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Commentary

Equipping Future Physicians with Artificial Intelligence Competencies through Student Associations

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Abstract: Advances in artificial intelligence (AI) in the medical sector necessitate the development of AI literacy among future physicians. This article explores the pioneering efforts of the AI in Medicine Association (AIM) at Brigham Young University, which offers a framework for undergraduate pre-medical students to gain hands-on experience, receive principled education, explore ethical considerations, and learn appraisal of AI models. By supplementing formal, university-organized pre-medical education with a student-led, faculty-supported introduction to AI through an extracurricular academic association, AIM alleviates apprehensions regarding AI in medicine early and empowers students preparing for medical school to navigate the evolving landscape of AI in healthcare responsibly.

Keywords: medical education; AI education; undergraduate education; AI in medicine; medical training

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1. Introduction

Rapid advances in artificial intelligence are reshaping numerous professional domains, including medicine. AI systems already demonstrate remarkable capabilities in medical imaging analysis [1–3], risk prediction [4], and even conversational interactions mimicking physician–patient dialogues [5]. As these technologies continue to evolve and integrate into healthcare practices, a critical need has emerged: ensuring future physicians can effectively use and responsibly guide the development of AI in medicine.

Already, established models like GPT-4 have been considered and tested within the scope of medicine, to surprising results. These models showcased strong problem-solving and logical reasoning within a medical context, suggesting roles such as learning aids for medical students, support for researchers, and artificial assistants for clinicians [4,5]. AI has also demonstrated an ability to improve diagnostic accuracy, as demonstrated by Paige Prostate's recent image recognition model, which achieved consistent sensitivity increases when used by physicians in simulations involving prostate cancer diagnosis [3].

Moreover, supplementary evaluations have been carried out on fine-tuned large language models (LLMs) without the involvement of medical professionals. One such model, AMIE, represents a milestone for the field, as it was assessed along multiple clinically relevant axes for conversational diagnostic medical AI and outperformed actual physicians within all reported axes [5]. Still, the results should be interpreted with appropriate caution. Translating from simulated dialogue to real-world healthcare tools has necessitated extensive research to ensure safety, reliability, fairness, efficacy, and privacy. Continuing this research will require effective future collaboration between AI developers and physicians.

Nonetheless, for AI to continue to be effectively integrated into healthcare systems, a significant gap within the current medical education landscape must be addressed, as training on AI principles and their clinical implications remains largely absent from standard pre-medical and medical school curricula. This lack of exposure can breed apprehension and resistance towards adopting AI-powered tools. Numerous studies have

highlighted how direct experience with AI applications can alleviate this attitude and cultivate openness to advanced technologies. Therefore, AI education and experience are needed to enhance patient care and improve our healthcare system [6–10].

The differences between the medical education systems in Canada and the United States, compared to other international medical education programs, introduce key distinctions that are crucial when examining how medical AI education has been explored so far and how it could evolve in the future. In the United States and Canada, aspiring medical students must first complete undergraduate pre-medical/pre-health education (PMU). This phase focuses on building foundational scientific knowledge through completing a relevant university degree, along with developing clinical skills, participating in research, shadowing practicing physicians, and scoring well on the Medical College Admissions Test (MCAT). Undergraduate pre-medical education serves to prepare students for graduate medical education (GMU), which then provides the specialized training specific to licensed physicians in the United States and Canada [11].

In countries other than the United States and Canada, medical education generally begins right after high school, with students entering medical school directly without the need for a separate, prerequisite university degree. This is typically referred to as undergraduate medical education (UME). Despite the differences in these education pathways, the need for enhanced AI education is critical across both PMU and UME, as AI will inevitably play an increasingly significant role in the future of medicine.

Within the last three years, multiple articles encompassing PMU, GMU, and UME have echoed the need for a new generation of AI-educated physicians [5–10,12–15]. Articles assessing medical students' attitudes and knowledge levels of AI in medicine have reported that while a high percentage of students were aware of AI's potential future impact, their knowledge of AI systems was low [7]. Additionally, in one study conducted by Stewart et al. in Western Australia, 56.6% of students expressed no concern toward AI and job security as a physician, leaving a significant number of students reporting some level of uncertainty regarding AI and job security [8]. These studies were conducted on UME student populations in international medical schools.

Recent reviews commonly address the necessity of implementing structured AI curricula in medical education and provide suggested categories of focus within the educational content, including working with AI systems, ethics, and appraisal of novel AI systems [7,9,15]. A combination of teaching methods, including hands-on learning, lecture-based education, and analysis of current published models, was also recommended. Additionally, across all included literature, education on the use of AI in navigating electronic health records was given considerable attention [1,12,15–20]. Examples of possible implementations were also presented, including classes taught in continuing medical education programs, MCAT testing, and clinical phase education [9,10,15–18].

Additionally, some UME institutions reported attempted implementation of elective classes designed toward introducing AI algorithms and their applications [12], as well as existing web-based resources within a classroom context [13,14,19]. These reports provide valuable insight into possible directions to take when introducing AI education in a medical setting and represent a valuable step forward in raising awareness for medical AI education and applying it to undergraduate medical education or graduate medical education. However, across all reviews considered, no consensus was reached regarding proper implementation across all forms of medical education. Particularly, no efforts to implement AI education within a PMU context have been reported to our knowledge.

Considering this pressing need and the information collected by researchers thus far, innovative approaches are required to bridge the AI literacy divide early for potential physicians—approaches that will prepare them for the use of AI in their medical education and their medical practices. Within the United States and Canada, this implementation should occur early, during the education PMU stage, if AI education programs are worked into the existing preparatory requirements. These programs should be easily incorporated into PMU education, include relevant applications and principles, and have significant,

measurable outcomes. One way to fulfill this promising initiative is the formation of student-led organizations dedicated to providing structured education and hands-on learning opportunities in medical AI for undergraduate pre-medical students.

2. Methods

The AI in Medicine Association at Brigham Young University pioneers such educational efforts for students in the PMU phase of their medical education. Founded by medical and data science faculty and operated by students, AIM establishes a multi-faceted approach encompassing four key elements as shown in Figure 1: hands-on AI research experience, education on essential AI principles, development of ethical thought processes, and appraisal of past and current AI models.

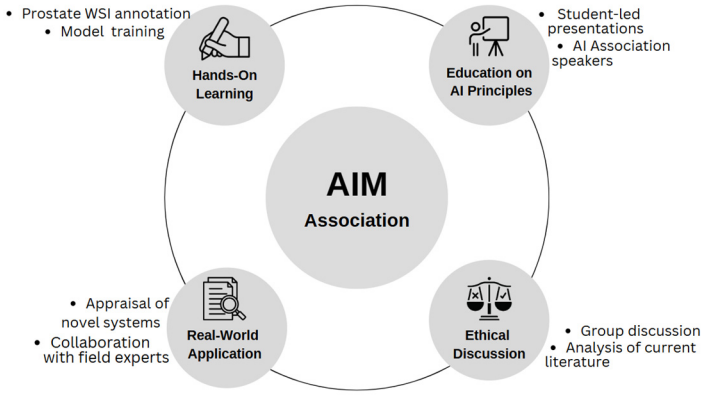

Figure 1. A graphical representation of key elements and activities associated with each element.

These four elements were chosen based on the recommendations of current literature regarding what medical students should learn about AI and how they should be taught the material. The reviewed articles discussed a combination of hands-on experience and lecture-based learning delivered by invited experts. These methods comprise AIM's four key elements [15,16]. Regarding which skills future medical professionals should learn, McCoy et al. state, "physicians need to understand AI in the same way that they need to understand any technology impacting clinical decision-making", and further suggest that students should develop the skills to use, interpret, and explain medical AI tools [16].

AIM's educational framework takes a multi-faceted approach, enabling students to develop essential skills at a basic level and establish a strong foundation in AI in medicine, which they can build upon throughout their medical education and careers. The four key elements of AIM's educational framework are implemented in the following ways (see Table 1):

Table 1. Recognizing crucial subjects to be reviewed by undergraduate pre-med students and how AIM educates on these subjects.

Category	Corresponding AIM Element	How AIM Meets Categorical Need
Working with AI systems	Hands-on experience	Prostate cancer detection project
Education on AI principles	Integrated learning/teaching	Weekly learning session given by AIM officers or guest speakers on AI concepts related to current project(s)
Ethics of AI	Review of current literature with group ethical discussions	Group reviews of the pace of AI model implementation and ethical implications
Real-World Application	Updates on medical AI developments	Reviews of current literature and how to interpret model performance based on research tables, figures, etc.

2.1. Hands-On Learning

Through collaborations with expert faculty such as professors of data science and MD/PhD medical professionals, AIM facilitates students' ability to use AI through direct involvement in AI initiatives while focusing on clinically relevant applications. A notable example is an ongoing project analyzing whole slide images of prostate tissue samples, where students annotate image data to support the development of AI-powered diagnostic models under the guidance of an experienced pathologist [1,21,22]. As students annotate images, they gain crucial knowledge about the importance of data organization and learn how models are trained and used within a medical context.

2.2. Education on AI Principles

Complementing practical experience, AIM's educational curriculum covers a comprehensive range of topics imparting conceptual mastery of AI principles and methods. Weekly lessons explore AI principles in a linear fashion, as the structure of the education follows different steps along the development path of AI models and discusses important vocabulary and ideas associated with each development step. Steps include data preprocessing techniques and study design, model training and characteristics of a good model, and finally, interpreting model performance and learning from model data.

These principles are taught by association officers in collaboration with Brigham Young University's AI association. AI association representatives contribute their expertise and experience with AI principles and provide general examples, which are then supplemented by real-world medical AI research analysis provided by AIM officers.

2.3. Ethical Discussion

Throughout these linear steps, special focus is given on the ethical implications of AI, and collaborative discussions on sensitive topics are conducted. These topics include patient privacy, algorithm transparency, data bias, and general patient safety. The ethical principles discussed follow a consensus of current literature as reviewed by AIM officers and follow closely to the AMA principles of medical ethics, with AI integrated into those principles [15,16,23].

2.4. Real-World Application

Moreover, AIM facilitates knowledge sharing on the latest breakthroughs and state-of-the-art research in medical AI through guest speaker seminars and literature review sessions. Guest speakers range from medical professionals, fellow students knowledgeable in AI, and leaders of medical AI companies. Additionally, throughout the provided education, research papers and novel models are presented by AIM officers for demonstration of AI principles and discussion of different study designs and model training techniques. Students are encouraged to read primary literature and receive guidance on how to do so. This practical exposure keeps students apprised of emerging developments, fostering an appreciation for the rapid pace of innovation in this field and the transformative potential of novel AI capabilities. It also provides students with valuable experience reading scientific literature and assessing the performance of the models presented in the literature. These skills facilitate increased AI literacy and provide safeguards against supporting models that are poorly trained or not generalizable.

3. Case Study: Prostate Cancer Whole Slide Image Database and Model

As part of the hands-on learning experience provided to AIM members, a current initiative is underway to develop a novel dataset of gland-level annotated prostate whole slide images, as well as utilize a Bayesian Framework that combines the outputs of multiple trained models to improve AI's ability to aid pathologists in the prostate cancer diagnosis process (see Figure 2). This project directly involves AIM members, as they aid in annotating the prostate whole slide images, working alongside an expert pathologist who reviews all final annotations [1].

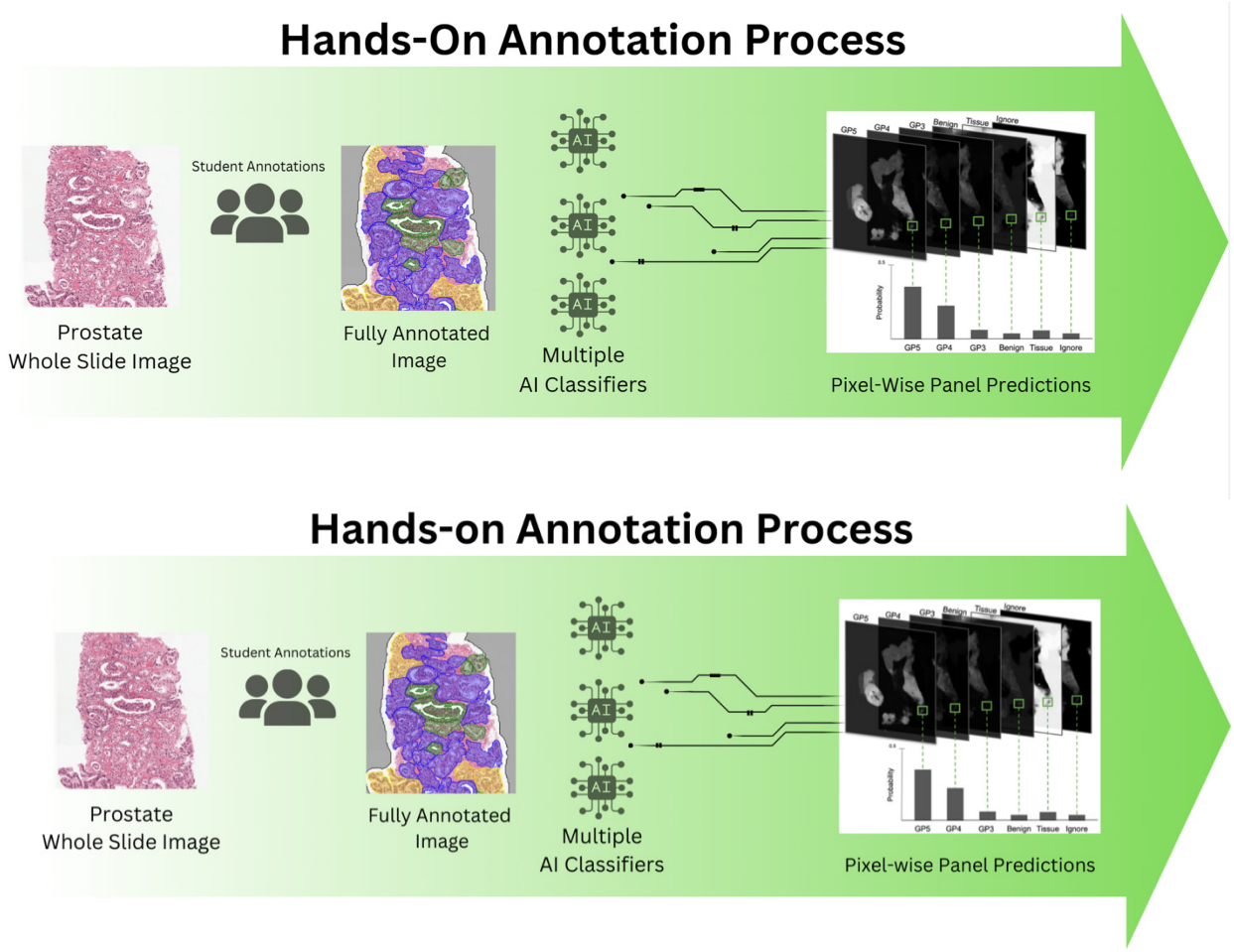

Figure 2. A graphical representation of the prostate cancer whole slide images database project [1]. Prostate whole slide images are annotated by students (the annotations shown were completed by an actual AIM member) and then used to train multiple AI models. The final result of the Bayesian framework as presented in [18] is shown, with results represented as a probability distribution.

Thus far, the efforts of the AIM association have led to the collaborative completion of over 600 prostate images. This process includes educating student research volunteers on simple pathological patterns and histological tendencies and guiding said students through an annotation process using the QuPath pathology program [24]. Once the students have completed annotations on an image to the best of their training/expertise, an experienced AIM officer reviews, edits, and preprocesses the files to ensure consistent annotations, image resolution, and size. This image is then reviewed by the expert pathologist and exported to the image database for training AI models. This project's impact and methods are explained in [1]. Through this project, almost 100 students have received training on annotating prostate whole slide images and at least a portion of AIM's AI educational curriculum. Projects like this allow students to gain valuable volunteer and research hours, which are required for graduate medical school applications, and additionally, provide an environment that encourages discussion and learning about the process of AI development.

4. Discussion

A student-led organization like AIM, while not formal in its integration of AI into a PMU setting, represents an effective introduction to AI and serves to prepare students for the inevitable integration of AI into their medical education and practices. AIM easily incorporates into a structured PMU education, welcomes all who are willing to learn, and includes relevant principles and experiences that will prepare students for a rapidly

developing, artificially intelligent medical field. By grounding AI theory in tangible medical use cases, students develop a contextual understanding of how these powerful techniques can be applied to address unmet needs and elevate standards of care. A quantitative assessment of AIM outcomes is outside the scope of this commentary but will be addressed in a follow-up case-control study with IRB support.

Qualitatively, students have demonstrated their willingness to improve their AI capabilities by attending the association's weekly meetings and participating in the education provided by the association officers. The elevated AI literacy provided by AIM empowers future physicians to contribute as active collaborators alongside computer scientists and AI experts, shaping the responsible development and real-world deployment of AI technologies in clinical settings.

While AIM's pioneering efforts have yielded promising results, it represents merely the first step towards a larger vision—the formal, institution-organized integration of AI education into all forms of medical education across many institutions. By establishing AI competencies as a core component of physician training pipelines, the medical field can cultivate a workforce adept at harnessing the full potential of artificial intelligence to drive improvements in diagnostic accuracy, treatment personalization, and overall quality of patient care. We invite other institutions to visit AIM sessions at Brigham Young University and to introduce similar programs for the benefit of their students. All training and presentation material can be made available upon request.

5. Conclusions

As AI continues its persistent march into healthcare domains, ensuring that future clinicians possess the requisite knowledge and skills to navigate this technological landscape is imperative. Initiatives like AIM demonstrate the eagerness of prospective medical professionals to embrace AI education and the tangible benefits of early exposure to these transformative technologies. We encourage other institutions to form similar undergraduate pre-medical associations and give due resources to the development of educated, AI-proficient medical learners. By proliferating similar undergraduate programs and catalyzing curriculum reforms, academic institutions can pave the way for safer, more effective adoption of AI that ultimately elevates standards of care and improves health outcomes on a population scale.

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