INTEGRATION OF ARTIFICIAL INTELLIGENCE IN MEDICAL EDUCATION: DEVELOPING A FRAMEWORK FOR CURRICULUM ENHANCEMENT

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Abstract: *Objectives: To explore integrating AI in medical education by creating a framework for the medical curricula at a Portuguese medical school.*
Methods: A phased approach was used: (1) a public forum was held to gather insights on AI application in medical education; (2) a collaborative framework was developed for integrating AI content into curriculum; (3) the framework was implemented within the curricular unit «DECIDES III»; (4) continuous evaluation of AI integration within the curriculum is ongoing.
Results: AI tools are additional and complementary to traditional teaching methods. The primary goal of incorporating AI tools in medical education is to strengthen students' creativity and critical thinking. Challenges include ethical considerations, the potential impact on clinical practice and academic settings, and copyright and intellectual property issues.
Conclusion: This ongoing study aims to develop a framework to integrate AI content into medical students' curriculum, preparing future healthcare professionals for the evolving healthcare landscape.

Keywords: *Artificial Intelligence; Medical education; Medical students; Medical ethics.*

Resumo: *Objetivos: Explorar a integração da inteligência artificial (IA) na educação médica, criando uma estrutura para o currículo numa escola médica em Portugal.*
Métodos: Utilizou-se uma metodologia faseada: (1) realização de fórum público para recolher ideias sobre IA na educação médica; (2) desenvolvimento de uma estrutura colaborativa para integrar IA no plano

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curricular do Mestrado Integrado em Medicina; (3) implementação de IA na unidade curricular de «DECIDES III»; (4) avaliação contínua da integração da IA em curso.

Resultados: As ferramentas de IA são complementares aos métodos de ensino tradicionais na educação médica, visando fortalecer a criatividade e o pensamento crítico dos estudantes. Os desafios incluem considerações éticas, o impacto potencial na prática clínica e em contextos académicos, e questões de direitos autorais e propriedade intelectual.

Conclusão: Este estudo, ainda em curso, visa desenvolver um quadro para integrar conteúdos de IA no currículo dos estudantes de Medicina, preparando os futuros profissionais de saúde para a integração de novas tecnologias no contexto da prática académica e assistencial.

Palavras-chave: *Inteligência Artificial; Educação médica; Estudantes de Medicina; Ética médica.*

INTRODUCTION

The application of NLP to medical education has been accelerating over the past several years (Chary et al., 2019; Paranjape et al. 2019). However, integrating artificial intelligence (AI) technologies into the medical school curriculum presents both opportunities and challenges. While there is an opportunity to integrate AI technologies into the curriculum, the readiness of medical education to embrace AI literacy remains a subject of inquiry (Wood, Ange and Miller 2021). The demand for curriculum reforms based on the latest technologies in education has been highlighted in the literature, emphasizing the need for medical education to create trust for AI-based applications, which is associated with the acceptance of the technology by its users (Iqbal et al. 2021; Chan and Zary 2019; Sun et al. 2023; Sallam 2023). However, the current undergraduate medical education curriculum may at times be out of sync with the new needs of an evolving technology (Grunhut, Marques and Wyatt 2022).

The ethical considerations and potential biases associated with the integration of AI in medical education have been subjects of increasing interest (Katznelson and Gerke 2021). Additionally, the importance of familiarizing students with the technical aspects of AI tools and the potential impact on clinical practice and academic settings, including issues related to copyright and intellectual property, have been emphasized (Grunhut, Marques and Wyatt 2022; Sit et al. 2020; Mehta et al. 2021).

This study explores the integration of AI, particularly focusing on NLP models, LLM, and chatbots, within the realm of medical education. Its primary goal is to establish a comprehensive and structured framework for embedding AI into the medical curricula at a Portuguese medical school. This initiative is designed to serve both educators and students by methodically incorporating AI technologies, thereby enhancing the overall teaching and learning experience. Furthermore, this approach aims to bridge the gap between traditional medical training and technological advancements, ensuring that future medical professionals are adept at leveraging AI for improved healthcare delivery.

1. METHODS

We employed a multi-phased, qualitative approach to explore the integration of AI tools in medical education. This approach involved a combination of public forums, collaborative framework development, practical implementation, and continuous evaluation, built upon the insights and findings of the previous one, and allowing for a dynamic and responsive adaptation of our strategies, ensuring that the integration of AI into medical education was both effective and aligned with the needs of all stakeholders involved.

1.1. Phase 1: Public Forum

We conducted a public forum on May 19, 2023, aiming to gather diverse insights on the application of AI tools in medical education. The forum convened around 90 stakeholders, including educators, students, and medical professionals, and featured a series of presentations and panel discussions. The insights generated in this phase were subsequently used to inform the development of the next phases.

1.2. Phase 2: Framework Development

Building upon the insights from the forum, we progressed to the second phase, focusing on the collaborative development of an integration framework. Faculty members and students created a comprehensive framework for integrating AI content into the curriculum of fourth-year medical students. This process involved interactive workshops and brainstorming sessions. The progress and preliminary results of the framework were presented at the Faculty of Medicine of the University of Porto on June 29, 2023, and ongoing feedback was solicited through further presentations.

1.3. Phase 3: Implementation

We are currently in the implementation phase, applying the developed framework within a specific curricular unit titled «Decision, Data, and Digital Health» as part of the mandatory curriculum of the Integrated Master's in Medicine Programme. The implementation involves the practical application of the framework in the curriculum, providing students and faculty with firsthand experience with the designated AI tools and methodologies.

1.4. Phase 4: Continuous Evaluation

Concurrently with the implementation, we have initiated a continuous evaluation phase to monitor and assess the effectiveness of AI integration within the curriculum. This includes feedback mechanisms, analysis of student engagement and performance, and iterative refinements of the framework based on findings. Documentation will be carried out through reflective journals, structures interviews and feedback questionnaire analysis to gather comprehensive qualitative data.

2. RESULTS

2.1. Key outcomes from First Forum

The initial forum convened on May 19, 2023, brought together a diverse group of 90 stakeholders to critically examine the integration of AI within the medical education landscape. The attendees, spanning various academic and clinical disciplines, contributed to the discussion on the subject of AI in medical teaching and practice.

A critical consensus emerged that AI tools are intended to complement, not replace, traditional teaching methodologies within the medical curriculum. The forum also sparked a strong interest in interdisciplinary collaboration, drawing educators from a variety of faculties, including arts and literature, in addition to medicine, where the forum was held and organized. The discussions pointed towards the exploration of cross-disciplinary pedagogical approaches.

The overarching objective was to use AI to boost student creativity and critical thinking, with a focus on careful prompt design and the judicious interpretation of their outputs. Further discussions emphasized the importance of students gaining proficiency in the technical foundations of AI tools. This understanding should be tailored to demystifying AI's role in clinical settings and equipping students with the skills to navigate future technological advancements in healthcare. Encouraging students to delve into AI-focused research projects emerged as a theme, suggesting an active approach to learning that aligns with the evolving dynamics of medicine and technology.

The dialogue also brought to light the inherent challenges and ethical dilemmas presented by AI, such as biases in models and their potential impacts on clinical practice and academia. Issues such as copyright and intellectual property were also discussed as important topics to convey to students. Concerns about the risk of dehumanizing care with the advent of AI systems prompted a discourse on the need for supervised educational use of these tools. Ensuring the proper flow of information and the credibility of AI-generated outputs was highlighted as imperative.

The forum was well-received by participants, who expressed appreciation for the opportunity to share their perspectives and learn from others. It also generated a number of valuable insights that will be used to inform the development of future research and initiatives in this area.

2.2. Framework Definition

The developed framework takes into account content selection, pedagogical approaches, assessment strategies, and ethical guidelines and is being developed based on the insights and conclusions drawn from the public forum.

2.2.1. Framework Goals

The second phase of our research concentrated on creating a collaborative framework for integrating AI tools into the education of fourth-year medical students. This collaborative effort, which brought together faculty and students, was intended to establish an environment in which critical thinking and creativity were essential to the learning process, as informed by the first forum. This was achieved by focusing on the careful design of AI tool prompts that challenged and provoked in-depth analysis, thereby enhancing students' ability to engage with complex problems creatively. The skill of prompt design was complemented by an emphasis on the critical evaluation of AI-generated outputs, ensuring that students not only ask the right questions, but also discern the quality and applicability of the answers they receive.

2.2.2. Framework Layout

«DECIDES III» is a required curricular unit in the fourth year of the Medicine program that focuses on knowledge and skills related to decision, data, evidence, and digital health. This unit encompasses subjects beyond the realm of AI, which will be competing for lecturing and activity time within the unit, together contributing to the total of four European Credit Transfer and Accumulation System credits. The educational framework for this module is bifurcated into theoretical and practical components to enhance the learning experience of medical students.

The theoretical component is delivered through recorded magistral classes that delve into the themes of AI and its applications in health and the use of chatbots by medical students and professionals. In the practical component, students are split into small classes in a computer lab setting. There, they have the opportunity to interact with AI tools directly under the supervision of a tutor and are presented with defined exercises.

The first exercise focuses on the use of an AI assistant to elucidate complex healthcare concepts in simple terms, making them accessible to a broader audience, including those without specialized knowledge. For instance, students might use the AI to distill the intricacies of blockchain technology in healthcare, translating it into layman's terms that a teenager could easily grasp. The goal is to ensure that students not only understand these concepts themselves but can also communicate them effectively to non-experts. In the second exercise, students engage with the AI assistant to tackle complex problems. This includes, for example, assessing the risks and benefits of regulations like General Data Protection Regulation (GDPR) in clinical research settings. Students are expected to use the AI tool to help formulate and chart technological strategies that could mitigate identified risks. The last exercise is generating clinical narratives and patient simulators. Students are tasked with creating detailed clinical stories that they can work through using SClinico, an electronic clinical record software. A task list was designed to serve as a structured pathway, enabling students to sequentially address the components of

patient care, from initial assessment and diagnosis to treatment planning and doctor--patient communication.

Finally, an additional activity involves using a chatbot as a study aid for other topics in the unit. In this exercise, students choose elements from the DECIDES III unit, such as slides or support materials. They then engage with the chatbot to formulate both multiple-choice and open-ended questions based on these materials.

2.3. Second Forum Highlights

The second forum, held on June 29, 2023, also added to the development of our educational framework for integrating AI into medical education. The event provided a platform for the first public presentation of a series of exercises designed to prepare students for interacting with AI tools. It also provided an opportunity for open discussion and feedback. Additionally, the forum provided insight into upcoming strategies for educators to enrich class content using chatbots. The collaborative discussion aimed to refine the proposed exercises, ensuring they would effectively contribute to the curriculum once students begin to engage with them.

2.4. Use of Chatbots by Educators

The potential of chatbots to assist in the creation of lesson plans and the elucidation of complex medical topics by educators was also explored. These tools can generate practice exercises and clinical case studies, providing students with realistic scenarios for study and discussion. Beyond generating raw data, they can be used to create scripts to generate datasets within certain constraints, making the data more relevant and applicable to the learning objectives.

Chatbots are also being used to streamline the creation of educational materials, such as reports and guides. They can convert formats from LaTeX to PDF, making it easier to create ready-to-use documents. In addition, chatbots can assist in the creation of diagrams, such as decision trees. They can do this by leveraging grammar-based tools like DOT. This helps students visualize complex decision-making processes and the importance of data quality in medical scenarios. In the classroom, chatbots can serve as an on-demand resource. Educators can pose questions and explore answers with students in real-time, fostering an interactive and engaging learning environment.

The use of chatbots also extends into the assessment phase. They can provide immediate feedback or assist educators in reviewing and grading student work, streamlining the evaluation process.

2.5. Challenges and Ethical Considerations

One of the main concerns is to guarantee equal access to these resources. For instance, some students may only have access to the basic version of AI, such as the freely available

GPT-3.5, while others may use more advanced iterations like GPT-4.0. In addition, the impending market demand for proficiency in these technologies suggests an urgent need to actively incorporate them into curricula. Educators are encouraged to share their experiences and adapt their teaching methods.

There is also a practical consideration regarding the infrastructure within educational settings. The suggestion to prepare labs where students can use up-to-date systems not only ensures that they are exposed to the relevant technology, but also addresses data protection concerns. Furthermore, LLMs have inherent biases that are embedded in their training data. This necessitates a critical discussion about the values and knowledge that these models propagate, and the importance of creating culturally and contextually relevant LLMs. For instance, developing region-specific models in Portugal or within the Community of Portuguese Language Countries could provide tailored educational experiences that align with local medical practices and ethical standards. There is also a growing concern about the risk of dehumanization in care with the advent of AI systems.

Recognizing that biases and complications can arise in any AI model, challenges associated with the use of AI tools were discussed, such as ethical considerations and the potential impact on clinical practice and academic settings, including issues related to copyright and intellectual property.

3. DISCUSSION

The integration of AI in medical education, while promising, presents a delicate balancing act between enhancement and replacement of traditional pedagogical methods (Chan and Zary 2019; Ghnemat, Shaout and Al-Sowi 2022; Charles Sturt University. Division of Learning and Teaching [20--]). The consensus from the forums highlighted the role of AI as a complementary tool designed to fortify existing educational frameworks rather than supersede them. This distinction is pivotal as it shapes the trajectory of curriculum development, ensuring that AI serves as a catalyst for enriching the learning experience without diminishing the value of conventional teaching methodologies.

The systematic review by Sapci and Sapci revealed recommendations for the integration of AI training into medical and health informatics curricula, aligning with the notion of AI as a complementary educational tool (Sapci, A. H. and Sapci, H. A. 2020). Additionally, the study by Paranjape et al. addressed the state of medical education and recommended a framework for evolving the medical education curriculum to include AI, further supporting the idea of AI as a fortifying element in education (Paranjape et al. 2019).

Interdisciplinary collaboration has become a cornerstone for effectively implementing AI in medical education. The intersection of various disciplines, as seen in the forums, not only enriches the educational landscape but also fosters a holistic understanding of AI's role across different fields of study. By serving as a connective tissue,

AI has the potential to unify disparate educational domains, enabling a synergistic transfer of knowledge that could be especially beneficial in the multifaceted world of healthcare.

The emphasis on AI as an instrument to bolster creativity and critical thinking among students cannot be overstated. By focusing on the design and interpretation of AI tool prompts, educators can cultivate an environment that challenges students to think critically and creatively. This approach underscores the need for a purposeful engagement with AI, one that leverages its strengths to enhance the educational process while consciously navigating its limitations. The systematic review by (Sun et al. 2023) provides valuable insights into the use of AI in medical education, shedding light on existing AI training practices and the applications of AI in the healthcare domain.

It is, however, important to be mindful of the limited time available in curricular units and the amount of background knowledge students need to fully utilize these technologies. The delivery of theoretical content through recorded magistral classes provides students with a comprehensive foundation on AI's applications in healthcare and the ethical use of chatbots. This groundwork is crucial for students to assimilate the necessary knowledge before they apply it practically. The transition to hands-on experience in a computer lab setting, supervised by tutors, is a pivotal shift from theory to practice. In addition to solidifying students' understanding, this experiential learning also fosters confidence in using AI tools in real-world scenarios.

Through the practical exercises, students confront complex legal and ethical issues, such as GDPR implications in clinical research, and are guided to develop problem-solving strategies. This not only acquaints them with the legal and ethical dimensions of healthcare data but also encourages a proactive approach to devising solutions. The issue of ownership of content produced by AI and chatbots is a broader issue that applies to the use of these technologies in various contexts (Lund et al. 2023).

In creating clinical narratives and simulators, students get an opportunity to understand the intricacies of clinical systems. Such exercises prepare them for the digitalization of patient care and medical decision-making processes, which are increasingly becoming a staple in modern healthcare settings (Alowais et al. 2023; Scherr et al. 2023). The culmination of these exercises within the DECIDES III module contributes to the holistic development of students, equipping them with a comprehensive skill set that extends beyond traditional medical knowledge.

Although we have found no research that directly supports the disparity in access to different versions of AI tools, such as the difference between GPT-3.5 and the more advanced GPT-4.0, it is possible that this could lead to inequities. However, it is important to note that the global availability of at least one version of these tools represents a significant step towards greater equity in access to educational AI technologies. This progress is especially noteworthy when compared to previous situations where access to such

advanced chatbots was even more limited. This topic raises the question of how to ensure a level playing field in the classroom and whether there should be uniformity in the AI tools that are made available to all students.

The integration of AI tools in medical education, while offering numerous benefits, also presents notable ethical challenges, especially in terms of academic integrity. The ready availability of AI-generated information and solutions might inadvertently foster dishonest practices among students, such as plagiarism or undue reliance on AI for assignments and research work (Simpson 2023). This challenge highlights the necessity for a shift in evaluation methods to focus on the analytical process and thought behind students' work, promoting critical thinking and ethical use of AI in future medical practice (Swiecki et al. 2022). By addressing these challenges head-on, medical education can harness the full potential of AI while upholding the highest standards of academic and professional ethics. The ethical sense when using AI can be fostered by educators during medical education to facilitate accountable and responsible AI usage by future healthcare providers (Alam, Lim and Zulkipli 2023).

Lastly, the potential dehumanization of care with the proliferation of AI systems has been a recurring theme in ethical discussions. The forums highlighted the importance of supervised and deliberate use of AI in education, ensuring that while students become adept in these technologies, they also maintain the empathetic core that is integral to patient care. As AI continues to evolve, its integration into medical education demands a careful, thoughtful approach that respects both the power of technology and the importance of human interaction in medicine. In line with this idea, Amann et al. highlight that people are concerned about the dehumanization of care that can result from technology use, and that relational aspects and empathy are important in healthcare (Amann et al. 2023). However, some instances have been described where shame presents a barrier to medical care, it may be ethically permissible to deploy AI/chatbots, suggesting that dehumanization in medicine is not always morally wrong (Palmer and Schwan 2022).

CONCLUSION

This ongoing study aims to develop a collaborative framework for integrating AI content into the medical students' curriculum. By fostering critical thinking, technical competence, and an awareness of ethical considerations, this framework will enable students to harness the potential of AI tools in clinical decision-making. Through this research, we strive to contribute to the advancement of medical education and prepare future healthcare professionals to effectively navigate the evolving landscape of healthcare.

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