

Awareness, knowledge, and attitude towards artificial intelligence: Perspective of medical students in Ghana

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Abstract

The adoption of emerging technologies among university students has become increasingly prevalent in recent years. AI-assisted technologies are gradually permeating medical education and practice to improve healthcare delivery and reduce resource waste. This study aimed to investigate the awareness, use, and perception of AI among medical students in Emmanuel Quaye Archampong Library at the University of Ghana. Using a survey research design, data were collected from medical students at the University of Ghana Medical School. Structured questionnaires were administered to the respondents online using Google Forms. With a total of 1366 respondents, Krejcie and Morgan's published table was employed to select the study sample size of 302 medical students. Forty-eight (39.0%) medical students agreed that the use of AI-assisted technologies was voluntary without being coerced to use them. More than half of the respondents (50.4%) reported being moderately aware of AI-assisted technologies and adequately understanding the concept of AI. Grammarly and ChatGPT were predominantly used in medical studies, despite the lack of opportunities for training on AI-assisted technologies. It is recommended that regular training and guidance be provided to students to appropriately use AI-assisted technologies in research and learning.

Keywords

artificial intelligence, technology acceptance model, medical students, academic library, Ghana

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Introduction

Artificial Intelligence (AI) assisted technologies have become increasingly prevalent in our daily lives, from virtual assistants like Amazon Alexa, Samsung Bixby, ChatGPT, Google Assistant, Apple Siri, and Microsoft Cortana to self-driving cars and manufacturing robots (Copeland, 2023; U.S.-EU Trade & Technology Council, 2022). The term AI means computer or machine intelligence and it also refers to machine learning, natural language processing, robotics, expert systems, and deep learning (Copeland, 2023). In this study, AI is defined as a library and information science

construct that involves the application of computational algorithms and technologies to enhance the retrieval of information, automation of routines and organization of knowledge within libraries and information centers.

Historically, academic libraries have evolved to embrace technological advancements to better serve the needs of their users, particularly students and

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faculty members (Cox, 2023). The current wave of AI technologies represents a significant leap forward, providing academic libraries with tools that go beyond traditional resource management. AI-assisted technologies in academic libraries help students in their studies by delivering knowledge, discussing areas of study, answering questions, and providing real-life responses (Seo et al., 2021). Through visualizations and simulations, these technologies also assist students with impairments to better understand their course material (Mikropoulos and Iatraki, 2023: 3912–3913).

Moreover, in the realm of medical education, the incorporation of AI is particularly promising, offering dynamic solutions to the unique challenges faced by medical students. AI's educational potential is evident in its ability to cater for diverse learning styles. By adapting to individual preferences, AI technologies in academic libraries create personalized learning experiences. These are achieved through the provision of virtual reality (VR) and augmented reality (AR) to library users to have realistic or real-world experiences directly through a smart device (Zhao et al., 2023). This allows medical students to learn sophisticated topics in anatomy, physiology, surgical procedures and so on in an easy way in the library without going into a laboratory or surgical theatre. Another key area where AI excels in academic library settings is through the creation of simulation for experiential learning using aids like 3D printing to create artificial conditions and artefacts that medical students can use to develop, build, and practice their clinical skills in a serene environment (Tang et al., 2022; Živković et al., 2023). Again, the integration of AI in academic libraries helps improve the learning outcomes of students. The academic library's role in providing user instructions on how to evaluate and use information sources like generative AIs ethically and mitigating its challenges such as inaccurate facts helps improve students' learning process, and over-reliance on AI and encourages the use of evidence-based information (Akakpo, 2023). However, the awareness, use, and perception of these AI technologies among medical students, especially in academic libraries in Ghana, are scarce or not available.

In recent years, many international organizations have made significant efforts to increase the use of technology among the youth, thereby reducing the digital divide. For instance, in 2015, the United Nations (UN) General Assembly launched the Sustainable Development Goals (SDGs) or Global

Goals, which succeeded the Millennium Development Goals (MDGs) which ended that year. The SDG has 17 goals and three goals focused on the access or use of Information and Communication Technology (ICT) or the Internet in the least-developed countries. These goals include SDG 9, which primarily focuses on infrastructure and innovation, SDG 4 (Quality Education) emphasizes the importance of providing equal access to quality education through digital tools and online learning platforms and SDG 5 (Gender Equality) highlights need to address gender disparities in accessing and using digital technologies (Odoom et al., 2023; United Nations, 2023). Thus, addressing the digital divide is crucial for achieving various SDGs and ensuring that everyone, particularly students, can benefit from the opportunities offered by the digital age.

Moreover, the African Union's (AU) Agenda 2063 has targets and goals like those of Global Goals. For example, AU Goal 2 (Educated citizens and skills revolution underpinned by Science, Technology, and Innovation) prioritizes education, and Science, Technology, and Innovation (STI) skills revolutions to help address many of the challenges that the continent faces in improving healthcare outcomes ranging from enhancing agricultural productivity to increasing access to education (The African Union Commission, 2023; United Nations Economic Commission for Africa, 2023). Thus, the use of AI by African students has the potential to significantly improve and develop Africa.

In Ghana, the Government has recognized the importance of digital technology and the Internet in education and has taken steps to bridge the digital divide and promote digital literacy among students. For example, the Ministry of Education has initiated "ICT in Education Reform" to help develop the desire and competencies of students to use ICTs and to support tertiary education through technology-based training (Ministry of Education, 2023). Therefore, the use of emerging technologies, such as AI, can help the government achieve its vision of minimizing the digital divide and promoting nation-building.

In a contextual setting, the University of Ghana (UG) is the premier university in Ghana and has four colleges: College of Humanities (CoH), College of Basic and Applied Sciences (CBAS), College of Education (CoE), and College of Health Sciences (CHS) (University of Ghana, 2022). The CHS has seven schools and institutes. The University of Ghana Medical School (UGMS) is one of the oldest schools in the college and is located at Korle-Bu,

Accra. Since 1969, the UGMS has graduated medical students, and as part of their training, they are taught basic sciences and other science courses such as medical information literacy to equip students with emerging digital technological knowledge and skills needed for their studies and research (University of Ghana, 2014). This knowledge and skills range from the above-basic use of computers, electronic databases, and point-of-care tools to referencing and learning management tools (Aggrey, 2009; Ankamah et al., 2021). The acquisition of these skills and knowledge is expected to enable students to sail through medical programs and become lifelong learners and professionals. The medical students are the principal users of the Emmanuel Quaye Archampong (EQA) library, formerly the College of Health Sciences (CHS) library located at the Charles Easmon Building on Korle Bu Campus (College of Health Science, 2024). The library provides health and medical collections, information services and instructions and conducive learning spaces for the students. Students have access to modern electronic resources such as ClinicalKey, UpToDate, Cochrane Medical Library, PubMed, CINAHL, Jaypee Digitals and ScienceDirect to retrieve evidence-based information for their studies, assignments, projects, and clinical rotations.

The Vice-Chancellor (VC) of the UG during her induction into office in 2021 shared her vision of enhancing stakeholders' experience through digitalization dubbed the "VC's Student Digitalization Initiatives". These initiatives include Hot-spot Comfort Zones, One Student One Laptop (1S1L), and Classroom Modernization. These capital-intensive initiatives will help "create a culture that promotes research teaching and learning, administrative processes, and extension activities driven by technology and anchored in humanism" (University of Ghana, 2023).

Despite the benefits and importance of goals, targets, and initiatives set by international organizations such as the UN and the AU, the Government of Ghana, and the management of the University of Ghana through the VC to increase equal access to ICT and the Internet and to reduce the digital divide, little is known about the awareness, use and perception of AI-assisted technologies in learning among university students in Ghana, especially at the University of Ghana medical students (Abosi et al., 2022). It has also been noted by the researcher, who doubles as a lecturer and librarian, that some medical students believe that the use of AI in studies

and research leads to academic dishonesty or plagiarism, which has made some students avoid its usage. The avoidance or low usage of emerging technologies like AI will lead to negative outcomes, such as high gender inequality, low innovation, low quality of education, and wastage of funds. Therefore, this study aimed to investigate the awareness, use, and perception of AI-assisted technologies among medical students in the EQA Library at the University of Ghana.

Objectives of the study

The study investigated the following specific objectives:

- (a) To find out about students' awareness and knowledge of AI-assisted technologies in their studies and research.
- (b) To ascertain the type of AI-assisted technologies that students use in their studies and research.
- (c) To find out the challenges students face in using AI-assisted technologies.

Research questions

- (a) Do students know and are aware of AI-assisted technologies relevant to their studies and research?
- (b) What types of AI-assisted technologies do students use?
- (c) What challenges or barriers do students face when using AI-assisted technologies?

Literature review

Access to artificial intelligence (AI) for students is one of the long-term implications of the proliferation of AI-assisted technology devices for educational purposes and potentially the development of what has been dubbed intelligent classrooms (Alimi et al., 2021). The adoption of computer technologies among university students is becoming increasingly prevalent. In a recent study by Kennedy et al. (2023) on public awareness of artificial intelligence in everyday activities, it found that 72% of university students in the United States are aware of AI, and 54% have used an AI-powered product or service. Kennedy et al. (2023) further explained that the most common AI-assisted technologies university students are aware of include chatbots, virtual assistants, and

recommendation engines, respectively. Also, Nilsone (2023) indicated that most students used ChatGPT for educational purposes. Nilsone further noted that grammar tools and chatbots were used in various fields of study. Regarding the source of awareness, Jindal and Bansal (2020) indicated that the Internet was the source of information for 67.4% and 11.9% learned about AI from friends and family. The use of the Internet for learning is seen to improve accessibility, efficiency, and quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration (e Rodrigues and Mandrekar, 2021). Specifically, Chao et al. (2020) stated two main sources of AI and relevant information that they obtained from social media (91.3%) and traditional media (90%), such as television and radio.

Despite the prevalent adoption of AI-assisted technologies among students, in a cross-sectional multicenter study conducted by Civaner et al. (2022) among medical students in Turkey, 96.2% of medical students asserted that knowledge and skills related to AI application should be taught in medical education. Moreover, Wood et al. (2021) reported that only a few students and faculty understood the use and benefits of AI-assisted technologies in medical education and training. However, Alimi et al. (2021) in their study on university students' awareness of, access to, and use of AI for learning in Kwara state concluded that most university students are not aware of AI for learning. In the same manner, Pinto dos Santos et al. (2019) asserted in their study that most medical students do not necessarily have any understanding of the technical principles underlying AI-assisted technologies. However, it was found in the same study that despite the absence of students understanding of the technical principles of AI, most of them were aware of AI-assisted technologies as a recent topic of discussion in radiology. AI-assisted technologies are being integrated gradually into the practice of medicine to improve healthcare delivery. AI has been simplified to mean machines that smartly process copious amounts of data like humans. Similarly, in a cross-sectional survey conducted on German medical students' views regarding AI in medicine, one-third of the medical students did not feel well informed about AI in medicine (McLennan et al., 2022).

AI-assisted technologies in healthcare involve the use of software to make meaning of digital information to make diagnoses and advice accordingly.

Kimmerle et al. (2023) admitted in their study that most medical students were aware that AI-assisted technologies were used in medicine with an adequate understanding of AI-assisted technologies. In a survey study exploring medical students' and faculty's perception of AI and robotics, 62.8% of participants confirmed that AI and robotics have dynamically integrated into medical practice although most medical students and faculty were slightly familiar with the concept of AI and robotics (Sassis et al., 2021). This implies that AI-assisted technologies have already taken place in medical education without prior knowledge and understanding of these technologies by medical students. Some studies have elaborated on the usefulness of AI-assisted technologies in several aspects of medical practices including ophthalmology, dermatology, respiratory medicine, and radiology (Kaplan et al., 2021; Sit et al., 2020).

Medical students face various challenges when using AI-assisted technologies, ranging from educational gaps and technical complexity to ethical considerations and resistance to change. Addressing these challenges requires a concerted effort from medical institutions, educators, and healthcare professionals to ensure that future medical practitioners can effectively and ethically use AI in healthcare. In terms of transparency, most AI algorithms are impossible to understand or interpret, and deep learning algorithms are used for imaging analysis (Davenport and Kalakota, 2019). The challenges with the use of AI-assisted technologies in medicine range from data collection concerns, algorithm development concerns, clinical implementation concerns, ethical concerns, social concerns, and biased and discriminatory algorithms (Aung et al., 2021; Jiang et al., 2021; Khan et al., 2023). Pucchio et al., (2022) identified the lack of educational opportunities in AI among medical students, given their desire to learn about AI and the strong belief that AI will positively impact medicine in the future. Although artificial intelligence (AI) has immense potential to shape the future of medicine, medical students need to understand its limitations. To produce appropriate medical recommendations, AI significantly relies on datasets that are comprehensive and accurately represent the population. However, AI has the potential to worsen healthcare disparity and provide poor recommendations for patient care if small, non-representative datasets are employed (Topol, 2019). There are not most trained AI educators, and it is not apparent which areas of the field should be taught. Additionally, there is a lot

about AI's potential application in healthcare that is currently unknown, which is another argument against its hasty integration into the curriculum of medical schools (Ngo et al., 2022). Dave and Patel (2023) posited that one major challenge with AI use among students is the potential for cheating. This is because some students may use AI to gain an unfair advantage over their colleagues. In a study by Chan and Hu (2023), which looked at the perception and challenges of GenAI technologies among students, the results showed that despite the positive outlook on GenAI technologies, students expressed some challenges. They noted over-reliance on technology, issues related to accuracy and transparency, privacy, and ethics, particularly on plagiarism issues on the originality of work as some of the issues. Again, they showed concerns about GenAI technologies which may hinder critical thinking and creativity among students. The lack of knowledge and skills is also another challenge hindering the use of AI-assisted technologies among medical students (Kansal et al., 2022).

To strengthen their clinical abilities, enrich their educational experiences, and stay up to date with medical breakthroughs, medical students are increasingly embracing AI-assisted technologies. Medical students will have more options to thrive in their study and practice as AI's role in medical education grows as it continues to develop.

Theoretical framework

Researchers and scholars have been interested in the factors that influence the adoption or rejection of innovative technologies for decades. One of the most well-known models that attempts to represent the influence of technology on society is Davis' Technology Acceptance Model (TAM) which was used to guide this study. TAM aims to understand and predict user acceptance of modern technologies within organizational and individual contexts (Venkatesh et al., 2003; Venkatesh and Bala, 2008). It is based on the theory of reasoned action (TRA), which posits that human behavior is influenced by behavioral intention, which in turn is determined by attitude and subjective norms (Hu, 2022; Marikyan and Papagiannidis, 2023). TAM proposes two main factors that affect the behavioral intention to use technology, that is, perceived usefulness (PU) and perceived ease of use (PEOU) (Marikyan and Papagiannidis, 2023; Venkatesh et al., 2003; Venkatesh and Bala, 2008). PU is the degree to which a person believes that using technology will

enhance their performance or outcomes whilst, PEOU is the degree to which a person believes that using technology will be free from effort or difficulty. Moreover, external variables such as experience, voluntariness, subjective norms, work relevance, output quality, outcome demonstrability, computer self-efficacy, computer anxiety, computer playfulness, perceptions of external controls, and social influence are key factors that determine these perceptions. TAM has been widely applied and evaluated in various contexts and technologies, such as mobile banking, e-learning, virtual reality, e-resources, machine learning, robotics, natural language processing, and so on. Some of the major extensions are TAM 2, TAM 3, and UTAUT (unified theory of acceptance and use of technology) (Marikyan and Papagiannidis, 2023; Venkatesh et al., 2003). This model was employed in this study to formulate research questions, and the methodology to ascertain awareness, knowledge, skills, and the challenges medical students face in their use of AI-assisted technologies.

Research methodology

The research methodology of this study was based on the positivist paradigm, which assumes that reality is objective and measurable, and that knowledge can be derived from empirical observations and analysis (Blaikie and Priest, 2019). The research approach adopted for this study was therefore quantitative, meaning that the data collected was numerical and could be analyzed using statistical methods. The quantitative approach allowed the researchers to evaluate hypotheses, measure variables, and examine relationships between them. The quantitative approach also allowed the researchers to quantify the extent, frequency, or magnitude of the phenomena of interest (Edmonds and Kennedy, 2017; Singh, 2007). Using the survey research design, the researchers collected quantitative data from the medical students at the University of Ghana Medical School. The total number of respondents in this study was 1366, consisting of 656 pre-clinical year students and 710 clinical students. The preclinical year students consisted of first to third-year students, while the clinical students consisted of fourth to sixth-year students. Krejcie and Morgan's published table was employed to select the study sample size of 302 (Krejcie and Morgan, 1970).

Moreover, a stratified sampling technique was used to obtain the required representative sample proportions from each stratum of medical students. The

sample size for each stratum was calculated using the stratified sampling formula proposed by Berman (2023): $n_h = (N_h / N) * n$. Where: n_h = sample size for stratum h , N_h = total population size in stratum h , N = total population size, and n = total desired sample size. See Table 1. Using the stratified sampling formula, the sample size for preclinical year students was 145, and for clinical year students was 157. In addition, the convenience sampling technique was employed to select the respondents. The questionnaire was sent to the target audience via WhatsApp platforms and those who were available and desired to participate in the study completed the questionnaire. Table 1 shows the population and the sample size for each stratum.

The research instrument used for data collection in this study was a questionnaire consisting of a set of structured questions developed on Google Forms. The link to the questionnaire was shared with the study respondents via WhatsApp. The development of the questionnaire was based on a review of the literature. The questionnaire consisted of four sections with thirteen (13) questions. The first section focuses on user demographics such as age, gender, level, and number of years they had used AI-assisted technology. The second section consists of four questions focused on the awareness and knowledge of

AI-assisted technologies. The third section consisted of four questions focused on the types of AI-assisted technologies, and the last section discusses the challenges faced in using AI-assisted technologies. To check the reliability, the questionnaire was pilot tested with ten respondents, that is, former medical students who had completed school between 2020 to 2022. The data was collected from September 13 to October 20, 2023, after sending several reminders to respondents, and then finally the link to the questionnaire was closed. Descriptive statistics such as mean and standard deviation, were computed using the Statistical Package for Social Sciences (SPSS, version 25) software. The questionnaire was measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was prepared using Google Forms and sent to respondents using WhatsApp. Out of a total of 302 respondents who were sent the questionnaire, 123 participated in the study, resulting in a response rate of 40.73%. Respondents were informed that their responses to the questionnaire were voluntary, and the data collected were for research purposes only.

Results and discussions

Table 2 presents the frequencies, percentages, means, and standard deviations of the demographic characteristics, including age group, gender, level, and years of using AI-assisted technologies. Out of the 123 respondents, 75 (61.0%) were 20 years and above, while 48 (39.0%) were below 20 years with a mean of 1.61 and a standard deviation of 0.490. In addition, 65 (52.8%) were males and 58 (47.2%) were females with a mean and standard deviation of 1.47 and

Table 1. Population and sample size.

Medical Students	Population	Sample size
Preclinical years	656	145
Clinical years	710	157
Total	1366	302

Table 2. Demographic characteristics of the respondents (N = 123).

Demographics	Variables	Frequency	Per cent	Mean	Standard Deviation
Age Group	Below 20 years	48	39.0	1.61	0.490
	20 years and above	75	61.0		
Gender	Male	65	52.8	1.47	0.501
	Female	58	47.2		
Level	Level 100–300 / preclinical years	91	74.0	1.26	0.441
	Level 400–600/clinical years	32	26.0		
Years of using AI-assisted technologies	Less than 1 year	53	43.1	2.45	1.621
	1 year	27	22.0		
	2 years	5	4.1		
	3 years	11	8.9		
	Over 3 years	27	22.0		

0.501, respectively. This implies that more males than females responded to the study. Further, 91 (74.0%) were in level 100–300/preclinical years whilst 32 (26.0%) were in level 400–600/clinical years with a mean score of 1.26 and a standard deviation of 0.441. Also, from Table 2, respondents were asked to indicate the number of years they had used AI-assisted technology. The evidence shows that 53 (43.1%) have used AI for less than a year, while 27 (22.0%) have used AI-assisted technologies for a year and more than three years, respectively, with a mean score and a standard deviation of 2.45 and 1.621, respectively. This result shows that most respondents have been using AI-assisted technologies for less than a year, suggesting that they have some form of experience using AI tools.

Awareness and knowledge of AI-assisted technologies

Awareness and knowledge about the use of AI-assisted technologies are crucial, as they help academic libraries identify whether the technology is being used to its full extent or is underused. It also informs stakeholders to make effective decisions to increase system usage. This section deals with the choice of using AI-assisted technologies, awareness of AI-assisted technologies, the concept of AI, and the sources of awareness in academic libraries.

Choice of using AI-assisted technologies

The authors asked this question to solicit the views of respondents concerning whether using AI-assisted technologies is voluntary for them or entirely their choice. Responses were rated on a 5-point Likert scale, ranging from; 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Their responses are presented in Table 3.

From Table 3, 48 (39.0%) of the respondents agreed that the use of AI-assisted technologies in medical libraries was voluntary or completely their own choice, 35 (28.5%) were neutral, and 23 (18.7%) indicated strong agreement with a mean score of 3.57 and a standard deviation of 1.064. The results indicate that most respondents agreed that the use of AI-assisted

technologies in medical libraries is completely voluntary. This is also an indication that respondents were not forced to use a particular type of AI-assisted technology in academic libraries. This can also be realized from the result that AI is not taught in universities, colleges, or schools and is therefore voluntary for them. This supports the result of the study in which it was revealed that most users in academic libraries said they had been using AI for less than a year. Due to the voluntary nature of AI, Pinto dos Santos et al. (2019) indicated that most medical students do not necessarily understand the technical principles underlying AI-assisted technologies in academic libraries. Academic librarians must teach medical students the required knowledge and skills in medical education (Civaner et al., 2022). The knowledge and skills acquired in the library while using AI-assisted technologies will assist learners to reap the benefits of using AI-assisted technology. Academic librarians need to incorporate AI into the seminars or workshops that learners are required to attend as it has a very crucial impact on the development of the healthcare sector.

Awareness of AI-assisted technologies

Respondents were asked to choose from a 5-point Likert scale ranging from 1 to 5, where 1 = not at all aware, 2 = slightly aware, 3 = neutral, 4 = moderately aware, and 5 = extremely aware to indicate their awareness of AI-assisted technologies. Table 4 shows their level of awareness.

Table 4 shows that more than half of the respondents (62 or 50.4%) reported being moderately aware of AI-assisted technologies, with 26 (21.1%) being slightly aware and less than 20% 'Neutral', 'Extremely Aware' and 'Not at all aware' of AI-assisted technologies with a mean score of 3.54 and a standard deviation of 0.994. The results clearly showed that respondents had moderate awareness of AI-assisted technologies in academic libraries. This means that although respondents do not

Table 3. Choice of using AI-assisted technologies.

Choice of using AI-assisted technologies	Strongly agree	23	18.7	3.57	1.064
	Agree	48	39.0		
	Neutral	35	28.5		
	Disagree	10	8.1		
	Strongly disagree	7	5.7		

Table 4. Awareness of AI-assisted technologies.

Variable	Frequency	Per cent	Mean	Standard Deviation
Not at all aware	1	0.8	3.54	0.994
Slightly aware	26	21.1		
Neutral	18	14.6		
Moderately aware	62	50.4		
Extremely aware	16	13.0		

have complete knowledge of all AI-assisted technologies, they do know some AI-assisted technologies that exist in academic libraries.

These results support Kennedy et al. (2023) study on public awareness of artificial intelligence in everyday activities. It was found that 72% of university students in the United States were aware of AI in academic libraries. The awareness may be because these AI-assisted technologies support learners in their studies and academic work. However, the results contradict those of Alimi et al., (2021), in their study on university students' awareness of, access to, and use of AI for learning in Kwara State, and concluded that most university students are unaware of AI for learning. This is because academic libraries' adoption of computer technologies among university students is becoming more common in the current study than in the previous one, where AI in libraries was new to the learning community. Artificial intelligence is a rapidly growing technology in libraries and therefore academic librarians need to create more awareness. Therefore, AI-assisted technologies are gradually being integrated into medical library practices to improve healthcare.

Basic understanding of AI concepts

The concept of AI is understood from different perspectives. This may be due to the nature of the term as it relates to different disciplines. Therefore, respondents were asked to best describe their understanding of the AI concept using a 5-point Likert scale ranging from 1, strongly disagree, to 5, strongly agree. Table 5 shows their responses:

In Table 5, the analysis shows that respondents tended to agree with all items on the scale. This means that respondents understand the concept of AI, with the highest mean of 3.95 (standard deviation = 1.031) being 'Artificial Intelligence (AI) is a branch of computer science that focuses on creating intelligent machines...' and the lowest mean of 3.20 (standard deviation = 0.911) being 'AI can be categorized into two types: narrow AI and general AI'. The results clearly showed that the respondents had basic knowledge and understanding of the concept of AI. It is also an indication that academic library users had varied understandings of the concept of AI, including being a branch of computer science that focuses on creating intelligent machines capable of performing tasks that typically require human intelligence.

Table 5. Concept of AI.

Variable	Mean	Standard Deviation
Artificial Intelligence (AI) is a branch of computer science that focuses on creating intelligent machines capable of performing tasks that typically require human intelligence.	3.95	1.031
AI involves the development of algorithms and systems that can learn from data, reason, understand natural language, and make decisions based on complex information.	3.86	1.104
AI can be categorized into two types: narrow AI and general AI. Narrow AI is designed for specific tasks and has limited capabilities, while general AI aims to possess the same level of intelligence as a human across various domains.	3.20	0.911
Machine learning is a subset of AI that enables machines to learn from data and improve their performance over time without being explicitly programmed.	3.58	1.086
Deep learning is a specific technique within machine learning that utilizes neural networks with multiple layers to extract meaningful patterns and representations from data.	3.37	0.978
Natural Language Processing (NLP) is a subfield of AI that focuses on enabling computers to understand, interpret, and generate human language.	3.31	0.951
AI has various applications across different industries, including healthcare, finance, transportation, cybersecurity, and entertainment.	3.93	1.114
AI technologies, such as robotics and automation, have the potential to augment human capabilities, improve efficiency, and contribute to societal advancements.	3.85	1.014
The development and deployment of AI raise concerns about the ethical implications, responsible use, and potential risks associated with the misuse or abuse of AI systems.	3.89	1.077
Ethical considerations in AI include privacy and data protection, algorithmic bias and fairness, accountability, transparency, and the impact of AI on employment and society.	3.82	1.033

The results support the work of Wood et al. (2021) that few students or faculty reports have a basic understanding of AI. In other words, most medical students

and faculty were slightly familiar with the concept of AI and robotics in academic libraries (Sassis et al., 2021). This implies that AI-assisted technologies have already taken place in academic libraries without medical students' prior knowledge and understanding of these technologies. However, Pinto dos Santos et al. (2019) indicated that most medical students do not necessarily understand the technical principles underlying AI. Academic librarians with the help of school management must integrate AI-assisted technologies into medical education and training, as both students and faculty have a keen interest in AI in medicine. Integrating AI into medical student education and training will provide students with the knowledge needed to become more knowledgeable about most AI-assisted technologies. The integration of AI in medical education and practice is a significant development and as such academic libraries need more resources to develop a good understanding of AI.

Sources of AI-assisted technologies awareness

The previous results on awareness showed that respondents had moderate awareness of AI-assisted technologies. To determine various sources of awareness, a follow-up question was asked. They had the option to choose from a five-point Likert scale ranging from "strongly disagree" to "strongly agree." Table 6 shows their responses.

It can be realized from Table 6 that after reviewing the Likert scores of each source of AI awareness in the order in which the responses were presented, the Internet was the most influential source (mean = 3.90 and standard deviation = 1.190). Other dominant sources were the media (mean = 3.69 and standard deviation = 1.288) and colleagues (mean = 3.51 and standard deviation = 1.302). The lower sources of AI

awareness were funding agencies, workshops, and libraries with mean scores of 2.20 or less. It is obvious from the findings that most learners use the Internet as their source of awareness. This may be because it is more accessible than the other sources.

The results corroborate the findings of Jindal and Bansal (2020), who indicated that the Internet was the major source of information on AI awareness. The Internet as the main source of information shows that most learners use the Internet in their daily activities. The internet has been the gateway to accessing AI-assisted technologies, but it is quite surprising that the library was among the lowest sources of awareness. AI technology has advanced human knowledge, and academic library staff need to search the Internet to familiarize themselves with the new AI-assisted technology in various fields to inculcate it to their users. A study by Chao et al. (2020) supported the view that major sources of awareness of AI and relevant information were obtained through social media and traditional media. This indicates that social media over the internet has been recognized as the most powerful tool for obtaining information in academic libraries related to AI. The results contradict the work of (Edzie et al., 2020) who indicated that most respondents were exposed to AI through conferences. The difference in results was due to respondents in the previous study being exposed to conferences and research articles on AI. The Internet helps medical students access the library's digital resources and services in the field of AI. Therefore, the use of the Internet for learning is seen as a means of improving accessibility, efficiency, and quality of learning by facilitating access to academic libraries' resources and AI services (e Rodrigues and Mandrekar, 2021).

Type of AI-assisted technologies

AI is an integral part of daily life. Therefore, various learners are exploring different types of AI tools for their academic work and lifelong learning. This section covers the types of AI-assisted technologies, areas of training, and AI development methods used.

To examine the type of AI-assisted technologies used in respondents' studies and research, they were asked to indicate their agreement to 29 statements from a five-point Likert scale, ranging from 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). Table 7 depicts respondents' responses.

Table 6. Sources of AI-assisted technologies awareness.

Variable	Mean	Standard Deviation
Professional/Student associations	2.95	1.366
Workshops/seminars	2.14	1.155
Colleagues	3.51	1.302
Library	2.20	1.185
Publishers	2.46	1.243
Literature	2.69	1.325
Funding agencies	2.08	1.106
Internet	3.90	1.190
Media	3.69	1.288

It was revealed from Table 7 that most respondents agreed that Grammarly (mean = 3.69, standard deviation = 1.102) and Chat GPT (mean = 3.69 and standard deviation = 1.242) were the types of AI technologies used in their studies and research. Other types of AI-assisted technologies used by the respondents included Google Assistant (mean = 3.53 and standard deviation = 1.126), QuillBot (mean = 3.39 and standard deviation = 1.157), and Apple Siri (mean = 3.30 and standard deviation = 1.274). It is evident from the results that learners used several types of AI-assisted technologies for their research and learning, with the majority being Grammarly and Chat GPT. This is not surprising, as these two technologies are the most popular AI-assisted technologies in libraries.

The results are consistent with those of Kennedy et al., (2023), who found that the most common AI-assisted technologies known to university students are chatbots, virtual assistants, and recommendation

engines, respectively. Chat GPT is a type of chatbot used by academic libraries to provide reference questions to users while Grammarly is used to help learners improve their academic grammar writing. Also, the results agreed with that of Nilsone (2023), who reported on the impact of artificial intelligence on higher education students. They found that most students used ChatGPT for educational purposes, in addition to grammar tools and chatbots. The use of these tools is crucial as they play a critical role in improving learners' research and learning. Academic libraries need to create awareness, knowledge, and skills to help medical students make the most use of these tools, while educating them about the legal and ethical issues surrounding the use of these AI tools.

Confidence in AI skills and competencies

To assess the level of confidence in each AI skill and competency, respondents were asked to indicate their level of confidence in ten statements on a five-Likert scale ranging from very unconfident = 1 to very confident = 5. Table 8 represents their responses.

It can be observed from Table 8 that the mean scores of the ten items across confidence levels for each AI skill and competency ranged from Natural Language Processing (2.81), Data Science and Analytics (2.89), Continuous Learning (2.99), Mathematics and Statistics (3.07), to Problem Solving and Critical Thinking (3.10). Others include Programming and Software Development, Machine Learning, Computer Vision, Deep Learning, and Ethical and Responsible AI with mean scores of 2.80, 2.79, 2.78, 2.77, and 2.65 respectively. It can be established that respondents rated problem-solving

Table 7. Types of AI technologies.

Variable	Mean	Standard Deviation
Natural language processing	3.11	1.175
Grammarly	3.69	1.102
Keras	2.74	1.023
Apache MXNet	2.77	1.023
TensorFlow	2.76	1.019
PyTorch	2.72	1.020
OpenNN	2.67	1.022
Google Assistant	3.53	1.126
Caffe	2.72	0.979
CNTK	2.78	1.029
Scikit-learn	2.73	1.033
Theano	2.72	1.035
OpenCV	2.87	1.101
Open AI Playground	3.00	1.166
Chat GPT-3/GPT-4	3.69	1.242
QuillBot	3.39	1.157
Fotor	2.76	1.003
Adobe Express & Firefly	3.13	1.187
Otter.ai	2.76	1.025
Stepwise math	2.85	1.114
Google Bard	2.95	1.130
Slidesgo	2.86	1.104
Invideo.io	2.77	1.015
Pdfelement	2.77	1.039
Amazon Alexa	2.89	1.189
Samsung Bixby	2.98	1.141
Magical Tome	2.74	1.015
Apple Siri	3.30	1.274
Microsoft Cortana	3.17	1.164

Table 8. Confidence in AI skills and competencies.

Variable	Mean	Standard Deviation
Programming and Software Development	2.80	1.185
Machine Learning	2.79	1.189
Deep Learning	2.77	1.186
Data Science and Analytics	2.89	1.207
Mathematics and Statistics	3.07	1.216
Natural Language Processing (NLP)	2.81	1.074
Computer Vision	2.78	1.090
Problem Solving and Critical Thinking	3.10	1.197
Ethical and Responsible AI	2.65	1.123
Continuous Learning	2.99	1.142

and critical thinking as top AI skills and competencies. This indicates that respondents were confident in problem-solving and critical thinking, as well as in mathematics and statistics of AI skills and competencies. Therefore, academic libraries need to integrate AI-assisted technologies into medical education and training, as learners' interest in AI in medicine is high. This is because AI gives learners more confidence in various areas of problem-solving and critical thinking, as well as mathematics and statistics.

Frequently offered training areas

The purpose of training is to support learners in acquiring the necessary knowledge and skills to use specific technology. A question was asked to understand how often the school, college, or university offered training on AI. Respondents were given the option to choose from a five-point Likert scale ranging from never = 1, rarely = 2, sometimes = 3, often = 4, to always = 5. Table 9 shows their responses.

It can be established from Table 9 that the mean and standard deviation of most respondents indicated Problem Solving and Critical Thinking (mean = 2.77 and standard deviation = 1.317), followed by Mathematics and Statistics (mean = 2.48 and standard deviation = 1.203), data science and analytics (mean = 2.34 and standard deviation = 1.165), and continuous learning (mean = 2.33 and standard deviation = 1.120). Other responses included Programming and Software Development and Ethical and Responsible AI (mean = 2.28), Machine Learning (mean = 2.17), Computer Vision (mean = 2.15), Natural Language Processing (mean = 2.14), and Deep Learning (mean = 2.12). From the results, it can be inferred that all respondents reported that the college rarely provided training in

areas such as problem-solving and critical thinking, mathematics and statistics, data science and analytics, and continuous learning with mean scores less than 3.0. The results clearly showed that academic libraries sometimes or rarely provided training in all these areas, such as problem-solving and critical thinking, mathematics and statistics, and others. This confirmed the results of the above confidence levels for AI skills and competencies, indicating that respondents were confident only in the areas of problem-solving and critical thinking, as well as mathematics and statistics. This confirmed why Civaner et al. (2022) pointed out that knowledge and skills related to AI applications should be considered in medical education. Academic libraries in consultation with Careers and Counselling Centre can regularly train learners in all areas of AI-assisted technologies, as AI plays a crucial role in the academic and professional progress of learners.

AI development methods used

Respondents were given the option to choose from a five-point Likert-type scale ranging from 1 to 5, where 1 = strongly disagree, 2 = moderately disagree, 3 = moderately agree, 4 = agree, and 5 = strongly agree. Respondents' responses are indicated in Table 10.

It can be seen from Table 10 that all respondents moderately disagree with the following professional or academic development methods applied to them in terms of developing their AI capacity with a mean score of less than 3. Most respondents indicated access to free online training resources on

Table 9. Frequently offered training areas.

Variable	Mean	Standard Deviation
Programming and Software Development	2.28	1.154
Machine Learning	2.17	1.006
Deep Learning	2.12	1.013
Data Science and Analytics	2.34	1.165
Mathematics and Statistics	2.48	1.203
Natural Language Processing (NLP)	2.14	1.035
Computer Vision	2.15	1.046
Problem Solving and Critical Thinking	2.77	1.317
Ethical and Responsible AI	2.28	1.105
Continuous Learning	2.33	1.120

Table 10. AI development methods.

Variable	Mean	Standard Deviation
I have received training in the last two years on AI technologies	1.95	1.055
The library provides AI-assisted technology training (e.g., workshops)	2.15	0.950
I have access to free online training resources on AI-assisted technologies	2.69	1.202
My university offers courses on AI-assisted technologies	2.23	0.974
The medical school offers courses in AI-assisted technologies	2.04	1.003
I participate in data AI-assisted technologies webinars	2.05	1.039
I attend conferences	2.11	1.015
Mentorship with peers	2.24	1.089

AI-assisted technologies (mean = 2.69 and standard deviation = 1.202). Others claimed that they are mentored by peers (mean = 2.24 and standard deviation = 1.089) and that their university offers courses on AI-assisted technologies (mean = 2.23 and standard deviation = 0.974). The results showed that respondents did not have the development methods that they had used to advance their AI skills, although the majority reported having access to free online training resources on AI-assisted technologies. This was demonstrated by Pinto dos Santos et al. (2019), where the study claimed that most medical students do not necessarily understand the technical principles underlying AI-assisted technologies. The results could be a good starting point for academic libraries to train learners in the use of AI-assisted technologies, as respondents early on indicated that the academic library does not frequently offer training in various areas of AI. On the other hand, learners need to learn more about AI through free training resources as Kaplan et al. (2021) and Sit et al. (2020) discussed the usefulness of AI-assisted technologies in various aspects of medical practice, including ophthalmology, dermatology, respiratory medicine, and radiology.

Challenges faced in using AI-assisted technologies

Although Artificial Intelligence plays a key role in supporting users in their daily activities, rapid advances in AI pose several challenges. In this regard, the respondents' views were self-rated on a five-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. In the descriptive analysis, mean scores were used to determine the respondents' level of agreement or disagreement with the statements. Thus, a mean score of 1 means that respondents strongly disagree, whereas a mean score of 5 means that respondents strongly agree with the statements. Table 11 shows respondents' responses.

The analysis and presentation of results in Table 11 show that respondents agreed that they face many challenges when using AI-assisted technologies, such as lack of training opportunities, inadequate skills, unreliable internet connectivity, and limited internet infrastructure, with mean scores higher than 3.5. This was followed by limited knowledge of the potential benefits of AI-assisted technologies (mean = 3.50 and standard deviation = 1.104). Other challenges included staying up to date with AI-assisted technologies (mean = 3.49 and standard

Table 11. Challenges in using AI-assisted technologies.

Variable	Mean	Standard Deviation
Lack of awareness about AI-assisted technologies	3.46	1.243
Limited knowledge of the potential benefits of AI-assisted technologies	3.50	1.104
Unreliable internet connectivity	3.58	1.138
Limited internet infrastructure	3.54	1.118
Poor attitude of stakeholders	3.37	1.035
Unstable electricity (power) supply	3.26	1.108
Inadequate skills	3.58	1.138
Staying up to date with AI-assisted technologies	3.49	1.066
Lack of time	3.00	1.086
Lack training opportunities	3.63	1.089
Lack of finance or funds	3.43	1.167
Lack of research/innovative infrastructure to support AI-assisted technologies	3.48	1.097
Legal restrictions (e.g., intellectual property)	3.19	1.074
Access restrictions (e.g., through sanctions)	3.26	1.062
Uncertainty of ethics and privacy issues surrounding AI-assisted technologies	3.37	1.096
Lack of legislative and policy guidelines for AI-assisted technologies	3.21	1.042
Lack of legitimacy in quality, process, and rigor in scientific production	3.20	1.053
Lack of motivation and incentive to use AI-assisted technologies	3.20	1.099

deviation = 1.243), lack of research/innovative infrastructure to support AI-assisted technologies (mean = 3.48 and standard deviation = 1.097), and lack of awareness about AI-assisted technologies (mean = 3.46 and standard deviation = 1.243). The least challenging was the lack of time (mean = 3.00 and standard deviation = 1.086).

The study highlighted the challenges encountered by medical students at the University of Ghana when deploying AI-assisted technologies, with the majority indicating a lack of training opportunities. The lack of training opportunities to make maximum use of AI is a serious concern for academic libraries in Ghana. As a result of this, medical students in academic libraries in Ghana find it difficult to familiarize themselves with various AI-assisted technologies. Similarly, Pucchio et al. (2022) found that medical students lack educational opportunities in the field of AI. This implies a desire to learn about AI and a strong belief that AI will have a positive impact on

medicine in the future. The lack of training may be because there are not many trained AI educators, and it is not clear which areas of the field should be taught. Further, the results support the view of Kansal et al. (2022). They pointed to a lack of knowledge and skills. Since AI is a rapidly evolving field, academic libraries in consultation with the school management need to organize training for librarians and medical students to enhance their skills in using AI. School management must provide necessary support for training both librarians and students. Therefore, learners need to acquire the necessary skills and knowledge in using AI-assisted technology to avoid some of the mentioned challenges.

Theoretical implications of the study

This study used the Technology Acceptance Model (TAM) to investigate the awareness, use, and perception of AI-assisted technologies among medical students at the University of Ghana. The TAM aims to understand and predict user acceptance of AI-assisted technologies. Based on empirical evidence, this study provides valuable contributions to academic librarians, school management, and policymakers at the University of Ghana Library System on student awareness and knowledge, the type of AI-assisted technologies, and the challenges students face in using AI-assisted technologies. This study offers the need for academic libraries to promote students' acceptance of AI-assisted technologies, such as Grammarly and ChatGPT, to transform learning environments and enhance medical students' outcomes. Finally, the results make a practical contribution to academic libraries by indicating the critical barriers such as lack of training opportunities, inadequate skills, unreliable internet connectivity, and limited internet infrastructure affecting the acceptance of AI-assisted technologies. These results have practical implications for academic libraries, enabling academic librarians and school management to address the challenges and improve AI-assisted technologies in the University of Ghana Library System

Conclusion and recommendations

AI-assisted technologies have become very significant in medical research, learning, and practice. Most medical students were moderately aware and familiar with the use of AI tools in their studies. Also, medical students predominantly use Grammarly and ChatGPT, among the many other AI technologies available on

the internet. As AI technologies are taking root in academic libraries, the challenge that comes with a lack of training opportunities must be well addressed, as most medical students expressed their concerns regarding the use of AI-assisted technologies. Unfortunately, some academic libraries have not been involved in creating awareness regarding the appropriate use of AI technologies for learning and research in universities.

Based on the results, the following recommendations were made. First, an awareness of AI-assisted technologies must be created. The results showed that respondents had moderate awareness of AI-assisted technologies. Therefore, academic libraries need to create awareness, knowledge, and skills for learners about AI-assisted technologies through various sources such as the internet, media, colleagues, funding agencies, workshops, and libraries. Library staff must also become familiar with AI-assisted technologies to inform users of these technologies. Additionally, training opportunities must be promoted. There is a need to train more learners to use AI tools for education, research, and lifelong learning. The academic libraries in consultation with school management must organize a series of training courses in the form of seminars, workshops, and webinars. This training needs to focus on AI tools, such as Grammarly and ChatGPT. These tools can assist users in improving their writing skills. Finally, the internet infrastructure must be enhanced. The internet infrastructure in academic libraries needs to be improved to facilitate the easy use of AI-assisted technologies. Moreover, libraries in consultation with school management must provide the necessary infrastructure to allow learners to access the Internet, as the Internet has been seen as the main source of AI awareness and a challenge for AI-assisted technologies. There is a need for system maintenance and improvement.

This study was limited to medical students' awareness and knowledge of the use of AI-assisted technologies using a survey research design. The future impacts of the use of AI-assisted technologies are recommended. This will make it easier for medical students to be trained by academic libraries. Future research may also consider both quantitative and qualitative research approaches to examine medical students', library staff's and school management's views on AI-assisted technologies. Finally, future research can explore the impact of Grammarly and ChatGPT on student learning and research and determine why other types of AI-assisted technologies are not predominantly used by medical students.

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