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The Educator-in-the-Loop: Intentional Integration of Generative Artificial Intelligence in Health Professions Education

Galina Gheihman[1] | Hange Li[2] | Gergely Csaba[3] | Stephen Bacchi[4] | Kathleen Huth[5] | Traci A. Wolbrink[6]

[1]Department of Neurology, Mass General Brigham, Boston, MA, USA | [2]Vanke School of Public Health, Tsinghua University, Beijing, China | [3]Department of Behavioural Sciences, Medical School, University of Pécs, Pécs, Hungary | [4]Adelaide Medical School, The University of Adelaide, Adelaide, South Australia, Australia | [5]Department of Pediatrics, Boston Children's Hospital, Boston, MA, USA | [6]Department of Anesthesiology, Critical Care and Pain Medicine, Boston Children's Hospital, Boston, MA, USA

Correspondence: Galina Gheihman (ggheihman@bwh.harvard.edu)

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The rise of generative artificial intelligence (gen-AI) marks a transformative moment in health professions education. Large language models (LLMs) such as OpenAI's ChatGPT and Anthropic's Claude have demonstrated remarkable ability to generate text, solve problems, simulate patient interactions and provide real-time feedback to learners [1]. These capabilities hold immense promise for content creation and delivery, automated personalised learning, individualised tutoring and scalable feedback [2, 3]. Yet, with such technological power comes a fundamental question for health professions educators: *If gen-AI can teach, tutor and assess—what then is the role of the educator?*

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We explore this question by briefly reviewing the potential uses of gen-AI in health professions education and outlining its challenges and pitfalls. We then propose the application of a conceptual framework—PICRAT [4]—to guide educators in intentionally leveraging gen-AI. Through a detailed case example of the TEACHABLE platform [5], we illustrate how gen-AI can be used to transform, rather than replace, our role as educators. We conclude with practical tips and a call for intentional, theory-informed integration of gen-AI in health professions education.

1 | The Promise of Generative AI in Health Professions Education

Gen-AI tools are being used across the spectrum of health professions education from undergraduate education to continuing professional development [1, 2]. Applications include content creation and personalisation, curriculum development, feedback and assessment, tutoring and study support, simulated patient encounters, administrative efficiency and support for education research and scholarship. There is excitement in leveraging gen-AI to support the shift to competency-based assessment and precision health professions education [6].

Health professions schools and healthcare organisations have embraced these opportunities by investing in secure sandbox environments, allocating funds for gen-AI research and implementation projects and developing courses for students and faculty on the use of gen-AI [7]. The question is no longer *whether* gen-AI will be used in education, but *how* and *by whom*?

2 | Significant Challenges, Pitfalls and Caveats

Despite excitement about the opportunities afforded by gen-AI, the potential challenges in health professions education are significant [3].

A first concern is bias and fairness. LLMs reflect the biases of their training data. They may generate outputs that are inappropriate or exclusionary, reflecting structural inequities and propagating stereotypes. A second concern is equity, as differential access to frontier AI tools risks exacerbating existing disparities. Third, the logic of AI systems may be opaque. This makes it difficult to trace reasoning or assess the validity of responses, undermining trust [8]. Gen-AI also raises novel security, ethical and legal concerns, with questions about data privacy, disclosure of AI use and accountability still being explored. Three additional concerns are of particular importance to the educator. First is limited evidence for efficacy. Despite the promise of early applications of gen-AI, the available evidence of impact on clinical or educational outcomes is limited [9]. We are not yet sure if gen-AI is equally useful for all students or of particular benefit to struggling learners. There is also concern that content generated by AI may be of inferior quality [10].

Second is the risk of clinical 'de-skilling' [11]. 'De-skilling' is the loss of previously acquired professional skills. We do not know the potential long-term consequences for learners of overreliance and misuse of this technology. Some have raised concerns that trainees may become passive consumers of AI-generated information rather than active learners. One observational study found endoscopist clinical deskilling after exposure to AI [12]. Others have warned about adopting errors or bias from AI systems (mis-skilling), or failing to reach competence (never-skilling) [13]. The theoretical risk of learner deskilling has been extensively explored, but empiric data collection is ongoing [14].

Third is the risk for unintended harm to students due to the misuse of AI in teaching. Current literature focuses on the misuse of AI among students, including plagiarism or over-reliance; less attention has been paid to its misuse among educators. Poorly or inappropriately deployed, AI may reduce learning efficiency, limit students' opportunities to collaborate with peers or impede communication between trainees and faculty. These concerns underscore the need for careful, intentional integration of gen-AI into educational practice, with support and guidance from a skilled, pedagogy-informed 'educator-in-the-loop'.

3 | The Educator-in-the-Loop: Rethinking the Role of the Educator in the Age of Gen-AI

The importance of maintaining a 'human-in-the-loop' [15] has been recognised as one way to monitor, evaluate and iterate gen-AI output to ensure accuracy and high-quality outcomes [16]. Human-in-the-loop systems require human interaction with the AI technology to complete a task, goal or operation (whether through direct human-computer interaction or human review of computer output) [17]. An analogous *'educator-in-the-loop'* approach is needed to deploy gen-AI in health professions education [18]. Instructional design is a series of small and large choices made by educators. The tremendous potential of gen-AI is in automating and facilitating different formats and approaches to education across various contexts. This same diversity of choices presents a major challenge to educators: how to select the most effective ways to leverage gen-AI and 'pedagogical intelligence' [19] to achieve desired learning outcomes.

> *"An analogous 'educator-in-the-loop' approach is needed to deploy gen-AI in health professions education."*

In the age of gen-AI, educators must undergo a shift from being knowledge sources and content experts to becoming curators,

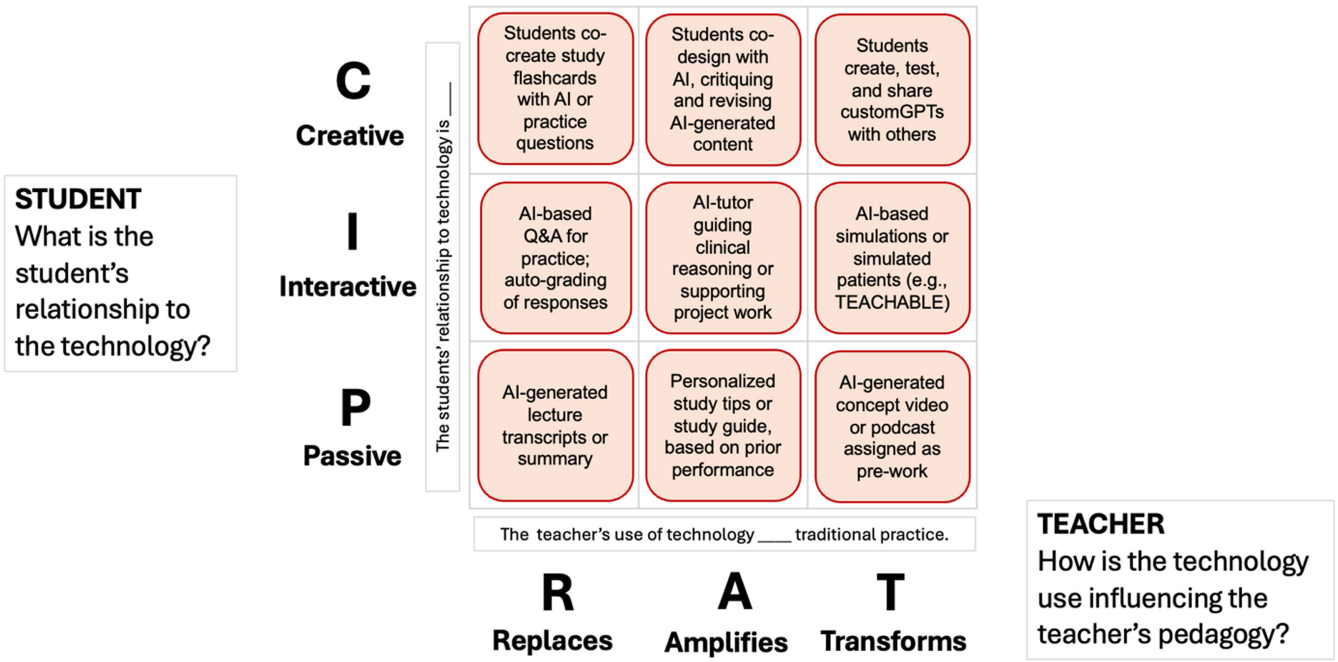
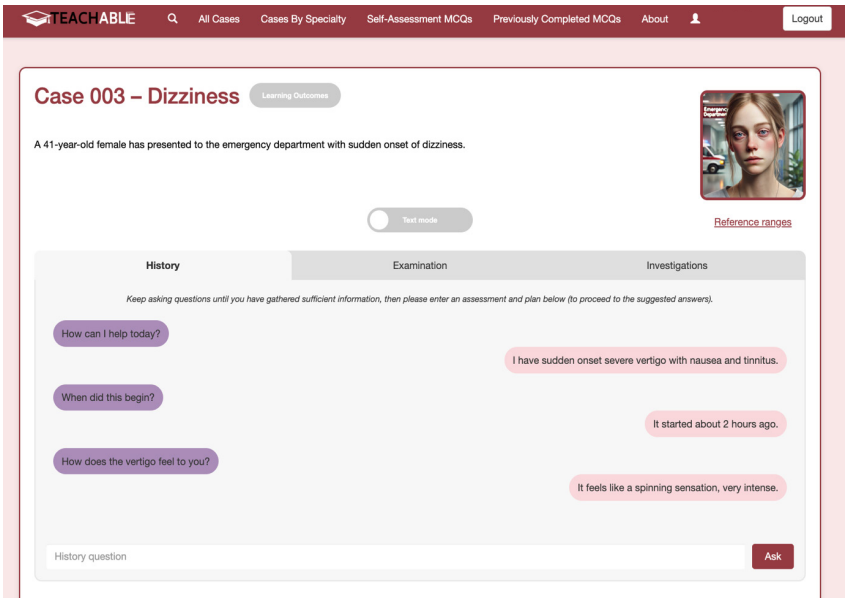


FIGURE 1 | Matrix summarising the PICRAT model for technology integration in education, as described by Kimmons et al. [4]. PIC stands for Passive, Interactive, Creative and refers to the learners' relationship to the technology. RAT stands for Replaces, Amplifies, Transforms and refers to how technology use is influencing the teacher's pedagogy. Technologies and tools, including gen-AI, may be integrated into educational experiences in several ways, mapping onto a segment of the nine-section matrix. We provide examples of how to use gen-AI in educational sessions aligned to each of the segments of the PICRAT matrix. Adapted from Figure 5 in Kimmons et al. [4].

A



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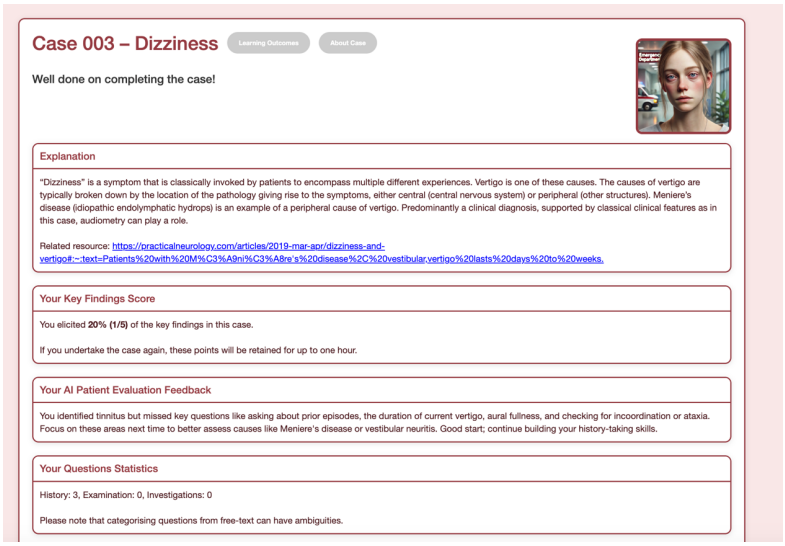

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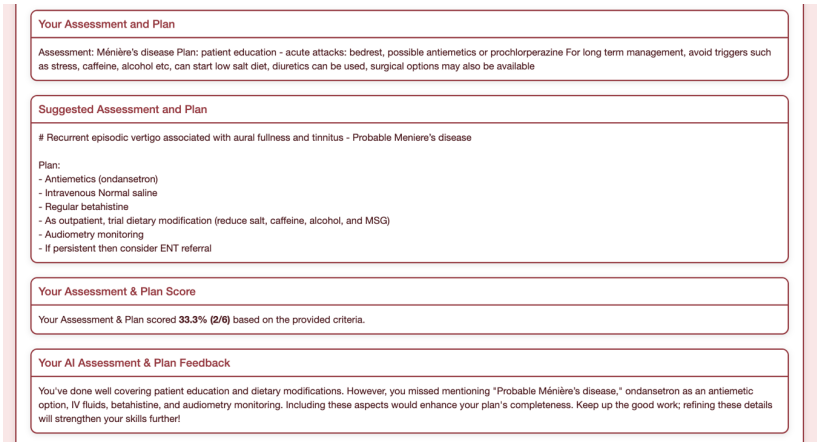

FIGURE 2 | Sample screenshots from the TEACHABLE AI-enabled case-based learning platform. Learners select a case to interact with from among hundreds of faculty-reviewed options. Learners can interact with the patient using free-text or voice-mode, obtaining history, examination results, and investigations (2A). Learners enter an Assessment & Plan and receive immediate automated quantitative scores and narrative feedback, generated by the AI based on key findings in the history and physical exam (2B) and assessment & plan (2C). Cases and associated key findings are written by experts and peer-reviewed before posting.

facilitators and co-designers of learning experiences [20]. While some educators might fear job displacement by gen-AI, we have cautious optimism. With unprecedented access to information, educators will need to reconsider both *what* to teach and *how* to teach it. Educators in the age of gen-AI will not be obsolete; however, new competencies for health professions educators [21] and our evolving roles must be reimagined and redefined.

> "*In the age of gen-AI, educators must undergo a shift from being knowledge sources and content experts to becoming curators, facilitators and co-designers of learning experiences.*"

4 | PICRAT: A Framework for Intentional Technology Integration

Gen-AI is not the first technology to disrupt education; new tools and technologies become available every year. As the 'educator-in-the-loop', we have an opportunity to ensure that the new educational technologies we choose to use (1) align with learning theory and evidence-based principles for instructional design; (2) are deployed equitably and transparently to optimise accessibility; and (3) foster, rather than replace, active, critical, socially contextualised learning.

One framework that can support educators to reflect on the intentional integration of technology into education is the PICRAT model [4]. Developed by Kimmons et al. (2020) [4], PICRAT guides educators to reflect on two key dimensions of any technology they are integrating into their teaching practice. First, *what is the student's relationship to the technology*—passive, interactive or creative? Second, *how does the technology support the teacher's pedagogy*—replacing, amplifying or transforming it? (see Figure 1 for a matrix of these interactions with examples). PICRAT guides educators to critically appraise design decisions about technology use and make intentional choices about student engagement and pedagogy to enhance learning.

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BOX 1 | Case example: Building the TEACHABLE (Transforming Education And Clinical Healthcare through Agent-Based Learning and Evaluation) platform for case-based learning.

TEACHABLE delivers online interactive cases that allow learners to take a patient's history, request examination findings and investigation results and formulate an assessment and plan. Learners then receive immediate feedback. Cases are written by specialist experts with peer-review, then animated using the gen-AI LLM-based platform. Below we illustrate how using the PICRAT model and our five reflection questions for educators supported the development of the platform.

1. **Are learners passively interacting with AI, or actively engaging with it, creating with it and critiquing it?**

   TEACHABLE supports individual self-study, group discussions and flipped classroom sessions. Learners may access cases for practice and educators can assign cases before, during or after didactic sessions to promote problem-based, interactive learning. This reaches the *Interactive* level in the PICRAT model. If students create their own cases, this may reach the *Creative* level.

2. **Does this tool *replace* something I do, or does it *amplify and transform* my pedagogy?**

   According to the PICRAT model, the TEACHABLE platform *Amplifies* an educators' teaching practice as it allows students to interact with the educators' content asynchronously, on their own time. Further, it can *Transform* pedagogy by providing immediate feedback to support learners' deliberate practice at scale, beyond what an individual educator can do. TEACHABLE can also identify learning gaps and offer individualised tutoring, potentially identifying and engaging struggling students. TEACHABLE cases can supplement other learning formats and are flexible to support remediation, extra practice and exploring new content.

3. **Is there an evidence-base or educational theory that supports the use of this technology in this context?**

   The platform's design is informed by Knowles' Adult Learning Theory and Kolb's Experiential Learning Cycle [23]. Cases are self-directed, relevant to medical practice and may be completed collaboratively. A digital platform supports flexibility and adaptability to different learners' knowledge levels (e.g., first year student versus clinical trainee versus advanced student). Real-time feedback allows for iterative improvement and supports deliberate practice.

4. **What caveats, concerns and challenges can I anticipate and mitigate?**

   Effective deployment of TEACHABLE requires thoughtful case design, faculty peer-review and ongoing monitoring for quality and appropriateness. We are developing an evidence base for the platform, designing studies to gain validity evidence [5] and learning from real-life application.

5. **Does using this tool promote an inclusive, accessible, universal design [22]?**

   TEACHABLE is free and accessible online to all learners at https://www.researchteaching.com/ (sign-up code: learningrocks). Learners can choose to interact with the platform through either text-based or voice-based prompts. Cases at different levels of complexity (from beginner to advanced) are offered, as are cases representing different geographies around the world. The website has an administrative function, enabling all educators, without any prior programming experience, to create cases to share with their learners.

How might PICRAT apply to gen-AI? By asking several questions, educators can evaluate a particular use of gen-AI by the learner interaction and pedagogy it supports:

1. Are learners passively interacting with AI, or actively engaging with it, creating with it and critiquing it?
2. Does this tool *replace* something I do, or does it *amplify and transform* my pedagogy? [4]
3. Is there an evidence-base or educational theory that supports the use of this technology in this context?
4. What caveats, concerns and challenges can I anticipate and mitigate?
5. Does using this tool promote an inclusive, accessible, universal design? [22]

5 | Case Example: Development of the TEACHABLE Platform

To demonstrate the intentional application of gen-AI in health professions education, we highlight the development of the TEACHABLE (Transforming Education And Clinical Healthcare through Agent-Based Learning and Evaluation) platform—a free, publicly available, LLM-enabled case-based teaching tool created to support active, self-directed learning (see screenshots in Figure 2) [5]. TEACHABLE hosts a digital library of interactive clinical cases, written by specialist faculty. The platform provides real-time feedback, supporting individual and group-based self-directed, active learning. TEACHABLE aims to transform how clinical reasoning is taught, redefining the role of the educator. TEACHABLE promotes learner *interactivity*. It also *amplifies and transforms* teaching practice by scaling the reach of an educator through a digital platform. Grounded in Knowles' Theory of Andragogy and informed by Kolb's Experiential Learning Cycle [23], the platform supports deliberate practice with iterative feedback. Box 1 illustrates how the PICRAT framework and our five suggested reflection questions for educators can be applied to the design, implementation and evaluation of the TEACHABLE platform.

Although the TEACHABLE platform demonstrates applying gen-AI to case-based learning, emerging evidence supports the use of gen-AI beyond this domain, including for clinical reasoning, professional identity formation [24] and assessment [25]. A randomised controlled trial found LLM-supported simulated patient encounters improved clinical decision making among medical students [26]. In a survey study across health professions students, professional identity formation correlated with readiness to use AI and readiness for interprofessional teamwork [27]. Using gen-AI allowed nursing students to creatively express their nursing philosophy and shape professional identity [28]. Thoughtful use of AI can augment narrative assessment in competency-based education [29]. By balancing pedagogical intention with gen-AI action, health professions educators can take full advantage of the promise gen-AI tools offer [30].

6 | Practical Tips for the Next-Gen Educator

In addition to reflecting on PICRAT, we suggest the following guiding principles for integrating gen-AI in health professions education, balancing theory and practice and emphasising critical reflection.

1. **Use gen-AI as a design partner** to amplify creativity and transform pedagogy: It can draft, brainstorm and scaffold ideas, with educator oversight and verification.
2. Cultivate a **growth mindset** regarding use of gen-AI and other technologies to enhance your efficacy as an educator and keep up to date with ever changing times.
3. **Disclose, document and discuss**: Be transparent about how you use AI in your teaching and demonstrate ethical practice about citing and disclosure for others. Support open dialogue about what gen-AI is and what it can and cannot do, role modelling responsible use for learners.
4. **Teach with and about AI**: Learners must learn not only *from* AI but also *about* its appropriate use, including its limitations, biases and pitfalls. Support learners to grapple with ethical issues and invite co-creation to mitigate challenges and improve these tools.
5. **Foster iteration and critical thinking**: Encourage learners to draft, verify, critique and revise—keeping a 'human-in-the-loop' with pauses for critical reflection will reduce errors and enhance gen-AI output; we are ultimately responsible and accountable.

7 | A Call for Intentional Practice

The application of gen-AI in health professions education is rapidly evolving; change is the only constant. Questions remain, including how to appropriately evaluate gen-AI tools, the long-term impact on learning and the role of AI in assessment, professional identity formation and communication skills [3]. Educators have the opportunity and responsibility to shape the future of AI in health professions education. By anchoring the use of gen-AI in educational theory, pedagogical principles and inclusive, equitable design, we can transform learning experiences and expand our impact. Let us proceed with optimism and intention, partnering with students, patients and gen-AI to shape the future of education and continuously improve how we teach, assess and engage learners.

> "*By anchoring the use of gen-AI in educational theory, pedagogical principles and inclusive, equitable design, we can transform learning experiences and expand our impact.*"

Author Contributions

Galina Gheihman: conceptualization, writing – original draft, writing – review and editing. **Hange Li:** conceptualization, writing – original draft, writing – review and editing. **Gergely Csaba:** conceptualization, writing – review and editing. **Stephen Bacchi:**

conceptualization, writing – review and editing. **Kathleen Huth:** conceptualization, supervision, writing – review and editing. **Traci A. Wolbrink:** conceptualization, supervision, writing – review and editing.

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Conflicts of Interest

Hange Li is an employee of XuetangX, a company that designs learning management systems with embedded artificial intelligence functionality for universities. The other authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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