

## Original Research Article

## Utility of generative AI for a medical teacher: Adopting LLMs in practice

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## Abstract

**Background:** Generative AI (Artificial Intelligence), particularly Large Language Models (LLMs), have emerged as transformative tools in medical education since the release of ChatGPT by OpenAI in November 2022. These models, including Gemini by Google, Claude by Anthropic, and others, excel at generating coherent text responses and have demonstrated advanced reasoning abilities. They are capable of tasks such as answering questions, summarizing documents, translating languages, drafting clinical case studies and generating images.

**Materials and Methods:** This is a narrative review exploring the utility of Generative AI LLMs in medical education enhanced by personal experience and supported by literature. We present a qualitative, experiential, and thematic approach, including theoretical perspectives with practical applications observed over the last two years and three months from December 2022 to March 2025.

**Results:** Multiple databases were explored and selective manuscripts were identified to understand broad use cases for medical educators as well as adoption of these models in non-biomedical domains. A thematic framework was used to organize our observations and literature into four key domains of LLM usage in medical education: (1) Automated Content Synthesis, (2) Automation of Routine Tasks, (3) Assistance in Teaching and Research, and (4) Accessibility Enhancement.

**Discussion:** The enthusiasm to understand the potential of LLMs for potentially transforming medical training, it's important to critically assess their role in education, acknowledging both their benefits and limitations. LLM-based chatbots like ChatGPT (GPT-4) have demonstrated advanced reasoning and language abilities, achieving scores at or near the passing threshold of the United States Medical Licensing Examination (USMLE) without medical-specific tuning. Various models have been released so far varying in scale and training, but all share the core capability of generating conversational human-like content on demand.

**Conclusion:** Generative AI is an exciting area under development with potential to revolutionize the landscape of medical education by shifting the traditional mode of information delivery to AI-driven student-centred practices. Medical teachers gain new relevance in this changing landscape. Generative AI can become a powerful tool in medical education through collaboration among educators, learners, AI developers, and policymakers, promoting innovative and human-centered training for future physicians.

**Keywords:** Generative AI, Large language models (LLMs), Medical education, Automated content synthesis, AI ethics.

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## 1. Introduction

OpenAI released ChatGPT for general use on November 30, 2022. Since then, large language models and Generative AI (Artificial Intelligence) became common parlance. This was followed by release of a flurry of similar models including Gemini (formerly known as Bard) by Google, Claude by Anthropic, Deepseek, Mistral, and llama by meta, to name a few.<sup>1-3</sup> Generative AI refers to technologies that can produce

new content (text, images, etc.) by learning patterns from vast datasets. LLMs are GenAI models specialized in language; they are trained on enormous corpora of text (including medical literature) to statistically predict the most likely next words in a sequence, thereby generating coherent text responses.<sup>4</sup> These models are powered by *transformer* neural network architectures that use self-attention mechanisms to understand context and to produce fluent, contextually

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relevant human like responses that we have become used to. Notably, LLM-based chatbots like ChatGPT (GPT-4) have demonstrated advanced reasoning and language abilities, achieving scores at or near the passing threshold of the United States Medical Licensing Examination (USMLE) without medical-specific tuning.<sup>2,5</sup> These models excel at tasks such as answering questions, summarizing documents, translating language, and even drafting clinical case studies or explanations of complex medical concepts.<sup>6,7</sup> Interest has grown in the potential of large language models (LLMs) for educational applications to transform education in general, and medical education in particular, by improving how students learn and how teachers use these tools.<sup>3,8</sup> This manuscript presents a narrative review concerning the usefulness of Generative AI (LLMs) in a medical education context. It is supported by relevant literature and corroborated by our own experiences within our system.

## 2. Methodology

This is a narrative review exploring the utility of Generative AI (Large Language Models - LLMs) in medical education enhanced by personal experience and supported by literature. We present a qualitative, experiential, and thematic approach, including theoretical perspectives with practical applications observed over the last two years and three months from December 2022 to March 2025. Literature for the review were identified from databases including PubMed including key search terms "LLMs in medical education", "ChatGPT for medical educators" and "AI-assisted teaching in healthcare". Only English language studies were considered from 2022 to 2025 for the purpose of the review. Other databases such as ERIC (Education Resources Information Center), IEEE (Institute of Electrical and Electronics Engineers) Xplore, and ACM (Association for Computing Machinery) Digital Library were also checked using search terms "LLMs in education" and "natural language processing in education" to explore usage trends in non-biomedical teaching domains.

## 3. Results

The databases mentioned above were explored and selective manuscripts were identified to understand broad use cases for medical educators as well as adoption of these models in non-biomedical domains. A thematic framework was used to organize our observations and literature into four key domains of LLM usage in medical education: (1) Automated Content Synthesis, (2) Automation of Routine Tasks, (3) Assistance in Teaching and Research, and (4) Accessibility Enhancement. These domains were identified inductively, based on recurring patterns in our day-to-day use of AI tools and their relevance to educational workflows.

## 4. Discussion

The enthusiasm to understand the potential of LLMs for potentially transforming medical training, it's important to critically assess their role in education, acknowledging both their benefits and limitations. LLM-based chatbots like ChatGPT (GPT-4) have demonstrated advanced reasoning and language abilities, achieving scores at or near the passing threshold of the United States Medical Licensing Examination (USMLE) without medical-specific tuning.<sup>5</sup> These models excel at tasks such as answering questions, summarizing documents, translating language, and even drafting clinical case studies or explanations of complex medical concepts. Various models have been released so far (**Table 1**). Each varies in scale and training, but all share the core capability of generating conversational human-like content on demand.<sup>9,10</sup>

A constructivist learning approach holds that students learn best through active engagement and by constructing knowledge through experience and reflection. LLMs can serve as interactive tools that promote this kind of active learning in medical education. LLM based chatbots can enable a dynamic dialogue: students can pose questions, receive answers, request clarification, and even ask the model to expand or challenge a point. This interactivity encourages active learning. Students benefit from this approach by gaining deeper, more durable understanding, as they are actively synthesizing information. Such AI-driven approach can also sharpen critical thinking skills by allowing students to pose questions to evaluate hypothetical (what if...) scenarios.

LLMs have the capacity to support adaptive, personalized learning experiences. Chatbots based on LLMs make it feasible to deliver personalized instructions hence students will be able to have a personal tutor matched to their learning speeds. A large language model can deliver tutoring or educational content on demand, at any time, without being limited by classroom schedules or instructor availability. They can also scale instruction in a way traditional methods cannot. For example, once properly developed, a single AI system could simultaneously provide a simulated patient encounter to an entire class of 200 medical students, each at their own computer, guiding each student through a case interactively. This efficiency in scaling can help overcome faculty and resource shortages, a common issue in medical training, by augmenting the educator workforce with AI assistants.<sup>22</sup> Considering these features of AI, it is essential for medical educators to incorporate LLM-driven tools into their teaching methodologies.

**Table 1:** Common generative AI Models (as on April 12, 2025) useful for medical teachers. This list is not comprehensive, as the field of generative AI is still evolving with new models being developed. Freemium refers to a model offering basic services for free, with premium features available at an additional cost

Text to Text and Text to Image Models					
Name of Generative AI	Available since	Models available	Access	Primary strengths	User Interface
ChatGPT (OpenAI) <sup>11</sup>	November 2022	GPT-4o, GPT-4, GPT-4 Turbo	Freemium	Versatility, strong conversational abilities	Web Browser, mobile application
Gemini (Google) <sup>12</sup>	March 2023 (as Bard)	Gemini 2.0 Flash, Gemini 2.0 Flash-Lite, Gemini 1.5 Flash, Gemini 1.5 Pro, Gemini 1.0 Pro, Gemini 1.0 Ultra <sup>14</sup>	Freemium	Strong conversational abilities, seamless Google service integration	Web Browser, mobile application
Text to Text Models					
ChatGPT (OpenAI)	November 2022	GPT-3.5 Turbo, o1, o3-mini	Freemium	Strong conversational abilities	Web Browser, mobile application
Claude (Anthropic) <sup>13</sup>	March 2023	Claude 3 Opus, Claude 3 Sonnet, Claude 3 Haiku, Claude 3.5 Sonnet, Claude 3.5 Haiku, Claude 3.7 Sonnet, Claude Instant, Claude 2 <sup>22</sup>	Freemium	Strong performance in reasoning, detailed analysis, long-form writing	Web Browser, mobile application
Deepseek <sup>14</sup>	November 2023 (first model)	DeepSeek Coder, DeepSeek LLM, DeepSeek-V2, DeepSeek-Coder-V2, DeepSeek-V3, DeepSeek-R1 <sup>112</sup>	Freemium	Cost-Effectiveness, Open-Source Availability, Support for Chinese language	Web Browser, mobile application
Mistral <sup>15</sup>	2023	Mistral 7B, Mixtral 8x7B, Mistral Large, Mistral Small, Mistral Edge, Codestral, Mathstral, Mistral Embed, Multimodal Models, Mistral Moderation, Mistral Saba, Mistral NeMo <sup>121</sup>	Freemium	Top-Tier Reasoning Capabilities, Transparency, cost-effectiveness	API, Mobile app
LLaMA (Meta) <sup>16</sup>	Feb 2023	7B, 13B, 70B parameter models, base and chat versions. LLaMA 1 LLaMA 2, LLaMA 3, LLaMA 4	Free (open source for research and commercial use)	Strong performance in natural language processing, efficient, scalable, multilingual capabilities	API, Hugging face platform
Grok (X) <sup>17</sup>	November 2023	Grok-1, Grok-2, Grok-3	Freemium	Multimodal interaction, advanced image generation, coding assistance	Web, Mobile Apps, X Premium (formerly Twitter)

Table 1 Continued....					
Text to Image Models					
DALL-E (OpenAI) <sup>18</sup>	January 2021	DALL-E, DALL-E 2, DALL-E 3 <sup>33</sup>	Freemium	Generates photorealistic images from text, image editing	Through Chat GPT interface
Stable Diffusion (Stability AI) <sup>19</sup>	2022	SD 1.5, SDXL, SD 3	Free (open source) with paid options	Generates photorealistic images from text, image editing (inpainting, outpainting)	Can run locally on desktops or laptops equipped with GPUs, Third-party mobile apps
Midjourney <sup>20</sup>	July 2022 (open beta)	Version 7, Version 6.1, Version 6, Niji 6, Version 5.2, Version 5.1, Version 5, Niji 5	Paid subscription	Generates photorealistic images from text, image editing, Retexture feature	Web browser
Gemini (Google)	July 2024	Imagen 3	Freemium	Generating highly realistic and photorealistic images from text descriptions. It offers improved detail, richer lighting, and fewer distracting artifacts	Can be accessed in Gemini App on web browser and mobile, API
Text to Video Models					
Sora (OpenAI) <sup>21</sup>	December 2024 (public for Plus/Pro)	Sora (text-to-video model)	Paid (via ChatGPT Plus/Pro/Team/Enterprise)	Generates realistic and imaginative short videos from text prompts	Chat bot on web browser, mobile app
Veo 2 (Google) <sup>22</sup>	December 2024	Veo 2	Limited paid access in specific geographic areas	State-of-the-art video generation with understanding of real-world physics and the nuances of human movement	API, VideoFX (Google’s experimental platform)

API: Application programming interface

In its present form, the interaction between a user and AI happens through a chatbot and the currency of this interaction is a prompt. The act of prompting can take three forms namely, prompt writing, prompt crafting and prompt engineering. (Table 2) Prompt engineering involves writing prompts to direct the language model's output, similar to how software engineering involves writing code to direct computer operations. The CRAFT framework stands for Context, Role, Action, Format, and Tone and is useful guide to help write effective prompts. (Figure 1).<sup>23-26</sup>

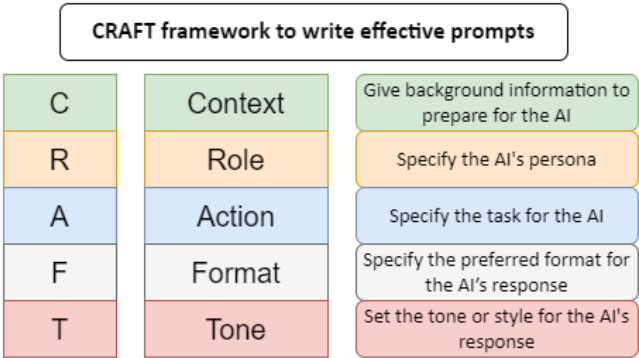


Figure 1: CRAFT framework to guide framing effecting prompts. AI (Artificial Intelligence)

**Table 2:** Understanding differences in prompt writing, crafting and engineering

Term	Definition	Skill Level	Focus	Example in Medical Education
<b>Prompt Writing</b>	Basic act of typing a question or command into an LLM to get a response.	Beginner	Simplicity, direct requests	“Explain the brachial plexus to a second-year MBBS student.”
<b>Prompt Crafting</b>	Thoughtful design of prompts to guide the model toward specific tone, structure, or purpose.	Intermediate	Clarity, structure, desired output format	“You are a medical educator. Create a 5-slide outline for a class on cleft lip embryology using case-based examples.”
<b>Prompt Engineering</b>	Advanced technique of designing prompts systematically to control outputs, integrate context, chain reasoning, or build reusable workflows.	Advanced	Optimization, precision, adaptability, reproducibility	“Given a clinical vignette of cleft lip with feeding difficulty, generate a stepwise management plan including surgical, nutritional, and counselling aspects. Present in a table format with references.”

The authors have been using AI tools in different instances since their launch in November 2022. Based on our interactions over the last couple of years, we are sharing key tips towards effectively utilizing LLMs chatbots (ChatGPT). We identified usage across the four key domains for a medical teacher. (**Table 3**)

**Table 3:** The ‘4 A’ domains of LLM Usage by a medical teacher

Domain	Description
1. Automated Content Synthesis	Using LLMs to generate structured educational content like lectures, quizzes, patient information, etc.
2. Automation of Routine Tasks	Streamlining academic, nonacademic and clinical tasks through AI.
3. Assistance in Teaching and Research	Acting as a co-pilot for class planning, scholarly writing, research planning, and student assessment.
4. Accessibility Enhancement	Access files and images with an aim of making information easier to interact with (e.g., summarizing PDFs, clarifying complex topics, extracting information from images).

#### 4.1. Automated content synthesis

This refers to using LLMs to generate structured educational content like lecture plan, quizzes, case-based learning material for residents, generated slide outlines for discussion.

##### 4.1.1. Prompt example

“I am a teaching faculty for undergraduate medical students. I have a 45-minute lecture session on cleft lip and palate deformities. As my teaching assistant, prepare me a lecture plan for the topic ‘perinatal considerations in cleft lip and palate deformities.’ Prepare it in a point-to-point format with bullet points “

##### Prompt breakup for understanding of readers

1. Context: I am a teaching faculty for undergraduate medical students. I have a 45-minute lecture session on cleft lip and palate deformities.
2. Role: As my teaching assistant
3. Action: prepare me a lecture plan for the topic ‘perinatal considerations in cleft lip and palate deformities.
4. Format: Prepare it in a point-to-point format with bullet points
5. Tone: Not necessary to assign in this situation as the AI understands that the presentation must be a formal tone based on the role assigned.

##### 4.1.2. Image generation

Image generation tasks have multiple uses for medical teachers as for example creation of outline diagrams, creation of images for presentation, creation of theme specific backgrounds for webinar software (eg; Zoom), or PowerPoint. While present image generation models like ChatGPT 4o (OpenAI) produce accurate anatomical images, detailed internal anatomy illustrations are not possible.

Prompt used (Tool ChatGPT, Model: 4o)

1. “I want an image to depict the effects of aging. Create me a close up of a female face one half showing the age changes including forehead lines, sagging eyebrows, sagging cheeks and lips, wrinkles with lines in the corners of the eye. The other half should be youthful. Prepare a minimalistic colour illustration in 1:1 ratio” (**Figure 2** (left))
2. “prepare a similar illustration as a watercolor sketch depicting the details” (**Figure 2** (right))

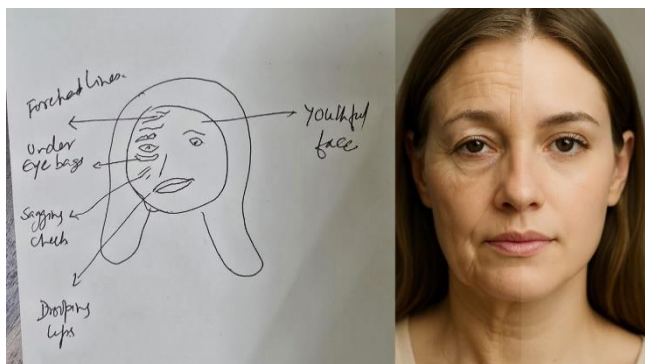


**Figure 2:** Image illustrating creation of simple sketches using generative AI from user prompts. Model used ChatGPT 4o

Image generation can be used to transform rough hand drawn sketches into detailed artistic sketch/images. (**Figure 3**)

Prompt used (Tool ChatGPT, Model: 4o)

1. A hand drawn figure is uploaded (**Figure 3** Left) and the following prompt inserted. “continuing with our above discussion. please convert my sketch into a photo realistic image depicting the same without labels” (**Figure 3** Right)



**Figure 3:** Figure depicting generation of detailed photorealistic images (right) from simple hand drawings (left) using generative AI. Model used ChatGPT 4o

#### 4.2. Automation of routine tasks

This refers to streamlining academic and clinical tasks through AI. Some tasks include, Drafting and refining emails

and formal communications. Creating outlines for events and online resources, tabulating complex information.

Prompt example: After an email is drafted, it can be uploaded to the chatbot to refine the subject and tone. “As my assistant, please refine the uploaded email draft to have a more formal tone”

Research is being conducted to integrate LLM-based autonomous agents into smartphones to automatically complete specific predefined tasks by combining public-domain knowledge from the LLM with domain-specific knowledge from the apps. Medical educators can collaborate with developers to create specialized agents that will be beneficial for their classrooms.<sup>27</sup>

#### 4.3. Assistance in teaching and research

This refers to assisting the user for scholarly writing, research planning, and student assessment. AI tool can assist medical teachers to organise student responses. Web based applications harnessing this potential of LLMs have been designed to provide formative feedback.<sup>28</sup> Teachers have used LLMs for pre-class rehearsal simulation in order to refine their sessions for providing better value to students.<sup>29</sup> The role of LLMs to evaluate student responses are being studied extensively.<sup>30-32</sup>

#### 4.4. Accessibility enhancement

This refers to accessing information in PDF and images and presenting them in a text format (e.g., summarizing PDFs, clarifying complex images). Files (pdfs, doc, Jpeg etc) can be uploaded on the chat interface. The chatbot can then be prompted to create a summary of the text or tabulate the information for better understanding or even generate questions to test understanding. Complex diagrams (**Figure 4**) can be uploaded in the chatbot, and the chatbot can summarize the information in a simpler manner.

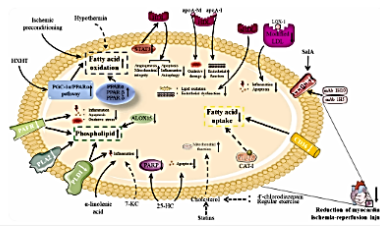
Audio overview feature of AI like Gemini can help create podcasts from an uploaded document in few minutes. This can be shared with students and listened on the go to have a faster understanding of the subject.

Most of the applications of generative AI in practical will involve combination of all the above-mentioned domains. Dedicated, user-customized instruction -tuned language models are available through Custom GPT (OpenAI) and NotebookLM (Google). These platforms allow users to upload their own sources, including PDFs, video files, audio files, and documents. These customized models allow medical educators and institutions to tailor AI capabilities closely to their unique educational requirements, enhancing



accuracy, relevance, and usability in clinical teaching and learning scenarios.<sup>33,34</sup>

#### Lipid Metabolism in MI 4.5



I have to take a class for undergraduate 3rd year medical students. this image is from a manuscript titled 'Abnormalities of glucose and lipid metabolism in myocardial ischemia-reperfusion injury'. As my teaching assistant can you summarize this image into few simple bullet points

Here's a simplified summary of the provided image for your undergraduate medical class:

#### Simplified Summary:

Title: Lipid Metabolism Changes in Myocardial Ischemia-Reperfusion Injury

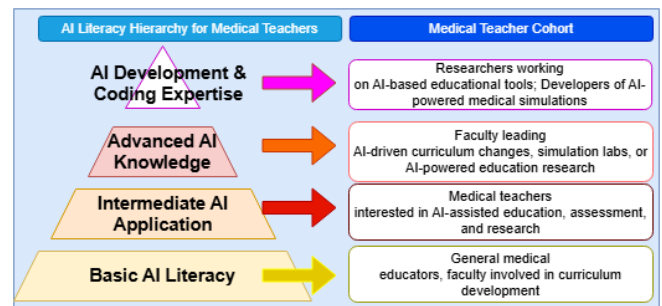
- **Protective Mechanisms (I Injury):**
  - **Increased Fatty Acid Oxidation:** Stimulated by factors such as hypothermia and ischemic preconditioning.
  - **Increased Phospholipids:** Reduces inflammation, apoptosis (cell death), and oxidative stress.
  - **Increased HDL (good cholesterol):** Improves endothelial function, reduces oxidative damage, and promotes angiogenesis (blood vessel growth).
  - **Decreased Fatty Acid Uptake:** Reduces mitochondrial stress and apoptosis, protecting heart muscle cells.
  - **Reduced Modified LDL (bad cholesterol):** Decreases inflammation and apoptosis.

Ask anything

**Figure 4:** An example of using the ChatGPT interface to obtain details from medical diagrams

#### Literacy of AI tools for medical teachers

Medical educators do not need to have a formal education in AI, but having a working knowledge of how AI, particularly generative AI and Large Language Models (LLMs) behave, could help them leverage the potential of these tools. No programming skills are needed to use AI tools like ChatGPT, Claude, or Gemini. Educators could instead, focus on prompt engineering, AI ethics, and end user applications (e.g. Custom GPTs). Learning software coding can be advantageous for educators who intend to develop applications based on LLMs that can be integrated into medical education systems. (Figure 5) If a medical educator seeks to create AI-based educational tools or engage in comprehensive AI research, basic knowledge of coding languages such as Python, R, and SQL is beneficial.



**Figure 5:** The pyramid depicts the requirement of AI literacy among medical teachers. The vast majority would need basic to intermediate AI literacy

#### 5. Limitations of LLMS

While LLMs are powerful tools in medical education, they can generate incorrect or biased information and lack access to the latest medical research. Additionally, they have limitations in interpreting visual diagnostic cues and cannot match human instructors' ability to integrate sensory and nonverbal information. Computational cost and data privacy are other major concerns.

#### 6. Ethical Considerations in AI-Based Medical Teaching

Ethical considerations in AI-based medical education include ensuring misinformation (also known as hallucinations) is avoided and biases (due to training data) are corrected. Academic integrity must be maintained by setting clear policies on AI use. Voluntary disclosure system to report AI use in academic environment should be mandated for teachers and students both. The impact on student-teacher interactions must be considered to preserve mentorship and human skills. Privacy and confidentiality of patient and student data must be safeguarded, with strong protections in place. Lastly, equitable access to AI tools must be ensured to prevent widening educational disparities. Addressing these issues responsibly enables educators to utilize AI's benefits while minimizing possible drawbacks.<sup>35-39</sup>

The present manuscript has tried to explain the usage of AI for medical teachers under broad domains. The use cases and software suggested within are in no way exhaustive. Newer tools are being crafted every day. The authors have not attempted to cover the myriad commercial applications designed around these LLMs and evolving every moment. Readers are suggested to explore further and find more use cases suitable for their work environment.

#### 7. Conclusion

Generative AI is an exciting area under development with potential to revolutionize the landscape of medical education by shifting the traditional mode of information delivery to AI-

driven student-centred practices. The role of the medical teacher is poised to evolve rather than disappear. Medical teachers gain new relevance in this changing landscape. Most medical teachers must develop basic to intermediate AI literacy skills to navigate this panorama. The manuscript aims to explain the advancing technology of generative AI and suggests selective use cases based on the authors' experiences. The examples provided are intended to generate interest, but it is up to the readers and medical teaching community to identify a broader range of applications for these tools. Being aware of the practice and pitfalls of generative AI will help medical teachers guide students in questioning and validating AI generated outputs. Teachers will concentrate on the emotional aspects of education methods by serving as mentors and imparting 'human' skills that current AI technology cannot replicate. The known limitations of hallucinations, bias, misinformation, and privacy concerns must be addressed proactively before implementing these tools on a large scale. Generative AI can become a powerful tool in medical education through collaboration among educators, learners, AI developers, and policymakers, promoting innovative and human-centered training for future physicians.

## 8. Source of Funding

None.

## 9. Conflict of Interest

None.

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