AI-Driven Medical Education for Personalized Health

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Abstract: The present study explores the integration of AI-driven solutions in the education of medical professionals and their role in achieving high-quality healthcare and personalized strategies. A range of AI tools is examined to evaluate how they shape training environments, support medical students during their studies, and influence their later professional practice. The primary objective is to analyze how AI contributes to the advancement of medical education and the transfer of acquired knowledge into daily clinical routines. While AI enables rapid access to information and decision support, medical professionals must also maintain the ability to make accurate judgments under pressure. This raises concerns about whether reliance on AI during training may reduce students' capacity for independent and rapid clinical reasoning. The study further investigates the extent to which AI-based simulations can provide realistic and comprehensive training experiences. Beyond replicating surgical procedures, it is critical to assess whether such systems can recreate the psychological, emotional, and tactile aspects of practice—such as stress management, operating under pressure, and the physical sensations of interacting with human tissue. Special emphasis is placed on identifying the benefits for patients, particularly whether AI-enhanced education ultimately contributes to more effective, personalized healthcare outcomes.

1 INTRODUCTION

Digital technologies, especially AI, have become a huge part of our daily lives. They're involved in so many areas like education, healthcare, retail, and even navigation on ships. What's even more interesting is how these technologies are linking these areas together in ways we didn't expect before. This is making it even more important for us to use them well, and also to be able to adapt ourselves and adjust these tools to fit our personal needs.

One example of this is how animal testing is being replaced with simulations [1], [2]. More and more, computer-based models are being used to train medical students, simulating things like blood tests, patient behavior, different reactions, or even emergencies. This shift is not only more ethical but also opens up the possibility for better and more efficient learning.

The main goal of all of this is to improve healthcare, to make sure medical professionals are well-prepared, and to reduce preventable mistakes. In the research, we will look into how AI is already being used in medical education, how it affects the learning of students, and how this knowledge is applied when they become practicing doctors. We'll also explore the consequences and impacts of bringing AI into medical training. The core argument of this study is that AI does not contribute to the development of empathy toward patients.

2 METHODS

2.1 Literature Review

This study includes a narrative review of the current literature on AI technologies in medical education and personalized healthcare. Sources were identified through keyword searches in databases such as Scopus, Spinger Natura, ResearchGate and PubMed using terms like "artificial intelligence", "medical education", "personalized medicine", and "adaptive learning". The review focused on papers published between 2004 and 2025. Only peer-reviewed articles and reputable conference papers in English were included. The aim was to summarize key trends, challenges, and research gaps relevant to the study topic.

2.2 An Online Survey

An online survey was conducted using Google Forms between April and May 2025. The participants included medical students and faculty members from various institutions in Bulgaria. A total of 68 responses were collected. Although the sample size is relatively limited, this reflects the current early stage of integration of AI-based training tools and simulations in Bulgarian medical education. As such technologies are not yet widely implemented, the study serves as an initial exploration of awareness and attitudes. The survey consisted of fully anonymous questions focused on perceptions, interest, and expectations related to AI in medical learning contexts. No demographic data were collected, as the study aimed to capture general attitudes and experiences, rather than conduct subgroup analysis. Moreover, the anonymous nature of the questionnaire was intended to encourage candid responses.

3 AI TOOLS IN MEDICAL EDUCATION – TYPES AND MODELS

AI in the fields of medical education can influence the student learning process in different ways [3]. There are different types of AI tools, and they serve different purposes. Practice indicates that the use of AI in medical education fosters critical thinking and the ability to make rapid decisions [4]. However, not all studies support this view, some suggest the opposite [5].

3.1 Virtual Patients - Simulation of Real Patient Cases

Virtual patient is a computer simulation of a real patient which is used in education for students or medical specialists. The virtual patient has symptoms, test results, and even AI tools that provide patient responses based on the user's choices. This happens without any risk, unlike with real patients [3]. Machine learning is incorporated to interpret laboratory data accurately and defect abnormal values [3], [6].

3.2 AI Robots in Surgery and Surgery Simulation

These Procedural skills can be assessed with Virtual Reality, where a simulated patient will be presented in a virtual environment, and the learner is asked to do a procedure [3]. Simulation training is one method of developing proficiency in a safe and risk-free environment and is used in formal surgical training [7]-[10]. One of the examples in this category is Touch surgery software - an effective instrument for medical student education that aims to teach surgical decision making to trainees without risk to patients [7]. Trainees can continue their learning during actual procedures using AI driven robotic systems [11].

The research shows that while AI is improving procedural safety, they also led to unintended negative effects on certain technical skills (like hands movement during surgery) [12].

3.3 AI Patient Diagnosis and Prescription - Chatbots

AI is integrated into medical education through the use of virtual patient simulations and surgical simulations, enabling students to develop skills in diagnosis and treatment planning. Furthermore, AI tools continue to support physicians after graduation by assisting them in real clinical environments. One of the most used AI tools is ChatGPT, with 66.7% of the 207 surveyed students reporting familiarity with it [13].

After graduation, specialists continue to use AI in their practice for patient diagnosis. DXplain is a big example; it is a clinical decision support system. The system assists healthcare professionals by providing a list of potential diagnoses based on the input of clinical findings, including symptoms, signs, and lab results [14].

Similar AI tools are AMIE (a Large Language Model - based AI) [15], [16] and FAMULUS (a Natural Language Processing model) [17]. Stanford Graduate School of Education is using web-based platforms to help medical students improve their ability to determinate a patient's initial diagnosis and treatment. It is called Clinical Mind AI [18]. The last one is documented in Standford Graduate School of Education paper. These tools provide high-quality consultations tailored to the personalized needs of patients [16].

3.4 AI Knowledge in Practice

Artificial intelligence is still not widely integrated into medical education. Studies show that approximately 75% of students in medicine, veterinary medicine, and dentistry have not received training involving AI [19]. At the same time, research indicates that students who have used AI during their education often continue or intend to use it in their

future professional practice, with most of them expressing a positive attitude towards AI [20]-[22].

3.5 AI-Enhanced Empathy Toward Patients

Simulation based education, especially in the medical field, significantly improves not only technical skills but also non-technical skills like teamwork and communication [23]-[26]. The focus is also on improving patient relationships by fostering empathy in students during their training phase. Dialogflow is representative of these types of AI systems. There are chatbots specifically designed to enhance communication skills through simulated patient interactions. These systems use an AI interface combined with Natural Language Processing (NLP) to understand and process human -language, enabling students to practice their empathy and communication skills in a realistic, controlled environment [27].

Despite all the benefits, concerns remain in the scientific community that the use of AI may compromise the quality of patient care, undermine the trust between physician and patient, reduce empathy, or diminish the humanistic aspect of medicine [22], [28], [29]. These concerns are not only reflected in research but are also shared by medical students themselves [30]. As previously mentioned, there are also conflicting views regarding the impact of AI on the development of critical thinking skills [5].

However, although these benefits are well recognized, the existing evidence does not clearly demonstrate that such improvements translate into greater empathy or more effective communication with patients. Rather, the gains in non-technical skills may primarily pertain to interactions within clinical teams rather than patient-centered communication [31]-[33].

4 USER SURVEY VIA GOOGLE FORMS

A survey was conducted among medical students and faculty members with the aim of exploring their attitudes toward the development of emotional connection and empathy in the patient-caregiver relationship. The objective was to investigate perceptions regarding the role of emotional competence in clinical practice, particularly in the context of medical training and education.

A total of 68 participants took part in the survey during the period April–May 2025. Although the sample size is relatively small, this can be attributed to the still limited integration of artificial intelligence technologies in medical education in Bulgaria, which may have influenced both awareness and interest in the topic. In addition, demographic data were not collected, as the primary aim of the study was to explore general attitudes and perceptions, rather than perform subgroup analysis. The survey was distributed via student groups on social media and among students and faculty from a university offering programs in human medicine, veterinary medicine, and related health sciences.

4.1 Participants

A total of 68 participants took part in the survey. Of these, 50% (n = 34) were medical students, 5.9% (n = 4) were medical educators, 11.8% (n = 8) were healthcare professionals who are not students or educators in medical schools but work within the healthcare sector, 27.9% (n = 19) were other medical professionals, such as doctors and nurses, and 4.5% (n = 3) were individuals not related to the medical field. The detailed distribution is present in Table 1.

The study divided participants into two groups based on whether they answered AI helped them better understand patients' needs. Given the aim of the study - to evaluate the impact of artificial intelligence on understanding patients in a medical context - only participants with a relevant academic or professional background in medicine were included in the analysis (only medical students and educators). These were medical students and educators, as their perspectives are directly related to clinical practice and medical education. Including other participants would have diluted the results and shifted the focus away from the specific medical context.

For the purposes of the quantitative analysis, only respondents who provided a clear and definitive answer ('Yes' or 'No') to the question of whether AI helped them better understand patients were included. Responses such as 'Not sure' or 'Other' were excluded, as they do not allow for clear interpretation or direct comparison in the context of binary analysis. This approach ensures greater clarity and statistical validity of the results.

4.2 Analysis

The paper Group YES included 16 participants who answered "Yes," and Group NO included 11 participants who answered "No." The groups were

compared across several questions to examine the role of AI in emotional connection, emotional preparation, and empathy development. The comparative results are summarized in Figure 1.

Table 1. Overall survey results.

Questions				
Do you think using artificial intelligence (AI) in your education has improved your ability to understand patients' needs?	Yes 44.1% (30)	No 23.5% (16)	Not sure 29.4% (20)	Other 3% (2)
How often do you interact with real patients compared to digital simulations during your training?	More than 80% of the time 36.8% (25)	21–40% of the time 27.9% (19)	Less than 20% of the time 29.4% (20)	Other 4.5% (3)
Do you feel that AI tools in your education help you prepare for an emotional response to patients?	Yes 19.1% (13)	No 45.6% (31)	Not sure 32.4% (22)	Other 3% (2)
Have you ever felt overly dependent on AI in your education or work?	Yes 19.1% (13)	No 79.4% (54)	Sometimes 1.5% (1)	- - -
How would you rate your ability to emotionally connect with patients before and after the introduction of AI in your training?	AI did not help me better understand the emotional state of patients 58.8% (40)	AI helped me better understand the emotional state of patients 13.2% (9)	Not sure 23.5% (16)	Other 4.5% (3)
Do you believe that remote learning in medical education is as effective as traditional face-to-face methods?	Yes 17.6% (12)	No 69.1% (47)	Not sure 11.8% (8)	Heavily dependent on goals of education/ student learning 1.5% (1)
Have you experienced a lack of motivation or connection to the learning process during digital training?	Yes 60.3% (41)	No 22.1% (15)	Not sure 16.2% (11)	NA 1.5% (1)
In your opinion, can fully digitalized education effectively prepare future doctors?	Yes 10.3% (7)	No 77.9% (53)	Not sure 11.8% (8)	- - -
Do you believe that technology in medical education should always be balanced with real human interaction?	Yes 91.2% (62)	No 7.4% (5)	Heavily dependent on goals of education/student learning 11.5% (1)	- - -

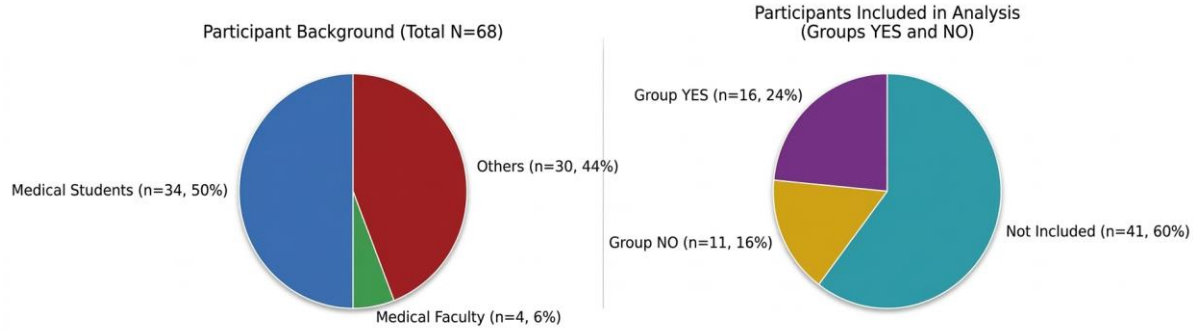

Figure 1: Analyzed groups.

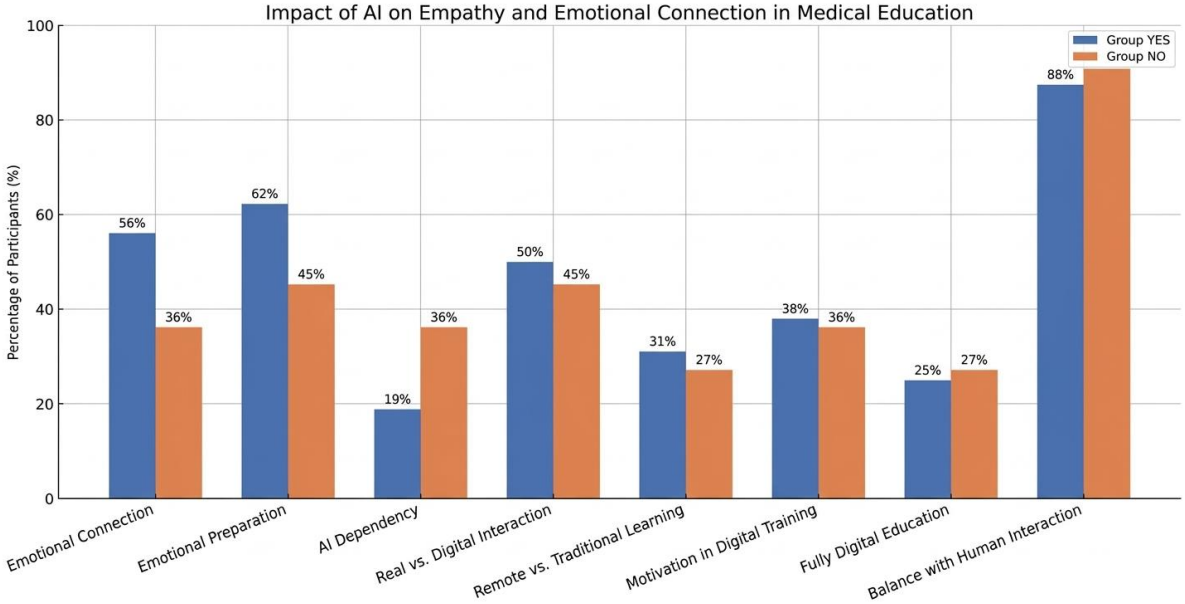

Figure 2: Perceived impact of AI on empathy development in medical education.

Regarding the question of whether AI helps emotionally connect with patients, the Chi-square statistic was 3.365 with a p-value of 0.131, indicating no significant difference between the groups. This suggests that AI did not significantly enhance emotional connection with patients, supporting the thesis that AI does not contribute to empathy development.

On whether AI tools help prepare for emotional responses to patients, the Chi-square statistic was 5.23 with a p-value of 0.157, again showing no significant difference. This indicates that AI does not play a major role in emotional preparation, further suggesting its limited impact on empathy. When asked about dependency on AI, Group YES had 3 participants reporting dependence, while Group NO had 4. The Chi-square statistic was 1.70 with a p-value of 0.192, meaning there was no significant difference between the groups, indicating that AI does not foster reliance that could replace emotional intelligence.

In terms of real patient interaction versus digital simulations, the Chi-square statistic was 4.22 with a p-value of 0.241, showing no significant difference. This suggests that AI does not influence the frequency of real patient interaction, meaning it does not enhance empathetic connections.

Regarding the effectiveness of remote learning compared to traditional face-to-face methods, the Chi-square statistic was 4.52 with a p-value of 0.212. Both groups preferred traditional methods, and the lack of impact on empathy suggests that AI-driven remote learning does not enhance emotional connection with patients.

On motivation during digital training, the Chi-square statistic was 1.89 with a p-value of 0.389,

showing no significant difference between the groups. This implies that AI did not improve motivation or engagement, further supporting the idea that AI lacks an emotional connection-building role.

When asked if fully digital education could prepare future doctors, the Chi-square statistic was 0.85 with a p-value of 0.356, indicating no significant difference. Both groups believed fully digital education was insufficient, suggesting that AI cannot replace the human interaction necessary for empathy development.

Finally, on whether technology should always be balanced with human interaction, the Chi-square statistic was 1.83 with a p-value of 0.400. Both groups overwhelmingly agreed that human interaction is essential, reinforcing the idea that AI does not replace the need for human empathy in medical training. These findings are presented in Figure 2.

5 CONCLUSIONS

In conclusion, The Chi-square tests for all questions showed no statistically significant differences between the two groups (p-values greater than 0.05 in all cases). While these results align with the hypothesis that AI may not have a significant impact on improving empathy or emotional connection with patients, it is important to note that the sample size was relatively small. Therefore, there is insufficient evidence to definitively support this thesis. Further research and larger studies are needed, as existing studies on AI's effect on empathy towards patients are limited or lacking.

Moreover, the findings suggest that while AI-driven tools can enhance technical knowledge and procedural skills, they may not adequately address the humanistic aspects of medical training. The ability to understand patients' emotions, communicate effectively, and build trust remains largely dependent on real-world interactions and mentorship from experienced practitioners. This highlights the need for medical curricula to balance technological innovation with opportunities for direct patient engagement and reflective practice.

Additionally, the study underscores the importance of evaluating the long-term implications of AI integration in medical education. While students may demonstrate improved efficiency in diagnosis or procedural simulations, it is still unclear how these skills translate to bedside competence, particularly in emotionally challenging scenarios. AI should therefore be viewed as a complementary tool rather than a replacement for traditional educational methods that foster empathy and ethical decision-making.

Furthermore, the survey responses indicate a general consensus among participants that human interaction cannot be fully substituted by digital simulations or AI-based training. This reinforces the necessity for hybrid educational models where AI technologies are integrated alongside patient-centered teaching methods. Such approaches could ensure that future healthcare professionals are not only technically proficient but also capable of providing compassionate and personalized care.

Finally, these results highlight critical areas for future research, including the development of AI applications that better simulate emotional and interpersonal dimensions of medical practice, as well as longitudinal studies to track the impact of AI exposure on professional behavior and patient outcomes. By addressing these gaps, educators and researchers can better harness the potential of AI while preserving the essential human qualities that define effective healthcare provision.

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