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Exploring the Ethical Dimensions of Artificial Intelligence and Robotics in Dental Education
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Abstract

Artificial intelligence (AI) and robotics have revolutionized healthcare, particularly dentistry. Their integration in dental education offers opportunities to enhance learning, diagnostics, treatment planning, and patient care. However, ethical implications must be addressed to ensure responsible and ethical integration of these technologies. This review explores AI and robotics in dental education and highlights the associated ethical considerations. These technologies provide improved learning experiences and simulations. Intelligent tutoring systems offer personalized feedback, virtual reality simulations enable practice in a safe environment, and AI algorithms aid in analysing radiographic images. Despite their potential, ethical challenges arise, including data privacy, autonomy, equity, and professional integrity. Addressing these challenges requires transparency, informed consent, bias detection, and accountability. Dental curricula should incorporate ethics, fostering collaborations between educators and AI/robotics experts. Professional development programs should prioritize ethics training, considering emerging technologies such as AI-powered learning and diagnostic assistance. By embracing ethical considerations, AI and robotics can be integrated in dental education guided by transparency, accountability, privacy, and patient-centric care. A comprehensive understanding of the ethical dimensions is essential to harness the transformative potential of AI and robotics while upholding ethical standards in dental education. © The Ibn Sina Trust.

Author Keywords

artificial intelligence; dental education; dentistry; ethics; health profession; informatics; learning; machine learning; patient care

Index Keywords

algorithm, artificial intelligence, data privacy, dental education, dentistry, female, human, information science, informed consent, machine learning, male, medical profession, patient care, privacy, professional development, review, robotics, simulation, treatment planning, virtual reality

References

- Bohr, A, Memarzadeh, K.
The rise of artificial intelligence in healthcare applications
(2020) *Artificial Intelligence in Healthcare*, pp. 25-60.
- Goldenberg, SL, Nir, G, Salcudean, SE.
A new era: artificial intelligence and machine learning in prostate cancer
(2019) *Nat Rev Urol*, 16 (7), pp. 391-403.
- Siontis, KC, Noseworthy, PA, Attia, ZI, Friedman, PA.
Artificial intelligence-enhanced electrocardiography in cardiovascular disease management
(2021) *Nat Rev Cardiol*, 18 (7), pp. 465-478.
- Panetta, K, Rajendran, R, Ramesh, A, Rao, S, Agaian, S.
Tufts Dental Database: A Multimodal Panoramic X-Ray Dataset for Benchmarking

Diagnostic Systems

(2022) *IEEE J Biomed Health Inform*, 26 (4), pp. 1650-1659.

- Cantu, AG, Gehrung, S, Krois, J, Chaurasia, A, Rossi, JG, Gaudin, R, Elhennawy, K, Schwendicke, F.
Detecting caries lesions of different radiographic extension on bitewings using deep learning
(2020) *J Dent*, 100, p. 103425.
- Kumari, M.
Perception of Dental Students In Incorporating Artificial Intelligence Into Dental Education
(2023) *Journal of Advanced Sciences*, 2 (1), pp. 41-45.
- Sardar, P, Abbott, JD, Kundu, A, Aronow, HD, Granada, JF, Giri, J.
Impact of Artificial Intelligence on Interventional Cardiology,
(2019) *JACC: Cardiovascular Interventions*, 12 (14), pp. 1293-1303.
- Nwana, HS.
Intelligent tutoring systems: an overview
(1990) *Artificial Intelligence Review*, 4 (4), pp. 251-277.
- Pottle, J.
Virtual reality and the transformation of medical education
(2019) *Future healthcare journal*, 6 (3), p. 181.
- Adams, SJ, Henderson, RD, Yi, X, Babyn, P.
Artificial intelligence solutions for analysis of X-ray images
(2021) *Canadian Association of Radiologists Journal*, 72 (1), pp. 60-72.
- Schönberger, D.
Artificial intelligence in healthcare: a critical analysis of the legal and ethical implications
(2019) *International Journal of Law and Information Technology*, 27 (2), pp. 171-203.
- Thurzo, A, Strunga, M, Urban, R, Surovková, J, Afrashtehfar, K.
Impact of Artificial Intelligence on Dental Education: A Review and Guide for Curriculum Update
(2023) *Educ Sci*, 13, p. 150.
2023
- Gaba, DM.
The future vision of simulation in health care
(2004) *BMJ Quality & Safety*, 13, pp. i2-i10.
(suppl 1)
- So, HY, Chen, PP, Wong, GKC, Chan, TTN.
Simulation in medical education
(2019) *Journal of the Royal College of Physicians of Edinburgh*, 49 (1), pp. 52-57.
- van der Vorst, T, Jelcic, N.
(2019) *Artificial Intelligence in Education: Can AI bring the full potential of personalized learning to education?*,
- Rhiemora, P, Haddawy, P, Khanal, P, Suebnukarn, S, Dailey, MN.
A virtual reality simulator for teaching and evaluating dental procedures
(2010) *Methods of Information In Medicine*, 49, pp. 396-405.
(04)

- Ramesh, A, Kambhampati, C, Monson, JR, Drew, P.
Artificial intelligence in medicine
(2004) *Annals of the Royal College of Surgeons of England*, 86 (5), p. 334.
- Vitiello, V, Lee, S-L, Cundy, TP, Yang, G-Z.
Emerging robotic platforms for minimally invasive surgery
(2012) *IEEE reviews in biomedical engineering*, 6, pp. 111-126.
- Dapri, G.
(2022) *Robotics in surgery and clinical application*, pp. 3-21.
Endorobotics: Elsevier
- Alam, MK, Hameed, HA, Hindy, A, Al-Sultani, HFF, Hasan, HA.
3D Computed Tomography (3D-CT) Study of the Mandibular Foramen in Iraqi Adults
(2020) *Bangladesh Journal of Medical Science*, 19 (2), pp. 310-314.
- Rokhshad, R, Ducret, M, Chaurasia, A, Karteva, T, Radenkovic, M, Roganovic, J, Hamdan, M, Lahoud, P.
Ethical Considerations on Artificial Intelligence in Dentistry: A Framework and Checklist
J Dent, 2023, p. 104593.
- Fa, Schwendicke, Samek, W, Krois, J.
Artificial intelligence in dentistry: chances and challenges
(2020) *J Dent Res*, 99 (7), pp. 769-774.
- Zhang, J, Zhang, ZM.
Ethics and governance of trustworthy medical artificial intelligence
(2023) *BMC Med Inform Decis Mak*, 23 (1), p. 7.
- Safdar, NM, Banja, JD, Meltzer, CC.
Ethical considerations in artificial intelligence
(2020) *Euro J Radiol*, 122, p. 108768.
- Bitterman, DS, Aerts, HJ, Mak, RH.
Approaching autonomy in medical artificial intelligence
(2020) *The Lancet Digital Health*, 2 (9), pp. e447-e9.
- (2021) *Ethics and governance of artificial intelligence for health: WHO guidance*, Organization WH
- Lutz, C.
Digital inequalities in the age of artificial intelligence and big data
(2019) *Human Behavior and Emerging Technologies*, 1 (2), pp. 141-148.
- Boon, IS, Lim, JS, Yap, MH, Yong, TPA, Boon, CS.
Artificial intelligence and soft skills in radiation oncology: data versus wisdom
(2020) *Journal of Medical Imaging and Radiation Sciences*, 51 (4), pp. S114-S5.
- Nowak, A, Lukowicz, P, Horodecki, P.
Assessing Artificial Intelligence for Humanity: Will AI be the Our Biggest Ever Advance? or the Biggest Threat [Opinion]
(2018) *IEEE Technology and Society Magazine*, 37 (4), pp. 26-34.
- Gardanova, Z, Belaia, O, Zuevskaya, S, Turkadze, K, Strielkowski, W.
Lessons for Medical and Health Education Learned from the COVID-19 Pandemic
(2023) *Healthcare (Basel)*, 11 (13), p. 1921.
- Nguyen, TT, Larrivé, N, Lee, A, Bilaniuk, O, Durand, R.
Use of artificial intelligence in dentistry. Current clinical trends and research advances
(2021) *J Can Dent Assoc*, 87 (17), pp. 1488-2159.

- Council, A.
Statement on algorithmic transparency and accountability
(2017) *Commun ACM*,
- Astromskė, K, Peičius, E, Astromskis, P.
Ethical and legal challenges of informed consent applying artificial intelligence in medical diagnostic consultations
(2021) *AI & SOCIETY*, 36 (2), pp. 509-520.
- Paulus, JK, Kent, DM.
Predictably unequal: understanding and addressing concerns that algorithmic clinical prediction may increase health disparities
(2020) *NPJ Digit Med*, 3, p. 99.
- Bogina, V, Hartman, A, Kuflik, T, Shulner-Tal, A.
Educating Software and AI Stakeholders About Algorithmic Fairness, Accountability, Transparency and Ethics
(2022) *International Journal of Artificial Intelligence in Education*, 32 (3), pp. 808-833.
- Königs, P.
Artificial intelligence and responsibility gaps: what is the problem?
(2022) *Ethics and Information Technology*, 24 (3), p. 36.
- O'Flaherty, J, McGarr, O.
The use of case-based learning in the development of student teachers' levels of moral reasoning
(2014) *Eur J Teach Educ*, 37 (3), pp. 312-330.
- Islam, NM, Laughter, L, Sadid-Zadeh, R, Smith, C, Dolan, TA, Crain, G, Squarize, CH.
Adopting artificial intelligence in dental education: A model for academic leadership and innovation
(2022) *J Dent Educ*, 86 (11), pp. 1545-1551.
- Chen, L, Chen, P, Lin, Z.
Artificial intelligence in education: A review
(2020) *Ieee Access*, 8, pp. 75264-75278.
- Paranjape, K, Schinkel, M, Panday, RN, Car, J, Nanayakkara, P.
Introducing artificial intelligence training in medical education
(2019) *JMIR medical education*, 5 (2), p. e16048.
- Choudhury, A, Asan, O.
Impact of accountability, training, and human factors on the use of artificial intelligence in healthcare: Exploring the perceptions of healthcare practitioners in the US
(2022) *Human Factors in Healthcare*, 2, p. 100021.
- Pokrivcakova, S.
Preparing teachers for the application of AI-powered technologies in foreign language education
(2019) *Journal of Language and Cultural Education*, 7 (3), pp. 135-153.
- González-Calatayud, V, Prendes-Espinosa, P, Roig-Vila, R.
Artificial intelligence for student assessment: A systematic review
(2021) *Applied Sci*, 11 (12), p. 5467.
- Chen, Y-w, Stanley, K, Att, W.
Artificial intelligence in dentistry: current applications and future perspectives
(2020) *Quintessence Int*, 51 (3), pp. 248-257.

- Abouzeid, HL, Chaturvedi, S, Abdelaziz, KM, Alzahrani, FA, AlQarni, AAS, Alqahtani, NM. **Role of Robotics and Artificial Intelligence in Oral Health and Preventive Dentistry-Knowledge, Perception and Attitude of Dentists** (2021) *Oral Health Prev Dent*, 19, pp. 353-363.
- Mikropoulos, TA, Natsis, A. **Educational virtual environments: A ten-year review of empirical research (1999–2009)** (2011) *Computers & education*, 56 (3), pp. 769-780.
- Hamet, P, Tremblay, J. **Artificial intelligence in medicine** (2017) *Metabolism*, 69, pp. S36-S40.

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