A Digital Humanities Exploration of AI-driven Learning Technologies in Medical Education

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ABSTRACT

Digital humanities (DH) is an emerging research method that blends critical analysis with computational tools to explore multifaceted research inquiries. Digital health humanities (DHH) is a related field that focuses on the intersection of digital technologies and healthcare. The rapid incorporation of Artificial Intelligence (AI) into medical education offers the potential to transform healthcare and educational procedures significantly. This paper explores the potential of AI-driven learning technologies in medical education through the lens of digital humanities and DHH. A research questionnaire was employed to assess the perceptions of medical undergraduates regarding AI-driven learning technologies in medical education. The results suggest that undergraduate medical students have a positive perception of AI-driven learning technologies in medical education. The highest average ratings were for AI Education Impact, AI Clinical Potential, and AI Concept Learning, indicating that students believe that the integration of AI technology in medical education can enhance learning efficiency and effectiveness, improve students' abilities to identify and solve clinical problems, and aid the understanding of complex medical concepts. The lowest average ratings were for AI Forum Participation and Filtering AI Information, indicating that students may need more encouragement and guidance to participate in online discussion forums and to identify and filter AI-related information from digital sources to avoid errors and biases. The findings of this study can inform the development of interventions to promote the use of AI-driven learning technologies in medical education and to address the challenges associated with their integration.

Keywords: Digital humanities, Digital health humanities, AI-driven learning technologies, Medical education.

1. INTRODUCTION

Artificial Intelligence (AI) stands at the forefront of a rapidly advancing field with the potential to reshape both healthcare and medical education [1] [2]. As a branch of computer science, AI is dedicated to constructing intelligent machines capable of executing tasks that conventionally demand human cognitive abilities, including learning, problem-solving, and decision-making. Through various forms like machine learning (ML) and large language models (LLMs), AI manifests its potential to enhance the efficiency and effectiveness of medical education [3] [4].

The integration of AI into healthcare has witnessed a recent surge, progressively leaving a notable imprint on medical education. AI's capabilities extend to facilitating the management of vast datasets, automating the assessment of written responses, and delivering reliable feedback on interpretations of medical images [5]. However, this integration introduces challenges, such as re-evaluating curricula and assessing students' comprehension due to the intricate nature of examinations and the existing gap in digitalization [6].

Emerging as a research method, digital humanities (DH) seamlessly blends critical analysis with computational tools to explore multifaceted research inquiries [7]. The field of DH, initially referred to as humanities computing, has witnessed substantial growth in recent decades and has established connections with various other fields. Digital humanities harmonizes insights drawn from linguistics, history, literature, music, communications, and computer science, creating innovative approaches to research [8]. While there is no specific term for DH in the medical or health sector, there are related fields that focus on the intersection of digital technologies and healthcare. These fields include medical humanities and digital health humanities (DHH) [9] [10] [11].

When coupled with AI, digital humanities can potentially yield innovative solutions to pressing issues within the medical realm [4] [11]. The infusion of humanities into medical education nurtures empathy and an in-depth grasp of the human condition, pivotal for nurturing a compassionate approach to patient care.

In light of the promising potential of AI-driven learning technologies in medical education, an apparent void exists in comprehending medical students' perspectives on these technologies. Addressing this gap, this paper embarks on a journey to dissect the current landscape of AI utilization in medical education while delving into medical students' perceptions of AI-driven learning technologies. Employing a research questionnaire that employs the Likert scale, this study aims to explore numerous facets of AI's role in medical education. These facets encompass the frequency of engaging with digital resources, active participation in online discussion forums, and the efficacy of AI-based technology in facilitating comprehension of intricate medical concepts. With this endeavor, the paper strives to contribute substantially to the ongoing discourse surrounding AI's role in medical education and its potential impact on the realm of medical humanities.

2. METHODS

This study is a cross-sectional survey that aims to explore the perceptions of undergraduate medical students towards AI-driven learning technologies in medical education. The participants are undergraduate medical students of the Faculty of Medicine Universitas Brawijaya, Malang, Indonesia, in the first, second, and third years. Participants must have actively utilized or interacted with artificial intelligence technologies, resources, or tools during their medical studies. This can include experiences such as accessing AI-driven medical resources, participating in AI-focused coursework, or using AI-based learning platforms. Students who have not actively utilized or interacted with artificial intelligence technologies, resources, or tools during their medical studies will be excluded from the study.

The study used an online questionnaire with Google Forms to collect data. The questionnaire consists of two sections: 1) demographic data and 2) perceptions about digital humanities in using AI during medical programs. The second section of the questionnaire includes ten questions with Likert scale responses, which assess the frequency of accessing digital resources, participation in online discussion forums, and the effectiveness of AI-based technology in aiding the understanding of complex medical concepts. The questionnaire was designed based on the existing literature on AI in medical education and medical humanities [3] [5] [6]. The questionnaire's construct validity was tested using factor analysis (SPSS ver. 26) to ensure that the questions accurately measure the intended constructs. The questionnaire was distributed to the participants through their official email addresses, and participation was voluntary and anonymous. Prior to participating in the study, all participants were informed about the research objectives and procedures. Their voluntary participation was confirmed through the acquisition of informed consent. Confidentiality of participants' responses was maintained throughout the research process.

The data gathered from the survey will be examined through descriptive statistics to identify data trends and patterns. The results of the questionnaire will be used to inform the discussion on the role of AI in medical education and its impact on medical humanities. The study aims to contribute to the ongoing discussion on the integration of AI-driven learning technologies in medical education and the potential benefits and challenges of this integration.

This study was approved by the The Ethics Committee for Health Research, Faculty of Medicine, Universitas Brawijaya with the ethics approval number No.144/EC/KEPK/05/2024. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

3. RESULTS AND DISCUSSIONS

3.1. Demographic Profile of Participants

The study included undergraduate medical students from the Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia. A total of 84 students agreed to participate in the study, but 20 were excluded because they had not actively utilized or interacted with artificial intelligence technologies, resources, or tools during their medical studies. Therefore, the final sample size was 64 students. The validation test was conducted on 30 different participants from the same population before. The participants were in their third, fifth, and seventh semesters of study, with the majority in their seventh semester. This suggests that the participants had some level of experience and knowledge in medical education and may have been more familiar with the use of digital technologies in medical education. The gender of the participants was balanced, with 33 female and 31 male participants, indicating that the study had a diverse sample population.

3.2. Questionnaire Validation Test

The validation test of the research questionnaire was conducted using Cronbach's alpha, which is a measure of internal consistency. The results showed that the questionnaire had high internal consistency, with a Cronbach's alpha of 0.803. This indicates that questionnaire items were measuring the same construct and were reliable. The Cronbach's alpha based on standardized items was also high, with a value of 0.800. This suggests that the items in the questionnaire were measuring the same construct even after standardization.

The Cronbach's alpha if each item of the ten variables was deleted was also calculated to determine the reliability of each item. Table 1 showed that all items had high reliability, with Cronbach's alpha values ranging from 0.758 to 0.814. This indicates that all items in the questionnaire were reliable and contributed to the overall internal consistency of the questionnaire.

The results of the validation test provide evidence that the questionnaire is a valid tool for assessing the perceptions of undergraduate medical students towards AI-driven learning technologies in medical education. The high internal consistency and reliability of the questionnaire suggest that the items in the questionnaire are measuring the same construct and are reliable. This indicates that the questionnaire can be used to assess the perceptions of undergraduate medical students towards AI-driven learning technologies in medical education.

Table 1. Factor analysis of the "AI-driven learning technologies in medical education" scale.

No.	Questionnaire Items	Cronbach's alpha if item deleted
1.	How often do you access digital resources, such as online scholarly articles or AI discussion forums, to enhance your understanding of the usage/implementation of AI in the context of medical education or to assist you in learning medicine? (*AI Learning Frequency*)	0.780
2.	How frequently do you participate in online discussion forums or campus study groups to further comprehend the latest developments in AI within the field of medicine? (*AI Forum Participation*)	0.778
3.	To what extent do you believe that data visualization methods (approaches utilizing graphs, diagrams, maps, and various other visual elements to represent data visually) can enhance the understanding of AI usage during medical education? (*Data Visualization Impact*)	0.772
4.	How strong is your interest in utilizing data mining (the process of gathering crucial information and data from large amounts of big data) to study the ethical implications of AI usage in the healthcare world? (*Ethical AI Mining*)	0.814
5.	In your opinion, how effective is the use of AI-based technology, such as chatbots or AI simulations, in aiding the understanding of complex medical concepts? (*AI Concept Learning*)	0.804
6.	To what extent do you argue that the incorporation of AI technology in medical education can enhance learning efficiency and effectiveness? (*AI Education Impact*)	0.783
7.	How do you perceive the potential of AI technology in improving students' abilities to identify and solve clinical problems? (*AI Clinical Potential*)	0.787
8.	How do you identify and filter AI-related information from digital sources to avoid errors and biases? (*Filtering AI Information*)	0.805
9.	How often do you leverage AI to complete individual tasks related to medical education? (*AI for Tasks*)	0.758
10.	How frequently do you utilize AI to accomplish group tasks related to medical education? (*Group AI Task*)	0.767

3.3. The Questionnaire on the Integration of AI-driven Learning Technologies in Medical Education

The integration of Artificial Intelligence (AI) into medical education presents a transformative potential that extends its influence across healthcare and the educational landscape. Within medical education, AI technologies have demonstrated their capacity to streamline the management of vast and intricate datasets, automate the evaluation of written assignments, and provide students with reliable feedback on their interpretations of medical images [5]. Nevertheless, this harmonious fusion of AI and medical education is not devoid of challenges. These challenges encompass the imperative to re-evaluate curricula and the means by which students' understanding is assessed, particularly in light of the intricate nature of examinations and the existing gaps in digitalization [6].

Simultaneously, the emergence of Digital Humanities (DH) as a pioneering research methodology enriches the discourse. DH seamlessly integrates the realms of critical analysis with the formidable potential of computational tools, opening new horizons for multifaceted research inquiries [7]. Drawing from diverse fields including linguistics, literature, history, music, media studies, communication, computer science, and information studies, DH forges innovative paradigms in research methodologies. The convergence of DH and AI in the medical arena holds promise in addressing pressing challenges. Notably, the infusion of humanities into medical education nurtures empathy and deepens comprehension of the human condition, characteristics foundational to the cultivation of a compassionate approach to patient care.

Table 2. Perceptions towards digital humanities of AI in medical education (n = 64)

Topic statement	Strongly Agree/Always n (%)	Agree/Often n (%)	Disagree/Rarely n (%)	Strongly disagree/ Never n (%)	Average Ratings
AI Learning Frequency	13 (20.31)	17 (26.56)	30 (46.88)	4 (6.25)	2.609
AI Forum Participation	5 (7.81)	9 (14.06)	31 (48.44)	19 (29.69)	2.000
Data Visualization Impact	19 (29.69)	34 (53.13)	11 (17.19)	0	3.125
Ethical AI Mining	18 (28.13)	32 (50.00)	12 (18.75)	2 (3.13)	3.031
AI Concept Learning	23 (35.94)	34 (53.13)	7 (10.94)	0	3.250
AI Education Impact	22 (34.38)	38 (59.38)	4 (6.25)	0	3.281
AI Clinical Potential	26 (40.63)	34 (53.13)	4 (6.25)	0	3.344
Filtering AI Information	17 (26.56)	25 (39.06)	20 (31.25)	2 (3.13)	2.891
AI For Tasks	14 (21.88)	19 (29.69)	26 (40.63)	5 (7.81)	2.656
Group AI Tasks	12 (18.75)	21 (32.81)	25 (39.06)	6 (9.38)	2.609

According to Table 2, the results of the questionnaire suggest that undergraduate medical students have a positive perception of AI-driven learning technologies in medical education. The highest average of Likert scale ratings were for "AI Clinical Potential" (3.344), "AI Education Impact" (3.281), and "AI Concept Learning" (3.250) items. The recognition of AI's potential to enhance students' abilities to identify and solve clinical problems ("AI Clinical Potential" item) underscores the belief that AI can be a valuable resource in honing critical thinking and diagnostic skills. The favorable ratings for the "AI Education Impact" item that represents the question "To what extent do you argue that the incorporation of AI technology in medical education can enhance learning efficiency and effectiveness?" indicate that students perceive AI as a tool that can improve the efficiency and effectiveness of their learning [4]. AI's capacity to adapt to individual learning needs and provide personalized feedback likely contributes to this perception. The high ratings for "AI Concept Learning" item suggest that students view AI as a means to aid their comprehension of intricate medical concepts. AI's ability to generate visual aids, simulations, and interactive learning materials likely contributes to this perception. This is consistent with the findings of other studies that have investigated medical students' perceptions of AI in medical education. For example, a study conducted in Kuwait found that the majority of medical students were familiar with AI and had a positive attitude towards its use in medical education [3]. Another study conducted in the United States found that medical students and faculty were interested in AI technology and its applications in healthcare [12]. Additionally, mixed methods survey study on US medical students revealed varying opinions regarding the specific format and topics for AI education. This underscores the importance of tailoring AI education to the diverse needs and preferences of students, ensuring a comprehensive and inclusive approach [13].

Despite the overall positive sentiment, certain aspects warrant attention and potential enhancement, for example "AI Forum Participation" (2.000) and "Filtering AI Information" (2.891) items. The lower average rating in the "AI Forum Participation" category suggests that students may require more encouragement and support to engage actively in online discussion forums related to AI. This could be addressed by fostering a collaborative and inclusive online learning environment that promotes active participation and peer-to-peer learning. Similarly, the lower rating in the "Filtering AI Information" category indicates that students may benefit from guidance on how to discern and filter AI-related information from digital sources effectively to avoid errors and biases. Incorporating training or resources on information literacy and critical evaluation of digital content can address this challenge. This finding is consistent with the need for medical students to understand AI concepts, which involve mathematics and computer science, and the challenges relating to content selection, clinical relevance, and teaching methods used to deliver the material [14].

Overall, the results of the questionnaire suggest that undergraduate medical students have a positive perception of AI-driven learning technologies in medical education. Medical educators should consider the positive disposition of students towards AI-driven learning technologies. The customization of AI tools to cater to individual learning needs and clinical skill development can enhance the educational experience [15]. Encouraging active participation in AI-related online forums can foster collaborative learning and the exchange of diverse perspectives, contributing to a more comprehensive understanding of AI in medicine. Besides, providing students with the skills to effectively identify, assess, and filter AI-related information can empower them to navigate the digital landscape responsibly and critically.

However, further investigation is required to recognize the constraints of this study, encompassing the prospect of response bias and the particularity of the study's setting. Future research can explore the specific preferences and needs of medical students concerning AI-driven learning technologies and delve deeper into the challenges and solutions related to their integration.

4. CONCLUSION

The positive perceptions of undergraduate medical students regarding AI-driven learning technologies in medical education suggest a promising avenue for the continued integration of AI in medical curricula. As AI continues to shape the landscape of healthcare, addressing the knowledge gap and providing accessible, relevant AI education is essential to prepare future medical professionals for the evolving healthcare environment.

To improve the incorporation of AI into medical education, it is advised to take into account the following recommendations:

- **Customized AI Tools:** Recognizing the favorable attitude of students towards AI-based learning technologies, medical educators should investigate ways to personalize AI tools to suit individual learning requirements and clinical skill enhancement. This personalization can elevate the educational experience and align more effectively with the varied preferences of medical students.

- **Active Participation in AI-related Forums:** The lower average rating in the 'AI Forum Participation' category suggests that students may benefit from more encouragement and support to engage actively in online discussion forums related to AI. Fostering a collaborative and inclusive online learning environment that promotes active participation and peer-to-peer learning can address this concern.

- **Information Literacy Training:** Considering the lower rating in the 'Filtering AI Information' category, it is advisable to incorporate training or resources on information literacy and critical evaluation of digital content into the curriculum. This can empower students to discern and filter AI-related information effectively, minimizing errors and biases in their understanding.

AUTHORS' CONTRIBUTIONS

WAC played a role in the conceptualization and design of the study, and was responsible for conducting final review and editing of manuscripts. IDR actively participated in the literature review and contributed significantly to the discussion section. DAP served a crucial role in data analysis and ensuring the reliability of the results. The authors worked collaboratively to navigate the complex landscape of AI-driven learning technologies in medical education. All authors have read and agreed to the published version of the manuscript.

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