LETTER TO EDITOR

GMJ.2026;15:e4209
www.salviapub.com

Received 2025-07-29
Revised 2026-04-28
Accepted 2026-06-13

AI-Enabled Smartphone Tools for Anatomy Education in Resource-Limited Settings

Ehsan Jangholi [1, 2], Soheila Salmasi [3], Ashkan Mowla [4], Seyede Roshana Nazari [1, 3], Elham Seifali [3]✉

[1] Brain and Spinal Cord Injury Research Center, Neuroscience Institute, Tehran University of Medical Sciences, Tehran, Iran
[2] Department of Neurosurgery, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran
[3] Department of Anatomical Sciences and Cognitive Neuroscience, TMS.C., Islamic Azad University, Tehran, Iran
[4] Pacific Neuroscience Institute, Santa Monica, CA, USA

Dear Editor,

Anatomy education forms the foundation of clinical reasoning, procedural competence, and safe patient care. However, access to high-quality anatomy education remains uneven worldwide, particularly in low- and middle-income countries (LMICs), where shortages of cadaveric resources, simulation facilities, and experienced faculty continue to limit educational opportunities [1, 2]. In recent years, smartphone-based digital technologies have expanded access to anatomy learning through portable 3-dimensional (3D) visualization, mobile educational platforms, surgical simulation applications, and, more recently, artificial intelligence (AI)-enabled learning systems [3-5]. Although these technologies are frequently discussed together, they differ substantially in their educational functions and should not be regarded as interchangeable.

Mobile 3D anatomy applications primarily facilitate spatial understanding by allowing learners to explore anatomical structures interactively, whereas virtual and augmented reality technologies provide immersive educational experiences. Surgical simulation platforms primarily support procedural rehearsal in postgraduate surgical education and technical-skill acquisition, while AI-enabled educational systems provide adaptive feedback, individualized learning pathways, and automated educational support [4-6]. Distinguishing these technologies is essential to ensure scientific precision and to avoid attributing AI capabilities to educational tools that rely only on digital visualization or simulation.

These technologies may be particularly valuable in resource-limited settings, where anatomy education is constrained by financial limitations, shortages of cadaveric materials, limited simulation facilities, and insufficient faculty resources [1, 2, 7]. Smartphone-based educational tools can improve access to interactive anatomy learning without requiring expensive laboratory infrastructure. Nevertheless, successful implementation depends on adequate digital infrastructure, institutional support, faculty development, and reliable internet connectivity [7, 8]. Consequently, smartphone technologies should complement, rather than replace, conventional anatomy teaching.

The rapid expansion of AI-enabled educational systems also introduces important ethical and governance challenges. Applications incorporating learner analytics may collect information related to educational performance, user interactions, and learning behavior, raising concerns regarding data privacy, ownership, and institutional oversight [9]. Additional challenges include algorithmic bias, transparency of automated feedback, and appropriate governance of cloud-based educational

Copyright© 2026, Galen Medical Journal.
This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/)
Email:gmj@salviapub.com

✉ **Correspondence to:**
Elham Seifali, Department of Anatomical Sciences and Cognitive Neuroscience, TMS.C., Islamic Azad University, Tehran, Iran.
Email Address: e.seifali@iautmu.ac.ir
Telephone Number: 021 7700 9836

data. Where patient-derived imaging or clinical datasets are incorporated into educational platforms, compliance with ethical standards and applicable data-protection regulations becomes essential [9].

Future research should prioritize rigorous comparative studies evaluating conventional teaching, smartphone-assisted anatomy learning, and AI-enabled educational systems using validated assessments of anatomical knowledge, spatial reasoning, simulation performance, long-term knowledge retention, usability, and cost-effectiveness. Evidence generated from LMICs will be particularly valuable in determining whether these technologies can improve educational equity while remaining feasible under local resource constraints [5, 7, 10].

In conclusion, smartphone-based digital technologies are valuable complementary educational tools for anatomy education, particularly in settings with limited educational resources. However, distinguishing AI-enabled systems from other digital educational technologies is essential for scientific accuracy and meaningful educational evaluation. Successful implementation will depend on evidence-based curriculum integration, equitable access, ethical governance, and high-quality educational research [4, 5, 7, 9].

Acknowledgment

The authors thank Ms. Atieh Hosseinkhani for providing technical support for this work.

Conflict of Interest

The authors declare no conflict of interest.

AI Disclosure Statement

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) for language editing and grammar improvement and Liboberry for reference management. After using these tools, the authors thoroughly reviewed, verified, and revised all AI-assisted content to ensure accuracy and originality. The authors take full responsibility for the integrity and final content of the manuscript.

[GMJ.2026;15:e4209]
DOI:10.31661/gmj.v15i0.4209

Keywords: Artificial Intelligence; Anatomy Education; Smartphone Learning; Medical Students; Resource-Limited Settings

References

1. Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. Ann Anat. 2016;208:151-7.
2. Singal A, Bansal A, Chaudhary P. Cadaverless anatomy: darkness in the times of pandemic Covid-19. Morphologie. 2020;104(346):147-50.
3. Winkler-Schwartz A, Yilmaz R, Mirchi N, Bissonnette V, Ledwos N, Siyar S, et al. Machine learning identification of surgical and operative factors associated with surgical expertise in virtual reality simulation. JAMA Netw Open. 2019;2(8):e198363.
4. Khakpaki A. Advancements in artificial intelligence transforming medical education: a comprehensive overview. Med Educ Online. 2025;30(1):2542807.
5. Arráez-Aybar LA. Evolving anatomy education: bridging dissection, traditional methods, and technological innovation for clinical excellence. Anatomia. 2025;4(2):9.
6. Fazlollahi AM, Bakhaidar M, Alsayegh A, Yilmaz R, Winkler-Schwartz A, Mirchi N, et al. Effect of artificial intelligence tutoring vs expert instruction on learning simulated surgical skills among medical students: a randomized clinical trial. JAMA Netw Open. 2022;5(2):e2149008.
7. Hernández Rincón EH, Jimenez D, Chavarro Aguilar LA, Pérez Flórez JM, Romero Tapia ÁE, Jaimes Peñuela CL. Mapping the use of artificial intelligence in medical education: a scoping review. BMC Med Educ. 2025;25:526.
8. Chan KS, Zary N. Applications and challenges of implementing artificial intelligence in medical education: integrative review. JMIR Med Educ. 2019;5(1):e13930.
9. Gerke S, Minssen T, Cohen G. Ethical and legal challenges of artificial intelligence-driven healthcare. In: Bohr A, Memarzadeh K, editors. Artificial Intelligence in Healthcare. London: Academic Press; 2020. p. 295-336.

10. Garavand A, Aslani N, Afsharifard P, Nadri H. Evaluation and examination of factors influencing the continued effective use of e-learning among faculty members of medical sciences universities. BMC Med Educ. 2025;25:417.