WebLog Journal of Internal Medicine

Review Article
Published: 29 Oct, 2026

From Digital Literacy to Clinical Intelligence: Reimagining Medical Education for the Age of AI, Virtual Care, and Data-Driven Medicine

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Abstract

The realm of digital health is revolutionizing the Knowledge, Skills and Performance (KSP) required by physicians. In this narrative review we describe the transition from basic digital literacy to clinical intelligence in the context of health care education. The major Health Information Technology (HIT) applications in clinical education, namely Artificial Intelligence (AI), generative AI, Virtual Reality (VR), Augmented Reality (AR), simulation, telemedicine, m-learning and learning analytics are presented. These new educational tools have the potential to support individualized learning, immediate feedback, competency assessment, and can facilitate preparation for health care that is increasingly delivered via digital means. Several challenges in the integration of these applications into health care education are identified including the risk of algorithmic bias, patient data privacy, the spread of misinformation, inequality in access to technology, preparedness of faculty to teach with technology, the risk of over-reliance on technology, and the potential to diminish the human element in patient care. Ultimately, health care curricula must move beyond mere mastery of the technical aspects of the digital tools and seek to equip future physicians with the ability to critically evaluate information generated by computers, manage uncertainty, protect patient data, and integrate the best of computational support for clinical care with professional ethics and values. To this end, we propose a DIGITAL-MED competency framework that includes 12 competencies covering data literacy, intelligent AI use, governance, inclusion, telemedicine, applied simulation, lifelong learning, medical ethics, evidence appraisal, and digital professionalism.

Keywords: Digital Health; Medical Education; Artificial Intelligence; Clinical Intelligence; Virtual Care; Digital Professionalism

Abbreviations

AI: Artificial Intelligence; AR: Augmented Reality; CDSS: Clinical Decision Support System; HER: Electronic Health Record; ICT: Information and Communication Technology; ML: Machine Learning; VR: Virtual Reality; XR: Extended Reality; DIGITAL-MED: Data literacy, Intelligent AI use, Governance and cybersecurity, Inclusion, Telemedicine, Applied simulation, Lifelong learning, Medical ethics, Evidence appraisal, and Digital professionalism

Introduction

Health care is undergoing a digital transformation that is affecting how health care is delivered as well as how clinicians make decisions. A number of technologies are becoming increasingly integrated into the clinical setting and into medical education. In addition to knowledge about clinical topics, students of medicine must now acquire digital literacy. They must be able to use the clinical information generated by health care technologies to make decisions about patient care, and to evaluate information in a variety of digital formats. They must also understand the limitations of health care technologies and be able to use clinical judgment in order to provide patient-centred care. Digital technologies have the potential to facilitate learning in a number of ways including the creation of personalized learning plans, the enhancement of access to education for students from around the world, and the use of simulation to create realistic clinical learning environments. However, digital health care technologies also present a number of risks and challenges, including issues related to privacy, bias, misinformation, and equity as well as the potential for over-reliance on

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Received Date: *14 Oct 2026*
Accepted Date: *27 Oct 2026*
Published Date: *29 Oct 2026*

Citation:
Chatterjee S, Kundu S. From Digital Literacy to Clinical Intelligence: Reimagining Medical Education for the Age of AI, Virtual Care, and Data-Driven Medicine. WebLog J Intern Med. wjim.2026.j2906. https://doi.org/10.5281/zenodo.23913080

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Figure 1: Evolution from digital literacy to clinical intelligence in medical education major digital technologies.

automated systems. This narrative review of the technologies that are currently being used in medical education describes the competencies required for health care providers who are able to practice in health care systems that are highly technology-enabled, reviews the numerous benefits and drawbacks of health care technologies, and presents a framework within which students can acquire the clinical intelligence that is required to integrate digital information with clinical expertise, ethical principles, and compassionate human values in order to provide safe and effective patient care.

Objectives

This review explores how AI, virtual care, simulation, learning analytics and other technologies are currently being used to revolutionize medical education. The review sets out the many benefits of these technologies for both clinical and educational purposes and explores the many ethical, pedagogical, infrastructure and equity issues which need to be addressed. It sets out the key digital competencies for future doctors and outlines an integrated framework to develop clinically intelligent and literate doctors who can use evidence from technology and exercise good ethical judgment while delivering patient-centred care of the highest quality.

Evolution from Digital Literacy to Clinical Intelligence

When the term "digital literacy" is used in medical education it often initially refers to using computerized resources, information systems, as well as virtual communication. As technologies such as electronic health records, mobile health apps, telehealth, and online medical education become increasingly prevalent in the health care system, the skills required for digital literacy become broader and include information evaluation, information security, and professional virtual communication. However, with the introduction of artificial intelligence, predictive analytics, generative models, and clinical decision-support systems, a new competency is emerging, that of clinical intelligence. As technology becomes an increasingly prevalent component of patient care, the ability to interpret outputs from algorithms and to make decisions based on both computational evidence and clinical knowledge is becoming more important. This requires not only an understanding of when to trust technology, but also when to question it and why. Therefore, as technology becomes an increasingly integral component of clinical decision-making, the goal of medically educated future physicians should be to become clinically intelligent and accountable, while maintaining a compassionately patient-centred approach to medical care. In order to reach this goal, computer literacy needs to move from a singular, isolated subject in medical school, to a competency that is addressed in a longitudinal and competency-based manner in the classroom, simulation centre, and clinical setting (Figure 1).

Several different digital technologies have the ability to change the way medical students get information, practice clinical skills, and receive feedback. First there's the use of Artificial Intelligence to support adaptive learning, automated assessment, and diagnostic reasoning exercises. Then there's Generative AI which can be used to automatically create lots of different things such as explanations, clinical scenarios, questions, and even dialogues between patients and medics. However, the results need to be verified for accuracy and potential bias and over reliance on such technology. Learning analytics can also be used to support these new technologies to assess student participation, performance, and progression to highlight any learning gaps that may need supporting.

Virtual Reality and Augmented Reality environments are increasingly available to support anatomy study, clinical skills training, management of rare or high-risk clinical situations, learning from complex clinical events and understanding interprofessional care. Simulation that includes feedback and is facilitated by faculty or educators can help students improve their clinical reasoning, teamwork, communication and many other clinical skills. Virtual patients, screen-based simulation and digital twins can be used to test decisions, see consequences of actions and to practice and repeat very complex clinical scenarios.

Telemedicine platforms can also help prepare students for scenarios where history taking, examination and clinical consultation take place remotely. Additionally, resources that are delivered on mobile devices such as learning applications, podcasts, e-books and microlearning on a wide range of topics can be revisited by students at the point of care.

Education can be further enhanced by utilizing tools that connect learning with current health data such as cloud-based collaboration and digital portfolios as well as wearable sensors and remote patient monitoring. The use of blockchain to secure verification of credentials of healthcare students and professionals is another area that is becoming increasingly prominent. Three-dimensional printing of anatomical models as well as patient specific models for surgical rehearsal are also becoming more prevalent and can create unique and personalized experiential learning environments that can be continually assessed.



Figure 2: Proposed DIGITAL-MED competency framework for medical education.

Table 1: Major digital technologies and their applications in medical education.

Digital Technologies	Educational Applications	Principal Benefits	Key Limitations
Artificial Intelligence and Machine Learning	Adaptive learning, automated assessment, diagnostic exercises and personalised feedback	Supports individualised learning and identifies competency gaps	Algorithmic bias, opacity, privacy concerns and automation dependence
Generative AI	Creation of clinical cases, explanations, quizzes, simulated dialogue and formative feedback	Enables interactive, rapid and scalable learning support	Hallucinations, misinformation, academic misconduct and overreliance
Virtual and Augmented Reality	Anatomy education, procedural rehearsal, surgical training and emergency simulations	Provides immersive, repeatable and riskfree practice	High costs, technical requirements and simulation sickness
Virtual Patients and Digital Twins	Clinical reasoning, decision-making and observation of treatment consequences	Enables exposure to rare or complex clinical scenarios	Limited realism and dependence on model accuracy
Telemedicine Platforms	Virtual consultation, remote examination, documentation and communication training	Prepares learners for virtual care and expands clinical access	Digital inequality, privacy risks and limited physical examination
Learning Analytics	Performance monitoring, early identification of difficulties and curriculum evaluation	Facilitates timely support and competency tracking	Surveillance concerns, data bias and misinterpretation
Electronic Health Records	Documentation, medication safety, data interpretation and teambased workflows	Improves readiness for contemporary clinical practice	Cognitive burden, usability problems and confidentiality risks
Mobile and Cloudbased Learning	Microlearning, digital portfolios, collaborative education and point-ofcare access	Supports flexible, accessible and selfdirected learning	Distraction, inconsistent quality and internet dependence

Digital Health Competencies

The concept of health in the digital age extends beyond using devices and software and thus needs to be operationalized for medical learners. They have to become data literate and be able to read out health information from IT systems, to assess the quality of the data, to understand analytics and to recognize the unsurity of results. Furthermore, they have to become AI literate and understand how algorithms and models have been validated and how they can be applied in medical settings. They have to be able to recognize bias, hallucinated information, automation errors and inappropriate recommendations.

To practice responsibly, future physicians must become aware of the range of ethical considerations, such as privacy, security, patient autonomy, and accountability, that are relevant in a digital age. Professionals also require an understanding of what constitutes proper online behavior and of the responsible use of social media. The entire range of health care tools must also be critically appraised for factors such as accuracy, usability, accessibility, effectiveness, and cost.

Further competencies for doctors include teamwork in multidisciplinary digitally connected teams, using of electronic health records effectively and explaining of results from algorithms to patients in an appropriate manner. These new competencies also need to take account of cultural sensitivity and of equity in health in order to address the inequalities that currently exist with regards to access to health care by means of digital technologies, across languages, with disabilities and on the basis of economic and social circumstances. The outputs of technologies must be assessed in the light of clinical expertise, ethical considerations, of specific situations and of patients' preferences and wishes, and a final clinical decision taken by the doctor.

Educational and Clinical Benefits

Digital health technologies can deliver personalized, accessible, experiential and learning needs-focused medical education. Adaptive learning software can provide students with learning paths tailored to their performance, as well as automated feedback to enable rapid identification of learner errors and the opportunity to correct them. Online resources, and mobile learning delivered via tablets and smartphones, can extend the reach of classroom based learning and support students to engage in flexible, self-directed, and lifelong learning.

Additionally, virtual patients, immersive simulation and augmented reality can be used to deliver repeated practices of key diagnostic, procedural and communication skills, all without the risk of harming patients.

In addition, digital health technologies can be used to implement clinical training that uses electronic health records, telemedicine, decision support systems and remote monitoring in order to familiarize students with current medical work processes and to support documentation, the analysis of data and interprofessional

Table 2: Core domains of the proposed DIGITAL-MED competency framework.

Domains	Core Competency	Suggested Educational Strategy	Assessment Approach
D - Data Literacy	Interpret clinical data, assess data quality and recognise uncertainty	Electronic health record exercises and datainterpretation cases	Case-based examination and data-appraisal task
I - Intelligent AI use	Critically evaluate AI outputs, bias, hallucinations and clinical relevance	Algorithm-appraisal workshops and AI-assisted clinical scenarios	Validated AI-output critique
G - Governance	Apply privacy, consent, cybersecurity and accountability principles	Ethics discussions and data-breach simulations	Scenario-based ethical assessment
I - Inclusion	Recognise digital inequalities and provide accessible, culturally appropriate care	Equity-focused case discussions and accessibility audits	Reflective assignment or structured case analysis
T - Telemedicine	Conduct safe, professional and patientcentred virtual consultations	Supervised teleconsultations and virtual patient encounters	Telemedicine-based OSCE
A - Applied Simulation	Practise clinical reasoning, procedures, teamwork and emergency responses	Virtual reality, augmented reality and simulation laboratories	Simulation-based competency assessment
L - Lifelong Digital Learning	Continuously update digital knowledge and evaluate emerging technologies	Digital portfolios, microlearning and continuing education	Portfolio review and reflective assessment
MED - Medical Ethics, Evidence Appraisal and Digital Professionalism	Integrate ethical judgement, research evidence and professional accountability with technology use	Journal appraisal, professionalism modules and patientcentred cases	Critical appraisal and professionalism evaluation

care as well as the continuity of care.

Technologies such as digital health systems can enhance many aspects of a student's learning including engagement, confidence, clinical reasoning and preparation for practice that is increasingly technology-enabled. Importantly however, the technologies should be used to enhance and support educational objectives, not replace them. The benefit of health technologies for learning is to enable more deliberate practice, timely feedback, equitable access to learning opportunities and evidence-based practice. Hence their effective integration can bring learning more closely into line with safe, effective and patient-centred clinical care.

Challenges and Risks

Risks associated with digital technologies in medical education are also to be considered, including educational, ethical and clinical risks. Unequal access to Internet, to end devices and to adequate support as well as to platforms, can lead to an inequality between students, between institutions and even between regions. Limited faculty competence, inadequate infrastructures, high costs and resistance to introduce new topics into the curricula are potential barriers to implementation. Screen-based learning may also lead to a reduced number of contacts with patients and thus to an impairment of communication skills and an increased risk of cognitive overload, of exhaustion and of an unhealthy technology addiction. Intelligent systems can also generate output that has been commissioned by someone else thereby posing the risk of academic misconduct.

Furthermore, students may mindlessly accept suggestions from algorithms or commission work to be generated by others through online services. And the big challenge is how learner data and patient data are collected, processed and stored. Who is responsible for the data? Where does it go? Who can access the data? Such are the major risks to be managed when using Intelligent Systems in health care education.

The evidence to support use of technology in education is generally of poor quality, heterogeneous, short-term and tends to show high levels of satisfaction rather than measurable improvements in clinical outcomes. Thus, robust governance, transparent validation, faculty development, inclusive design, cybersecurity measures, and ethical stances are required to reduce risks and enable technology to support, rather than replace, supervised learning, clinical judgment and responsibility of health education teachers, students and patients.

Proposed Framework

We propose the DIGITAL-MED Framework for medical education through digital literacy translation into clinical intelligence. DIGITAL-MED is an acronym for 9 interrelated areas or domains that can enable technological capabilities to be connected to critical thinking, accountability and patient-centred practice, and these are: Data literacy; Intelligent and responsible artificial intelligence use; Governance, privacy, and cybersecurity; Inclusion and equitable access; Telemedicine and technology-mediated communication; Applied simulation and immersive learning; Lifelong digital learning; and Medical ethics, Evidence appraisal, and Digital professionalism.

A curriculum based on the DIGITAL-MED Framework should be implemented across the different stages of medical education. The knowledge of the different DIGITAL-MED domains should be transmitted in modules, through demonstrations and by means of case discussions in the early stages of medical education. In the intermediate stages the application of the DIGITAL-MED domains should be stressed by means of virtual patients, simulation, the use of electronic health records, and by means of teleconsultations. The advanced learner can demonstrate supervised integration of digital evidence in complex clinical decisions.

Assessments using exams, telehealth observations, simulations, Health Information Technology (HIT) portfolios, algorithm evaluations, and reflective papers or assignments will measure learners' clinical decisions based on digital evidence. Digital literacy and technology skills can be measured through entrustable activities such as selecting appropriate technology, identifying technology limitations, ensuring patient confidentiality, and effectively communicating digital information to patients and other healthcare providers. Faculty, technology, patient, and curriculum development support are essential to implementation of the DIGITAL-MED Framework to promote safe use of technology while ensuring that learners are able to make clinical decisions using digital information.

Future Directions

Future medical education will take place in intelligent, immersive and adaptable learning environments. Generative AI can act as tutor, patient, feedback provider and clinical reasoning assistant. Multimodal systems process text, speech, images, genetics and physiological data and enable their integration into learning scenarios. Virtual and

augmented reality as well as haptic systems, digital twins and high-fidelity simulations will increase the scope of individualised training of surgical procedures. Learning analytics will identify competency gaps of learners and support them with precision education.

This new pedagogy will have to incorporate in curriculum and training programs of new healthcare solutions using remote monitoring, wearables, robotic, precision and virtual care delivered from decentralized locations. As with any educational innovation, rigorous evaluation, transparent algorithmic validation, education for safe use of health IT, equitable access to education, and meaningful patient involvement are needed.

Future research on the integration of new technologies into medical education should move on from mere assessment of student satisfaction and short-term gains in knowledge, and evaluate the impact of technology on clinical performance, patient safety, and the professional behavior of students and doctors alike. The costs and long-term benefits of such technology for learning and medical practice should also be assessed. Digitalization of medical education must be managed by multidisciplinary governance groups consisting of stakeholders such as educators, clinicians, technologists, ethicists, patients and students. These new technologies should strengthen, rather than undermine, the humanistic side of medicine and allow more time for communication, reflection, for empathy and for joint decision-making.

Conclusion

Health digitalization is increasingly replacing the classical education within classrooms with the creation of a data-based learning ecosystem. Of utmost importance to establish this kind of educational setting are AI applications, virtual simulations, telemedicine, learning analytics, and mobile health applications. However, in order to create added value for education and patients alike, digitalization in health must be supported by high-quality pedagogy and the necessary infrastructure and human resources. Health digitalization must also be sufficiently governed and continuously evaluated. Accordingly, in addition to teaching digital literacy in medical education, it is increasingly important to impart clinical intelligence to future physicians, i.e. to enable them to deal critically with health data and applications and to combine the results of digital applications with their professional expertise, their ethical views, and the patients' views and needs. Within the proposed DIGITAL-MED Framework, these capabilities are to be taught systematically in all phases of the medical curriculum. The use of digital health applications in education must support patient involvement and the human dimension of health care and must never replace the physicians' decisions and actions. Clinically intelligent physicians are required to ensure that health care is delivered in a evidence-based and compassionate manner.

Illustration Declaration

The authors gratefully acknowledge OpenAI's DALL·E platform for assisting in the creation of the conceptual illustrations presented in this article. The authors reviewed and refined all figures to ensure their scientific relevance and accuracy.

Ethical Approval

Not required because this narrative review used previously published, nonidentifiable information.

Funding

No specific funding was received.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. World Health Organization. Global strategy on digital health 2020–2027. 2021.
2. World Health Organization. Digital education for building health workforce capacity. 2020.
3. Car J, Ong QC, Fox TE, Leightley D, Kemp SJ, Švab I, et al. The Digital Health Competencies in Medical Education Framework: an international consensus statement based on a Delphi study. JAMA Netw Open. 2025; 8(1): e2453131.
4. Boillat T, Otaki F, Baghestani A, Zarnegar L, Kellett C. A landscape analysis of digital health technology in medical schools: preparing students for the future of health care. BMC Med Educ. 2024; 24: 1011.
5. Lee J, Wu AS, Li D, Kulasegaram KM. Artificial intelligence in undergraduate medical education: a scoping review. Acad Med. 2021; 96(11S): S62-S70.
6. Chan KS, Zary N. Applications and challenges of implementing artificial intelligence in medical education: integrative review. JMIR Med Educ. 2019; 5(1): e13930.
7. Wartman SA, Combs CD. Medical education must move from the information age to the age of artificial intelligence. Acad Med. 2018; 93(8): 1107-1109.
8. Kolachalama VB, Garg PS. Machine learning and medical education. NPJ Digit Med. 2018; 1: 54.
9. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019; 25(1): 44-56.
10. Masters K. Artificial intelligence in medical education. Med Teach. 2019; 41(9): 976980.
11. Boscardin CK, Gin B, Golde PB, Hauer KE. ChatGPT and generative artificial intelligence for medical education: potential impact and opportunity. Acad Med. 2024; 99(1): 22-27.
12. Sallam M. ChatGPT utility in healthcare education, research, and practice: systematic review on the promising perspectives and valid concerns. Healthcare. 2023; 11(6): 887.
13. Feigerlova E, Hani H, Hothersall-Davies E. A systematic review of the impact of artificial intelligence on educational outcomes in health professions education. BMC Med Educ. 2025; 25: 129.
14. Lee YM. Artificial intelligence competencies for medical graduates: outcomes of a Delphi survey and medical student–educator questionnaire. Acad Med. 2024; 99(5): 524-533.
15. Garvey KV, Thomas CKJ, Russell R, Novak LL, Moore D, Miller BM. Considering clinician competencies for the implementation of artificial intelligence based tools in health care: findings from a scoping review. JMIR Med Inform. 2022; 10(11): e37478.
16. Kyaw BM, Saxena N, Posadzki P, Vseteckova J, Nikolaou CK, George PP, et al. Virtual reality for health professions education: systematic review and meta-analysis by the Digital Health Education Collaboration. J Med Internet Res. 2019; 21(1): e12959.
17. Kim HY, Kim EY. Effects of medical education programs using virtual reality: a systematic review and meta-analysis. Int J Environ Res Public Health. 2023; 20(5): 3895.
18. Tene T, Vique LDF, Valverde APE, Puente LMO, Gomez CV. Virtual reality and augmented reality in medical education: an umbrella review. Front Digit Health. 2024; 6: 1365345.
19. Waseh S, Dicker AP. Telemedicine training in undergraduate medical education: mixed-methods review. JMIR Med Educ. 2019; 5(1): e12515.

20. Budakoğlu İİ, Sayılır MÜ, Kıyak YS, Coşkun Ö, Kula S. Telemedicine curriculum in undergraduate medical education: a systematic search and review. Health Technol. 2021; 11: 773-781.

21. Stovel RG, Gabarin N, Cavalcanti RB, Abrams H. Curricular needs for training telemedicine physicians: a scoping review. Med Teach. 2020; 42(11): 1234-1242.

22. Pit SW, Velovski S, Cockrell K, Bailey J. A qualitative exploration of medical students' placement experiences with telehealth during COVID-19 and recommendations to prepare the future medical workforce. BMC Med Educ. 2021; 21:331.

23. Ellaway RH, Coral J, Topps D, Topps M. Exploring digital professionalism. Med Teach. 2015; 37(9): 844-849.

24. O'Connor S, Zhang M, Honey M, Lee JJ. Digital professionalism on social media: a narrative review of the medical, nursing, and allied health education literature. Int J Med Inform. 2021; 153: 104514.

25. Kaczmarczyk JM, Chuang A, Dugoff L, Abbott JF, Cullimore AJ, Dalrymple J, et al. E-professionalism: a new frontier in medical education. Teach Learn Med. 2013; 25(2): 165-170.