Jl. of Interactive Learning Research (2023) **34**(2), 401-424

Integrating Artificial Intelligence into Medical Education: Lessons Learned From a Belgian Initiative

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In the last decades, the medical practice has been facing noteworthy transformations driven by the advancement of innovative technologies like Artificial Intelligence (AI). This rapid and widespread transition generated the increasing need for an adequate education curriculum, capable of properly teaching medical students about the prospects and potentials of AI in healthcare. In this paper, we aim to present and describe the elaboration and implementation of a new academic program at the University of Mons (UMONS) designed to educate medical students about AI in healthcare. The course

was implemented in the 2022-2023 academic year aiming to train the next generation of healthcare professionals to effectively leverage AI in their work, ultimately leading to improved patient outcomes and advances in medical research.

Keywords: Artificial intelligence in medical education; Machine learning; Deep learning models; Educational technologies; Curriculum reforms, Medical curricula.

INTRODUCTION

AI has been widely recognized as one of the most transformative and ground-breaking technological advancements in healthcare (Obermeyer & Emanuel, 2016). From disease diagnosis to drug development, AI has successfully proven its efficacy in numerous modern-day medicine (Ayyad et al., 2021; Briganti & Le Moine, 2020; Dlamini et al., 2022; Erickson et al., 2017b; Shmatko et al., 2022) , but its adoption has yet to be improved (Briganti & Le Moine, 2020). The effectiveness of AI-powered technologies in the field of healthcare relies heavily on the participation of healthcare professionals (HCPs) in the creation and testing of these technologies (Charow et al., 2021).

The need for integrating AI in medical education has been abundantly discussed (Charow et al., 2021; Civaner et al., 2022; Sapci & Sapci, 2020) and literature showed that medical students seem to achieve little knowledge about AI and its applications in clinical practice during their academic education (Sapci & Sapci, 2020). To respond to the lack of AI literacy, a new mandatory AI program has been implemented at the University of Mons (UMONS) for the bachelor's degree in medicine.

The scope of this work is to showcase and analyse the results, advantages, and limitations of this program which, by leveraging AI, aims to provide students with real-time feedback, adaptive learning paths, and interactive simulations that replicate real-world clinical scenarios. The goal is to create a more engaging and effective learning experience that can ultimately lead to better patient outcomes.

This work will discuss the potential benefits of AI in medical training and investigate the multiple reasons supporting the implementation of teaching AI in medical curricula. Subsequently, the paper will first provide an overview of the current state of AI in medical education and the chal-

lenges faced by medical students, mostly in relation to the lack of AI education and the expanding applications of modern technologies in the clinical sphere. Furthermore, the paper will present and describe the development and implementation of the new AI program developed at the University of Mons, Belgium in 2022. The paper will then discuss the evaluation methods used to assess the effectiveness of the AI program and its findings, including student performance and feedback. Finally, we will interpret the results in light of existing literature, discussing the future educational applications of AI in healthcare training and its limitations.

Overall, this paper seeks to contribute to the ongoing efforts to improve and enhance medical education and integrate AI adequate training which will make HCPs capable to operate efficiently in the era of AI and improving patient care and personalized healthcare.

LITERATURE REVIEW

Medical students are asked to analyse, interpret, and memorize a vast amount of medical information during their academic training since clinical expertise is interconnected to having efficient knowledge (Densen, 2011). A large part of medical training focuses on consuming as much information as possible and learning how to apply this knowledge to patient care (Paranjape et al., 2019). However, since this process is still mainly memorization-based, the use of AI in the process of manipulating data using has significant implications for medical education. The current and largely memorization-based curriculum must transition to one that teaches competence in the effective integration and employment of data from a developing range of sources (Wartman & Combs, 2018).

Undeniably, in the last decades, medical progress made medical information grow at a breakneck speed and the number of data students need to memorize continues to develop (Densen, 2011). With the advent of new technologies and medical discoveries, the expansion of medical information resulted in the increasing difficulty for medical students, physicians and HCPs to keep pace (Paranjape et al., 2019).

That is where AI steps in. Indeed, artificial intelligence is capable of organizing and merging considerable volumes of data and perfecting the decision-making process of HPCs, thus simplifying the path leading to diagnosis identification and recommend treatments (Briganti, 2023; Coppola et al., 2021; Paranjape et al., 2019; Topol, 2019). Recent literature endorsed the role of AI and machine-learning predictive algorithms as extremely ad-

vantageous catalysers and fast analysers of clinical data; these tools represent indeed the keys to unlocking the data capable of informing real-time decisions (Chen & Asch, 2017).

Predictive algorithms are already used to avert hospitalization for patients with low-risk pulmonary embolisms (PESI), prioritize patients for liver transplantation by means of MELD scores (Chen & Asch, 2017). In the future deep learning is expected to be utilized by a wide range of clinicians, from specialty doctors to paramedics (Topol, 2019). The implementation of AI tools has been discussed, tested and/or adopted in several medical areas, such as histopathology (Abdelsamea et al., 2022; Acs & Hartman, 2020; Attallah, 2021; Ayyad et al., 2021; Kayser et al., 2009; Lui et al., 2020; Saldanha et al., 2022; Shmatko et al., 2022), radiology (Brady & Neri, 2020; Codari et al., 2019; Erickson et al., 2017b; Jin et al., 2021; Pianykh et al., 2020; Reyes et al., 2020; Tajmir & Alkasab, 2018), cancer prevention (Ayyad et al., 2021; Byng et al., 2022; Dlamini et al., 2022; Hegde et al., 2022; Saldanha et al., 2022; Shmatko et al., 2022).

HCPs must develop and master the skill to interpret such results (Briganti, 2023; Briganti & Le Moine, 2020; Paranjape et al., 2019). As we are shifting from the Information Age to the Age of Artificial Intelligence (Wartman & Combs, 2018). This technological upheaval requires medical workers to learn how to manage the exponential growth of available data. Hence, the actual medical education model will and needs to undergo substantial reform. Indeed, the expansion of knowledge is likely to force medical schools to define those concepts that form the essential core of what students must learn. Present medical curricula mainly leave to the students the task to form the connections that integrate discipline-based knowledge with patient complaint/disease-focused information (Densen, 2011). By implementing AI training in medical education, medical curricula would be finally equipping future physicians and HCPs with the ability to interpret enormous amounts of medical data using AI, thus providing better patient care, diagnosis identification and treatment, in a tighter timeframe. As a matter of facts, AI applications not only simplify data collection and interpretation, but it also allows it to be done in a shorter amount of time consequently reducing inaccuracies due to human fatigue and simultaneously lessening healthcare costs (Coppola et al., 2021; Paranjape et al., 2019). Decision management can assist the examination of massive amounts of data and enable the physician to make an informed and meaningful evaluation (Paranjape et al., 2019).

The implementation of AI, however, does not have to exist in a logic of exclusion of the human work. On the contrary, the two need to co-ex-

ist and co-operate. Human interaction is not only essential because of the social and psychological aspects of medical practice, which could also be accomplished by different professional figures (Masters, 2019) but also because such technologies need to be wisely mastered. Medical practitioners must be aware of AI implication in order to master the machine, since the aim of the implementation of AI in healthcare is not to replace doctors, but enhance and assist their role, combining machine-learning software with the finest human clinician "hardware" (Chen & Asch, 2017). Solely the equilibrium of the two elements will allow medical practitioners to dispense a quality of care that "outperforms what either can do alone" (Chen & Asch, 2017). Despite the fact that computers may at times appear to detect patterns that are imperceptible to humans , the human element is still essential and therefore needs to be accurately and adequately trained about the machine applications and potential (Erickson et al., 2017b). Recent research support the thesis of a multilateral combination of players in the upcoming healthcare systems: in the future, medical practice is expected to involve a deliberate collaboration between physicians, other HCPs, patients, and machines, comprising both hardware and software (Wartman & Combs, 2018).

Medical curricula may benefit of a reboot (Wartman & Combs, 2018) incorporating AI fundamentals in order to empower future HCPs and assure improved patient-centered care (Charow et al., 2021). The lack of AI literacy in medical education today represents not only a widely discussed dilemma in literature, but also "a significant barrier to the adoption and use of AI-enabled technologies to their full capacity in various medical specialties." (Charow et al., 2021). Although the National Academy of Medicine's Quintuple Aim Model (Cox et al., 2017) encourages the integration of AI technologies in healthcare to enhance patient care, a shortage of AI education may be hindering health care systems from fully embracing and implementing these technologies (Charow et al., 2021).

In order to ensure their safe and effective application, it is crucial to have a thorough understanding of the properties of machine learning tools. (Erickson et al., 2017). As we enter the era of artificial intelligence, the acquisition of new skills and expertise will become compulsory. These may include utilizing the insights from cognitive psychology, fostering a closer relationship between humans and machines in education, and increasing the use of simulations that focus on integrating machines into healthcare delivery and empowering patients to actively participate in their care. Additionally, learners must have a fundamental grasp of how data is collected, analysed, and ultimately personalized through artificial intelligence applications in clinical delivery (Wartman & Combs, 2018).

Overview of recent literature related to teaching AI to medical students

As a result of the rapid growth of AI applications in numerous fields, in the latest years the interest in integrating AI education into medical school curricula has significantly flourished and has been correspondingly nourished by literature. As AI is increasingly being used in healthcare, it is important for medical students to understand its principles and potential applications (Briganti, 2023) . In this section, we review some of the recent literature related to teaching AI to medical students.

Recent literature has highlighted the potential of AI in medical education, particularly in helping medical students master complex medical concepts and improve their clinical reasoning skills. Various studies have insisted on the crucial role of implementing AI education in medical studies and numerous authors, having analysed the current landscape of medical education, assessed the ineffectiveness of medical curricula to integrate proper AI training. Nonetheless, AI literacy is far from being widespread among healthcare students and professionals. Despite the potential benefits of AI over traditional methods, there is a notable absence of its implementation in curriculum reviews. One possible explanation for it, is the inadequate level of digitalization within medical education's learning management systems, which is necessary to develop a comprehensive curriculum map (Chan & Zary, 2019)

Moreover, medical students seem to lack the basic scientific knowledge correlated to the role of AI in their own professional environment. Although clinicians are asked to master and develop their knowledge of AI in health care, medical education fails to provide them with such skills (Sapci & Sapci, 2020). Medical students are particularly aware of the increasing role AI is taking in healthcare and have expressed the necessity to be more educated about its potential and applications in medical practice (Civaner et al., 2022; Frommeyer et al., 2022). In 2022, a study highlighted the lack of familiarity of future physicians with AI proved that they would become better physicians with the widespread use and knowledge of AI. It shows that they student do not receive enough adequate training on AI in medicine event if predominantly favourable to structured training on AI applications during medical education (Civaner et al., 2022).

Additionally, HCPs are inadequately sensibilized and trained about AI, thus preventing patients from receiving AI improved care. Recent literature asses that only a small percentage of future HCPs feels adequately qualified to inform patients about the features and hazards associated with

AI technologies (Civaner et al., 2022), thus enhancing the limited knowledge of medical professionals when it comes to provide reliable information about AI to their patients (Frommeyer et al., 2022). Furthermore, HCPs can benefit from very few chances for to receive education and training on AI. Most realistically, AI will continue to drastically transform healthcare in the following decades. To respond to the changing landscape of medicine, and train effective medical practitioner, academic education must adapt and reform their curriculum, incorporating teaching AI (Wartman & Combs, 2018).

Based on existing literature, we have identified three main issues in present medical education: firstly, AI not widespread as an educational subject in any healthcare linked curricula; secondly, medical students lack the basic scientific knowledge related to the role of AI in their own professional environment; thirdly, HCPs are inadequately sensibilized and trained about AI, thus preventing patient from receiving AI improved care. Subsequently, AI programs in medical education, internationally, should include the following elements: a) solve the lack of AI education in medical field; b) sensibilize medical students, which will be future HCPs, in the field of new technologies applied to medicine; c) consider the lack of students' prior scientific knowledge, which is necessary to approach AI learning.

Challenges and opportunities identified in the literature

AI is becoming increasingly prevalent in the healthcare industry, and HCPs must be prepared to understand and work with AI systems. However, current AI education and training opportunities for HCPs are limited, leading to a shortage of AI-literate HCPs (Frommeyer et al., 2022). This section explores the challenges and opportunities of AI education in healthcare, as identified in the literature.

One of the primary challenges of AI education is the lack of standardized and consistent curricula across healthcare institutions (Chan & Zary, 2019; Charow et al., 2021). This is linked to the relatively recent and rapid emergence of AI in healthcare. Numerous healthcare-linked curricula are still exploring the potential of AI and are in the process of developing or testing their own programs to teach AI concepts to HCPs. As a result, there is a wide-ranging dissimilarity in the complexity and extensiveness of AI education across different healthcare educational institutions due to various constraints, such as financial limitations and inadequate technological infrastructure (Charow et al., 2021; Foster & Tasnim, 2020).

Additionally, the rapidly evolving nature of AI technologies may make it difficult for educators to keep the curriculum up to date (Chan & Zary, 2019; Kang et al., 2017). The integration of AI education may require significant resources, including expertise from AI professionals, access to relevant data sets, and development of educational materials (Charow et al., 2021; Densen, 2011; He et al., 2019; Reyes et al., 2020). Furthermore, AI education may require significant financial investments in technology, infrastructure, and training, which may not be feasible for some healthcare institutions (Charow et al., 2021).

Moreover, the shortage of qualified AI educators in healthcare makes it difficult to provide adequate training to HCPs and students, and certain healthcare organizations may not be equipped with AI well-versed teaching personnel to provide thorough education and training on artificial intelligence (Chan & Zary, 2019; Charow et al., 2021; Frommeyer et al., 2022). Staff members may not have the requisite skills and knowledge to effectively implement AI solutions in healthcare operations or the adequate time (Charow et al., 2021; Wartman & Combs, 2018). This can lead to a slower adoption of AI and hinder the potential benefits it can bring to the organization and patient care.

Furthermore, the growing importance of AI in healthcare necessitates a thorough understanding of its applications, limitations, and ethical considerations for future medical professionals (Densen, 2011; Paranjape et al., 2019; Srivastava & Waghmare, 2020). Incorporating AI into medicine brings forth a range of ethical concerns that must be considered in order to ensure responsible and equitable applications of the technology. One major ethical issue is the potential for biased decision-making resulting from biased training data, which could lead to inequitable healthcare outcomes for certain populations (Obermeyer et al., 2019). Additionally, the use of AI in medicine raises concerns about patient privacy and data security, as large amounts of personal health information are required to train and operate AI systems effectively (Park et al., 2019). Besides, the "black box" nature of certain AI algorithms may challenge traditional notions of medical accountability, as it may become difficult to determine responsibility in cases of misdiagnosis or treatment errors (Castelvecchi, 2016; Nicholson Price II, 2014). Ensuring transparency and explainability in AI systems is crucial for upholding trust and ethical standards in medicine (Holzinger et al., 2019). Lastly, the widespread adoption of AI may lead to changes in the doctor-patient relationship, as AI could alter the nature of medical decision-making, shifting the balance between human expertise and algorithmic recommendations (Char et al., 2018). Addressing these ethical concerns is essential to

ensure that AI is implemented in a manner that upholds the core principles of medical ethics and preserves the trust between healthcare professionals and their patients (Kostkova, 2015).

Despite the challenges, AI education presents significant opportunities for future HCPs. One of the primary opportunities is improving patient outcomes and quality of care (Charow et al., 2021; Kang et al., 2017). AI technology can help HCPs to identify potential health issues earlier, predict future health risks, and personalize treatment plans for patients (Srivastava & Waghmare, 2020). This can lead to improved patient outcomes, increased efficiency, and reduced healthcare costs (Hu et al., 2022; Kang et al., 2017; Srivastava & Waghmare, 2020).

Moreover, AI education can improve collaboration, time-management and communication between HCPs and other stakeholders in the healthcare system. AI technology can help HCPs to collaborate and share data more effectively and in a shorter period of time, leading to improved care coordination, enhanced work-flow and better patient outcomes (Lillehaug & Lajoie, 1998; Long & Magerko, 2020; Makridakis, 2017; Robeznieks, 2018).

Description and rationale of the AI program developed for medical students

To respond to the need of AI training in healthcare related education, the University of Mons, a Belgian institution that recently launched a Chair of AI and Digital Medicine, has taken a proactive approach to integrating AI education within its medical curriculum. This mandatory educational program aims to equip medical students with the necessary knowledge and skills related to AI and its applications in healthcare. The program is structured in a way that encourages students to not only grasp theoretical concepts but also to apply them in real-life situations through group work and data analysis.

The AI and Digital Medicine educational program consists of five main modules, followed by a practical group assignment. Each module is designed to introduce medical students to different aspects of AI and its applications in healthcare:

1. **Introduction to AI as a field**
   Time: 2 hours.
   Teaching Method: Online recorded lecture and supplementary reading materials

Process: Students learn about the history and evolution of AI, its various applications, and its potential impact on society.
Performance Assessment: Short online quiz to assess the understanding of the fundamental concepts of AI.

2. **Introduction to machine learning and expert systems**
   Time: 4 hours.
   Teaching method: Online recorded lecture, supplementary reading materials, and hands-on exercises.
   Process: Students learn about different machine learning algorithms, expert systems, and their applications in various fields.
   Performance Assessment: Hands-on exercises where students apply machine learning algorithms on sample data and an online quiz to assess their understanding of the concepts.

3. **Introduction to machine learning in healthcare**
   Time: 4 hours.
   Teaching Method: Online recorded lecture, supplementary reading materials, and case studies.
   Process: Students learn about the specific applications of machine learning in healthcare, such as diagnostics, treatment planning, and patient monitoring.
   Performance Assessment: Case study analysis where students apply machine learning concepts to healthcare scenarios and an online quiz to assess their understanding of the subject matter.

4. **Introduction to machine vision**
   Time: 3 hours.
   Teaching Method: Online recorded lecture, supplementary reading materials, and practical exercises.
   Process: Students learn about the basics of machine vision, including image processing, feature extraction, and object recognition.
   Performance Assessment: Practical exercises where students apply machine vision techniques on sample images and an online quiz to test their understanding of the concepts.

5. **Introduction to image recognition in healthcare**
   Time: 3 hours.
   Teaching Method: Online recorded lecture, supplementary reading materials, and hands-on exercises.

Process: Students learn about the applications of image recognition in healthcare, such as medical imaging, diagnostics, and treatment planning.
Performance Assessment: Hands-on exercises where students apply image recognition techniques on medical images and an online quiz to assess their understanding of the subject matter.

In addition to the modules, students were required to work in groups to analyze datasets using machine learning techniques and produce a consolidated report. This project served as the primary performance assessment, where students applied the knowledge and skills gained throughout the program. Instructors evaluated the reports based on the accuracy and relevance of the applied methods, the clarity and coherence of the presentation, and the critical evaluation of the results. This approach ensured constructive alignment, as the learning objectives, teaching methods, and assessments were consistent throughout the course.

Besides the core learning materials, five supplementary online modules to acquaint the students with the specialized domain of Digital Medicine were developed. These modules provided essential context for understanding the evolving landscape of healthcare and the role that technology plays in it. The topics covered included: (a) an overview of health data and its significance; (b) an introduction to Electronic Health Records and their role in modern healthcare; (c) an exploration of the ways in which digital medicine is transforming healthcare delivery; (d) a discussion of the impact of digital medicine on research and innovation within the medical field; and (e) a comprehensive analysis of the various applications of AI in healthcare.

METHOD

Sample

In the inaugural edition of the AI and Digital Medicine educational program during the 2022-2023 academic year, a cohort of 25 students was recruited to participate. In order to assess the effectiveness of the AI and Digital Medicine educational program, a survey was conducted among these 25 medical students. This evaluation aimed to gather their feedback and opinions on various aspects of the program, including the quality and relevance of the course content, the teaching methods employed, and their overall satisfaction with the program. By engaging with the students in this

manner, the University of Mons sought to gain a deeper understanding of the program's strengths and areas for improvement, ensuring that the course remains responsive to the needs and expectations of its participants. The survey results provided valuable insights into the students' perspectives on the program and their experiences, which can be used to refine and enhance future iterations of the AI and Digital Medicine educational program, ultimately improving the quality of AI education for medical students at the University of Mons. We introduce the survey and the analysis of data in the methods section.

As the program aimed to integrate AI education within the medical curriculum, it was crucial to have a representative sample that could collectively contribute to the development and evaluation of the program. By including these 25 students, the University of Mons was able to gather valuable insights and feedback on the effectiveness of the AI and Digital Medicine educational program, informing potential improvements and adjustments for future iterations. 20 out of the 25 students participated in the survey (80% participation rate).

These students represented a broad range of backgrounds and interests within the field of medicine, thereby ensuring a rich and varied perspective on the applications of AI in healthcare. Students are enrolled in a medical school program, currently in the third year of medical school. In Belgium, medical school is a six-year long program split into a bachelor's degree (3 years) and master's degree (3 years). At the University of Mons, like many other medical schools in Belgium, there is no major or minor system in the curriculum. In the third year of medical school, students are typically 20-22 years old. We chose not to collect age or gender information because of the low sample size and to respect anonymity.

Survey

In order to assess the students' perception of the AI program, we conducted a survey composed of 13 questions. The instructor of the course recruited the participants of our study by sending a Google Form questionnaire to all the medical students that were registered for the course. The survey aimed to evaluate various aspects of the course, such as the potential impact of AI on medicine, the effectiveness of medical education in teaching AI concepts, students' expectations of the program, and the overall quality of the course. Additionally, the survey inquired about students' satisfaction with the topics covered and instructors, their understanding of

AI's role in medicine, the balance between real-world examples and theoretical content, as well as the presentation of AI's benefits, limitations, and risks in medical diagnosis and treatment. Furthermore, the survey explored the participants' confidence in critically evaluating AI-generated diagnoses and treatment recommendations, their ability to apply the acquired knowledge in their future medical practice, and their understanding of the ethical and legal issues related to AI in medicine. The full list of questions can be found in the supplementary materials, along with the data obtained from the survey as well as a graphical approach to the results (Briganti & Pizzolla, 2023).

While we did not perform a formal reliability and validity study on the survey, we took several steps to ensure that the survey captured the intended information and provided valuable insights into the students' experiences and perceptions of the AI program. Prior to administering the survey, we conducted pilot testing with a small group of students to identify potential issues with question clarity, response options, and survey length. Based on the feedback received, we revised the survey to ensure that the questions were clear, concise, and accurately captured the intended information.

Statistical analysis

The statistical analysis was performed with the JASP open-source software. To analyse the survey results, we performed a descriptive statistics analysis to identify the core trends in the responses. Since the answers were based on the Likert scale, we opted to use percentages to present the findings. This approach allowed us to efficiently summarize the students' perceptions and opinions on various aspects of the AI program, and to identify areas of success and potential improvement. By using percentages, we could effectively illustrate the distribution of responses and gain insights into the overall satisfaction and perceived effectiveness of the AI program among the participating medical students.

RESULTS

Our data presents survey results from 20 participants regarding their views on AI's impact on medicine and their experience with an AI program in medical education. The main findings are summarised below:

Impact of AI on future medicine. According to the survey, the majority of respondents believe that AI will have a significant impact on the field

of medicine in the future. Specifically, 55% of respondents think it is somewhat likely, and 45% think it is very likely.

Teaching AI in medical education. The survey also asked about the teaching of AI concepts in medical education. The responses were mixed, with 45% of respondents feeling that it was done somewhat well, while 30% felt that it was not done very well. Only 10% felt that it was done extremely well, and 15% were unsure.

Effectiveness and quality of the AI program. Respondents were also asked about the effectiveness of the AI program. While some felt that it exceeded their expectations or was extremely well done (35%), others felt that it fell short (20%). The largest group (35%) thought that the AI program met their expectations. When asked to rate the overall quality of the AI program, 45% of respondents rated it as good, 40% rated it as fair, and 15% rated it as poor.

Satisfaction with the AI program and instructor. Satisfaction with the AI program was mixed. While 60% of respondents were somewhat satisfied with the topics covered, 25% were neutral, 10% were somewhat dissatisfied, and only 5% were very satisfied. In terms of instructor satisfaction, 40% of respondents were very satisfied, 30% were somewhat satisfied, 25% were neutral, and 5% were somewhat dissatisfied.

Understanding the impact of AI in present medicine. The AI program's effectiveness in understanding AI's role in medicine was rated extremely well by 20%, not sure by 10%, not very well by 5%, and somewhat well by 65%.

Real-world examples. The survey also asked about the use of real-world examples in the AI program. While 45% of respondents felt that the program provided sufficient examples, 30% said it provided only a few examples, and 20% were unsure. Only 5% felt that it was not very well done.

Demonstrating and understanding potential benefits and limitations of AI in medicine. When asked about the program's effectiveness in demonstrating the potential benefits and limitations of AI in medicine, 35% of respondents rated it extremely well, 45% thought it was somewhat well done, 15% thought it was not very well done, and 5% said it was not at all well done. The survey also asked about the effectiveness of the AI program in helping respondents understand potential limitations or risks of AI in medical diagnosis and treatment. 35% of respondents felt the AI program was extremely effective, while 40% felt it provided a clear understanding. However, 20% were somewhat uncertain, and 5% were unsure or felt it was not very well done.

Confidence in evaluating AI-generated diagnoses and treatment recommendations. In terms of confidence in evaluating AI-generated diag-

noses and treatment recommendations, 60% felt somewhat confident, while 15% felt neutral and 25% felt somewhat unconfident.

Confidence in applying AI program learnings to future medical practice. In terms of confidence in applying AI program learnings to future medical practice, 40% felt somewhat confident, while 15% were extremely confident. However, 20% were somewhat uncertain, and 5% were extremely uncertain.

Understanding ethical and legal issues related to AI in medicine. Finally, 50% felt that the AI program provided a somewhat clear understanding of ethical and legal issues related to AI in medicine. 20% were neutral, while 25% were unsure or felt it was not very well done.

DISCUSSION

In this discussion section, we aim to provide a comprehensive examination of the findings from our study on the integration of AI in medical education at the University of Mons. By assessing the opinions and feedback from the medical students who participated in the AI program, we can better understand the effectiveness of this educational approach, its implications for the future of medical education, and potential areas for further improvement. Additionally, we will address the potential limitations and challenges associated with incorporating AI into medical education and highlight possible avenues for future research and development in this field. Our survey results provide valuable insights into the perceptions of medical students or professionals regarding the impact of AI on the medical field and their experience with an AI program in medical education.

Specific Survey Components

Impact of AI on medicine. All respondents believe that AI will have an impact on the field of medicine, with 55% considering it very likely, thus supporting the fact that students are aware of the future implications of AI in health-related practice (Briganti & Le Moine, 2020; Civaner et al., 2022). This indicates a general consensus on the importance and potential of AI in shaping the future of healthcare, thus supporting the necessity of improving AI teaching to provide students with the ability to use and interpret such technologies (Charow et al., 2021; Kang et al., 2017).

AI in medical education. There was a mixed opinion on how well medical education teaches AI concepts. While a majority (55%) believed it was taught at least somewhat well, there is still room for improvement as 30% feel it is not taught very well. This supports the idea of a reboot of medical curricula in order to better integrate AI concepts to prepare future healthcare professionals for a rapidly changing landscape (Wartman & Combs, 2018).

AI program evaluation. There was a wide range of opinions on the AI program's effectiveness in meeting expectations and its overall quality. However, more respondents rated the program positively (meeting or exceeding expectations) than negatively. This could imply that the AI program generally meets the needs of the participants, but there might be some areas where it could be improved, particularly in addressing AI legal and ethical concerns. It is noteworthy that 25% of respondents expressed uncertainty or dissatisfaction regarding the program's ability to adequately address ethical and legal issues related to AI in medicine. Furthermore, 20% of respondents remained neutral on this question, suggesting a possible lack of AI literacy in medical curricula and a consequent lack of knowledge regarding ethical and legal aspects of AI. These findings highlight the importance of enhancing the program's focus on ethical and legal considerations to ensure a comprehensive understanding of these critical aspects within the context of AI in medicine.

Satisfaction with program content and instructors. Most respondents were at least somewhat satisfied with the topics covered and the instructors. This suggests that the program's curriculum and teaching staff are generally well-received, but there is still potential for further enhancements. Thus, the results show that if such programs are attributed to qualified AI educators, students are more likely to be satisfied with the instructor and the topics covered. However, a huge limitation is represented by the shortage of AI well-versed teaching personnel (Chan & Zary, 2019; Frommeyer et al., 2022). As mentioned above, this could result in a delayed adoption of AI, impeding its potential to offer benefits to both the organization and patient care.

AI program effectiveness. The AI program appears to be effective in helping participants understand the role of AI in medicine, its benefits, limitations, and potential risks. However, the ethical and legal issues associated with the use of AI in medicine require more attention as participants need further assistance in comprehending these aspects. To ensure that the implementation of AI in medicine aligns with the fundamental principles of medical ethics and sustains the trust between healthcare professionals and their patients, it is imperative that future programs insist on the ethical concerns

associated with AI in healthcare (Char et al., 2018; Charow et al., 2021; Kostkova, 2015) .

Confidence in AI-related skills. While most respondents are somewhat confident in their ability to evaluate AI-generated diagnoses and treatment recommendations, as well as applying AI program learnings to their future medical practice, there is still a considerable percentage of respondents with neutral or negative opinions. This could indicate that the AI program might need to focus more on practical aspects and skill-building to boost participants' confidence in these areas (Charow et al., 2021). One possible explanation for the variation in student confidence could be attributed to the diverse educational backgrounds of medical students in Belgium. Although an entry examination exists for access to the medical curriculum, students may have different levels of exposure to technical subjects, such as mathematics and statistics. This disparity could lead to a range of views and opinions regarding hard sciences, including AI, even when applied to healthcare.

It is important to acknowledge that not all medical students may have a strong initial interest in AI, which could contribute to the neutral or negative opinions observed in our survey results. Nevertheless, understanding the reasons behind this lack of confidence is crucial for improving AI education in medical programs. To address this issue, future studies could incorporate qualitative research methods, such as interviews or focus groups, to gain a deeper understanding of the factors that influence student confidence in their AI-related skills. This information could help identify areas for improvement in the curriculum, as well as tailor teaching methods to better accommodate students with diverse educational backgrounds and interests.

Broader implications

By exploring these factors, our findings can better inform other institutions and curriculum developers as they consider integrating AI education into their programs. This approach could help to address the needs of students with different levels of prior knowledge and interest in AI, ultimately enhancing their confidence in using AI in their future medical practice.

The survey results indicate that the medical community generally recognizes the potential impact of AI on the field of medicine and that AI programs in medical education are seen as valuable. However, there are areas where improvements can be made, such as better integration of AI concepts in medical education, enhancing the AI program's content and delivery, and focusing on practical skill-building to increase participants' confidence in

using AI in their future medical practice (Chan & Zary, 2019). To provide practical implications for the areas of improvement identified, we propose the following measures: first, medical curricula should be designed to interweave AI concepts throughout the various stages of learning, rather than treating AI as an isolated topic. This could involve embedding AI-related case studies in clinical and diagnostic courses or incorporating AI-driven tools in medical simulations and practice settings, allowing students to develop a more holistic understanding of AI's role in medicine.

Second, to ensure that the AI program remains relevant and engaging for students, the content should be regularly updated to reflect the latest advancements in the field. Additionally, the program should employ diverse teaching methods, such as interactive workshops, online tutorials, and hands-on training with AI-driven tools, to cater to different learning styles and help students better grasp the material.

Third the AI program should place a greater emphasis on developing students' practical skills in applying AI to medical practice. This could involve incorporating more real-world examples, case studies, and exercises that require students to work with AI tools and systems directly. By providing students with opportunities to apply their AI knowledge in realistic clinical scenarios, they can build the confidence and competence necessary to effectively utilize AI in their future medical practice.

Despite these challenges, our findings underscore the importance of incorporating AI into medical education. In the broader context of medical education and digital medicine, the significance of our findings lies in the potential to inform other institutions and curriculum developers as they consider integrating AI education into their programs. The collected results provide valuable insights into the aspects of AI education that are most effective in helping students grasp the complexities of AI applications in healthcare, as well as the potential areas for improvement. Our findings indicate that the AI program at the University of Mons successfully provided medical students with a foundational knowledge of AI and its use in the medical field. The positive feedback from students in our survey suggests that the integration of AI education in the medical curriculum is both timely and relevant.

The results also suggest several avenues for future research and development. One such avenue could be the investigation of optimal teaching methods and strategies for AI education, ensuring that students are well-equipped to navigate the complexities of AI applications in healthcare. Furthermore, research could focus on identifying the specific AI competencies that are most relevant to medical professionals, allowing for the develop-

ment of targeted and effective curricula (Chan & Zary, 2019; Char et al., 2018; Charow et al., 2021).

In conclusion, our study highlights the importance of integrating AI into medical education to prepare future healthcare professionals for the increasingly data-driven and technologically advanced landscape of healthcare. By addressing potential limitations and challenges and exploring avenues for future research, we can continue to refine AI education and ensure that medical students are well-equipped to make the most of AI's potential in improving patient care and outcomes.

LIMITATIONS

The results of our study should be met with a number of limitations. We outline three of them. First, because of the low sample size and the limited outreach of the program (only one class, in one university, in Belgium), the percentages reflected in our results section on the student's appreciation of the AI course might not replicate with a similar program in another university. Future studies may endeavor to reproduce our efforts to look for improved outcomes.

Second, although we conducted a large review of the literature, we did not perform a systematic review, as it was beyond the scope of this study. Future studies may endeavor to perform a systematic review of active AI programs in healthcare curricula. Third, we did not perform any statistical inference on our sample, which largely limits the information we can gather from the questionnaire: this was chosen beforehand because of the low sample size, which would limit the generalizability of the inferential results. Future studies may endeavor to perform more in-depth questionnaire submitted to a larger sample of students, as to be able to perform classical statistical tests and infer more on the educational processes accompanying the learning of AI in healthcare curricula.

CONCLUSION

In conclusion, the medical practice has undergone significant changes due to the advancements of innovative technologies and AI in recent years. However, the current landscape of medical education does not seem to adequately prepare medical students for the potential of AI in healthcare. To address this issue, the University of Mons (UMONS) has implemented a new

academic program designed to educate medical students about AI in healthcare. While the AI program developed at UMONS has shown great potential in assisting medical students in their training, it has some limitations that need to be considered. These limitations suggest that further research and development are needed to make the program more effective and useful in a broader context.

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