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Technological Literacy as a Framework for Health Professions Education in the Digital Era

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Abstract. With increasing use of information and communications technologies (ICTs) in health, and rapid technological changes, there is a pressing need to prepare current and future health professionals to use ICTs as an integral part of their practice. We propose the *Technological Literacy Framework*, which includes 3 interlinked elements—knowledge, capabilities, and critical thinking and decision making—as an overarching structure for organizing and designing competencies, learning objectives, and educational interventions for health professions education in the digital era. We provide examples of EHR and telehealth educational interventions and how they map to the framework.

Keywords. Informatics education, technological literacy, telehealth, electronic health record

1. Introduction

Widespread implementation of information and communication technologies (ICTs) in health care (e.g., electronic health records [EHRs], clinical decision support [CDS], patient portals, and mobile apps) has transformed care delivery and patient engagement. Recently, the COVID-19 pandemic accelerated the adoption of telehealth and developments in generative artificial intelligence (AI) have supercharged interest in augmented medicine [1, 2]. While these developments hold tremendous promise, they

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are also disruptive innovations that herald a change in how clinicians train and practice [3].

Clinical experts, national advisory bodies, and industry stakeholders agree there is a pressing need to prepare current and future health professionals to use ICTs as an integral part of their practice [4]. This need extends beyond current technologies to emerging applications and future innovations that could transform traditional professional roles, create ethical dilemmas, and challenge our collective ability to preserve humanistic health care. In health professions education (HPE), we need a framework to guide competency and curriculum development, and training initiatives on the use of ICTs. We propose Technological Literacy as one such framework and illustrate how its components interact and direct the creation of educational interventions.

2. Selecting a Framework for Health Professions Education in the Digital Era

A framework for guiding HPE in the digital era must be flexible; capable of adapting to new technologies and fostering life-long learning. Additionally, it needs to allow for competencies beyond the basic use of the technology. Realizing the benefits and potential of ICT in health requires advanced use [5]. For example, to better care for people with diabetes, we must leverage EHR features such as CDS to align with guideline-based care and patient registries to identify those needing intervention, and interfaces to support patient self-monitoring, reporting, and management. Research has shown that simple, scalable strategies (e.g., EHR video tutorials) can influence clinical practice [6].

In deploying current ICTs, we have seen systems affect practice in both intended and unintended ways. For example, EHR implementation fundamentally changes the way clinicians interact with patients [7]. Using technologies like computerized provider order entry (CPOE) often translates to more or new work, changes in workflow, and clinician overdependence on technology [8]. Similarly, we may see unintended consequences of AI applications including changes to roles and work processes of health care professionals [4, 9], factual errors or the perpetuation of existing practice biases by codifying societal biases and inequities reflected in training sets [10]. The *Technological Literacy Framework* described herewith addresses these concerns and can guide educational initiatives to prepare clinicians for the digital era of health care.

3. Technological Literacy

Technological literacy has been defined as "the ability to use, manage, assess, and understand technology" [11]. It consists of: (1) ***knowledge*** of and about technology; (2) ***capability*** to use the technology to solve problems; and (3) ***critical thinking and decision making*** when weighing the risks and benefits of technology. A technologically literate person should be able to [11]:

- "recognize the pervasiveness of technology in everyday life", be familiar with the technology design process and its limitations, and understand the associated risks with technology that cannot always be predicted (***knowledge***);
- operate the technology and solve simple technical problems (***capabilities***); and

- ask well-informed questions about technology limitations, weigh risks and benefits of use, and participate in decisions about the development and deployment of technology (***critical thinking and decision making***).

Knowledge, capabilities, and critical thinking can be depicted as three axes in 3-dimensional space. A person starts at a certain point within this space; education and training help the learners move farther along one or more of these axes.

Notably, the three dimensions of technological literacy are not separate, but rather, interlinked, and interdependent [11]. They are dynamic and may evolve as a result of each other. In the following examples, we illustrate these concepts and how they inform educational interventions for EHRs and virtual care.

4. Using the Technological Literacy Framework to Inform Health Professions Education

4.1. Example 1: Electronic Health Records (EHRs)

It is crucial to ***know*** that EHRs can be used for purposes beyond direct patient care. They can be used to proactively manage patients at a population level, store and organize data for research and quality improvement (QI), and support patient education and engagement beyond the clinical visit. To achieve this, several ***capabilities*** are required. First, clinicians must be able to use advanced EHR features to generate patient quality measures reports. Second, until ambient AI is commonplace, clinicians must document complete and structured data in the EHR so that research and QI efforts can retrieve complete, accurate, and sufficiently granular data. Third, clinicians must be facile using the EHR as a patient-centered communication tool. We developed educational interventions to teach these capabilities, including video tutorials on advanced EHR features [6] and exploration-based learning for quality data entry [12].

Critical thinking about the application of these capabilities requires clinicians to recognize the limitations and unintended consequences associated with EHR use. For example, asking clinicians to document research-quality data is burdensome and can contribute to burnout [13]. Shifting documentation responsibilities to trainees may detract from their education and well-being [14, 15]. Given EHR use can affect clinical reasoning, decision-making, and patient-clinician communication [7], it is important to provide communication training (e.g., educational infographics, simulations, didactics, and observed structured clinical exams [OSCEs]) [16-19] to patients and clinicians alike to promote competent and humanistic use of the technology in practice.

4.2. Example 2: Telehealth

Over the last three years, we developed and piloted a telemedicine curriculum designed for medical students and residents in primary care specialties [20]. The *Technology Literacy Framework* was a natural fit for sequencing content and evaluating learner performance. We began by introducing foundational and cross-cutting ***knowledge***. For example, practitioners must know about universal communication precautions and how they are crucial in telemedicine to build rapport, help patients use the technology, and gather a complete and accurate history [21]. They then need to acquire the ***capabilities***

to apply this in their practice. Learners should then be able to describe to their patients the uses, benefits, and limitations of telemedicine [22].

In this case, the *Technology Literacy Framework* serves as an operator's manual for how to guide learners from basic knowledge acquisition to higher order thinking skills. To practice skills and engage critical thinking in telemedicine, we used a mixture of instructional techniques including simulations, one-on-one coaching, large group discussions, and small group exercises. For example, we incorporated a standardized technology failure into a telemedicine simulation so learners could learn in a safe and supportive setting the ability to troubleshoot technology and recover an encounter [23].

Critical thinking in the context of telemedicine includes realizing the pros and cons of various communication media, which translates to the capability of choosing a medium that fits for individual situations. It requires the ability to assess patient safety during a telehealth encounter, identify risks and failure modes, and proactively prepare for emergencies. For example, many mental health conditions are suitable for telepsychiatry, but the practitioner should always be prepared to escalate care quickly. If a patient with major depressive disorder expresses suicidal ideation, the clinician should be able to either guide the patient to live emergency services or dispatch services to the patient's physical location. We, therefore, designed a simulation wherein the student must conduct a suicide risk severity assessment and formulate a safety plan with the patient, engage community resources, or guide the patient to a hospital admission [24].

5. Discussion

We illustrate how the *Technological Literacy Framework* can inform educational initiatives e.g., for EHRs and telehealth. The framework is adaptable and can help define both basic capabilities and higher-level skills (e.g., critical thinking and decision making) thereby meeting the required criteria we set forth.

The importance of practical experience and research for educational interventions cannot be underestimated; especially since not all impacts of technology can be anticipated from the outset. For example, the impacts of EHRs on patient-clinician interactions and physician burnout were revealed over time, requiring new ways to critically think about EHRs and for new capabilities to be taught. As a general, broad framework that is not overly specific, *Technological Literacy* supports future adaptations and changes to the details underneath each element of the framework.

5.1. Limitations

We were not aware of the *Technological Literacy Framework* when we designed the educational initiatives described above. Therefore, the examples provided represent a retrospective analysis. Nevertheless, we find the framework useful and propose that it is used prospectively in developing competencies, programs, curricula, and educational interventions for HPE in the digital era. For future work, it would be useful to implement the framework from the outset and evaluate it using data collected throughout the educational intervention. This research would also help update and modify the theoretical framework to adapt for the specific context of HPE in the digital era.

References

[1] Doraiswamy S, Abraham A, Mamtani R, Cheema S. Use of telehealth during the COVID-19 pandemic: scoping review. J Med Internet Res. 2020;22(12):e24087, doi: 10.2196/24087

[2] Haug CJ, Drazen JM. Artificial intelligence and machine learning in clinical medicine, 2023. N Engl J Med. 2023;388(13):1201-8, doi: 10.1056/NEJMra2302038

[3] Briganti G, Le Moine O. Artificial intelligence in medicine: today and tomorrow. Front Med. 2020;7, doi: 10.3389/fmed.2020.00027

[4] Cornelius J A, Wachter RM, Woolliscroft JO. Preparing clinicians for a clinical world influenced by artificial intelligence. JAMA. 2022;327(14):1333-4, doi: 10.1001/jama.2022.3580

[5] Monkman H, Mir S, Borycki EM, Courtney KL, Bond J, Kushniruk AW. Updating professional competencies in health informatics: a scoping review and consultation with subject matter experts. Int J of Med Inform. 2023;170:104969, doi: 10.1016/j.ijmedinf.2022.104969

[6] Randhawa GK, Shachak A, Courtney KL, Kushniruk A. Evaluating a post-implementation electronic medical record training intervention for diabetes management in primary care. BMJ Health Care Inform. 2019;26(1):e100086, doi: 10.1136/bmjhci-2019-100086

[7] Crampton NH, Reis S, Shachak A. Computers in the clinical encounter: a scoping review and thematic analysis. Journal of the American Medical Informatics Association: J Am Med Inform Assoc. 2016;23(3):654-65, doi: 10.1093/jamia/ocv178

[8] Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2006;13(5):547-56, doi: 10.1197/jamia.M2042

[9] Coiera E. The price of artificial intelligence. Yearb Med Inform. 2019;28(1):14-5, doi: 10.1055/s-0039-1677892

[10] Parikh RB, Teeple S, Navathe AS. Addressing bias in artificial intelligence in health care. JAMA. 2019;322(24):2377-8, doi: 10.1001/jama.2019.18058

[11] National Research Council. Tech tally: approaches to assessing technological literacy: National Academies Press; 2006, 10.17226/11691

[12] Crampton NH. Teaching electronic medical record (EMR) data discipline to clinical trainees: a Canadian pilot study: University of Toronto; 2020.

[13] Arndt BG, Beasley JW, Watkinson MD, Temte JL, Tuan W-J, Sinsky CA, et al. Tethered to the EHR: primary care physician workload assessment using EHR event log data and time-motion observations. Ann Fam Med. 2017;15(5):419-26, doi: 10.1370/afm.2121

[14] Cassese T, Sharkey MS, Pincavage AT, Schwanz K, Farnan JM. Avoiding pitfalls while implementing new guidelines on student documentation. Ann Intern Med. 2019;170(3):193-4, doi: 10.7326/M18-1924

[15] Gagliardi JP, Turner DA. The electronic health record and education: rethinking optimization. J Grad Med Educ. 2016;8(3):325-7, doi: 10.4300/JGME-D-15-00275.1

[16] Alkureishi M, Lee WW, Farnan J, Arora V. Breaking away from the iPatient to care for the real patient: implementing a patient-centered EMR use curriculum. MedEdPORTAL.10:9953, doi: 10.15766/mep_2374-8265.9953

[17] Alkureishi MA, Lee WW, Webb S, Arora V. Integrating patient-centered electronic health record communication training into resident onboarding: curriculum development and post-implementation survey among housestaff. JMIR Med Educ. 2018;4(1):e1, doi: 10.2196/mededu.8976

[18] Shachak A, Domb S, Borycki E, Fong N, Skyrme A, Kushniruk A, et al. A pilot study of computer-based simulation training for enhancing family medicine residents' competence in computerized settings. Stud Health Technol Inform. 2015;216:506-10, doi: 10.3233/978-1-61499-564-7-506

[19] Alkureishi MA, Johnson T, Nichols J, Dhodapkar M, Czerwiec MK, Wroblewski K, et al. Impact of an educational comic to enhance patient-physician–electronic health record engagement: prospective observational study. JMIR Hum Factors. 2021;8(2):e25054, doi: 10.2196/25054

[20] Lesselroth B, et al. Assessing telemedicine competencies: developing and validating learner measures for simulation-based telemedicine training. AMIA Annu Symp Proc. 2023;2023:474-83.

[21] Coleman C. Health literacy and clear communication best practices for telemedicine. Health Lit Res Pract. 2020;4(4):e224-e9, doi: 10.3928/24748307-20200924-01

[22] Association of American Medical Colleges (AAMC). Telehealth competencies across the learning continuum. AAMC New and Emerging Areas in Medicine Series. Washington, DC: AAMC; 2021.

[23] Monkman H, Palmer R, Ijams S, Kollaja L, Rodriguez KA, Liew A, et al. Using simulations to train medical students for unanticipated technology failures in telemedicine. Stud Health Technol Inform. 2022;294:775-9, doi: 10.3233/shti220582

[24] Liew A, Monkman H, Palmer R, Kollaja L, Rodriguez K, Ijams S, et al. A telepsychiatry simulation for suicide assessment: teaching telemedicine safety competencies. AMIA Annu Symp Proc. 2022;2022:700-8.