INTERNATIONAL JOURNAL OF EDUCATION AND PEDAGOGY (IJEP)
(Open Access, Double-Blind Peer Reviewed Journal)
EDU SCHOOL ijep.in
ISSN Online: ISSN Print

Technology-Enhanced Learning in Medical Education: Latest Developments

Sundaravally

Assistant Professor, Department of Education, Manonmaniam Sundaranar University, Abhishekapatti, Tirunelveli, Tamil Nadu, India.

Article information
Received: 9th July 2025
Received in revised form: 17th August 2025
Accepted: 8th September 2025
Available online: 9th October 2025

Volume: 1
Issue: 4
DOI: https://doi.org/10.5281/zenodo.17550056

Abstract

The integration of technology-enhanced learning (TEL) in medical education has undergone substantial transformation, driven by advances in digital infrastructure, pedagogical innovation, and evolving healthcare demands. This paper examines latest developments in TEL within medical education, analyzing emerging technologies, pedagogical frameworks, implementation strategies, and educational outcomes. Through comprehensive review of current literature, this analysis identifies key trends including virtual reality simulation, artificial intelligence-powered adaptive learning, mobile health applications, and collaborative digital platforms. The research question guiding this investigation is: What are the most significant recent developments in technology-enhanced learning for medical education, and how do these innovations impact learning outcomes, clinical competency development, and pedagogical practice? Employing a theoretical framework synthesizing constructivist learning theory with technology acceptance models, this paper critically evaluates the effectiveness, challenges, and future trajectories of TEL in medical education. Findings suggest that while TEL demonstrates significant potential for enhancing medical education through personalized learning experiences, improved accessibility, and realistic clinical simulation, successful implementation requires careful consideration of pedagogical design, technological infrastructure, faculty development, and assessment strategies. The implications extend beyond immediate educational outcomes to encompass broader transformations in clinical training paradigms, competency-based education, and preparation of healthcare professionals for technology-intensive practice environments.

Keywords: - Technology-Enhanced Learning, Medical Education, Virtual Reality, Artificial Intelligence, Simulation-Based Learning, Digital Health Education

I. INTRODUCTION

Medical education stands at a critical juncture where traditional pedagogical approaches intersect with rapidly evolving technological capabilities, creating unprecedented opportunities for innovation in clinical training and professional development. The contemporary healthcare landscape demands physicians who possess not only comprehensive medical knowledge and clinical skills but also technological literacy, adaptive learning capabilities, and proficiency in digital health systems. Technology-enhanced learning (TEL) has emerged as a transformative force in medical education, encompassing diverse modalities including simulation-based training, virtual and augmented reality applications, artificial intelligence-driven adaptive learning systems, mobile health applications, and collaborative digital platforms.

The significance of TEL in medical education extends beyond mere technological adoption to fundamentally reshape pedagogical philosophies, learning environments, and assessment methodologies. Recent developments reflect broader shifts toward competency-based education, personalized learning pathways, and authentic clinical experiences facilitated through technological mediation. The COVID-19 pandemic accelerated the adoption of digital learning technologies, revealing both the potential and limitations of technology-mediated medical education while catalyzing innovations that persist in post-pandemic educational models.

Despite substantial investment in educational technology and growing enthusiasm for TEL innovations, critical questions remain regarding the pedagogical effectiveness of specific technologies, optimal implementation strategies, impact on clinical competency development, and long-term implications for medical practice. The proliferation of educational technologies has outpaced systematic evaluation of their educational value, creating a need for rigorous analysis of recent developments and evidence-based guidance for educational institutions.

- Research Question: What are the most significant recent developments in technology-enhanced learning for medical education, and how do these innovations impact learning outcomes, clinical competency development, and pedagogical practice?
- Purpose Statement: This paper provides comprehensive analysis of latest developments in TEL within medical education, examining emerging technologies, pedagogical frameworks, implementation strategies, and educational outcomes.
- Scope: This investigation focuses on developments in TEL occurring primarily within the past five years (2020-2025), with particular emphasis on technologies demonstrating scalability, pedagogical effectiveness, and alignment with contemporary medical education competencies.

II. LITERATURE REVIEW

2.1. Theoretical Frameworks for Technology-Enhanced Learning

Contemporary TEL in medical education draws upon multiple theoretical frameworks that inform pedagogical design and implementation strategies. Constructivist learning theory emphasizes active knowledge construction through authentic experiences, positioning technology as a tool for creating meaningful learning environments promoting deep understanding. The Technology Acceptance Model (TAM) provides frameworks for understanding factors influencing technology adoption among medical educators and learners, including perceived usefulness, ease of use, and social influences.

Cognitive load theory informs the design of technology-mediated learning experiences by addressing the relationship between instructional design and working memory limitations, particularly relevant for complex medical simulations and multimedia learning environments. Communities of practice theory conceptualizes learning as social participation, supporting the development of collaborative digital platforms and networked learning communities in medical education.

2.2. Virtual Reality and Augmented Reality in Medical Training

Virtual reality (VR) and augmented reality (AR) technologies have emerged as powerful tools for medical education, offering immersive learning experiences that simulate clinical scenarios with unprecedented realism and interactivity. Recent systematic reviews demonstrate that VR-based surgical training improves technical skills, procedural knowledge, and performance in operating room settings compared to traditional training methods. AR applications overlay digital information onto physical environments, enabling anatomy education that combines tactile examination with digital visualization and interactive exploration.

The pedagogical value of VR and AR extends beyond technical skill development to encompass communication training, diagnostic reasoning, and clinical decision-making in complex scenarios. Recent developments include haptic feedback systems providing realistic tactile sensations, multi-user virtual environments enabling collaborative learning, and AI-powered virtual patients responding realistically to clinical interventions. However, implementation challenges include high costs, technical complexity, accessibility limitations, and the need for robust pedagogical frameworks maximizing educational effectiveness.

2.3. Artificial Intelligence in Medical Education

Artificial intelligence (AI) represents a transformative force in medical education, offering capabilities for personalized learning, intelligent tutoring, automated assessment, and clinical decision support training. Recent applications include adaptive learning platforms customizing content delivery based on individual learner performance, natural language processing systems analyzing clinical documentation and providing feedback, and machine learning algorithms for image interpretation training.

AI-powered virtual patients provide realistic clinical scenarios with dynamic responses to diagnostic and therapeutic decisions, enabling learners to practice clinical reasoning in safe, repeatable environments. Intelligent tutoring systems offer personalized feedback and guidance, adapting instructional strategies to individual learning needs. Recent developments in large language models have created new possibilities for conversational AI tutors, automated feedback on clinical reasoning, and simulation of patient interactions.

2.4. Simulation-Based Learning Technologies

Simulation-based learning has become a cornerstone of medical education, with technological advances enabling increasingly sophisticated training experiences. High-fidelity mannequin simulators reproduce physiological responses to clinical interventions, allowing learners to practice emergency scenarios, procedural skills, and team-based care in controlled environments. Recent developments include wireless simulators, hybrid simulation combining standardized patients with technological augmentation, and in-situ simulation conducted in actual clinical environments.

Research evidence demonstrates that simulation-based learning improves clinical skills, diagnostic accuracy, and patient safety when designed according to evidence-based principles including deliberate practice, mastery learning, and debriefing. Integration of simulation into curricula requires careful consideration of learning objectives, fidelity requirements, assessment methods, and faculty development needs.

2.5. Mobile Learning and Learning Management Systems

Mobile devices have become ubiquitous tools in medical education, supporting learning through point-of-care resources, mobile applications, and microlearning opportunities. Contemporary mobile learning platforms incorporate multimedia content, interactive case studies, adaptive quizzing, and social learning features. Learning management systems

(LMS) have evolved from simple content repositories to comprehensive digital learning environments supporting diverse pedagogical approaches.

Recent developments in digital learning platforms emphasize social learning, competency-based progression, and personalized learning pathways. Learning analytics provide insights into learner engagement, performance patterns, and learning behaviors, enabling data-informed instructional decisions and early intervention for struggling learners.

III. METHODOLOGY

3.1. Research Design and Approach

This paper employs a comprehensive literature review methodology to examine recent developments in technology-enhanced learning in medical education. The review synthesizes empirical research, theoretical frameworks, systematic reviews, and expert commentaries to provide evidence-based analysis of TEL innovations, implementation strategies, and educational outcomes.

3.2. Information Sources and Search Strategy

A comprehensive literature search was conducted using multiple electronic databases including PubMed/MEDLINE, ERIC, Web of Science, and Google Scholar. The search strategy incorporated controlled vocabulary terms and keywords related to technology-enhanced learning, medical education, specific technologies (virtual reality, artificial intelligence, simulation), and educational outcomes.

The search focused primarily on literature published between 2020 and 2025 to capture latest developments, with selective inclusion of seminal earlier works establishing theoretical foundations. Additional sources were identified through citation tracking and reference list examination.

3.3. Inclusion and Exclusion Criteria

- Inclusion criteria: Peer-reviewed research articles, systematic reviews, and meta-analyses addressing technology-enhanced learning in medical education contexts; publications in English language; focus on recent technological developments.
- Exclusion criteria: Non-peer-reviewed sources (except critical grey literature); publications focused exclusively on health professions other than medicine; studies examining outdated technologies without relevance to contemporary practice.

3.4. Theoretical Framework

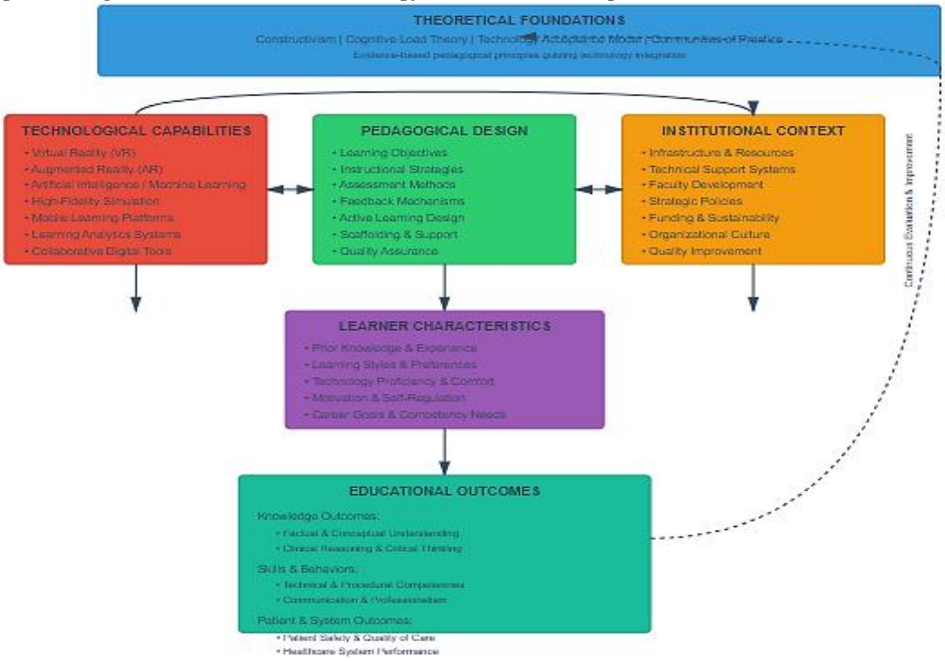
The analysis is informed by an integrated theoretical framework combining constructivist learning theory, technology acceptance models, and cognitive load theory. This framework positions technology as a mediating tool shaping learning experiences, with educational effectiveness determined by interaction between technological capabilities, pedagogical design, learner characteristics, and institutional contexts.

IV. ANALYSIS AND DISCUSSION

4.1. Emerging Technologies and Educational Applications

Recent years have witnessed emergence and maturation of several technological innovations with significant implications for medical education:

Fig 1: Conceptual Framework for Technology-Enhanced Learning in Medical Education



4.1.1. Virtual and Augmented Reality Systems:

Contemporary VR and AR applications have transcended early novelty implementations to become integrated components of surgical training, anatomy education, and clinical skills development. Recent platforms incorporate advanced haptic feedback, eye-tracking for attention analysis, and multi-user collaborative environments. Educational research demonstrates that VR-based surgical training produces skill transfer to operating room performance, with effect sizes comparable to or exceeding traditional training methods for specific procedural competencies.

4.1.2. Artificial Intelligence and Adaptive Learning Platforms:

AI applications in medical education have expanded rapidly, with recent systems demonstrating capabilities for personalized learning pathway optimization, intelligent content recommendation, automated performance assessment, and conversational tutoring. Machine learning algorithms analyze learner interaction patterns, knowledge assessment results, and learning behaviors to customize content sequencing and instructional support.

4.1.3. High-Fidelity Simulation Technologies:

Simulation technologies have evolved to incorporate wireless connectivity, real-time performance analytics, integrated audiovisual documentation, and scenario libraries with branching clinical pathways. In-situ simulation, conducted in actual clinical environments using portable simulation equipment, enables team training in authentic settings while maintaining patient safety.

4.1.4. Mobile Learning Ecosystems:

The ubiquity of smartphones and tablets has created opportunities for pervasive learning integrated into clinical workflows. Contemporary mobile learning extends beyond simple content access to incorporate spaced repetition systems for long-term knowledge retention, microlearning modules designed for brief learning episodes, and point-of-care decision support integrated with clinical practice.

4.1.5. Learning Analytics and Educational Data Systems:

The accumulation of digital learning data has enabled sophisticated analytics providing insights into learning patterns, predicting learner difficulties, and informing instructional decisions. Learning analytics platforms analyze patterns including content engagement, assessment performance trajectories, and help-seeking behaviors to identify at-risk learners and optimize instructional sequencing.

4.1.6. Collaborative Digital Platforms:

Contemporary learning platforms emphasize social interaction, collaborative knowledge construction, and community engagement. Recent systems incorporate features including peer discussion forums, collaborative case analysis tools, social annotation of educational resources, and virtual study groups.

4.2. Comparative Analysis of Technology Effectiveness

Table 1. Comparison of Educational Technologies in Medical Education

Technology	Primary Applications	Evidence of Effectiveness	Implementation Challenges	Cost Range
Virtual Reality	Surgical skills, procedural competency, spatial anatomy, emergency scenarios	Strong evidence for skill acquisition and transfer (ES: 0.5-1.2); Moderate for knowledge retention	High initial investment, technical expertise required, accessibility limitations, cybersickness	High ($15K-$100K+)
Augmented Reality	Anatomy education, clinical examination, procedural guidance, diagnostic imaging overlay	Moderate evidence for anatomy learning (ES: 0.4-0.8); Emerging for clinical applications	Device requirements, software complexity, limited content availability	Moderate-High ($5K-$50K)
Artificial Intelligence	Personalized learning, adaptive assessment, clinical reasoning, image interpretation	Moderate evidence for personalized learning; Strong for specific diagnostic training	Algorithm transparency, bias mitigation, faculty acceptance, data privacy	Variable ($10K-$200K)
High-Fidelity Simulation	Emergency medicine, anesthesia, team training, procedural skills, crisis management	Strong evidence across competencies (ES: 0.6-1.5); Demonstrated patient safety improvements	Space requirements, equipment maintenance, faculty training, scheduling	Very High ($50K-$300K+)
Mobile Learning	Just-in-time learning, microlearning, spaced repetition, point-of-care reference	Moderate for knowledge retention; Strong for accessibility and engagement	Distraction management, quality control, digital professionalism, device variability	Low-Moderate ($1K-$20K)
Learning Analytics	Performance monitoring, predictive intervention, curriculum evaluation, competency tracking	Emerging for early intervention; Moderate for curriculum optimization	Data privacy, algorithmic fairness, faculty data literacy, system integration	Moderate ($20K-$100K)

Screen-Based Simulation	Clinical reasoning, diagnostic decision-making, branching scenarios, virtual patients	Moderate for knowledge/reasoning (ES: 0.3-0.7); Cost-effective alternative	Lower fidelity, limited psychomotor skills, engagement variability	Low-Moderate ($5K-$50K)
Collaborative Platforms	Peer learning, discussion, case-based learning, social knowledge construction	Moderate for engagement and knowledge construction; Variable outcome evidence	Faculty facilitation skills, participation disparities, assessment challenges	Low-Moderate ($5K-$30K)

Note: Effect sizes (ES) represent Cohen's d values from meta-analytic reviews. Cost ranges are approximate institutional implementation estimates.

Table 2. Pedagogical Frameworks and Technology Alignment

Learning Theory	**Compatible Technologies**	**Pedagogical Strategies**	**Educational Outcomes**
Constructivism	VR/AR, simulation, virtual patients, case-based platforms	Experiential learning, problem-solving, authentic tasks, reflection	Deep understanding, clinical reasoning, transfer of learning
Cognitive Load Theory	Adaptive AI systems, multimedia modules, chunked mobile content	Worked examples, scaffolding, dual coding, segmentation	Efficient learning, reduced cognitive overload, improved retention
Social Learning	Collaborative platforms, discussion forums, peer feedback tools	Group discussion, peer teaching, community of practice	Professional identity, communication skills, collaborative competency
Deliberate Practice	Simulation with feedback, skills trainers, VR repetition, adaptive quizzing	Focused repetition, immediate feedback, progressive challenge	Skill mastery, automaticity, sustained competency
Metacognition	Learning analytics dashboards, reflective portfolios, self-assessment tools	Self-monitoring, learning strategies, reflective practice	Self-regulated learning, lifelong learning skills, insight

Educational effectiveness varies significantly across different TEL modalities. Meta-analytic evidence demonstrates that simulation-based learning produces robust educational effects for procedural skills, team training, and emergency management competencies, with effect sizes frequently exceeding 1.0 for specific clinical skills. Virtual reality applications show promising effectiveness for spatial learning, surgical skills, and scenario-based clinical decision-making.

Artificial intelligence applications demonstrate variable effectiveness depending on implementation quality, with well-designed adaptive learning systems showing moderate improvements in learning efficiency and knowledge retention. Mobile learning effectiveness depends heavily on instructional design, with spaced repetition systems and microlearning approaches showing stronger evidence for long-term retention.

4.3. Implementation Strategies and Success Factors

Successful implementation of TEL requires attention to multiple organizational, pedagogical, and technical factors:

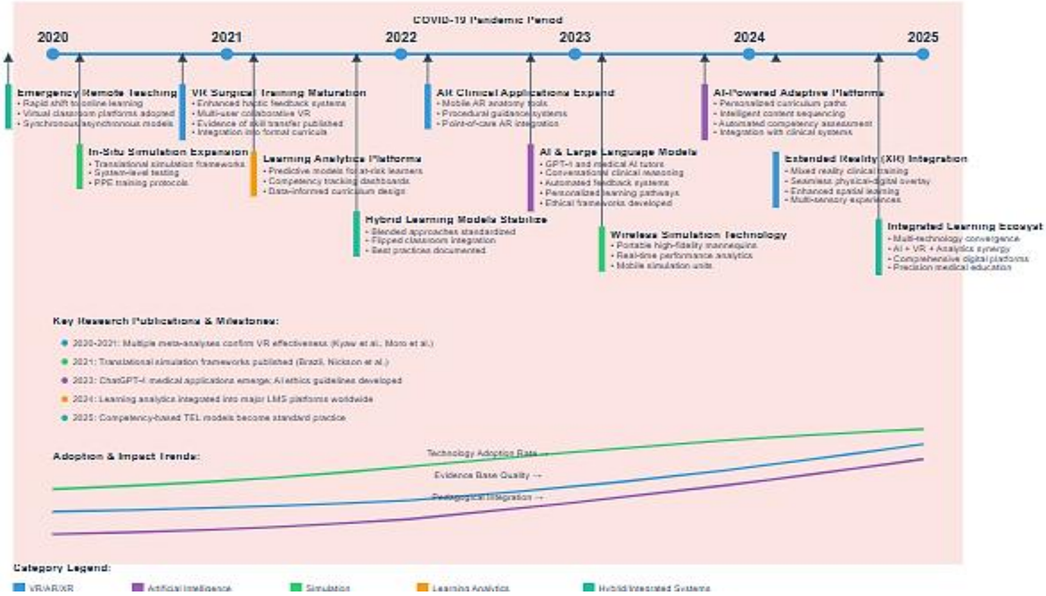
- Pedagogical Design Quality: Technology effectiveness depends fundamentally on instructional design quality rather than technological sophistication alone. Successful implementations ground technology selection in educational objectives and design learning experiences according to evidence-based principles.
- Faculty Development and Support: Educator competence and confidence with educational technology significantly influences implementation success. Effective faculty development programs provide hands-on technology experience, pedagogical guidance, ongoing technical support, and communities of practice for sharing expertise.
- Institutional Infrastructure: Sustainable TEL implementation requires institutional commitment including adequate funding, technical infrastructure, support personnel, and strategic integration into curricula. Integration of TEL into institutional strategic plans ensures sustained commitment.
- Learner Engagement and Acceptance: Technology adoption by learners depends on perceived usefulness, ease of use, and integration with learning workflows. Successful implementations provide clear rationale, training and support, and designs that enhance rather than complicate learning processes.
- Assessment and Evaluation Systems: Effective TEL implementation includes robust evaluation addressing educational outcomes, user experiences, technical performance, and cost-effectiveness through clear learning objectives, valid assessment methods, and continuous quality improvement.

4.4. Challenges and Limitations

Despite substantial potential, TEL implementation faces persistent challenges:

- Technical Challenges: Technological reliability, compatibility issues, learning curves for complex systems, and rapid technological obsolescence create ongoing implementation difficulties.

Fig 2: Timeline of TEL Innovations in Medical Education (2020-2025)



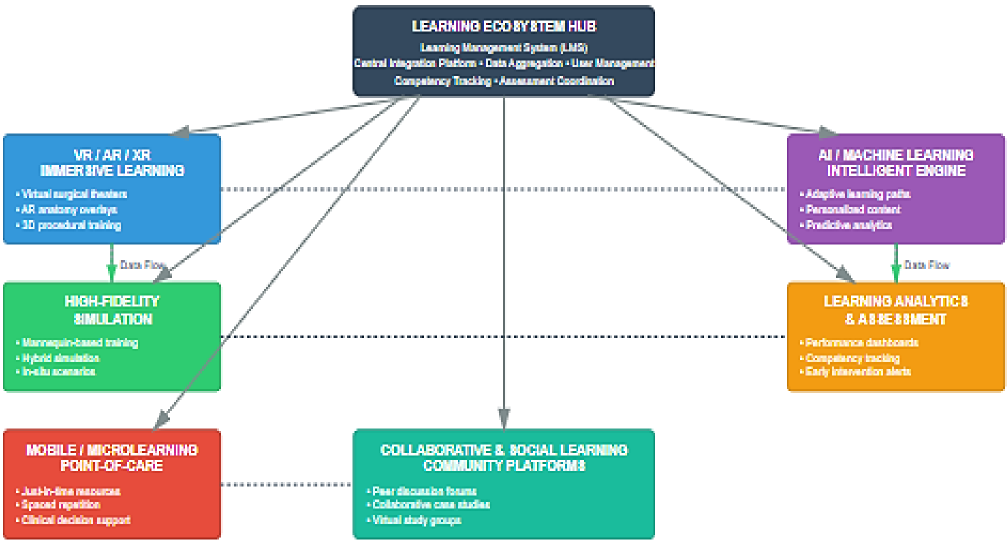
- Pedagogical Challenges: Risk of technology-driven rather than pedagogy-driven implementation, inadequate instructional design expertise, and tension between innovation and evidence-based practice require ongoing institutional navigation.
- Resource Challenges: High costs for some technologies, competing resource priorities, inadequate technical support personnel, and sustainability concerns limit widespread adoption.
- Assessment Challenges: Difficulty measuring complex clinical competencies through technology-mediated assessment and concerns about validity and reliability of automated assessment create ongoing dilemmas.
- Human Factors: Risk of reduced human interaction, concerns about empathy development in technology-mediated learning, and generational differences in technology comfort require pedagogical attention.

4.5. Future Directions

Analysis of current research and technological trajectories identifies several emerging trends:

- Integration of Multiple Technologies: Future implementations will increasingly combine multiple technologies into integrated learning ecosystems, such as AI-powered adaptive systems within VR environments and AR-enhanced simulation with real-time analytics.
- Extended Reality Advancement: Continued development of mixed reality technologies will blur boundaries between virtual and physical learning environments, enabling seamless integration of digital information into clinical settings.
- Generative AI and Large Language Models: Emerging applications include conversational clinical tutors, automated feedback on complex clinical reasoning, personalized case generation adapted to learner needs, and intelligent study companions.
- Precision Medical Education: Application of learning analytics, AI, and adaptive technologies will enable increasingly personalized learning pathways optimized for individual learner characteristics, similar to precision medicine approaches in clinical care.

Fig 3: Integration Model for Multi-Technology Learning Ecosystems



4.6. Example Integration Scenarios:

- AI-Enhanced VR Surgery: AI analyzes VR surgical performance, provides adaptive feedback, tracks progress in analytics dashboard
- AR + Mobile + Analytics: AR anatomy overlay on mobile devices with analytics tracking usage patterns and knowledge gaps
- Simulation + AI Patients: High-fidelity mannequins with AI-driven patient responses and automated performance assessment

V. IMPLICATIONS FOR MEDICAL EDUCATION

The developments in TEL analyzed in this paper have profound implications for medical education policy, practice, and scholarship:

5.1. Curricular Implications

TEL innovations enable fundamental rethinking of curricular structures, learning sequences, and educational modalities. Flipped classroom models leverage digital content delivery to prioritize active learning during face-to-face instruction. Competency-based curricula utilize technology-enabled assessment and personalized learning pathways to replace time-based progression with demonstrated mastery.

The availability of sophisticated simulation technologies challenges traditional apprenticeship models requiring extensive patient exposure for skills development, enabling early procedural competency development before clinical immersion. However, technology cannot fully replace authentic clinical experience, requiring thoughtful integration that leverages technological capabilities while preserving essential elements of patient-centered clinical learning.

5.2. Assessment and Competency Evaluation

Technology-enhanced assessment enables more frequent, standardized, and objective competency evaluation while creating challenges for validity and authenticity. Digital portfolios and workplace-based assessment applications facilitate competency-based assessment programs through systematic documentation of clinical experiences and performance feedback.

5.3. Faculty Roles and Professional Development

TEL transforms faculty roles from primarily content delivery toward learning facilitation, instructional design, assessment, and mentorship. This requires substantial professional development addressing not only technological skills but also pedagogical strategies for effective technology-mediated teaching.

5.4. Equity and Access Considerations

While technology promises increased educational access and flexibility, implementation must address digital divides in device access, connectivity, and technical literacy. Institutional policies should ensure equitable technology access, provide devices and connectivity support for learners lacking resources, and design learning experiences accessible across variable technical capabilities.

5.5. Research and Scholarship Implications

The rapid evolution of educational technology creates ongoing need for rigorous research examining effectiveness, optimal implementation strategies, and long-term educational consequences. Research priorities include comparative effectiveness studies, investigation of mechanisms underlying educational effects, and implementation science research addressing factors influencing successful adoption.

VI. CONCLUSION

Technology-enhanced learning has become integral to contemporary medical education, with recent developments demonstrating substantial potential for improving educational effectiveness, accessibility, and alignment with healthcare practice demands. This analysis has identified significant innovations across multiple domains including virtual and augmented reality, artificial intelligence, simulation technologies, mobile learning, learning analytics, and collaborative digital platforms.

Evidence demonstrates educational effectiveness for well-designed, pedagogically grounded technology implementations, particularly for procedural skills, clinical reasoning, and knowledge retention. However, technology alone does not determine educational outcomes; rather, pedagogical design quality, faculty development, institutional support, and thoughtful implementation strategies mediate technology's educational impact.

Successful TEL integration requires evidence-based instructional design, alignment with educational objectives, attention to human factors, and continuous evaluation and improvement. Challenges including resource requirements, technical complexity, faculty development needs, and equity considerations require ongoing institutional attention.

The future trajectory of medical education will likely involve increasing integration of multiple technologies into comprehensive learning ecosystems, personalization of learning pathways through AI and analytics, and continued evolution toward competency-based, technology-enhanced models. However, the essential human elements of medical education—mentorship, empathy, professional role modeling, and patient-centered care—must remain central as technological capabilities expand.

Medical educators, researchers, and institutional leaders must approach TEL with both enthusiasm for innovation and critical evaluation of educational impact. Investment in educational technology should be guided by educational objectives rather than technological novelty, grounded in pedagogical theory and evidence, and evaluated rigorously for educational effectiveness and equity of access.

As medical education continues evolving, the integration of technology should enhance rather than replace the fundamental human elements that define excellent medical practice. The most promising future lies not in choosing between traditional and technology-enhanced approaches but in thoughtful integration that leverages the unique strengths of both to prepare the next generation of physicians for 21st-century healthcare challenges.

References

Ayoub, A., & Pulijala, Y. (2019). The application of virtual reality and augmented reality in oral & maxillofacial surgery. *BMC Oral Health, 19*(1), 238. https://doi.org/10.1186/s12903-019-0937-8

Brazil, V. (2017). Translational simulation: Not 'where?' but 'why?' A functional view of in situ simulation. *Advances in Simulation, 2*(1), 20. https://doi.org/10.1186/s41077-017-0052-3

Chan, K. S., & Zary, N. (2019). Applications and challenges of implementing artificial intelligence in medical education: Integrative review. *JMIR Medical Education, 5*(1), e13930. https://doi.org/10.2196/13930

Cook, D. A., Brydges, R., Zendejas, B., Hamstra, S. J., & Hatala, R. (2013). Mastery learning for health professionals using technology-enhanced simulation: A systematic review and meta-analysis. *Academic Medicine, 88*(8), 1178–1186. https://doi.org/10.1097/ACM.0b013e31829a365d

Cook, D. A., Hatala, R., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., Erwin, P. J., & Hamstra, S. J. (2011). Technology-enhanced simulation for health professions education: A systematic review and meta-analysis. *JAMA, 306*(9), 978–988. https://doi.org/10.1001/jama.2011.1234

Cook, D. A., Levinson, A. J., Garside, S., Dupras, D. M., Erwin, P. J., & Montori, V. M. (2010). Instructional design variations in internet-based learning for health professions education: A systematic review and meta-analysis. *Academic Medicine, 85*(5), 909–922. https://doi.org/10.1097/ACM.0b013e3181d6c319

Driessen, E., van Tartwijk, J., van der Vleuten, C., & Wass, V. (2007). Portfolios in medical education: Why do they meet with mixed success? A systematic review. *Medical Education, 41*(12), 1224–1233. https://doi.org/10.1111/j.1365-2923.2007.02884.x

Ellaway, R. H., & Topps, D. (2018). Preparing for practice: Issues in virtual medical education. *Perspectives on Medical Education, 7*(4), 214–218.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Gordon, M., Patricio, M., Horne, L., Muston, A., Alston, S. R., Pammi, M., Thammasitboon, S., Park, S., Pawlikowska, T., Rees, E. L., Doyle, A. J., & Daniel, M. (2020). Developments in medical education in response to the COVID-19 pandemic: A rapid BEME systematic review: BEME Guide No. 63. *Medical Teacher, 42*(11), 1202–1215. https://doi.org/10.1080/0142159X.2020.1807484

Hatala, R., Cook, D. A., Brydges, R., & Hawkins, R. (2015). Constructing a validity argument for the Objective Structured Assessment of Technical Skills (OSATS): A systematic review of validity evidence. *Advances in Health Sciences Education, 20*(5), 1149–1175. https://doi.org/10.1007/s10459-015-9593-1

Kononowicz, A. A., Woodham, L. A., Edelbring, S., Stathakarou, N., Davies, D., Saxena, N., Tudor Car, L., Carlstedt-Duke, J., Car, J., & Zary, N. (2019). Virtual patient simulations in health professions education: Systematic review and meta-analysis by the Digital Health Education Collaboration. *Journal of Medical Internet Research, 21*(7), e14676. https://doi.org/10.2196/14676

Kyaw, B. M., Saxena, N., Posadzki, P., Vseteckova, J., Nikolaou, C. K., George, P. P., Divakar, U., Masiello, I., Kononowicz, A. A., Zary, N., & Tudor Car, L. (2019). Virtual reality for health professions education: Systematic review and meta-analysis by the Digital Health Education Collaboration. *Journal of Medical Internet Research, 21*(1), e12959. https://doi.org/10.2196/12959

Langenau, E., Kachur, E., & Horber, D. (2014). Web-based objective structured clinical examination with remote standardized patients and Skype: Resident experience. *Patient Education and Counseling, 96*(1), 55–62. https://doi.org/10.1016/j.pec.2014.04.016

Masters, K. (2019). Artificial intelligence in medical education. *Medical Teacher, 41*(9), 976–980. https://doi.org/10.1080/0142159X.2019.1595557

Masters, K., Ellaway, R. H., Topps, D., Archibald, D., & Hogue, R. J. (2016). Mobile technologies in medical education: AMEE Guide No. 105. *Medical Teacher, 38*(6), 537–549. https://doi.org/10.3109/0142159X.2016.1141190

McGaghie, W. C., Issenberg, S. B., Barsuk, J. H., & Wayne, D. B. (2014). A critical review of simulation-based mastery learning with translational outcomes. *Medical Education, 48*(4), 375–385. https://doi.org/10.1111/medu.12391

McGaghie, W. C., Issenberg, S. B., Cohen, E. R., Barsuk, J. H., & Wayne, D. B. (2011). Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Academic Medicine, 86*(6), 706–711. https://doi.org/10.1097/ACM.0b013e318217e119

Moro, C., Štromberga, Z., Raikos, A., & Stirling, A. (2021). The effectiveness of virtual and augmented reality in health sciences and medical anatomy. *Anatomical Sciences Education, 14*(3), 305–320. https://doi.org/10.1002/ase.1696

Olum, R., Atulinda, L., Kigozi, E., Nassozi, D. R., Mulekwa, A., Bongomin, F., & Kiguli, S. (2020). Medical education and e-learning during COVID-19 pandemic: Awareness, attitudes, preferences, and barriers among undergraduate medicine and nursing students at Makerere University, Uganda. *Journal of Medical Education and Curricular Development, 7*, 2382120520973212. https://doi.org/10.1177/2382120520973212

Payne, K. F., Wharrad, H., & Watts, K. (2012). Smartphone and medical related app use among medical students and junior doctors in the United Kingdom (UK): A regional survey. *BMC Medical Informatics and Decision Making, 12*(1), 121. https://doi.org/10.1186/1472-6947-12-121

Pottle, J. (2019). Virtual reality and the transformation of medical education. *Future Healthcare Journal, 6*(3), 181–185. https://doi.org/10.7861/fhj.2019-0036

Pugh, D., Touchie, C., Wood, T. J., & Humphrey-Murto, S. (2016). Progress testing: Is there a role for the OSCE? *Medical Education, 50*(6), 623–631. https://doi.org/10.1111/medu.12423

Regmi, K., & Jones, L. (2020). A systematic review of the factors – enablers and barriers – affecting e-learning in health sciences education. *BMC Medical Education, 20*(1), 91. https://doi.org/10.1186/s12909-020-02007-6

Sandars, J., & Lafferty, N. (2010). Twelve tips on usability testing to develop effective e-learning in medical education. *Medical Teacher, 32*(12), 956–960. https://doi.org/10.3109/0142159X.2010.507710

Steinert, Y., Mann, K., Anderson, B., Barnett, B. M., Centeno, A., Naismith, L., Prideaux, D., Spencer, J., Tullo, E., Viggiano, T., Ward, H., & Dolmans, D. (2016). A systematic review of faculty development initiatives designed to enhance teaching effectiveness: A 10-year update: BEME Guide No. 40. *Medical Teacher, 38*(8), 769–786. https://doi.org/10.1080/0142159X.2016.1181851

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer. https://doi.org/10.1007/978-1-4419-8126-4

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences, 39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Wenger-Trayner, E., & Wenger-Trayner, B. (2015). *Introduction to communities of practice: A brief overview*. https://www.wenger-trayner.com/introduction-to-communities-of-practice/

Young, J. Q., Van Merrienboer, J., Durning, S., & Ten Cate, O. (2014). Cognitive load theory: Implications for medical education: AMEE Guide No. 86. *Medical Teacher, 36*(5), 371–384. https://doi.org/10.3109/0142159X.2014.889290