Tech-Empowered Health Workers: Skills for the Future
Competencies and Curricula Across the Spectrum of Learners in Health/Clinical Informatics

William Hersh, MD
Professor
Department of Medical Informatics & Clinical Epidemiology
School of Medicine
Oregon Health & Science University
Portland, OR, USA
https://www.ohsu.edu/informatics
Email: hersh@ohsu.edu
Web: http://www.billhersh.info/
Blog: https://informaticsprofessor.blogspot.com/
X/Twitter: @williamhersh
BlueSky: @billhersh.bsky.social

References

Benda, N.C., Veinot, T.C., Sieck, C.J., Ancker, J.S., 2020. Broadband Internet Access Is a Social Determinant of Health! Am J Public Health 110, 1123–1125. https://doi.org/10.2105/AJPH.2020.305784

Bichel-Findlay, J., Koch, S., Mantas, J., Abdul, S.S., Al-Shorbaji, N., Ammenwerth, E., Baum, A., Borycki, E.M., Demiris, G., Hasman, A., Hersh, W., Hovenga, E., Huebner, U.H., Huesing, E.S., Kushniruk, A., Hwa Lee, K., Lehmann, C.U., Lillehaug, S.-I., Marin, H.F., Marschollek, M., Martin-Sanchez, F., Merolli, M., Nishimwe, A., Saranto, K., Sent, D., Shachak, A., Udayasankaran, J.G., Were, M.C., Wright, G., 2023. Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics: Second Revision. Int J Med Inform 170, 104908. https://doi.org/10.1016/j.ijmedinf.2022.104908

Cox, S.M., Johnson, S.B., Shiu, E., Boren, S., 2021. The national landscape of culminating experiences in master's programs in health and biomedical informatics. Journal of the American Medical Informatics Association. https://doi.org/10.1093/jamia/ocaa348

Forman, T.M., Armor, D.A., Miller, A.S., 2020. A Review of Clinical Informatics Competencies in Nursing to Inform Best Practices in Education and Nurse Faculty Development. Nurs Educ Perspect 41, E3–E7. https://doi.org/10.1097/01.NEP.0000000000000588

Fridsma, D.B., 2018. Health informatics: a required skill for 21st century clinicians. BMJ 362. https://doi.org/10.1136/bmj.k3043

Friedman, C.P., 2013. What informatics is and isn't. J Am Med Inform Assoc 20, 224–226. https://doi.org/10.1136/amiajnl-2012-001206

Friedman, C.P., 2009. A "fundamental theorem" of biomedical informatics. J Am Med Inform Assoc 16, 169–170. https://doi.org/10.1197/jamia.M3092

Gadd, C.S., Steen, E.B., Caro, C.M., Greenberg, S., Williamson, J.J., Fridsma, D.B., 2020. Domains, tasks, and knowledge for health informatics practice: results of a practice analysis. J Am Med Inform Assoc 27, 845–852. https://doi.org/10.1093/jamia/ocaa018

Gardner, R.M., Overhage, J.M., Steen, E.B., Munger, B.S., Holmes, J.H., Williamson, J.J., Detmer, D.E., AMIA Board of Directors, 2009. Core content for the subspecialty of clinical informatics. J Am Med Inform Assoc 16, 153–157. https://doi.org/10.1197/jamia.M3045

Glasziou, P., Burls, A., Gilbert, R., 2008. Evidence based medicine and the medical curriculum. BMJ 337. https://doi.org/10.1136/bmj.a1253

Greenes, R.A., Florance, V., Miller, R.A., 2022. Don Lindberg's Influence on Future Generations: The U.S. National Library of Medicine's Biomedical Informatics Research Training Programs. Stud Health Technol Inform 288, 43–50. https://doi.org/10.3233/SHTI210980

Hersh, W., 2024a. A Quarter-Century of Online Informatics Education: Learners Served and Lessons Learned. J Med Internet Res 26, e59066. https://doi.org/10.2196/59066

Hersh, W., 2024b. Search still matters: information retrieval in the era of generative AI. J Am Med Inform Assoc 31, 2159–2161. https://doi.org/10.1093/jamia/ocae014

Hersh, W., 2022. Competencies and Curricula Across the Spectrum of Learners for Biomedical and Health Informatics. Stud Health Technol Inform 300, 93–107. https://doi.org/10.3233/SHTI220944

Hersh, W., 2009. A stimulus to define informatics and health information technology. BMC Med Inform Decis Mak 9, 24. https://doi.org/10.1186/1472-6947-9-24

Hersh, W., Biagioli, F., Scholl, G., Gold, J., Mohan, V., Kassakian, S., Kerns, S., Gorman, P., 2017. From Competencies to Competence: Model, Approach, and Lessons Learned from Implementing a Clinical Informatics Curriculum for Medical Students, in: Health Professionals' Education in the Age of Clinical Information Systems, Mobile Computing and Social Networks. Elsevier, pp. 269–287.

Hersh, W., Ehrenfeld, J., 2020. Clinical Informatics, in: Health Systems Science, 2nd Edition. pp. 156–170.

Hersh, W., Fultz Hollis, K., 2024. Results and implications for generative AI in a large introductory biomedical and health informatics course. NPJ Digit Med 7, 247. https://doi.org/10.1038/s41746-024-01251-0

Hersh, W., Williamson, J., 2007. Educating 10,000 informaticians by 2010: the AMIA 10x10 program. Int J Med Inform 76, 377–382. https://doi.org/10.1016/j.ijmedinf.2007.01.003

Hersh, W.R., 2022. Health Informatics: Practical Guide, 8th Edition. Lulu.com.

Hersh, W.R., Gorman, P.N., Biagioli, F.E., Mohan, V., Gold, J.A., Mejicano, G.C., 2014. Beyond information retrieval and electronic health record use: competencies in clinical informatics for medical education. Adv Med Educ Pract 5, 205–212. https://doi.org/10.2147/AMEP.S63903

Kulikowski, C.A., Shortliffe, E.H., Currie, L.M., Elkin, P.L., Hunter, L.E., Johnson, T.R., Kalet, I.J., Lenert, L.A., Musen, M.A., Ozbolt, J.G., Smith, J.W., Tarczy-Hornoch, P.Z., Williamson, J.J., 2012. AMIA Board white paper: definition of biomedical informatics and specification of core competencies for graduate education in the discipline. J Am Med Inform Assoc 19, 931–938. https://doi.org/10.1136/amiajnl-2012-001053

McCarthy, K.A., Eldredge, C., Mercado, F., Wong, A., Gajjar, R., 2024. Characteristics of U.S. Baccalaureate Health Informatics Programs. Appl Clin Inform 15, 778–784. https://doi.org/10.1055/a-2368-3514

Meehan, R., Sharp, J., 2023. Making a Difference, 1st edition. ed. Productivity Press.

Mollick, E.R., Mollick, L., 2023. Assigning AI: Seven Approaches for Students, with Prompts. https://doi.org/10.2139/ssrn.4475995

Moore, J.H., Boland, M.R., Camara, P.G., Chervitz, H., Gonzalez, G., Himes, B.E., Kim, D., Mowery, D.L., Ritchie, M.D., Shen, L., Urbanowicz, R.J., Holmes, J.H., 2019. Preparing next-generation scientists for biomedical big data: artificial intelligence approaches. Per Med 16, 247–257. https://doi.org/10.2217/pme-2018-0145

Otero, P., Hersh, W., Luna, D., González Bernaldo de Quirós, F., 2010. A medical informatics distance-learning course for Latin America. Translation, implementation and evaluation. Methods Inf Med 49, 310–315. https://doi.org/10.3414/ME09-02-0009

Patel, T.N., Chaise, A.J., Hanna, J.J., Patel, K.P., Kochendorfer, K.M., Medford, R.J., Mize, D.E., Melnick, E.R., Hron, J.D., Youens, K., Pandita, D., Leu, M.G., Ator, G.A., Yu, F., Genes, N., Baker, C.K., Bell, D.S., Pevnick, J.M., Conrad, S.A., Chandawarkar, A.R., Rogers, K.M., Kaelber, D.C., Singh, I.R., Levy, B.P., Finnell, J.T., Kannry, J., Pageler, N.M., Mohan, V., Lehmann, C.U., 2024. Structure and Funding of Clinical Informatics Fellowships: A National Survey of Program Directors. Appl Clin Inform 15, 155–163. https://doi.org/10.1055/a-2237-8309

Payne, P.R.O., Bernstam, E.V., Starren, J.B., 2018. Biomedical informatics meets data science: current state and future directions for interaction. JAMIA open 1, 136–141. https://doi.org/10.1093/jamiaopen/ooy032

Presiado, M., Montero, A., Lopes, L., Published, L.H., 2024. KFF Health Misinformation Tracking Poll: Artificial Intelligence and Health Information. KFF. URL https://www.kff.org/health-misinformation-and-trust/poll-finding/kff-health-misinformation-tracking-poll-artificial-intelligence-and-health-information/ (accessed 10.18.24).

Russell, R.G., Lovett Novak, L., Patel, M., Garvey, K.V., Craig, K.J.T., Jackson, G.P., Moore, D., Miller, B.M., 2023. Competencies for the Use of Artificial Intelligence-Based Tools by Health Care Professionals. Acad Med 98, 348–356. https://doi.org/10.1097/ACM.0000000000004963

Safran, C., 2009. Informatics training for clinicians is more important than hardware and software. Yearb Med Inform 164–165.

Safran, C., Detmer, D.E., 2005. Computerized physician order entry systems and medication errors. JAMA 294, 179; author reply 180-181. https://doi.org/10.1001/jama.294.2.179-a

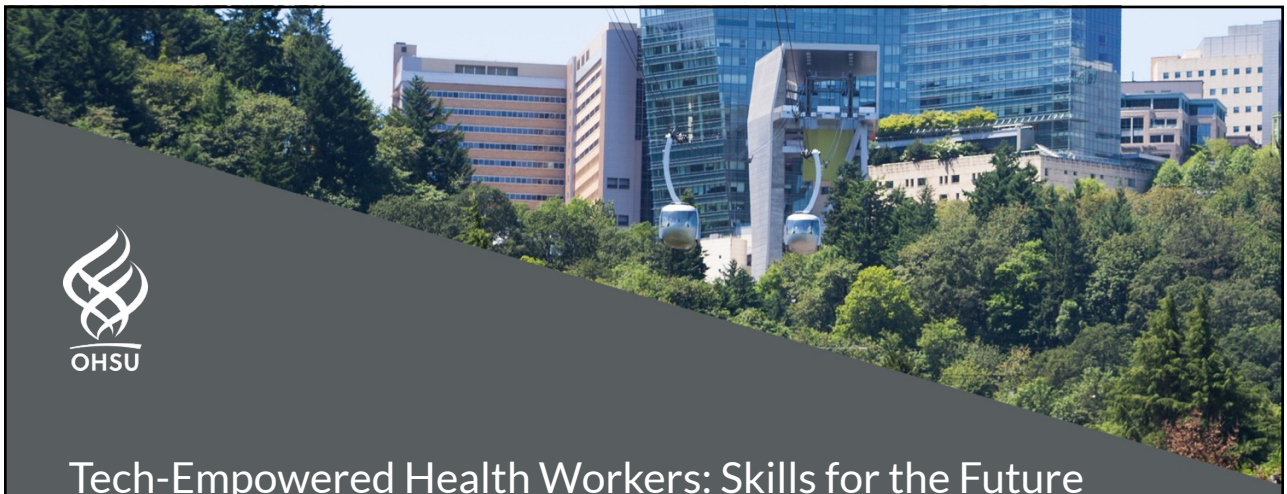
Silverman, H.D., Steen, E.B., Carpenito, J.N., Ondrula, C.J., Williamson, J.J., Fridsma, D.B., 2019. Domains, tasks, and knowledge for clinical informatics subspecialty practice: results of a practice analysis. J Am Med Inform Assoc 26, 586–593. https://doi.org/10.1093/jamia/ocz051

Valenta, A.L., Berner, E.S., Boren, S.A., Deckard, G.J., Eldredge, C., Fridsma, D.B., Gadd, C., Gong, Y., Johnson, T., Jones, J., Manos, E.L., Phillips, K.T., Roderer, N.K., Rosendale, D., Turner, A.M., Tusch, G., Williamson, J.J., Johnson, S.B., 2018. AMIA Board White Paper: AMIA 2017 core competencies for applied health informatics education at the master's degree level. J Am Med Inform Assoc 25, 1657–1668. https://doi.org/10.1093/jamia/ocy132

Valenta, A.L., Meagher, E.A., Tachinardi, U., Starren, J., 2016. Core informatics competencies for clinical and translational scientists: what do our customers and collaborators need to know? J Am Med Inform Assoc 23, 835–839. https://doi.org/10.1093/jamia/ocw047

Welcher, C.M., Hersh, W., Takesue, B., Stagg Elliott, V., Hawkins, R.E., 2018. Barriers to Medical Students' Electronic Health Record Access Can Impede Their Preparedness for Practice. Acad Med 93, 48–53. https://doi.org/10.1097/ACM.0000000000001829

Wu, K., Wu, E., Cassasola, A., Zhang, A., Wei, K., Nguyen, T., Riantawan, S., Riantawan, P.S., Ho, D.E., Zou, J., 2024. How well do LLMs cite relevant medical references? An evaluation framework and analyses. https://doi.org/10.48550/arXiv.2402.02008



Tech-Empowered Health Workers: Skills for the Future

Competencies and Curricula Across the Spectrum of Learners in Health/Clinical Informatics

William Hersh, MD, FACP, FACMI, FIAHSI, FAMIA
Oregon Health & Science University

1

Competencies and curricula across the spectrum of learners in health/clinical informatics

- Overview of health/clinical informatics in context of education
- Competencies and curricula for diverse learners of health informatics
- Role of artificial intelligence (AI)

- What follows is US-centric view; hope to hear other perspectives from audience

2

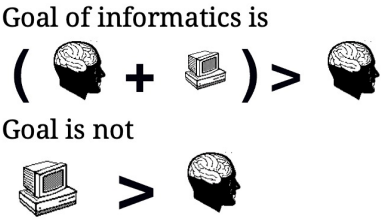
Health/clinical informatics in context of education

- An interdisciplinary field requiring some level of knowledge and skills in
  - Biomedicine
  - Healthcare and systems
  - Computer science (CS)
  - Data science
  - Machine learning (ML)
  - Artificial intelligence (AI)
- With practitioners, professionals, and others at different levels
  - Researchers
  - Developers
  - Implementers
  - Users
    - Clinicians
    - Community health workers
    - Consumers/patients/citizens

3

Informatics is not just the sum of biomedicine, healthcare, CS, AI, etc.

- While no single aspect of informatics is impertinent to any other field, the interactions of them give rise to unique aspects
- Despite interdisciplinary nature of field, there are unique aspects
- Friedman
  - Fundamental Theorem (2009)
  - What Is and Isn't Informatics (2013)



4

Many types of learners, with diverse needs and activities

- Informaticians
- Clinicians
- Researchers
- Community health workers
- Patients/Consumers/Citizens

- And students in all of above

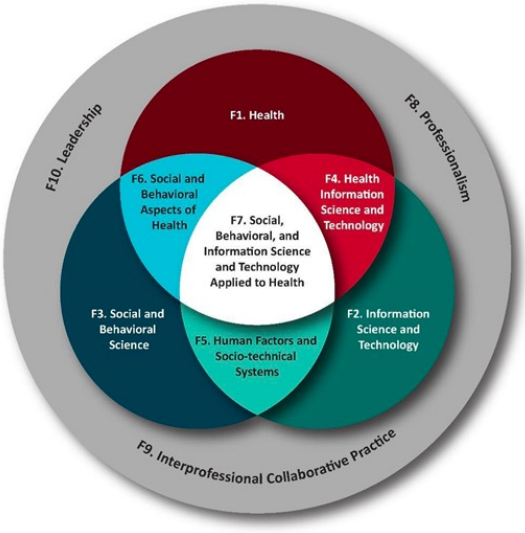
5

Competencies for informatics professionals

- Core content of clinical informatics (Gardner, 2009)
- Core competencies for graduate education in biomedical informatics (Kulikowski, 2012)
- Foundational domains of applied health informatics (Valenta, 2018)
- Domains, tasks, and knowledge for clinical informatics subspecialty practice (Silverman, 2019)
- Domains, tasks, and knowledge for health informatics practice (Gadd, 2020)
- IMIA educational recommendations (Bichel-Findlay, 2023)
- Working in health informatics – industry, healthcare, health insurance, consulting, government, etc. (Meehan, 2023)

6

Foundational domains of applied health informatics (Valenta, 2018)



7

AMIA informatics practice workforce domains (Silverman, 2019; Gadd, 2020)

Health Informatics

Domains	Task statements	KS statements
Domain 1. Foundational Knowledge and Skills	NA	31
Domain 2. Enhancing Health Decision-making, Processes, and Outcomes	11	21
Domain 3. Health Information Systems	26	36
Domain 4. Data Governance, Management, and Analytics	17	28
Domain 5. Leadership, Professionalism, Strategy, and Transformation	20	28
Total	74	144

Clinical Informatics Subspecialty (CIS)

Domains	Task statements	KS statements
Domain 1. Foundational Knowledge and Skills	NA	26
Domain 2. Improving Care Delivery and Outcomes	7	28
Domain 3. Enterprise Information Systems	16	33
Domain 4. Data Governance and Analytics	10	27
Domain 5. Leadership and Professionalism	9	28
Total	42	142

8

Curricula for achieving competence in informatics

- Graduate-level training – master's and PhD degrees
  - About 80 master's programs at 76 universities in US (Cox, 2021)
- Fellowship programs
  - 18 NLM-funded programs for PhD and postdoc students (Greenes, 2022)
  - Physicians in clinical informatics – subspecialty of all specialties (Patel, 2024)
- Baccalaureate programs
  - Growing number in US; highly variable in scope (McCarthy, 2024)
- Individual courses
  - Introduction to Biomedical Informatics & Artificial Intelligence (Hersh, 2022; Hersh, 2024) – taught to
    - Graduate students
    - Medical students
    - Continuing education students (10x10, "ten by ten")

Introductory course

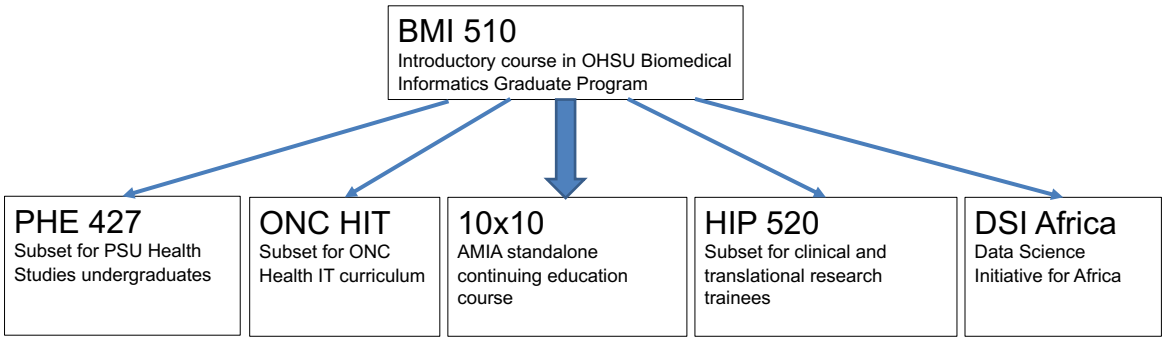
- Started when Dr. Charles Safran, former AMIA Chair, stated need to train one physician and one nurse from each of America's 6,000 hospitals in informatics (Safran, 2005)
  - Online introductory graduate course already existed
- Original aim to train 10,000 individuals in informatics by the year 2010 (Hersh, 2007)
  - OHSU largest and most successful offering, with 1000 completing program by end of 2010 and over 3300 at present
  - About 10-15% pursue graduate study, mostly at OHSU
- https://dmice.ohsu.edu/hersh/10x10.html

Topics – Introduction to Biomedical Informatics and Artificial Intelligence

Unit	Topic
1	Overview of Fields and Problems Motivating Them
2	Computing Concepts for Biomedical Informatics and AI
3	Electronic and Personal Health Records (EHR, PHR)
4	Standards and Interoperability
5	Artificial Intelligence
6	Advanced Use of the EHR
7	EHR Implementation, Security, and Evaluation
8	Information Retrieval (Search)
9	Research Informatics
10	Other Areas of Informatics – Public Health, Nursing, Consumer

11

Course content is reusable and scalable



Sampling of materials available at http://informatics.health

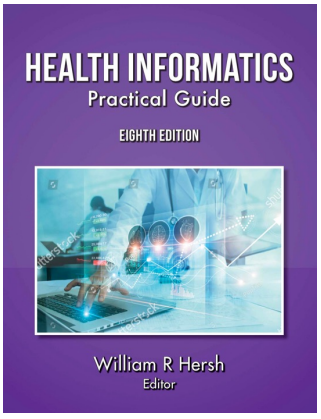
12

Also translated into Spanish and delivered in Latin America (Otero, 2010)

13

Online teaching modalities for introductory course

- Lectures
  - Voice over Powerpoint – many tools over the years; currently use Powerpoint exported to MP4
  - Units broken down into 5-8 segments of 20-30 minutes duration
  - Viewable on computers, tablets, and smartphones
- Assessment
  - 10 multiple-choice questions per unit that aim to apply material
- Interaction
  - Discussion forums
  - In some instances, use “flipped classroom” approach
- Readings
  - Optional readings from textbook mapped to units (Hersh, 2022)



14

Informatics is not only for informaticians

- Physicians and medical students – first addressed by AAMC Medical School Objectives Project (1998)
- Clinical and translational scientists (Valenta, 2016)
- Next-generation research scientists (Moore, 2019)
- Nurses (Forman, 2020)
- Patients
  - Broadband Internet access is a social determinant of health (Benda, 2020)
  - Americans use at least once a week to seek health information and advice (Presiado, 2024)
    - Internet search – 63%
    - Social media – 56%
    - AI chatbots – 13%
- (Community health workers)

OHSU

15

Also critical is education of clinicians

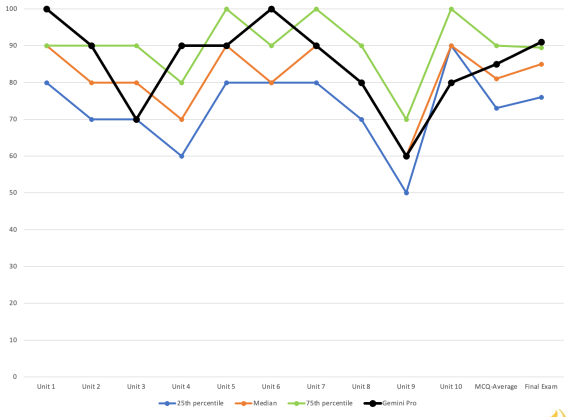
- "Search engine as essential as stethoscope" for clinical practice (Glasziou, 2008)
- "Informatics training for clinicians is more important than hardware and software" (Safran, 2009)
- Health informatics is a "required skill for 21st century clinicians" (Fridsma, 2018)
- Competencies (Hersh, 2014; Hersh, 2020), curricula (Hersh, 2017), and challenges (Welcher, 2018)
- Competencies for use of AI-based tools by healthcare professionals (Russel, 2023)

1. Find, search, and apply knowledge-based information to patient care and other clinical tasks
2. Effectively read from, and write to, the electronic health record (EHR) for patient care and other clinical activities
3. Use and guide implementation of clinical decision support (CDS)
4. Provide care using population health management approaches
5. Protect patient privacy and security
6. Use information technology to improve patient safety
7. Engage in quality measurement selection and improvement
8. Use health information exchange (HIE) to identify and access patient information across clinical settings
9. Engage patients to improve their health and care delivery though personal health records and patient portals
10. Maintain professionalism in use of information technology tools, including social media
11. Provide clinical care via telemedicine and refer patients as indicated
12. Apply personalized/precision medicine
13. Participate in practice-based clinical and translational research
14. Use and critique artificial intelligence (AI) applications in clinical care

16

What about role of generative AI? Good (Mollick, 2023) and less so (Hersh, 2024)

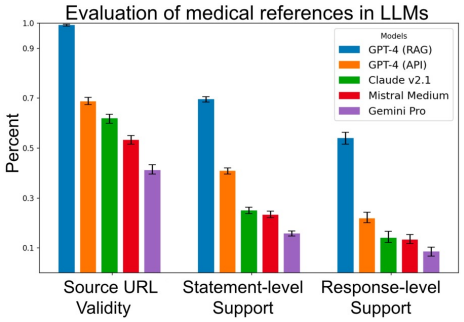
AI USE	ROLE	PEDAGOGICAL BENEFIT	PEDAGOGICAL RISK
MENTOR	Providing feedback	Frequent feedback improves learning outcomes, even if all advice is not taken.	Not critically examining feedback, which may contain errors.
TUTOR	Direct instruction	Personalized direct instruction is very effective.	Uneven knowledge base of AI. Serious confabulation risks.
COACH	Prompt metacognition	Opportunities for reflection and regulation, which improve learning outcomes.	Tone or style of coaching may not match student. Risks of incorrect advice.
TEAMMATE	Increase team performance	Provide alternate viewpoints, help learning teams function better.	Confabulation and errors. "Personality" conflicts with other team members.
STUDENT	Receive explanations	Teaching others is a powerful learning technique.	Confabulation and argumentation may derail the benefits of teaching.
SIMULATOR	Deliberate practice	Practicing and applying knowledge aids transfer.	Inappropriate fidelity.
TOOL	Accomplish tasks	Helps students accomplish more within the same time frame.	Outsourcing thinking, rather than work.



17

Must also develop other skills, e.g., search and critical appraisal

- Search still matters (Hersh, 2024)
- For some tasks that many of us do, need more than answers, e.g.,
  - Clinical – patient-care questions
  - Research – methods and insights
  - Teaching – synthesizing knowledge for our students
- LLMs not necessarily good at citing their sources (Wu, 2024)



18

Thank you!

William Hersh, MD
Professor
Department of Medical Informatics &
Clinical Epidemiology
Oregon Health & Science University
Portland, OR, USA
Email: hersh@ohsu.edu
Web: http://www.billhersh.info
Blog: https://informaticsprofessor.blogspot.com/
BlueSky: @billhersh.bsky.social