The Role of AI in Transforming Medical Education

lecturio

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Introduction

The advent of Artificial Intelligence (AI) represents a significant and promising development for medical education. The integration of AI offers a compelling solution to a perennial challenge in medical education – how to provide students with tailored and efficient learning experiences, ensuring that they not only acquire knowledge but also develop a deep understanding of complex medical concepts. AI promises to revolutionize these traditional methods.

The use of AI tools in medical education has gained traction due to its potential to enhance personalized learning experiences, improve learning outcomes, and bridge the gap between theory and practice. Developments in AI technology have encouraged some educators to devise new techniques that incorporate the fascinating capabilities of AI-powered platforms. Chatbots like ChatGPT can play a helpful role in aspects of instruction such as automated scoring, curriculum development, teaching assistance, and personalized learning[1].

The discourse around AI in medical and nursing education is developing everyday. The use of AI in medical education has the potential to facilitate complex tasks and improve efficiency. For example, AI is being explored to help automate the assessment of written responses and provide feedback on medical image interpretations[2].

This whitepaper explores the burgeoning paradigm shift in medical education due to AI. It looks at notable initiatives and applications that have emerged, illustrating how AI is altering the educational landscape. It also discusses the associated challenges, ranging from issues of trust and ethical concerns to the imperative for adequate training in this new educational environment.

The paper also explores two pioneering AI-driven features introduced by Lecturio: the AI Tutor and the AI Question Writer. In doing so, this paper contributes to the ongoing discourse on how AI stands to redefine the educational journey for medical students, equipping them with the knowledge and skills they need to become proficient and empathetic healthcare practitioners.

AI in Medical Education

A historical perspective

The use of AI in medical education is a relatively new but rapidly growing field. AI has the potential to revolutionize the way medical professionals are trained and educated by providing personalized learning experiences, enhancing diagnostic capabilities, and facilitating easier curriculum creation and implementation.

Early Exploration of AI in Medical Education (1970s-1990s)

The early exploration of AI in medical education began in the 1970s with the development of intelligent tutoring systems (ITS). These systems were designed to provide individualized instruction to medical students, adapting to their specific learning needs and providing feedback on their progress. An ITS works by incorporating three types of knowledge: domain knowledge, pedagogical knowledge, and knowledge about learners[3,4].

ITS were initially limited by the computational power of the time, but as technology advanced, so did their capabilities. In the 1980s and 1990s, researchers began to develop more sophisticated ITS that could incorporate natural language processing, expert systems, and machine learning techniques. These systems were able to provide more personalized and effective instruction, and they began to be used in a wider range of medical education settings.

Emergence of AI in Medical Education (2000s-present)

The 21st century has seen an explosion of AI research and development, and this has led to a surge of new AI applications in medical education. AI is now being used to develop a wide range of tools and technologies for medical education, including:

- **Personalized learning:** AI can be used to create personalized learning experiences for medical students, by adapting to their individual learning styles, knowledge gaps, and pace of learning[6].
- **Adaptive assessments:** AI can be used to develop adaptive assessments that can provide more accurate and personalized feedback to medical students[7].
- **Virtual reality (VR) and augmented reality (AR):** VR and AR can be used to create immersive and realistic learning experiences for medical students, allowing them to practice procedures and learn about anatomy and physiology in a more hands-on way[8].
- **Natural language processing (NLP):** NLP can be used to develop chatbots, like ChatGPT and other virtual assistants that can provide medical students with information and support.
- **Machine learning (ML):** ML can be used to analyze large amounts of data to identify patterns and trends that can be used to improve medical education.

Implications of recent AI advances on medical education

Today, AI is rapidly evolving and becoming increasingly sophisticated. Chatbots like ChatGPT are at the forefront of this advancement. These Large Language Model (LLM) chatbots stand out for their remarkable content generation capabilities. They can generate natural-sounding human language for various tasks, including language translation, text summarization, dialogue systems, chatbots, question answering, creative writing, and more. An LLM's ability to process sequential data like natural language allows it to grasp context and generate coherent text.

The implications of apps like ChatGPT on medical education are many[1]:

1. **Automated evaluation:** The assessment of student papers and essays is streamlined through ChatGPT, offering an effective means of evaluation for educators, thereby alleviating their workload[9,10].

2. **Educational support:** ChatGPT serves as a valuable resource for generating exercises, quizzes, and practice scenarios for both instructional and evaluative purposes[11,12]. Additionally, it excels in producing translations, explanations, and summaries, contributing to the simplification of complex educational material.

3. **Tailored learning experiences:** Leveraging its capabilities, ChatGPT can construct virtual tutors, responding to inquiries, offering feedback, and customizing study plans to align with individual learning preferences.

4. **Support in academic research:** ChatGPT extends assistance in answering research queries, producing text summaries, generating bibliographies, outlines, and research aids, as well as contributing to literature reviews and data analysis[13]. Furthermore, it proves valuable in summarizing pertinent articles and identifying key findings.

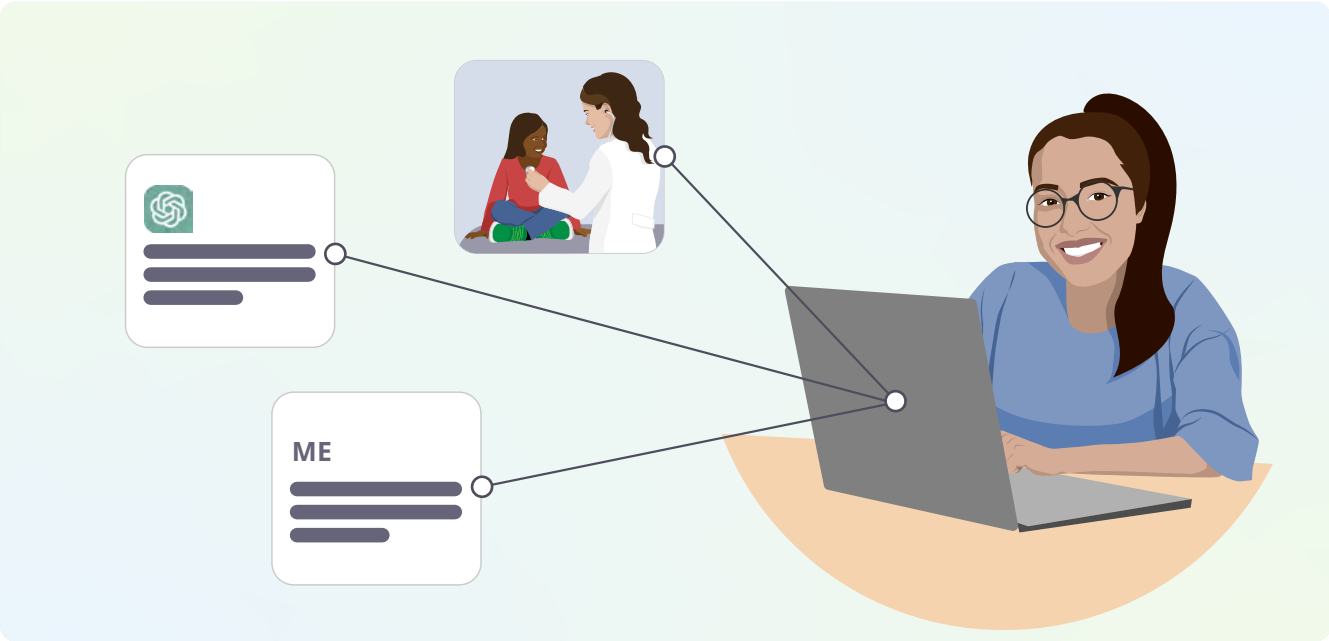
5. **Rapid information retrieval:** ChatGPT emerges as a reliable source for furnishing accurate and current information on medical subjects, encompassing diseases, treatments, and procedures[14].

6. **Scenario generation:** ChatGPT showcases its proficiency in crafting case studies and scenarios, providing medical students with opportunities to enhance their diagnostic and treatment planning skills[15].

7. **Content creation for educational materials:** ChatGPT excels in the generation of concise summaries, quizzes, and flashcards, facilitating the learning process.

8. **Multilingual capabilities:** With its language translation capabilities, ChatGPT aids medical professionals and educators in effective communication with patients from diverse linguistic backgrounds.

In a recent review of 39 studies on the use of AI in medical education, the use of AI emerged in teaching implementation (24 studies), teaching evaluation (10 studies), and teaching feedback (5 studies)[16].



Teaching implementation included the use of AI and virtual reality for anatomy education[17,18], chatbots for anatomy questions and feedback, deep learning systems for supporting learners in recognizing fractures on radiographs[19], analyzing learner's eye movements and providing feedback to improve ECG interpretation[20], as well as intelligent evaluation and feedback of psychomotor skills in surgery[21], among many others.

Teaching evaluation included algorithms that can categorize learners into proficiency levels[22], predicting student performance[23] and automated scoring[24].

Teaching feedback included assessment of quality of feedback provided by teachers[25] to students as well as feedback given by students on their courses[26], which can save faculty time in effort for analysis of regular feedback.

Lastly, the implications on medical practice cannot be understated[27]. This inevitably has further implications on how students learn, how educators teach, and how healthcare professionals practice and develop as practitioners.

Challenges

Implementing AI in medical education comes with its set of challenges, reflecting the nuanced nature of integrating technology into a field as critical as healthcare training. Some notable challenges that emerged in the 2023 review[16] include:

Technical immaturity and limitations

- Current prototypes and systems were found to be immature, with technical limitations necessitating further improvements in system performance to enhance user-friendliness
- Specific technical enhancements, such as real-time automated feedback and arrow markers, were identified as areas requiring improvement

Effectiveness and evaluation challenges

- Some studies raised concerns about the effectiveness of AI applications in medical education, with two studies noting that some applications had not been tested in medical students, making it challenging to prove their effectiveness in actual medical education
- Others emphasized the need for different evaluation strategies, sufficient sample sizes, and larger-scale testing to demonstrate effectiveness and ensure reproducibility
- Difficulties in verification due to a lack of test sets and prior knowledge were identified as additional challenges

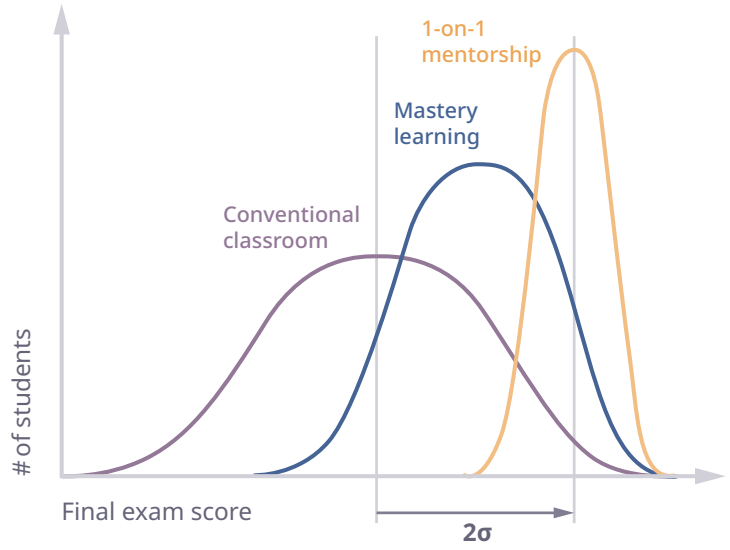
AI algorithm training challenges

- Issues related to the samples used to train AI algorithms were highlighted in three studies, with one study pointing to the small sample size used for training AI models
- Quality issues with input data that can impact the training and accuracy of AI models were identified as a challenge
- Data privacy and protection concerns were raised, emphasizing the legal issues that may arise if real patient data and sensitive information are not handled properly

AI algorithm interpretability and generalization

- The black box nature of deep learning algorithms was identified as a challenge in two studies, limiting the interpretability of results
- Concerns were raised about the generalization ability of AI algorithms, emphasizing the need for testing in new populations to ensure that the algorithms do not overfit

AI Integration in Lecturio



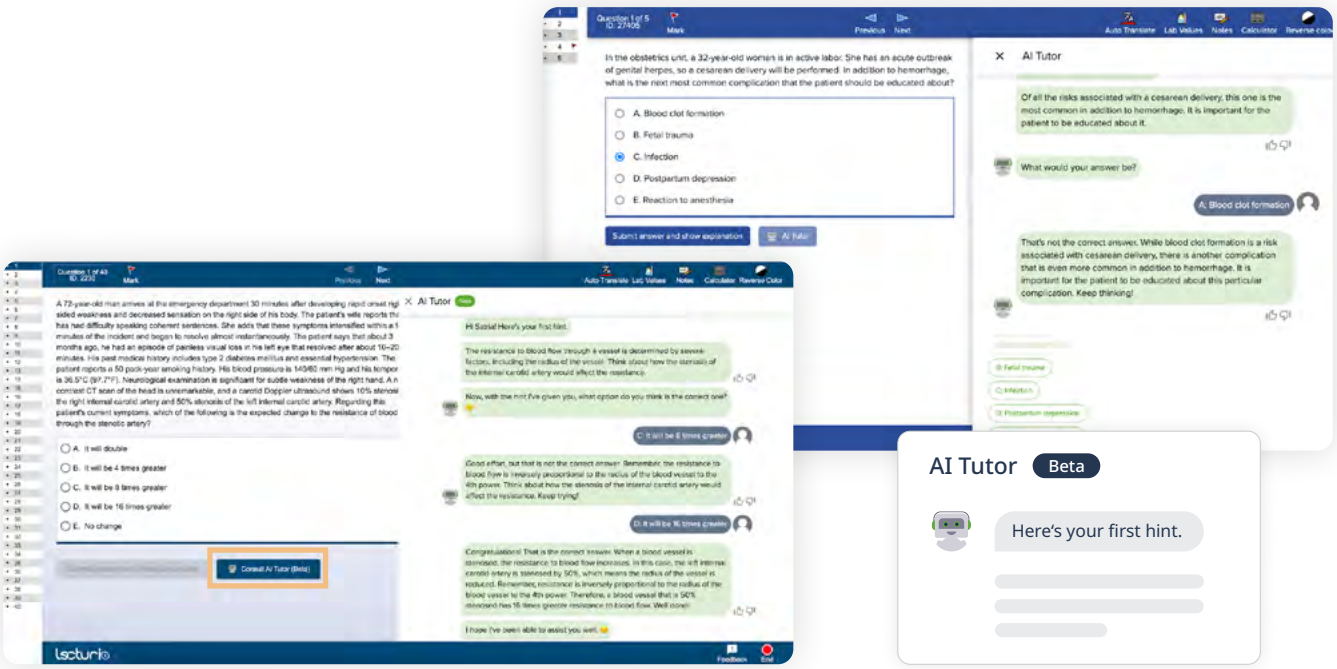
The AI Tutor

According to Bloom's 2 Sigma Problem, the average student tutored one-to-one using mastery learning techniques performs two standard deviations better than students educated in a classroom environment(28). Bloom identified the mastery learning techniques required as part of this one-to-one tutoring strategy as formative assessment, feedback, and corrective instruction.

Despite the huge gains shown for students using this strategy, institutions still struggle with faculty shortages for group learning, much less one-to-one instruction.

Lecturio's AI Tutor provides the opportunity for each student to receive one-to-one tutoring using the mastery learning techniques of formative assessment, feedback, and corrective instruction, as Bloom suggested, in order to increase student performance. Students engage with case-based questions with the AI Tutor enabled (formative assessment). When a learner makes an error, the tutor points out the error (feedback), and then follows up with further explanation and clarification (corrective) to ensure the student's understanding.

Lecturio provides adaptive review flows, personalized progression and AI Tutoring, enabling a scalable 1-on-1 mentorship model. Students receive personalized direction and correction for their answers, along with a tailored list of remediation resources. This one-to-one mentorship is proven to affect exam scores of the students who use Lecturio's different smart learning tools.



The **AI Tutor** can be activated for any Qbank test. Students submit their chosen answer to the AI engine to receive the guidance they need as they attempt to find the correct answer.

The AI language model reads the Qbank question contents (question, answers, explanation, etc.) and responds to the learner's answer choices as a friendly expert educator.

The AI Tutor, embedded within Lecturio's interactive Qbank, transforms the way students engage with clinical case studies as virtual companion who accompanies learners throughout their educational journey. Our AI Tutor is engineered to cultivate critical thinking and problem-solving skills. By guiding students to think analytically and arrive at the correct answers independently, educators can nurture a deeper understanding and retention of knowledge.

Furthermore, the AI Tutor offers insightful analytics, allowing educators to fine-tune teaching strategies based on real-time data in order to identify gaps in understanding and adjust instruction to meet the evolving needs of students.

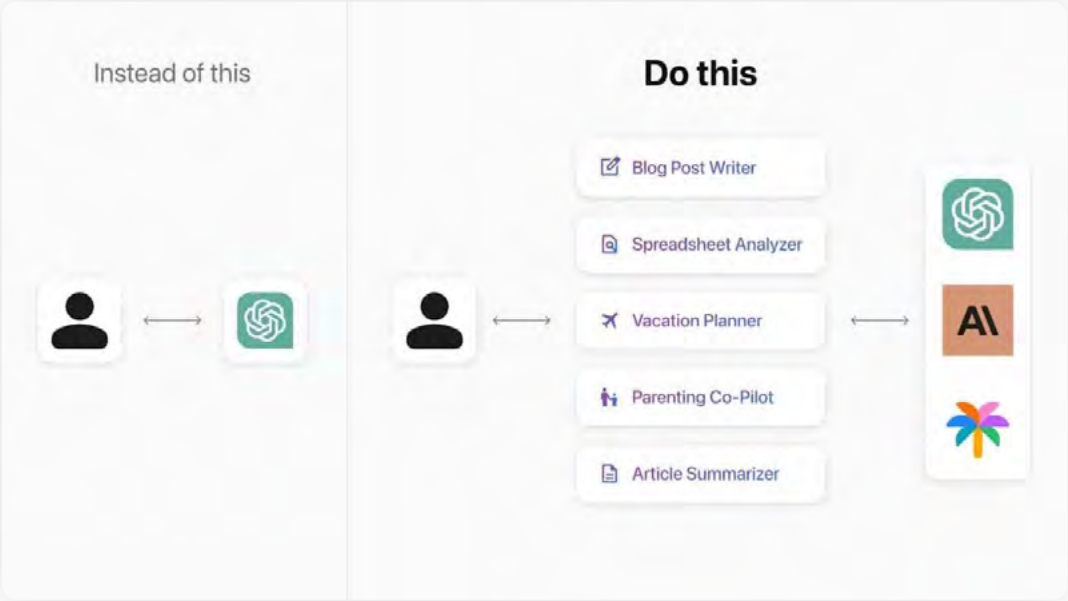
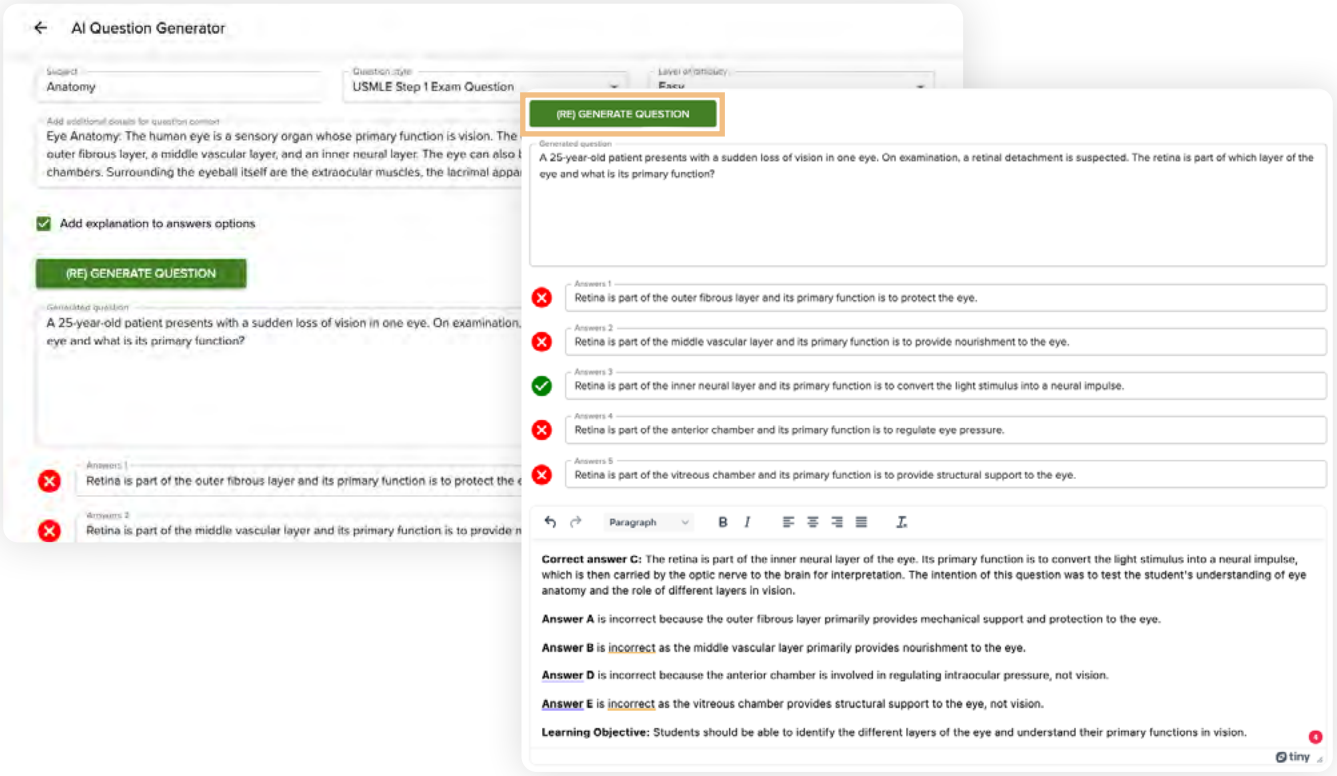


Image from YouAI

AI question writer application layer

In the foreseeable future, the evolution of application layers is expected to significantly shape the user experience with language models like ChatGPT. The new GPTs are expected to function in this way, despite their limitations on data storage, privacy, and only being used within the ChatGPT environment. For other software environments, AI can be incorporated more smoothly behind the scenes. Rather than directly interacting with standalone models, users are likely to interface with these AI models through sophisticated application layers. These application layers will serve as an intermediary, providing a seamless and tailored interaction experience. Developers are expected to design these layers with a user-centric approach, integrating LLMs into various applications to enhance functionality across diverse domains.

These applications could span customer service chatbots, educational tools, content creation platforms, and more. By embedding LLMs within specific applications, users can benefit from contextualized interactions, specialized functionalities, and a more intuitive experience. The development of such application layers is anticipated to not only simplify user engagement but also to unlock the full potential of LLMs across a spectrum of practical and user-specific scenarios.



Lecturio's AI Question Writer

Lecturio's new AI Question Writer introduces a paradigm shift in educational technology by empowering educators to effortlessly craft high-quality assessment questions. This application layer harnesses the capabilities of artificial intelligence to generate intricate questions based on user-input criteria, including the desired difficulty level. The AI Question Writer not only formulates multiple-choice options and a correct answer but goes a step further by providing comprehensive explanations for each choice. This feature enriches the learning experience, offering students valuable insights into the reasoning behind each option. Additionally, the AI Question Writer aligns questions with specific learning objectives, ensuring that assessments are not merely evaluative but also contribute to targeted educational outcomes.

A study looking at technology uptake in higher education pinpointed five critical factors influencing adoption: staff release time, ease of Learning Management System (LMS) use, LMS utility, training and support for online content development, and technology reliability[29]. The AI Question Generator addresses these factors by assisting educators in creating online content, thereby mitigating the demand for staff release time. This tool streamlines the content development process, aligning with the identified factors crucial for effective integration of technology in higher education settings.

Conclusion

This paper has explored the potential impact of AI on the transformation of medical education, underscoring its role in personalized learning, assessment enhancement, and the scalable evolution of educational methodologies. As we navigate the challenges that arise, new avenues emerge, propelling medical education into a future where AI-driven tools revolutionize the learning landscape.

Lecturio's commitment to innovation shines through in the introduction of new AI features, such as the AI Tutor and AI Question Writer. These tools not only address challenges but serve as examples of how AI can be harnessed to elevate the educational experience. Embracing the opportunities presented by AI in medical education is not just a necessity but a commitment to shaping a future where medical professionals are equipped with the knowledge and skills necessary for the evolving healthcare landscape.

References

1. Khan RA, Jawaid M, Khan AR, Sajjad M. ChatGPT - Reshaping medical education and clinical management. Pak J Med Sci. 2023;39(2):605–7.

2. Tolsgaard MG, Pusic MV, Sebok-Syer SS, Gin B, Svendsen MB, Syer MD, et al. The fundamentals of Artificial Intelligence in medical education research: AMEE Guide No. 156. Med Teach. 2023 Jun 3;45(6):565–73.

3. Capuano N, Santo MD, Marsella M, Molinara M, Salerno S. A multi-agent architecture for intelligent tutoring. In 2000 [cited 2023 Nov 25]. Available from: https://www.semanticscholar.org/paper/A-multi-agent-architecture-for-intelligent-tutoring-Capuano-Santo/ce50bd86a1620fc3d8ebb44daf363187904932e8

4. Frasson C, Mengelle T, Aïmeur E. Using Pedagogical Agents In a Multi-strategic Intelligent Tutoring System. In 2008 [cited 2023 Nov 25]. Available from: https://www.semanticscholar.org/paper/Using-Pedagogical-Agents-In-a-Multi-strategic-Frasson-Mengelle/c00fb37e1c456756fbeb34407cb7d8d95ef03469

5. Anohina-Naumeca A. The Problem-Solving Modes and a Two-Layer Model of Hints in the Intelligent Tutoring System for Minimax Algorithm. 2006 Jan 1;

6. Varma JR, Fernando S, Ting BY, Aamir S, Sivaprakasam R. The Global Use of Artificial Intelligence in the Undergraduate Medical Curriculum: A Systematic Review. Cureus. 2023 May;15(5):e39701.

7. Hu X, Shubeck K, Sabatini J. Artificial Intelligence-enabled adaptive assessments with Intelligent Tutors [Internet]. Paris: OECD; 2023 Apr [cited 2023 Nov 25]. Available from: https://www.oecd-ilibrary.org/education/innovating-assessments-to-measure-and-support-complex-skills_22731ca8-en

8. Dhar P, Rocks T, Samarasinghe RM, Stephenson G, Smith C. Augmented reality in medical education: students' experiences and learning outcomes. Med Educ Online. 2021 Dec;26(1):1953953.

9. Gilson A, Safranek CW, Huang T, Socrates V, Chi L, Taylor RA, et al. How Does ChatGPT Perform on the United States Medical Licensing Examination? The Implications of Large Language Models for Medical Education and Knowledge Assessment. JMIR Med Educ. 2023 Feb 8;9:e45312.

10. Kung TH, Cheatham M, Medenilla A, Sillos C, De Leon L, Elepaño C, et al. Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. PLOS Digit Health. 2023 Feb 9;2(2):e0000198.

11. Why ChatGPT is such a big deal for education [Internet]. [cited 2023 Nov 25]. Available from: https://scalar.usc.edu/works/c2c-digital-magazine-fall-2022---winter-2023/why-chatgpt-is-bigdeal-education

12. Gao CA, Howard FM, Markov NS, Dyer EC, Ramesh S, Luo Y, et al. Comparing scientific abstracts generated by ChatGPT to real abstracts with detectors and blinded human reviewers. NPJ Digit Med. 2023 Apr 26;6(1):75.

13. Huang J, Tan M. The role of ChatGPT in scientific communication: writing better scientific review articles. Am J Cancer Res. 2023 Apr 15;13(4):1148–54.

14. Jeblick K, Schachtner B, Dexl J, Mittermeier A, Stüber AT, Topalis J, et al. ChatGPT Makes Medicine Easy to Swallow: An Exploratory Case Study on Simplified Radiology Reports [Internet]. arXiv; 2022 [cited 2023 Nov 25]. Available from: http://arxiv.org/abs/2212.14882

15. Buholayka M, Zouabi R, Tadinada A. The Readiness of ChatGPT to Write Scientific Case Reports Independently: A Comparative Evaluation Between Human and Artificial Intelligence. Cureus. 15(5):e39386.

16. Zhang W, Cai M, Lee HJ, Evans R, Zhu C, Ming C. AI in Medical Education: Global situation, effects and challenges. Educ Inf Technol [Internet]. 2023 Jul 10 [cited 2023 Nov 25]; Available from: https://doi.org/10.1007/s10639-023-12009-8

17. Karambakhsh A, Kamel A, Sheng B, Li P, Yang P, Feng DD. Deep gesture interaction for augmented anatomy learning. Int J Inf Manag. 2019 Apr;45:328–36.

18. Li YS, Lam CSN, See C. Using a Machine Learning Architecture to Create an AI-Powered Chatbot for Anatomy Education. Med Sci Educ. 2021 Dec;31(6):1729–30.

19. Cheng CT, Chen CC, Fu CY, Chaou CH, Wu YT, Hsu CP, et al. Artificial intelligence-based education assists medical students' interpretation of hip fracture. Insights Imaging. 2020 Nov 23;11(1):119.

20. Sqalli MT, Al-Thani D, Elshazly MB, Al-Hijji M. A Blueprint for an AI & AR-Based Eye Tracking System to Train Cardiology Professionals Better Interpret Electrocardiograms. In: Baghaei N, Vassileva J, Ali R, Oyibo K, editors. Persuasive Technology. Cham: Springer International Publishing; 2022. p. 221–9. (Lecture Notes in Computer Science).

21. Yilmaz R, Winkler-Schwartz A, Mirchi N, Reich A, Christie S, Tran DH, et al. Continuous monitoring of surgical bimanual expertise using deep neural networks in virtual reality simulation. Npj Digit Med. 2022 Apr 26;5(1):1–9.

22. Alonso-Silverio GA, Pérez-Escamirosa F, Bruno-Sanchez R, Ortiz-Simon JL, Muñoz-Guerrero R, Minor-Martinez A, et al. Development of a Laparoscopic Box Trainer Based on Open Source Hardware and Artificial Intelligence for Objective Assessment of Surgical Psychomotor Skills. Surg Innov. 2018 Aug;25(4):380–8.

23. Baloul MS, Yeh VJH, Mukhtar F, Ramachandran D, Traynor MD, Shaikh N, et al. Video Commentary & Machine Learning: Tell Me What You See, I Tell You Who You Are. J Surg Educ. 2022 Nov 1;79(6):e263–72.

24. Lam A, Lam L, Blacketer C, Parnis R, Franke K, Wagner M, et al. Professionalism and clinical short answer question marking with machine learning. Intern Med J. 2022 Jul;52(7):1268–71.

25. Neves SE, Chen MJ, Ku CM, Karan S, DiLorenzo AN, Schell RM, et al. Using Machine Learning to Evaluate Attending Feedback on Resident Performance. Anesth Analg. 2021 Feb;132(2):545.

26. Borakati A. Evaluation of an international medical E-learning course with natural language processing and machine learning. BMC Med Educ. 2021 Mar 25;21(1):181.

27. Ye Y, Sarkar S, Bhaskar A, Tomlinson B, Monteiro O. Using ChatGPT in a clinical setting: A case report. MedComm – Future Med. 2023;2(2):e51.

28. Bloom BS. The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. Educ Res. 1984 Jun;13(6):4–16.

29. Nanayakkara C. A Model of User Acceptance of Learning Management Systems. Int J Learn Annu Rev. 2007;12(12):223–32.

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