing virtual tutors, personalised learning experiences, and data-driven insights for better educational planning. Nevertheless, its full potential in education remains untapped (Mathew and Mgina, 2024).

Despite the ongoing efforts by the Ministry of Health to integrate digital technologies into health training, there still needs to be a significant gap in the full implementation of AI in Tanzanian health training institutions. The potential benefits, such as improved clinical decision-making and streamlined learning processes, are well recognised. However, barriers such as infrastructure limitations, insufficient funding, and a lack of clear policy guidelines have hindered the effective adoption of AI. This study addresses these challenges by exploring experts' perceptions of how AI can be integrated into health training institutions.

This study investigates expert perspectives on the role of AI in transforming teaching methodologies within health training institutions in Tanzania. It aims to identify AI's potential benefits, the challenges associated with its implementation, and the strategies required to ensure successful integration into educational frameworks. This research contributes to the ongoing dialogue on AI's potential to revolutionise health education in Tanzania, helping prepare future healthcare professionals with the necessary skills to meet the demands of an evolving healthcare industry.

The study will focus on the following research questions:

- (1) How do experts perceive the role of AI in transforming teaching methodologies in health training institutions?
- (2) What factors influence and hinder the integration of AI into health education?

2. Literature review

2.1 Global trends in AI in education

Globally, the integration of artificial intelligence in education has advanced significantly, with AI applications employed to enhance adaptive learning, facilitate automated grading, and create intelligent tutoring systems. For instance, adaptive learning platforms have been effectively used in medical education to provide personalised learning paths, improving knowledge retention and application in practical settings (Gligorea *et al.*, 2023). Similarly, AI-powered simulations, such as virtual patients, have allowed learners to practice clinical skills in risk-free environments, bridging gaps in traditional training models (Li *et al.*, 2024).

AI has become a key driver of change in higher education, facilitating personalised learning, predictive analytics, and intelligent tutoring systems (Chen *et al.*, 2020). In developed countries, institutions increasingly rely on AI to enhance adaptive learning experiences, streamline administrative processes, and support decision-making in educational planning (Holmes *et al.*, 2023). However, recent studies caution that while AI presents significant opportunities, its adoption also introduces risks, including potential biases in AI-generated recommendations, the ethical implications of student data usage, and the digital divide between technologically advanced institutions and those with limited resources (Eden *et al.*, 2024; Schaeffer *et al.*, 2024). For AI to be effectively implemented in diverse educational settings, well-defined governance frameworks and institutional support structures are needed to mitigate risks and maximize its potential (Chatterjee and Bhattacharjee, 2020). These factors are particularly critical in Tanzania, where AI adoption in education is still at an early stage, requiring both policy interventions and capacity-building initiatives.

Studies indicate that AI can enhance student engagement, automate administrative tasks, and provide data-driven insights into learning behaviours (Korobenko *et al.*, 2024). However, challenges such as algorithmic bias, ethical concerns, and issues related to digital literacy persist (Adel *et al.*, 2024; Klimova *et al.*, 2023; Williams, 2024). Moreover, the reliance on data-driven decision-making raises concerns about privacy, security, and the ethical use of student information (Adel *et al.*, 2024; Alrayes *et al.*, 2024; Alsbou and Alsaraireh, 2024; Jose, 2024). While AI presents a significant opportunity for improving access to education, particularly in resource-limited settings, ensuring its responsible and context-sensitive implementation remains a priority.

2.2 Challenges of AI integration in low-resource settings

Despite its transformative potential, integrating AI into education in low-resource settings faces systemic challenges that require targeted solutions. In many low- and middle-income countries (LMICs), inadequate technological infrastructure, such as unreliable electricity and limited internet connectivity, significantly hampers the adoption of AI-based educational tools. For example, in rural India, efforts to deploy adaptive learning platforms often fail due to inconsistent power supply and a lack of affordable digital devices (Das *et al.*, 2021; Sindakis and Showkat, 2024). Similarly, in sub-Saharan Africa, research highlights that while mobile phone penetration is high, internet bandwidth and affordability remain key barriers, limiting access to AI-driven educational applications (Joseph, 2019).

Another critical challenge in low-resource settings is the scarcity of skilled educators trained to incorporate AI technologies into their teaching practices (Al-Zahrani, 2024; Panjwani, 2024). In countries like Kenya, where educational reforms aim to integrate digital tools, teachers report insufficient training and support, leading to underutilisation of available technologies (Chepkilot *et al.*, 2024). Moreover, cultural resistance to new teaching methodologies, particularly among older educators accustomed to traditional approaches, further impedes AI adoption (Islam *et al.*, 2024).

Financial constraints compound these challenges. Many educational institutions in LMICs operate on limited budgets, making investing in necessary infrastructure, such as computers, AI software, and maintenance difficult. The lack of policy coherence and institutional frameworks to support AI integration exacerbates these issues. For instance, studies in Ghana show that while national strategies promote digital education, the absence of specific implementation plans leaves schools struggling to bridge the gap (Manu, 2020).

In Tanzania, these barriers manifest in similar ways, with additional contextual nuances. Limited internet connectivity, particularly in rural areas, outdated infrastructure, and constrained financial resources are persistent obstacles (Mathew and Mgina, 2024). Health training institutions, which are pivotal in preparing the healthcare workforce, rely heavily on traditional teaching methods due to a lack of AI tools and the inadequate preparation of educators to utilise such technologies effectively (Sirili *et al.*, 2023). This reliance on conventional methods limits opportunities for personalised and experiential learning, critical components of effective health education.

While promising initiatives like the “Twende Digital” platform have demonstrated the potential for AI-driven personalised learning and virtual tutoring in Tanzania (Rwegoshora, 2023), these efforts remain isolated. The absence of a comprehensive policy framework to guide AI adoption perpetuates these challenges. Policymakers must prioritise creating strategic plans that include phased implementation, targeted funding, and collaborative partnerships with technology providers to bridge these gaps.

2.3 Tanzania’s digital education landscape

Tanzania’s commitment to advancing digital education is evident through initiatives such as the national digital education strategy (2024/25–2029/30) and the digital health strategy (2019–2024). These policies emphasise the integration of ICT and emerging technologies like AI to improve educational access and quality (MOE, 2024; MoH, 2019). However, the application of these strategies in health training institutions has been uneven, with rural areas experiencing the most significant gaps in infrastructure and educator preparedness (Mathew and Mgina, 2024).

Collaborative efforts, such as partnerships with technology providers, have shown potential to bridge these gaps, exemplified by the “Twende Digital” initiative. Nonetheless, sustained progress requires a robust framework for AI adoption, encompassing resource allocation, professional development, and context-specific implementation strategies.

2.4 Theoretical foundations in AI education research

The integration of artificial intelligence (AI) in health training institutions is underpinned by three foundational educational theories: Constructivism, Technological Pedagogical Content Knowledge (TPACK), and Activity Theory (AT). These frameworks collectively inform the study’s design, analysis, and interpretation of results, offering a multidimensional understanding of AI’s role in transforming teaching methodologies.

Constructivism emphasises that learning builds upon prior experiences (Anthony, 1996; Burns *et al.*, 2022). This perspective aligns with AI’s potential to personalise learning by adapting content to individual needs. For example, intelligent tutoring systems and virtual simulations provide personalised, hands-on learning experiences essential for mastering clinical skills in health education (Dai and Ke, 2022; Narayanan *et al.*, 2023). In this study, constructivism informed the exploration of AI’s capacity to enhance student-centred learning, particularly in resource-constrained environments.

TPACK focuses on the interplay between technology, pedagogy, and content knowledge, highlighting the importance of integrating these domains to achieve effective teaching outcomes (Koh *et al.*, 2015; Mishra *et al.*, 2023; Voogt *et al.*, 2013). In this study, TPACK guided the analysis of how educators can use AI tools, such as virtual simulations and adaptive assessments, to support health education objectives. The framework also shaped recommendations for professional development, emphasising the need for educators to

develop competencies in leveraging AI within pedagogical practices. However, practical implementation remains challenging, as AI tools must align with pedagogical goals to be effective. [Runge et al. \(2025\)](#) demonstrate that AI-enhanced teaching methodologies can improve engagement and facilitate competency-based learning when integrated effectively with TPACK principles.

AT provides a lens to examine the interactions between students, educators, and AI tools within a broader socio-cultural context. ([Engeström, 1999](#); [Sannino et al., 2009](#)). This study applied AT to explore how AI can mediate learning activities and address systemic challenges, such as infrastructure limitations and resistance to technological change. AT also informed the development of context-specific strategies for AI implementation, ensuring alignment with Tanzania’s educational and cultural needs. Adopting AI in Tanzanian health training institutions involves complex interactions between students, educators, and institutional structures, necessitating a deeper understanding of AT’s role in shaping these dynamics. Recent work by [Uden and Ching \(2024\)](#) highlights the importance of AT in structuring AI-enabled learning interactions, ensuring that new tools align with existing pedagogical structures and cultural contexts.

This study’s conceptual framework ([Figure 1](#)) is constructed from the theoretical perspectives of constructivism, TPACK and AT. AI is viewed as a tool that enhances learning by personalising education to meet individual student needs (Constructivism), integrating seamlessly into teaching strategies to support content delivery (TPACK), and mediating interactions between students and educators in a way that promotes practical skill development and clinical decision-making (AT).

3. Methodology

This study employed a qualitative, interpretivist research philosophy to explore expert perspectives on integrating AI into health training institutions in Tanzania. Recognising the contextual and subjective nature of the research topic, this approach allowed for an in-depth understanding of participants’ experiences and insights.

3.1 Study design

A case study design was chosen to provide an in-depth analysis within a bounded system, focusing on specific institutional, technological, and educational contexts for AI integration in Tanzanian health training institutions. This design enabled the study to analyse interactions between AI tools, educators, and students, facilitating a nuanced understanding of AI adoption’s challenges and potential solutions.

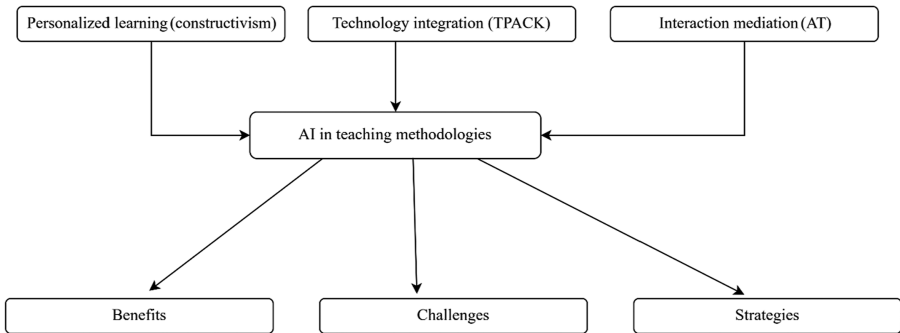


Figure 1. Conceptual framework. Source: Authors’ work

3.2 Sampling

The study selected a non-probability purposive sample of 15 participants with relevant AI, health education, and policy expertise. This sampling approach targeted individuals directly engaged in digital education initiatives and AI applications in healthcare, including Ministry of Health policymakers, health educators, and technical experts from AI providers. While the small sample size limits the generalizability of findings, it facilitated rich, detailed insights valuable for exploratory research in a low-resource setting. This selection ensured that participants with diverse expertise and roles contributed perspectives, enhancing the study's depth. Participants' demographic characteristics were considered to ensure representativeness within the sample size constraints. The cohort included professionals from public and private health training institutions, spanning various roles, such as educators, policymakers, and technical advisors. Gender and age diversity were also prioritised to capture balanced viewpoints. These details are outlined in [Table 1](#).

3.3 Data collection

Semi-structured interviews served as the primary data collection method, allowing for a comprehensive exploration of participants' perceptions, challenges, and recommendations regarding AI integration. Semi-structured interviews are widely used in qualitative research as they provide flexibility while maintaining a structured approach to data collection ([Creswell and Poth, 2017](#); [Kallio et al., 2016](#)). The interview guide was designed to align closely with the research questions, covering themes such as AI's role in teaching, barriers to adoption, and potential implementation strategies. A well-structured interview guide helps maintain consistency while allowing researchers to probe deeper into relevant topics as needed ([Castillo-Montoya, 2016](#)).

Open-ended questions encouraged in-depth responses, with structured follow-up prompts ensuring interview consistency. Open-ended questioning allows participants to elaborate on their perspectives without restrictions, which enhances the richness of qualitative data ([Patton, 2015](#)). Each session lasted between 45 and 60 min and was conducted privately to ensure confidentiality, following best practices for ethical research involving human participants ([Flick, 2018](#)). Interviews were audio-recorded with participants' consent and transcribed verbatim, enhancing the accuracy of qualitative data analysis ([Braun and Clarke, 2006](#); [Nowell et al., 2017](#)).

Table 1. Participant demographics

Id	Role	Gender	Institution type	Years of experience
P1	Educator	M	Public	10
P2	AI specialist and educator	F	Private	8
P3	Policy expert	M	Public	12
P4	Educator	F	Public	7
P5	AI specialist	M	Private	9
P6	Researcher	F	Public	6
P7	Education Technologist	M	Private	11
P8	Curriculum developer	F	Public	15
P9	Educator	M	Public	13
P10	AI specialist	M	Private	9
P11	Digital strategist	F	Private	10
P12	Lecturer	M	Public	14
P13	Instructional designer	F	Public	7
P14	Educator	M	Private	10
P15	Educator	F	Public	12

Source(s): Authors' work

To enhance data reliability, triangulation was employed by cross-referencing interview insights with secondary data sources, such as policy documents and institutional reports. Triangulation strengthens the credibility of qualitative research by validating findings through multiple sources (Denzin, 2012; Patton, 2015). Furthermore, member checking was conducted, where participants reviewed summaries of their responses to confirm accuracy and ensure that their perspectives were correctly interpreted. Member checking is a recognised technique to enhance trustworthiness in qualitative studies, helping to reduce misinterpretation and confirm the authenticity of responses (Birt *et al.*, 2016; Lincoln and Guba, 1985). Table 2 table outlines the interview questions used in the study.

3.4 Data analysis

Thematic analysis was used to identify, analyse, and report patterns within the data, following the six-phase framework outlined by Braun and Clarke (2006). Initial coding was conducted inductively, capturing explicit and implicit meanings in participants’ responses. Constructivism, TPACK, and AT provided a theoretical lens for organising and interpreting the codes, ensuring alignment with the study’s conceptual framework. For instance, codes related to “AI as a tool for personalised learning” were linked to constructivist principles, while those addressing “institutional support for AI” were analysed using the AT framework. Peer debriefing was conducted with an independent coder who reviewed the thematic structure to mitigate researcher bias. Discrepancies were discussed and resolved through consensus, enhancing analytical rigour.

The combination of inductive and deductive approaches ensured a comprehensive analysis. While the initial coding captured emergent themes, the theoretical frameworks refined them, linking them to the study’s broader objectives. MAXQDA software facilitated systematic coding and organisation, enabling transparent and replicable analysis.

3.5 Limitations and justifications

This study acknowledges several limitations. The small sample size restricts the breadth of perspectives, particularly from underrepresented rural institutions. However, the purposive selection of participants ensured relevance and depth of expertise, making the findings valuable for theory-building and practical applications. The focus on expert perspectives excluded other stakeholders, such as students, which limits the study’s comprehensiveness. Future research should address this gap by incorporating diverse voices and employing mixed-method approaches.

Table 2. Structured interview questions

Question	Focus area
1. How do you perceive AI’s role in transforming teaching methodologies in health training institutions?	Perceptions of AI in teaching methodologies
2. What potential benefits could AI bring to health education?	AI’s benefits in health education
3. What challenges or barriers do you see in adopting AI tools in health training institutions in Tanzania?	Challenges and barriers to AI adoption
4. How does the current infrastructure in your institution affect the integration of AI into teaching and learning?	Institutional infrastructure for AI integration
5. What steps would be necessary to implement AI tools effectively in health education?	Implementation strategies for AI in education
6. How can educators be better prepared or supported to use AI in their teaching processes?	Support and preparation for educators to use AI
Source(s): Authors’ work	

Furthermore, the reliance on self-reported data introduces potential biases, as participants may have provided socially desirable responses. These biases were mitigated through expert validation, triangulation with existing literature, and encouraging participants to share sincere experiences. While qualitative methods limit generalizability, they provide rich, context-specific insights critical for exploratory studies in low-resource settings. Finally, the interpretivist approach was chosen to capture detailed, subjective experiences, acknowledging that this perspective prioritises depth over breadth.

3.6 Reliability and validity

Expert validation was conducted in two phases to ensure the validity and reliability of the interviews, a widely recommended approach in qualitative research (Creswell and Poth, 2017; Kallio *et al.*, 2016). First, the interview guide was reviewed by three independent AI and education specialists to assess its relevance, clarity, and alignment with the study's objectives. The expert review helps refine question wording, improve coherence, and reduce potential biases in qualitative research instruments (Castillo-Montoya, 2016). Their feedback led to minor refinements in question phrasing and structure to enhance comprehensibility.

Second, a pilot interview was conducted with two educators not part of the main study sample. Pilot testing ensures that interview questions are interpreted as intended and allows for adjustments to improve clarity and flow (Majid *et al.*, 2017; van Teijlingen and Hundley, 2002). This step helped refine probing strategies and assess whether participants comprehended the questions as expected. The final version of the interview guide was then used in data collection.

Furthermore, to maintain consistency in the interview process, all interviews followed a standardised protocol, including an introduction to the study, confidentiality assurances, and structured follow-up prompts to elicit detailed responses. Standardised interview protocols help minimise interviewer bias and enhance the reliability of collected data (Patton, 2015). These strategies ensured that participants provided rich, meaningful insights while adhering to ethical considerations in qualitative research.

3.7 Ethical consideration

Ethical approval for this study was obtained from the university ethics review board. Informed consent was secured from all participants, who were briefed about the study's purpose, their rights as participants, and the use of their data. Participants were assured that their responses would be anonymised and that no personally identifiable information would be disclosed in the final report. The audio recordings and transcripts were securely stored to ensure confidentiality, and only the research team had access to the data.

4. Results

This section presents the key findings regarding adopting AI in teaching methodologies across Tanzanian health training institutions. The results highlight this transformative process's current applications, challenges, benefits, and strategies. Figure 2 visually summarises these findings in a clear and structured format to aid understanding.

4.1 Current use of AI in health training institutions

Thematic analysis of interview data with educators and policymakers reveals that AI usage in Tanzanian health training institutions remains informal, mainly driven by individual initiatives rather than coordinated institutional efforts. Participants' responses underscore the potential and limitations currently affecting AI adoption. This section presents vital interview themes, illustrating educators' current practices and perceptions of AI within their teaching contexts.

4.1.1 Existing applications in health training. No formal AI applications are customised explicitly for health training in these institutions. However, informal use of generative AI tools

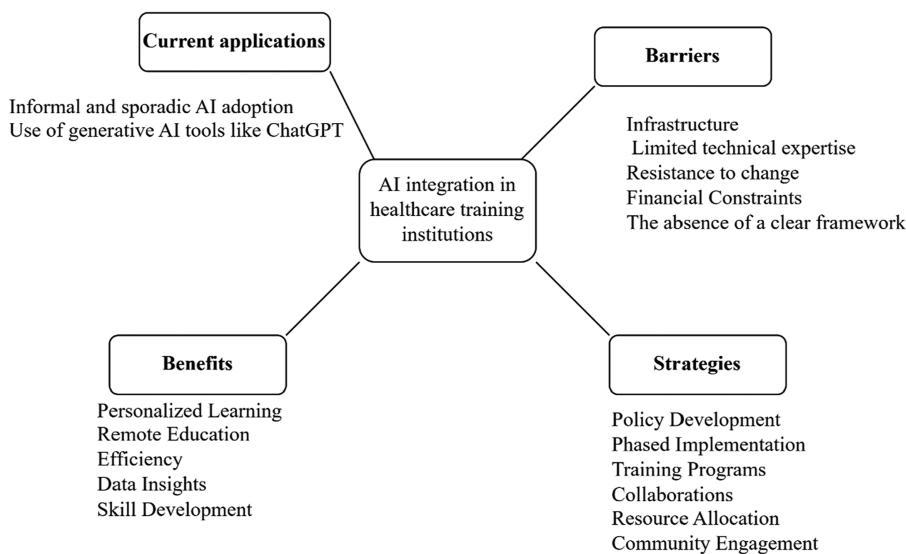


Figure 2. Summary of findings. Source: Authors’ work

like ChatGPT and other AI-based platforms has emerged, primarily among educators seeking to enhance their teaching methods on their initiative. “Currently, we do not have formal AI tools for teaching, but I have started using ChatGPT to help with drafting lesson plans and grading” (P1). This sentiment was echoed by other educators, who have begun exploring generative AI tools informally, using them to enhance their teaching efficiency in assignment review and content delivery. Despite this informal use, no institution has formally integrated AI into its curriculum, which means that applications are sporadic and rely on individual initiative rather than structured support. “We do not have AI training or guidelines. I use it independently for grading and giving students feedback” (P4). Figure 3 visualises the generative AI tools most commonly used, emphasising ChatGPT’s prominence among educators.

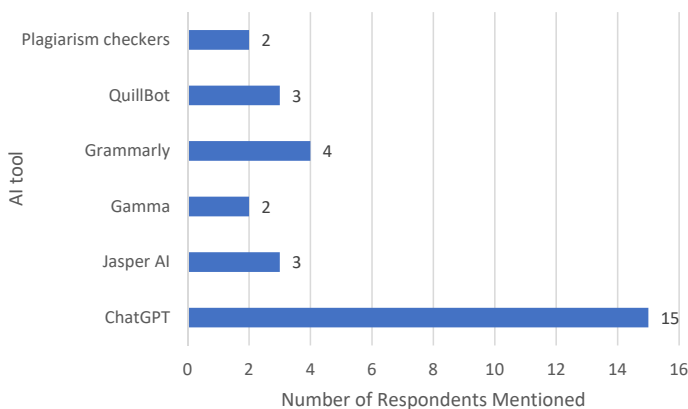


Figure 3. Illustrates the current AI tools employed in Tanzanian health training institutions. Source: Authors’ work

4.1.2 Emerging practices and initial outcomes. In Tanzanian health training institutions, AI integration is still in its early stages, primarily driven by individual rather than institutional efforts. Figure 4 illustrates the emerging AI practices, including personalised learning, simulation and virtual training, automated assessment, data-driven decision support, and virtual tutors. While educators experiment with generative AI tools, these efforts remain informal and limited, reflecting the challenges to achieving broader institutional adoption.

4.1.2.1 Personalised learning. There is no formal AI-driven personalised learning in these institutions. Educators rely on traditional teaching methods, such as lectures and textbooks, with no AI tools to adapt content to individual student needs. *“We do not have AI systems that can adjust learning to individual students’ needs. We mostly rely on lectures, textbooks, and online sources” (P9).* This finding demonstrates that AI has yet to impact personalised learning experiences in health training institutions.

However, individual efforts have emerged among educators, who have independently sought existing AI tools to support their teaching. *“I sometimes use ChatGPT to create practice questions and explanations for my students, especially those struggling to keep up with the standard pace. It is not part of the curriculum but helps some students get additional support” (P15).* Such individual initiatives demonstrate educators’ willingness to explore AI tools despite the lack of formal resources, yet these efforts remain isolated and unsupported by institutional frameworks.

4.1.2.2 Simulation and virtual training. AI-powered simulation tools like virtual patients are not currently utilised in Tanzanian health training institutions. Students continue to rely on limited practical training in hospitals, *“We do not have any AI simulations or virtual patients. Our students still need to travel to hospitals for practicals, and even then, they do not get enough exposure” (P2).* The lack of access to necessary technology and infrastructure is a significant barrier, limiting the use of AI for practical skill development.

Another participant expressed similar sentiments, acknowledging limited awareness of AI-powered virtual training locally: *“I am not aware of any virtual training in our health institutions here. I think I read somewhere about such simulations, but honestly, I have no experience with these in Tanzanian health training institutions” (P5).* This lack of exposure and familiarity with AI-driven simulation tools highlights a significant barrier, as educators rely on traditional, hands-on methods without the supplemental support that virtual training could offer.

4.1.2.3 Automated assessment and feedback. No formal AI systems are used to automate assessments or provide input in these institutions. While student record systems are in place to assist with grading and other administrative tasks, many processes still rely heavily on manual work, often using tools like Excel. *“Although we have systems, much of the grading and feedback process is still done manually. It becomes complicated with large classes” (P14).*

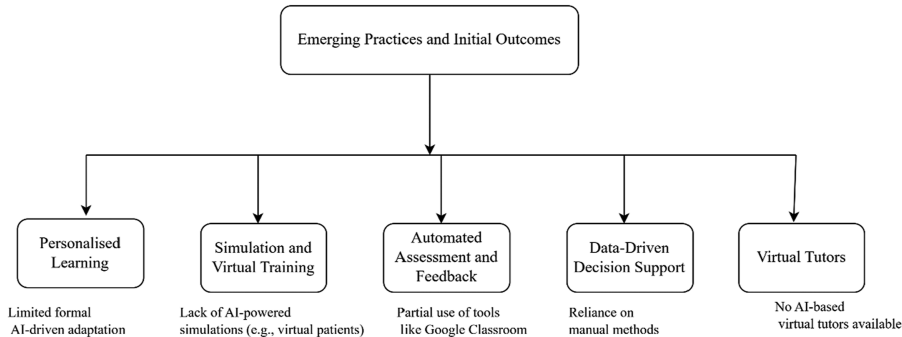


Figure 4. Current emerging practices in health training institutions. Source: Authors’ work

This excerpt reflects the gap in adopting AI-driven tools that could enhance efficiency and improve learning through automated assessments and timely feedback.

Despite lacking formal support, some educators have independently adopted tools like Google Classroom to address these limitations partially. *"I started using Google Classroom for assignments and quizzes to help manage submissions and provide quicker feedback. It is not a complete solution, but it helps keep track of student work more efficiently"* (P7). This individual effort underscores educators' proactive steps to bridge the gap in automated assessment, even though comprehensive AI-based assessment tools are not yet integrated into the institution's systems.

4.1.2.4 Data-driven decision support. The use of AI to support data-driven decision-making in education is currently non-existent. Educators and policymakers rely on traditional methods to monitor student progress, with no AI systems in place to provide real-time insights or performance tracking. *"We do not have AI systems to track or analyse student performance. We rely on manual methods and occasional exams to assess progress"* (P9). The absence of data-driven AI tools limits the ability to address student learning needs proactively.

Another participant emphasised the challenge of data management without AI support, stating, *"We lack systems that can compile or analyse student data over time, so we end up with much paperwork that does not give us a clear picture of how students are doing overall"* (P12). These insights illustrate how the absence of AI-based data analytics hinders educators and policymakers from gaining a holistic view of student performance, impacting the ability to adapt learning support effectively and monitor student progress continuously.

4.1.2.5 Virtual tutors. AI-powered virtual tutors are not part of the educational landscape in Tanzanian health training institutions. Students still depend entirely on face-to-face interactions with their educators for support, with one educator noting, *"There is no AI tutor or support system in place for our students. They still have to come to us directly for help, and we do not always have the time"* (P15). This quote highlights the lack of AI-driven systems that could provide continuous, personalised support outside of traditional classroom hours.

Recognising this gap, a policymaker revealed recent efforts to address AI integration, stating, *"Now we have woken up; that is why this year we had a stakeholder meeting in Dar es Salaam to discuss AI in teaching methodologies. Virtual tutors are expected to emerge and be incorporated into our health institutions. We have had several opinions from educators, and we hope to improve our education system in Tanzania's health institutions through AI"* (P8). This statement reflects a promising shift towards incorporating AI solutions, including virtual tutoring, to enhance educational support and accessibility within Tanzanian health training institutions.

4.2 Perceived benefits of AI in health training institutions

The participants highlighted several potential benefits of integrating AI into health training institutions, emphasising its capacity to enhance learning experiences and improve educational outcomes. One of the most frequently mentioned advantages was AI's potential to personalise learning. Participants observed that AI could adapt to individual learning paces, enabling customised instruction that helps students better understand complex health concepts. This adaptability was crucial in health education, where students often vary significantly in their grasp of intricate subject matter. *"AI has the potential to personalise learning, especially in health training where individual progress can vary significantly"* (P10).

Another benefit frequently cited was the ability of AI to support remote learning opportunities, particularly for students in underserved or rural areas. Participants noted that AI-enabled platforms could bridge gaps in resource accessibility by delivering health education remotely, thus expanding the reach of educational programs and making them accessible to a broader population. This was especially relevant in the Tanzanian context, where physical access to health training facilities is limited for some students. *"AI could*

provide remote learning opportunities, especially in rural areas where health education resources are scarce” (P13).

Moreover, several participants highlighted AI’s role in organising and analysing data on student performance. By tracking learning progress and identifying areas where students struggle, AI could enable timely interventions and more effective support for students. For example, AI could help educators detect student performance patterns, providing insights into where additional focus might be needed. *“AI could help us analyse student progress more quickly, allowing for timely intervention when students are struggling”* (P2).

Furthermore, participants appreciated AI’s potential efficiency in monitoring and managing educational data. By automating administrative tasks, such as record-keeping and progress tracking, AI could free educators to focus on direct teaching tasks, improving overall instructional quality. Participants felt that, over time, this would lead to a more efficient and effective health training environment that better supports educators and students. *“AI is a tool for better data organisation, helping track student records and learning outcomes effectively”* (P7).

4.3 Barriers to AI implementation in health training institutions

Participants identified several significant barriers to implementing AI in Tanzanian health training institutions despite the potential benefits. The most commonly cited obstacle was insufficient infrastructure, particularly in rural and underserved areas. Participants highlighted issues such as poor internet connectivity, limited computer access, and outdated technology as barriers to adopting AI tools effectively. *“We face challenges around internet connectivity, especially in rural health institutions where digital learning could be beneficial”* (P3). *“Our infrastructure is outdated, making it difficult to introduce advanced technology like AI”* (P11).

Another frequently mentioned barrier was the resistance to new technology among some educators, particularly those more accustomed to traditional teaching methods. This resistance stemmed from a lack of familiarity with AI tools and a reluctance to change established teaching practices. *“There is a challenge in resistance to new technology among staff who are used to traditional methods”* (P13).

In addition to resistance, limited technical skills among educators emerged as a barrier. Many participants felt that a lack of AI-related training hindered the effective integration of AI tools in teaching. Educators may struggle to adopt these tools effectively in their classrooms without adequate support or training in AI technologies. *“A major barrier is the lack of trained educators who can integrate AI effectively in their teaching”* (P6).

Participants also pointed to financial constraints as a critical barrier, highlighting the limited budget for upgrading technology and purchasing necessary AI tools. They noted that even if the institution recognised the importance of AI, budgetary limitations made it challenging to prioritise the essential investments. *“Allocating a budget specifically for AI technology in health training would be essential but is difficult with current financial constraints”* (P3).

Lastly, participants emphasised the need for a clear policy framework from the Ministry of Health or relevant educational authorities to guide AI adoption in health education. Without formal guidelines or a strategic framework, health training institutions face challenges understanding the requirements and best practices for AI integration. *“We need a clear policy and framework from the ministry to guide AI adoption in health education”* (P5).

4.4 Strategies for overcoming barriers

Several strategies emerged from participant feedback, supported by triangulation and expert validation, to address the challenges of implementing AI in Tanzanian health training institutions. These strategies aim to create a supportive environment for AI integration, involving policy support, phased implementation, targeted training, collaboration with AI providers, and resource allocation.

4.4.1 Policy framework and facilitator guide. A foundational recommendation is to establish a clear policy and strategic framework from the Ministry of Health to guide AI adoption consistently across institutions. The Ministry's current effort to prepare a facilitator guide on AI use in teaching offers a promising framework. This guide outlines principles for AI integration, emphasising hands-on learning, ethical considerations, and practical applications in teaching. *"This guide will help standardise AI integration across institutions and support educators in adapting AI tools effectively"* (P3). Expert validation reinforced the importance of this guide, highlighting its role in addressing concerns about standardisation and ethical implementation. Adhering to this guide will support institutions in aligning their AI initiatives with national standards, ensuring uniformity and minimising inconsistencies in AI use across training programs.

This is supported by findings from similar resource contexts where frameworks have successfully guided AI adoption in education. Several studies demonstrated the value of structured policies combined with institutional collaboration to streamline AI integration (Ahmad *et al.*, 2023; Chan, 2023; Goosen and Mugumo, 2024; Shailendra *et al.*, 2024).

4.4.2 Phased implementation approach. Participants emphasised the importance of a phased approach to AI implementation, allowing institutions to gradually integrate AI tools and refine processes before scaling up. This approach can be structured in stages, starting with pilot programs in select institutions or departments to test essential AI applications, such as automated grading or virtual simulations. *"Institutions need a phased approach, starting with pilot programs to see how AI can be adapted locally"* (P11). Each pilot program should include clear timelines, assessment metrics, and resource requirements to evaluate effectiveness and identify potential obstacles. Following each phase, evaluations based on the facilitator guide's recommended methods, such as presentations and interactive assessments, can provide valuable insights from educators and students, helping institutions refine their AI integration plans. Based on pilot program outcomes, AI implementation can gradually expand across more departments and institutions, ensuring that necessary resources and staff training are in place at each stage. This phased approach allows institutions to build experience incrementally, reduce implementation risks, and develop best practices that can be applied more broadly. This aligns with studies highlighting the success of phased AI adoption models in sub-Saharan Africa, where incremental deployment reduced infrastructure strain and provided lessons for scaling (Das *et al.*, 2021).

4.4.3 Professional development and training programs. Effective AI integration depends heavily on educators' familiarity with AI tools and confidence in using these technologies in the classroom. As such, structured training and professional development are critical. Institutions should organise routine workshops focused on hands-on AI training, as participants and the facilitator guide recommended. Expert validation emphasised the need for certification programs to motivate participation and recognise AI proficiency formally. *"Regular workshops and training sessions would help educators stay updated on AI technologies"* (P3). This reflects a widespread sentiment on the importance of skill-building initiatives. These workshops can include demonstrations of AI tools, interactive exercises, and guided practice sessions, helping educators build practical skills with AI technologies. Establishing mentorship initiatives where experienced, tech-savvy educators guide others in AI integration was highlighted as a practical and cost-effective strategy.

4.4.4 Collaboration with AI providers. Building strong partnerships with AI providers offers institutions access to affordable AI solutions and ongoing technical support. Expert reviewers stressed that collaboration can accelerate AI adoption through negotiated discounts, phased payment plans, and bundled solutions, making AI adoption more feasible within limited budgets. Collaboration can also provide essential benefits, including technical support, software updates, and troubleshooting assistance. *"Collaboration with technology providers could help us access AI tools at a lower cost and with the necessary support"* (P13). Furthermore, partnerships can include training sessions AI companies provide to help educators learn how to use these tools effectively.

Findings from triangulation indicated that partnerships with AI providers facilitated lower-cost adoption and access to technical expertise in studies conducted in LMICs, including Tanzania (Rwegoshora, 2023).

4.4.5 Infrastructure investment and resource allocation. The successful integration of AI in health training institutions also requires dedicated resources and infrastructure improvements. Based on the facilitator guide's recommendations, institutions should prioritise securing essential resources, such as internet connectivity, laptops, learning management software, and other digital tools. *"We face challenges around internet connectivity, especially in rural health institutions where digital learning could be beneficial"* (P9). This emphasises the need for reliable infrastructure. These resources are critical for implementing AI-based teaching and learning effectively. Institutions should also establish a budget line for purchasing and maintaining AI tools. *"Allocating a budget specifically for AI technology in health training would be essential"* (P7). This underscores that proper funding allocation could bridge the gap in necessary resources. Budget allocation should consider ongoing operational costs, including software updates, equipment replacements, and upgrades to prevent interruptions.

4.4.6 Monitoring and continuous improvement. Institutions must establish continuous monitoring and improvement mechanisms for AI to be sustainably integrated into health training. Regular feedback from educators and students can inform ongoing improvements. Using the evaluation methods in the facilitator guide, institutions can collect valuable input on AI's impact, challenges, and areas for refinement. Furthermore, AI tools that support data collection and analytics can help institutions monitor the effectiveness of AI applications over time. *"AI could help us analyse student progress more quickly, allowing for timely intervention when students are struggling"* (P1). This reflects the potential of AI to support continuous improvement. Institutions can adjust their AI strategies to enhance learning outcomes and ensure alignment with institutional goals by analysing data on usage patterns, student performance, and educator feedback.

5. Discussion

This study's findings reveal promising benefits and substantial barriers to AI integration within health training institutions in Tanzania, aligning with the study's theoretical underpinnings. The insights gathered echo the principles of constructivism, TPACK, and AT, offering a grounded understanding of how AI could enhance health education. In this context, AI's role as a personalised, adaptive learning tool is well-aligned with constructivist theory. This perspective, which emphasises individualised learning experiences, supports the observed benefits of AI in delivering customised educational experiences that accommodate varying learning paces among health students. Similar to findings by Salas-Pilco et al. (2022), AI's ability to offer real-time feedback and facilitate practice in controlled environments provides experiential learning crucial to clinical training, reinforcing constructivist views.

In line with TPACK, this study highlights the challenges of integrating new technologies within established curricula and pedagogical practices. Effective AI integration requires a blend of technological, pedagogical, and content knowledge to support educators in health institutions. Participants emphasised that lacking training and limited infrastructure constrain AI's role in improving health education, which aligns with Voogt et al. (2013), who emphasised the need to develop educators' competencies across these domains. The findings underscore a need for structured professional development programs, enabling educators to effectively integrate AI tools like intelligent tutoring systems and virtual simulations, thus bridging knowledge gaps in clinical competencies.

AT framework is particularly useful for understanding the social and systemic factors influencing AI implementation. Participants highlighted the role of AI as a mediating tool within the educational environment, linking it to practical skills and clinical decision-making abilities necessary in healthcare. AT's emphasis on the socio-cultural context resonates with this study's findings that Tanzanian health training institutions face unique challenges, such as resource

limitations and technology resistance among educators. These barriers reflect observations from studies in other low-resource settings (Mirata *et al.*, 2022), where technology integration is often hindered by systemic limitations and a lack of policy frameworks to support AI use in education.

Regarding AI's perceived benefits, participants anticipated improvements in personalised learning, administrative efficiency, and data management, echoing findings by Gligorea *et al.* (2023) and Sapci and Sapci (2020). AI's ability to adapt educational content and provide remote learning opportunities aligns with the global trend of using AI to bridge resource gaps in healthcare education, a pressing issue in low and middle-income countries. However, studies like those by Chen *et al.* (2020) indicate that achieving these benefits necessitates a supportive infrastructure and policy framework presently lacking in Tanzania.

Challenges and Barriers observed in this study, such as insufficient infrastructure, limited digital skills among educators, and financial constraints, align with barriers identified in other studies in similar contexts (Zawacki-Richter *et al.*, 2019). These challenges are particularly pronounced in Tanzania, where internet access and technical support are limited, especially in rural areas. Educators' resistance to new technologies further complicates AI adoption, echoing concerns that Liu *et al.* (2022) raised the need for cultural and systemic support to foster digital adoption in educational settings.

To overcome these barriers, participants emphasised collaboration with AI providers, structured professional development, phased implementation, and continuous monitoring, aligning with existing research on sustainable technology integration. Partnerships with AI providers can facilitate cost-effective, tailored solutions while providing technical support and training. A phased implementation approach allows institutions to manage initial costs, adapt incrementally, and enable educators to build familiarity with AI tools, reducing resistance to change. Structured professional development programs, complemented by mentorship systems, are critical for equipping educators with technical and pedagogical competencies to effectively integrate AI into health training. Continuous monitoring and feedback mechanisms ensure adaptive and sustainable AI adoption, enabling institutions to refine strategies based on real-time insights. Lessons from similar low-resource settings, such as Kenya and India, highlight the value of these strategies in fostering successful AI integration in education.

Furthermore, Community-based programs can foster awareness and acceptance of AI technologies, especially in rural areas (Igwama *et al.*, 2024). These programs engage local leaders, parents, and students to build trust and demonstrate AI's potential benefits (Goslen *et al.*, 2024). Such initiatives help overcome cultural resistance and create champions for AI adoption within communities. Moreover, involving stakeholders ensures AI tools are adapted to meet local needs, making implementation more sustainable (Bharath Suhas *et al.*, 2024; Goslen *et al.*, 2024).

Cross-institutional collaboration allows institutions to share AI resources, expertise, and infrastructure (Shao *et al.*, 2020). This approach reduces costs, promotes collective learning, and enhances scalability. Collaborative networks can also support joint research and innovation efforts, enabling institutions to pilot AI programs collectively and exchange best practices (Xu *et al.*, 2022). These partnerships can bridge resource gaps and create opportunities for knowledge transfer.

Open-source AI tools can reduce costs and enable customisation to local contexts. These tools offer affordable alternatives to proprietary software, ensuring accessibility and flexibility. Open-source platforms also allow for continuous updates and community-driven improvements, making them adaptable to evolving needs (Šarčević *et al.*, 2024). Institutions can collaborate with developers to adapt tools to specific educational objectives.

Offering grants, awards, or recognition programs can motivate educators and institutions to adopt AI technologies early (Kriti and Bhaskar, 2020). These incentives encourage experimentation and innovation, helping institutions identify effective use cases for AI tools. Recognising early adopters inspires others to embrace AI, accelerating its integration into teaching practices (Hannan and Liu, 2023).

6. Study implications

The findings of this study hold significant implications for research, practice, and policy, particularly within the Tanzanian context and other low-resource settings. This study addresses a notable knowledge gap in AI integration within health training institutions, emphasising the need for research on adaptive learning systems, virtual tutors, and simulation-based training in such settings. Future studies should focus on developing AI-driven pedagogical frameworks tailored to Tanzania's infrastructural and cultural contexts. Longitudinal research will be crucial in assessing AI's long-term impact on student outcomes, educator proficiency, and institutional effectiveness.

The study highlights the urgent need for capacity-building initiatives to enhance AI literacy for educators and institutions. Professional development programs, including targeted workshops and certification courses, are essential for equipping educators with the competencies required for AI adoption (Bekiaridis and Attwell, 2024; Nazaretsky *et al.*, 2022). Moreover, infrastructure investments in digital devices, internet connectivity, and AI-compatible learning management systems will play a vital role in bridging technological gaps, particularly in rural areas (Truong and Diep, 2023).

Policymakers must formulate actionable frameworks that address AI ethics, data privacy, and phased implementation strategies to guide institutions in structured adoption (Korobenko *et al.*, 2024). Engaging AI providers in public-private partnerships can help alleviate resource constraints, ensuring accessibility to affordable AI-driven solutions while securing ongoing technical support.

At a societal level, AI integration in health training institutions can significantly enhance healthcare outcomes by equipping a more skilled and adaptable workforce. AI-driven remote learning solutions can mitigate educational disparities, ensuring equitable access to high-quality health education. However, this transformation must be accompanied by efforts to address cultural resistance to technology, promoting an innovation-driven mindset within the education sector. Ultimately, the successful implementation of AI in education can catalyse broader digital transformation, fostering socio-economic development and technological progress across multiple sectors.

7. Study limitations and future research

This study acknowledges several limitations that may influence the interpretation and applicability of its findings. First, the sample size was relatively small, consisting of 15 participants drawn from health training institutions, policymakers, and AI specialists. While this sample provided rich qualitative insights, it limits the generalizability of the findings to a broader population. However, purposive sampling ensured that participants had relevant expertise, enhancing the collected data's depth and relevance. Future research could expand the participant pool to include a more diverse range of stakeholders, such as students and administrators, to obtain a more comprehensive perspective on AI integration in health education.

Second, the study focused solely on expert perspectives, excluding the viewpoints of students who are direct beneficiaries of AI-based teaching methodologies. While experts provide valuable insights into implementation challenges and strategic recommendations, student experiences and learning outcomes remain critical to understanding AI's effectiveness in education. Future research should incorporate student perspectives through focus groups or mixed-method approaches to offer a more holistic analysis.

Third, the reliance on self-reported data introduces potential biases, as participants may have provided socially desirable responses rather than candid assessments of AI integration challenges. To mitigate this, triangulation was employed by cross-referencing interview data with secondary sources, such as policy documents and institutional reports. Furthermore, member checking was conducted to allow participants to review and validate their responses, reducing the risk of misinterpretation.

Fourth, the study is cross-sectional, capturing expert perspectives simultaneously. This approach may not fully account for the evolving nature of AI adoption in Tanzanian health training institutions. A longitudinal study could provide deeper insights into how AI integration progresses, including policy shifts, technological advancements, and changing institutional attitudes.

Finally, the context-specific study focuses on AI adoption in Tanzanian health training institutions. While the findings provide valuable insights for similar low-resource settings, contextual differences such as variations in educational policies, infrastructure, and technological readiness may limit the applicability of these findings to other regions. Future comparative studies across different LMICs could strengthen the external validity of AI implementation strategies in diverse educational settings.

Despite these limitations, the study provides meaningful contributions by highlighting the barriers and opportunities associated with AI integration in health training institutions. The findings offer practical recommendations for policymakers, educators, and technology providers seeking to improve AI adoption in education. Moreover, by applying constructivist, TPACK, and Activity Theory frameworks, the study provides a theoretically grounded analysis of AI's role in shaping digital learning environments in healthcare education.

8. Conclusion

This study explored the integration of AI into teaching methodologies in Tanzanian health training institutions, focusing on expert perspectives regarding its potential benefits, challenges, and implementation strategies. The findings reveal that while AI holds significant promise for enhancing health education through personalized learning, virtual simulations, and administrative efficiency its adoption remains limited due to inadequate infrastructure, financial constraints, resistance to change, and the lack of a clear policy framework. These challenges are particularly pronounced in low-resource settings, where digital transformation in education is still in its early stages.

By applying Constructivism, TPACK, and Activity Theory, this study provided a theoretical lens for understanding how AI can support pedagogical practices in health training institutions. The results underscore the need for structured AI adoption strategies, including phased implementation, professional development programs for educators, collaboration with AI providers, and institutional support through policy development. Addressing these areas can help facilitate a more effective and sustainable AI integration process, ultimately improving the quality of health education in Tanzania.

Despite its limitations, this study contributes valuable insights by highlighting both barriers and opportunities in AI-driven education. Future research should adopt longitudinal approaches to assess the evolving impact of AI on teaching and learning outcomes. Also, incorporating student perspectives will provide a more comprehensive understanding of how AI can be optimized to support different learning needs. Comparative studies across other low- and middle-income countries (LMICs) could further enhance the generalizability of AI implementation strategies in resource-constrained educational environments.

Ultimately, the successful integration of AI into health training institutions requires a collaborative effort between policymakers, educators, and technology providers. With targeted investments in infrastructure, capacity building, and policy reforms, AI has the potential to transform health education in Tanzania, equipping future healthcare professionals with the necessary skills to navigate an increasingly technology-driven healthcare environment.

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