

PERSPECTIVE ARTICLE

Artificial intelligence algorithmic literacy:
Gaining and deepening the artificial intelligence
knowledge of global health workforce education
in the Fifth Industrial RevolutionSeble Frehywot^{1*}  and Yianna Vovides²¹Department of Global Health and Department of Health Policy and Management, George Washington University, Washington, District of Columbia, United States of America²Centers in New Design in Learning and Scholarship, Georgetown University, Washington, District of Columbia, United States of America

Abstract

Technologies invented in the five industrial revolutions (IRs) have profoundly transformed Global Health Workforce Education (GHWFE), reshaping teaching methodologies, faculty approaches, and student learning. This article first reflects on the influence of technology on GHWFE from the first to the fourth IRs. Then, it focuses on the present, Fifth IR (5IR), the era of human-artificial intelligence (AI) centric collaboration, and the fact that the global health workforce educators are not trained for being nimble to utilize AI and its related technologies in 5IR. The manuscript envisions new directions for the future with the goal of establishing nimbler educators that acknowledge the benefits of interdisciplinary dialogue as a means of deepening AI knowledge and community. The article expands the AI algorithmic literacy framework and proposes a Human-AI Centric Workshop Series that moves global health workforce educators from awareness to knowledge, to applied innovation, and toward expertise in 5IR.

Keywords: Artificial intelligence; Fifth industrial revolution; Artificial intelligence algorithmic literacy; Global health workforce; Human-artificial intelligence centric education

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1. Introduction

From the mid-18th century to the present, the five industrial revolutions (IRs) have profoundly transformed global health workforce education, reshaping teaching methodologies, faculty approaches, and student learning through groundbreaking technological advancements. Since 2020, artificial intelligence (AI) advances have moved us solidly into the fifth IR (5IR), and it is critical to create a human-centric approach to guide the path forward by emphasizing collaboration between humans and machines.¹ In Global Health Workforce Education (GHWFE), human-machine collaboration refers to the synergistic integration of human expertise—such as clinical judgment, empathy, and ethical decision-making—with machine intelligence, such as AI-driven diagnostics, data analytics, and simulation tools.² This means preparing

physicians, nurses, public health specialists, and allied professionals to work alongside AI systems to address challenges, such as the projected 11 million health worker shortage by 2030.³

2. First IR to Fourth IR: Technology's influence on global health workforce education

Each IR introduced innovations that redefined how knowledge is imparted and consumed, creating a more skilled and adaptable health workforce. The mid-15th century marked the Gutenberg printing press, and it became a pivotal invention that revolutionized medical education.⁴ It enabled the mass production of medical texts and standardized curricula across institutions.⁵

The first IR, 1750–1850,⁶ was marked by the era of mechanization and industrialization. Initially, teaching during this era was authoritative, centered on lectures, and students engaged in passive learning while apprentices gained practical experience under mentors.⁷ However, the growth of mechanization and industrialization generated unprecedented factory trauma and urban epidemics because of poor, crowded living conditions.⁸ This led to the birth of teaching hospitals to produce trained professionals equipped to treat the injuries of a mechanized age.

The second IR, 1850–1914,⁶ brought electricity, microscopes, and early X-rays, significantly enhancing health diagnostics education.^{9,10} Electricity illuminated lecture halls and powered laboratory equipment, creating conducive learning environments. Teaching evolved to include laboratory work and field observations, encouraging active learning.¹¹

The third IR, 1947–2000⁶, often termed the Digital Revolution, introduced computers, statistical software, computed tomography (CT) scans, and magnetic resonance imaging (MRI), making health education more data-supported and accessible.¹² Faculty adopted interactive methods such as problem-based learning. Students embraced blended learning, combining lectures, laboratories, computers, and other digital tools, and engaged in inquiry-based learning.¹³

The fourth IR, beginning in the 21st century,⁶ ushered in an era of convergence with virtual and augmented reality (VR/AR), the Internet of Things (IoT), wearables, cloud computing, big data, and biotechnology.¹⁴ These technologies transformed health education through the development of flipped classrooms, AI-powered chatbots, and VR/AR simulations.¹⁵

3. Impact of 5IR technology on global health workforce education

The dawn of the 5IR, starting around 2020,¹⁶ ushered in a transformative era defined by human-machine collaboration. The 5IR integrates advanced technologies such as generative AI, IoT, machine learning, brain-computer interfaces, quantum computing, bio-digital sensors, and the metaverse to create a synergy that amplifies human potential.^{17,18} At the heart of the 5IR's impact on GHWFE lies bio-digital convergence, where AI and biology intertwine to create innovative learning paradigms and the metaverse, enabling students to engage in simulated high-stakes scenarios through experiential learning.¹⁹

Beyond technical skills, the 5IR emphasizes empathy, ethics, and creativity, a mindset that balances technological innovation with human values where students are not passive recipients but active co-designers, working alongside AI and faculty to develop interventions that prioritize patient well-being.²⁰ The problem, however, is that *global health workforce educators are often unprepared to adapt quickly*.

As the 5IR continues to evolve, so will the pedagogical approaches toward enabling a human-centric ethos that ensures the GHWFE is as ethical and empathetic as it is efficient and innovative. In this paper, we outline how the AI algorithmic literacy framework (ALF) *Human-Centric AI Workshop Series* can be applied within organizations to help global health workforce educators and practitioners embrace lifelong learning on how AI is influencing their work in 5IR and beyond.

4. Proposed intervention: AI algorithmic literacy human-centric AI workshop series for GHWFE education in 5IR

Gaining and deepening AI expertise for global health workforce faculty and students does not mean becoming computer scientists. Instead, it involves understanding foundational AI concepts, applying relevant tools in their field, and collaborating with technical experts. [Figure 1](#) highlights the hierarchy among digital literacy, AI literacy, and AI algorithmic literacy.

In studies on the evaluation of AI literacy among health science students and faculty, it is characterized by interest and positive attitudes toward AI, yet it is hindered by low technical understanding, inconsistent prior training, and a scarcity of standardized curricula.²¹ The limited expertise among faculty constrains the adoption of innovative educational strategies and teaching methods.²²

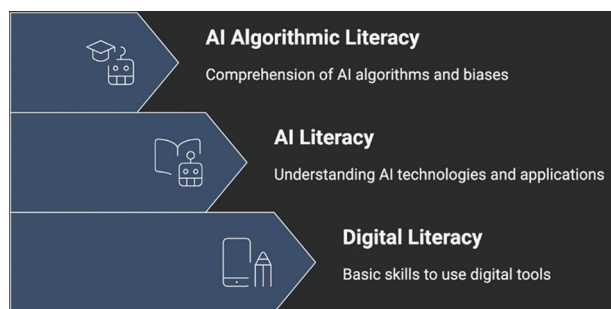


Figure 1. The hierarchy among digital literacy, AI literacy, and AI algorithmic literacy. Image created by the authors.

Abbreviation: AI: Artificial intelligence.

Students self-rate their critical appraisal and practical application skills higher than their grasp of AI mechanics, whereas faculty often lack the preparation or infrastructure to teach these competencies effectively.²³ Global disparities in AI integration underscore the need for cohesive, evidence-based frameworks that embed ethical awareness, digital competence, and transversal skills across undergraduate medical and nursing education.^{23,24} Institutions must prioritize interdisciplinary faculty development, ethical guidelines, and systematic curricular reform, alongside regional research on implementation barriers and cost-effectiveness to ensure equitable, responsible AI adoption in global health workforce education during the 5IR.

To integrate human-machine collaboration in the 5IR effectively, GHWFE must evolve from siloed training to hybrid models that emphasize cocreation, cultural relevance, and scalability. This will require addressing the GHWFE to concentrate on embedding AI literacy and ethical training in core curricula, adopting interprofessional and simulation-based learning, fostering global Communities of Practices, measuring and upskilling for human-AI synergy, and securing funding and policy support for scalability.¹⁸

A significant barrier to adopting AI in GHWFE is faculty apprehension. Many perceive AI as overly complex, akin to neurosurgery or rocket science. Many education systems struggle to address the growing AI digital skills gap, crucial for students' employability, ethical technology use, and the development of an AI-ready workforce.²⁵

To bridge the gap, the ALF emphasizes simplifying AI concepts and fostering individual and organizational readiness through interdisciplinary engagement, leveraging existing expertise within universities, and creating an innovative ecosystem for AI integration in GHWFE.²⁶ ALF forms the backdrop of our continued work in fostering a community approach to knowledge and skill development within an interdisciplinary environment. Successful implementation of ALF requires a solid foundation

within a CoP space that enables discourse,¹⁸ ensuring that GHWFE remains innovative, relevant, and responsive to the demands of the 5IR.

For individual development, ALF starts with a series of workshops that move individuals from *Awareness* to *Knowledge* to *Applied Innovation* toward *Expertise* (Figure 2).

We expand our work by recommending AI human-centric workshops related to the categories shown in Figure 3 for developing individual AI readiness based on key questions outlined in our previous work.²⁶ However, the workshops are the beginning of establishing a community and, therefore, would require subsequent engagements to develop a peer network that becomes part of the organization's learning ecosystem.

Given the focus on peer-to-peer learning and community development, we utilize the Reflective-Reflexive Design Method (R2DM) as our design framework for the workshops, as it focuses on reflective sensemaking and therefore engages participants to begin examining their own motivators that foster collaboration.²⁷ R2DM is grounded on the Motivation Assessment for Team Readiness, Integration, and Collaboration, Team Effectiveness Model for Science, and Maslow's Hierarchy of Needs models. "More explicitly, these three models (i) surface the implicit motivations of individuals, (ii) enable the design of an evaluative tool for individuals and teams, and (iii) provide development theory and structure for assessing team mindset."^{27,p.2} Ultimately, we rely on sensemaking activities such as visioning, relating, and inventing to develop awareness into knowledge and expertise.^{28,29} The workshops are designed to support this developmental process through dialogic inquiry that merges individual reflection with group reflexivity.²⁷ Table 1 shows the readiness categories, key questions to be addressed, the workshop goals, and strategies used to engage participants in generative dialogue.

The strategies described in Table 1 require minimal resources but can yield significant results by simply leveraging existing expertise and fostering dialogue. This approach not only enables individuals to better understand AI principles through the lens of their existing expertise but also that of their peers from other disciplines. It encourages openness and supports nimbleness. This allows for the development of respect and trust, supporting individuals to transition from novices to informed users of AI tools. External resources, such as partnerships with other universities or organizations, can supplement internal capacity and capabilities through an expanded knowledge network.

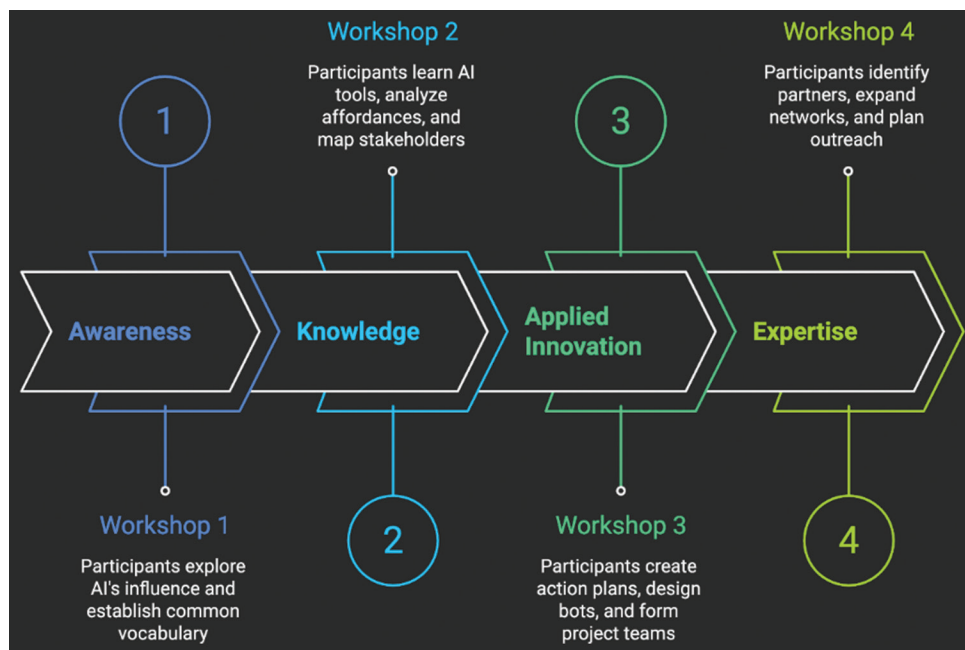


Figure 2. Progression of the AI readiness workshop series. Image created by the authors.
Abbreviation: AI: Artificial intelligence.

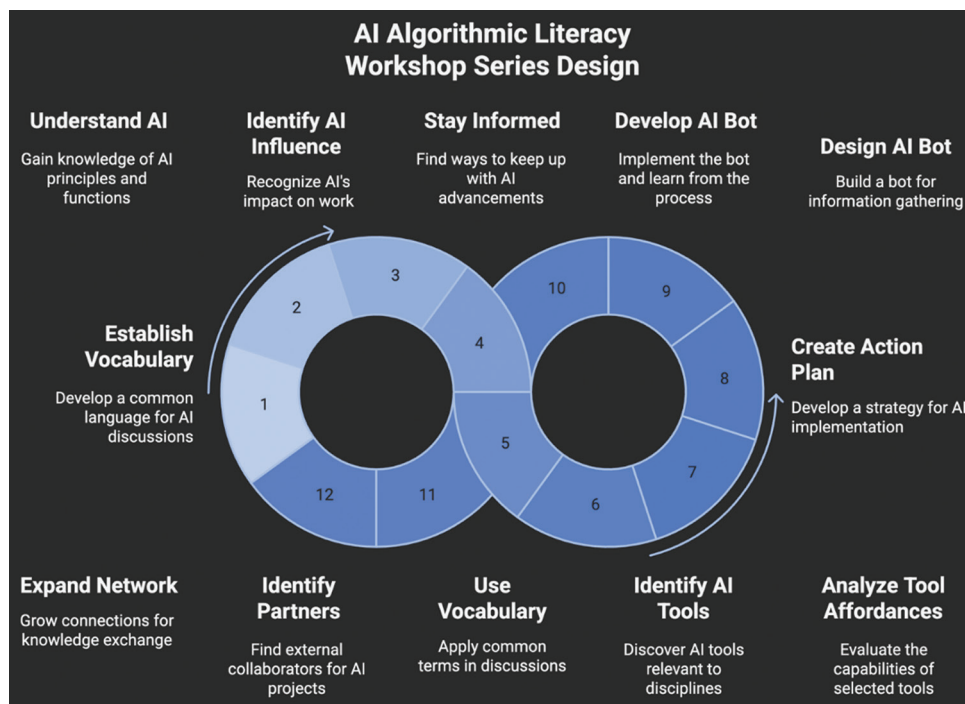





Figure 3. Design of the AI algorithmic literacy workshop series. Image created by the authors.
Abbreviation: AI: Artificial intelligence.

The ALF forms a layered design approach, with trust as the foundation, followed by knowledge acquisition and skill development. Initial workshops that focus on awareness include vetted resources that support the development of

foundational AI knowledge. This ensures that a common AI vocabulary can be established across disciplinary boundaries so that all are ready to engage in meaningful dialogues with technical experts and apply AI tools in their specific domains.

Table 1. Recommendations on ALF human-AI centric workshop series

Readiness progression	Key questions answered	Workshop series goals	Generative dialogue strategies
Awareness	How is AI influencing my work? How can AI help me in my work?	Establish a common vocabulary Gain an understanding of how AI works Identify how AI is influencing your work Identify ways to stay informed	Surface individual motivators for collaboration and establish group norms Acknowledge the differences in awareness and engage in conversation on how AI influences each other's work Identify opportunities for continuing the conversation and organizing social activities
	<ul style="list-style-type: none">• Self-assessment results (pre-post)• Commitment to action (individual selects at least one action to take based on recommendations from self-assessment results)• Satisfaction survey• Join the online community of practice		
Knowledge	How does AI work? What are the common AI tools utilized in my discipline? How do I stay informed? What investment is needed to secure platforms?	Use the common vocabulary Identify the AI tool used in one's discipline Analyze the affordance of the selected tool Identify ways to stay informed	Discuss individual motivators for collaboration and adjust group norms as needed Surface differences and commonalities in AI needs by discipline, and create a stakeholder map Continue to identify opportunities for continuing the conversation and organizing social activities
	<ul style="list-style-type: none">• Self-assessment results (pre-post)• Commitment to action (individual selects at least one action to take based on recommendations from self-assessment results)• Satisfaction survey• Draft initial influence map		
Applied innovation	What aspect of my work could I potentially improve with AI? How do I go about it? How do I know that the AI I am thinking of buying is the right AI for me and my organization? What did I find out?	Create an action plan for the use of AI in one's work Design a bot to identify ways to stay informed Determine the appropriate tool for developing the bot Develop the bot. Identify lessons learned.	Reflect on individual motivators for collaboration and align with group norms Determine a common challenge in your work that AI can provide a solution and establish a project team to address the challenge Continue to identify opportunities for continuing the conversation and organize social community outreach activities to share lessons learned
	<ul style="list-style-type: none">• Self-assessment results (pre-post)• Commitment to action (individual selects at least one action to take based on recommendations from self-assessment results)• Satisfaction survey• Expand initial influence map• Create action plan• Design applied innovation project		
Expertise	What are some ways I can deepen my knowledge and skills in AI? How can VR and AI simulations help in deepening my expertise and teaching in AI? How can I help others learn?	Identify external partners for collaboration Identify opportunities to expand one's network for knowledge exchange	Reflect on individual motivators for collaboration aligned with group norms and create a list of potential partners Determine viable collaboration opportunities and organize outreach efforts

Abbreviations: AI: Artificial intelligence; ALF: AI algorithmic literacy framework; VR: Virtual reality.

5. Discussion

Implementing AI in GHWFE demands flexibility, adaptability, and attention to data governance, security, and privacy, as well as engagement of expertise across disciplines for advancing innovation in teaching and

learning. The traditional models of selecting enterprise-wide solutions lack the agility to address AI tool adoption across organizations in higher education. IT departments do not tend to have extra resources to support these needs, leading to reliance on external vendors or slow progress. Moreover, global health workforce education remains

hampered by stark regional disparities that perpetuate inequity and undermine outcomes worldwide. The digital divide—marked by unreliable infrastructure, low internet penetration, 26% in East Africa versus 97% in Northern Europe,³⁰ device scarcity, and inadequate digital literacy—excludes millions in low- and middle-income countries and rural areas from online learning and telehealth tools, many of which are designed in high-income settings without local adaptation. Compounding these barriers, language mismatches, culturally insensitive materials, and health-literacy gaps written in complex jargon erode comprehension, trust, and care quality, while faculty shortages, brain drain, and chronic underinvestment in educator training leave institutions dependent on short-term external initiatives rather than sustainable local capacity.^{22,31} It is imperative that we consider the adoption of technologies in global health workforce training, especially AI, with care and ask, “Who are we leaving behind?” and “What can we do about it to mitigate the risk of widening health disparities?”¹⁶ Overcoming these interconnected challenges demands inclusive technology design, culturally attuned curricula, equitable resource allocation, and long-term investment in local faculty and infrastructure to ensure effective, accessible health education for all populations.

ALF advocates for a systems-level approach in 5IR, where teaching centers or cross-disciplinary teams assess institutional needs and advocate for solutions that balance innovation with practicality. Its implementation is based on convening cross-disciplinary stakeholders to engage in productive discourse for advancing individual knowledge and skills about AI and how it is utilized in the professions.

For example, to support faculty, ALF recommends starting with a self-assessment tool to identify learning needs and readiness for AI adoption. This tool should be paired with curated, vetted resources tailored to health sciences professionals. For example, teaching centers can compile a list of accessible AI courses or workshops and make them available on institutional websites. These resources should address both foundational knowledge and practical skills, ensuring faculty are not left to navigate the complex AI landscape alone. [Table 1](#) outlines a series of workshops that could be implemented within an organization.

In addition, students, particularly in health sciences and computer science, are critical to implementing the ALF organization-wide. ALF proposes giving students a “driver’s seat” in certain learning activities, allowing them to explore AI applications in public health or medicine. For example, students could be tasked with creating AI-supported presentations on public health topics, explaining their

process and reasoning. This fosters critical thinking, preparing students for real-world problem-solving. Grants or incentives could further engage instructors and students, encouraging them to explore AI’s implications critically.

Collaboration is at the heart of ALF. Institutions should seek partners within and beyond their campuses, including other universities, research institutes, or industry stakeholders. For instance, if a medical school lacks a robust data science department, it could partner with a neighboring institution or leverage online platforms for expertise. Effective communication is key. AI technical expertise must be translated into language that resonates with health sciences professionals.

6. Conclusion

The ALF encourages a dialogic approach to engaging faculty from multiple disciplines in knowledge exchange. The strategies presented in this article are grounded in educational development. We are asking our experts to change their habits and embrace change. This needs to begin with establishing an open dialogue space that global health workforce faculty can build confidence in using AI.

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Author contribution

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Not applicable.

Availability of data

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