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Artificial Intelligence in Clinical Education: Balancing Humanism and Technology in Ethical Frameworks – A Commentary

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Introduction

Medical education stands at the intersection of tradition and innovation. The explosion of the growth of medical knowledge, the increasing sophistication of health systems, and the advent of a new generation of digital learners who demand instant access, tailored content, and interactive engagement have imposed an unprecedented level of pressure on traditional educational systems [1]. The inherent limitations of patient-based education, including inequity in learning opportunities, ethical concerns, and issues of patient safety, have also highlighted the need for a paradigmatic shift in clinical education pedagogy [2].

To address this paradigmatic shift, this discussion is conducted based on theoretical models of technology-enriched instructional design. In this context, the SAMR model is used as a framework for assessing the level of technology integration in the learning process. The model has four levels: substitution, augmentation, modification, and redefinition, each of which demonstrates the transformative potential of technology in the learning environment [5].

Additionally, the TPCK model, based on the synthesis of three facets: technology knowledge, pedagogy knowledge, and content knowledge, is employed to study the successful integration of these factors in clinical education [6]. The model enables the identification of the most effective combination for achieving effective and sustainable learning.

The collaborative use of these two models provides a theoretical and practical platform to gain insights into how AI can be integrated into medical education, as well as the groundwork on which cutting-edge and evidence-based educational programs can be built.

Artificial intelligence and its spawn, machine learning (ML) and natural language processing (NLP), have been born not as replacement teachers but as cognitive augmentators and facilitators. AI is able to review vast amounts of educational and clinical data to learn patterns of education, identify gaps in knowledge, and adapt education interventions in real time [3, 7, 8]. This ability is in the vanguard of the movement toward competency-based medical education (CBME), where progression is gauged by the attainment of competence [4].

Educational Strategies Enabled by AI

AI facilitates the scalable and cost-effective application of evidence-based educational strategies. These include:

1. Intelligent Simulation-Based Learning

Deep neural networks applied to build virtual patients that exhibit nonlinear and dynamic physiological responses facilitate practice in diagnosis, differential diagnoses, and clinical interventions within complicated decision-making procedures [7].

2. AI-Assisted Problem-Based Learning

The use of AI to generate sophisticated, high-dimensional clinical vignettes and analyze students' written rationales to provide personalized and scaffolded feedback [8].

3. Personalized Flipped Classroom

Application of AI to provide educational content (videos, scientific papers) that is customized to fill every student's knowledge gaps [9]. It not only accelerates access to content but also offers materials of different types to aid extensive scientific study and enables comparison of papers, making it possible to critically analyze scientific sources.

Clinical Setting Execution Techniques

1. Real-Time Feedback during Clinical Interviews

Use of AI for the observation of patient interviews and proper recall of clinical histories against necessary specifications [10]. It is crucial for highlighting essential specifications and standards, allowing the required competencies of general practitioners to be trained.

2. Diagnostic Competition "Human vs. AI."

AI facilitates the simultaneous display of a paraclinical examination or radiological image to the student and the AI diagnosis program, and requests for denial, affirmations, or comparison of outputs with logical reasoning [11]. The display of several radiographic images, CT scans, and MRIs for different subject matters is also an appreciated function of this method.

3. Prognostic Simulation and Treatment Planning

Aligning the treatment plan and prognosis offered by the student with the output of the AI predictive model trained using extensive data sets [12]. This makes the decision-making skill functional in uncertain environments.

4. Scientific Resource Recommendations in Journal Clubs

Using AI to recommend article title suggestions in evidence-based journal clubs and analyzing articles' methodology through education, as well as critiquing them during discussion sessions, creates an analytical discussion space.

5. Generating Complex Clinical Scenarios

AI generates complex clinical scenarios from cases involving diagnostic and treatment challenges, applicable in clinics, teaching rounds, and scientific conferences to elevate discussions.

6. Test Analysis and Question Design

The application of AI for test analysis and planning diverse clinical reasoning, problem-based, and conventional analysis questions, and academic and scoring levels in written, OSCE, and practical exams is another significant application of the technology within clinical settings.

Challenges

The findings categorically demonstrate that AI is transforming the clinical training environment. However, its adoption is not trouble-free:

1. Algorithmic Bias

AI models that operate on historical data can embed hidden systemic bias in healthcare [13]. Information literacy is crucial for acquiring the skills needed to effectively use AI. 100% accuracy in analysis is also unchecked.

2. Transparency and Accountability

The "black box" nature of some high-technology algorithms is difficult to believe within the medical field. Development and use should always ensure that there is no disconnect between commitment and responsibility.

3. Teaching Human Touch in Instructional Design

To preserve human instructor-student interactions, instructional designs must explicitly teach and assess communication, empathy, and

professional identity in technology-rich environments, positioning AI as an aid for deeper analysis rather than a substitute.

Future Outlook

Foresight models anticipate the development in the cognitive capacity of physicians to provide more compassionate, precise, and evidence-based interventions. Medicine is envisioned to be evolving toward a new paradigm of practice that combines AI literacy, enhanced analytical and critical thinking, and efforts to bridge the functional deficits and lacunae of AI in science.

Conclusion

This commentary explores the transformative impact of artificial intelligence (AI) on clinical education, focusing on strategies, methods, and techniques while addressing ethical challenges. Drawing on theoretical models like SAMR and TPCK, it analyzes AI's role in enhancing competency-based medical education through simulation, personalized learning, and real-time feedback. Key findings highlight risks such as reduced physician confidence, algorithmic bias, and diminished empathy, advocating for novel ethical, educational, and organizational frameworks to balance technology with human values like empathy, accountability, and autonomy. Recommendations emphasize AI as an augmenter, not a replacement, to foster compassionate, evidence-based practice.

AI acts as a partner in enhancing competency-based medical education. It complements evidence-based learning design and introduces new methods for teaching critical thinking, decision-making under uncertainty, and collaborative practice. The success of this integration relies on addressing ethical challenges and establishing clear frameworks for responsibility and accountability in health services quality improvement.

The preparation of human resources (teachers and learners) for the future of human-machine collaboration is highly essential. Augmenting the human factor with AI as a catalyzing agent is the future of clinical education, and not a replacement. Using teaching strategies, approaches, and tools can improve the quality of clinical services.

References

1. Wartman SA, Combs CD. Reimagining Medical Education in the Age of AI. JAMA. 2019;322(18):1767-1768.
2. Masters K. Artificial intelligence in medical education Med Teach. 2019;41(9):976-980.
3. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: an integrative review. BMC Med Educ 2019;19:460.
4. Holmboe ES, Sherbino J, Englander R, Snell L, Frank JR. A call to action: The controversy of and rationale for competency-based medical education Med Teach. 2017;39(6):574-581.
5. Puentedura, R. R. A model for technology and transformation. [Blog post]. Retrieved from http://hippasus.com/resources/sweden2010/RP_Sweden2010_Keynote.pdf
6. Koehler, M. J. and Mishra, P. What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 2009;9(1), 60-70.
7. McCoy LG, Nagaraj S, Morgado F, Harish V, Das S, Celi LA. What do medical students actually need to know about artificial intelligence? NPJ Digit Med. 2020;3:86.
8. Kolachalama VB, Garg PS. Machine learning and medical education NPJ Digit Med. 2018;1:54.
9. Chen P, Lu Y, Li W. Effectiveness of the Flipped Classroom in Medical Education: A Systematic Review and Meta-Analysis Med Sci Educ. 2022;32(1):49-60.
10. Devlin J, Chang MW, Lee K, Toutanova K. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. arXiv:1810.04805v2. 2019.
11. Sapci AH, Sapci HA. Artificial Intelligence Education and Tools for Medical and Health Informatics Students: Systematic Review. JMIR Med Educ 2020;6:e19285.
12. Hashimoto DA, Rosman G, Rus D, Meireles OR. Artificial Intelligence in Surgery:

Promises and Perils Ann Surg. 2018;268(1):70-76.
13. Obermeyer Z, Powers B, Vogeli C, Mullainathan S. Dissecting racial bias in an algorithm used to manage the health of populations. Science. 2019;366(6464):447-453.