The Role of Artificial Intelligence and Personalized Education in Medical Curriculum: A Systematic Review of Applications and Challenges

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Abstract

Artificial Intelligence (AI) is a trend of Technology; a "Game-changer" that affects many various industries; including Medical Education. Using Personalized Education (PE)\PL has the potential to transform Medical Education by providing individualized learning experiences that cater to the unique needs of medical students. This systematic review aims to analyze and synthesize the existing literature about the role of Artificial Intelligence (AI) and personalized education in Medical curricula. A total of 20 studies published between 2013 and 2023 were included in the review, which focused on the impact of AI and PE on medical curricula; learning outcomes, student engagement, and satisfaction. A comprehensive search was conducted in major databases such as PubMed, Scopus, EKB, and Web of Science; using relevant keywords. The search terms used included "Artificial Intelligence", "Personalized Education", "Adaptive Learning", "Intelligent Tutoring Systems", "Machine Learning", "Deep Learning", and "Natural Language Processing". The results of the review indicate that the role of AI and PE in Medical curricula is multifaceted and can be applied in various ways; such as improving students' understanding of complex medical concepts, leading to better learning outcomes, developing Intelligent Tutoring Systems; that provide personalized feedback and guidance to medical students, analyzing student data, providing recommendations for individualized instruction and supporting assessment and evaluation processes. The integration of AI into the medical curriculum can also enhance learning outcomes, student engagement, and satisfaction by tailoring instruction to their specific needs. However, several challenges need to be addressed to ensure the ethical and effective integration of AI and personalized education into medical curricula; including concerns about data privacy and security, transparency, potential bias, and discrimination. Future research should focus on developing best practices for integrating AI and personalized education into medical curricula. Overall, the review suggests that AI has the potential to enhance learning outcomes, engagement, and satisfaction in personalized education, but careful consideration of ethical concerns is needed to ensure the effective and ethical integration of AI.

Keywords: artificial intelligence, smart education systems, machine learning, personalized education, medical curricula.

دور الذكاء الاصطناعي والتعليم المخصص في المناهج الطبية: دراسة مراجعة منهجية للتطبيقات والتحديات.

ريهام محمود ربيع

يُعَد الذكاء الاصطناعي (AI) اتجاهاً تقنياً يؤثر على العديد من الصناعات بما في ذلك مناهج التعليم الطبي، حيث يمكن للتعليم المخصص (PE) أن يحدث تحولاً في التعليم الطبي من خلال توفير خبرات تعلم فردية تتناسب مع احتياجات طلاب المجال الطبي المختلفة. وتهدف هذه الدراسة إلى تحليل وتجميع الأدبيات السابقة حول دور الذكاء الاصطناعي (AI) والتعليم المخصص PE في المناهج الطبية. وقد شملت المراجعة 25 دراسة نُشرت بين عامي 2013 و2023؛ والتي ركزت على تأثير الذكاء الاصطناعي والتعليم المخصص في المناهج الطبية، والنتائج التعليمية، والتفاعلية والرضا .ولذلك تم إجراء بحث شامل في قواعد البيانات الرئيسية مثل PubMed و Scopus و EKB و Web of Science ؛ باستخدام الكلمات المفتاحية ذات الصلة في البحث "الذكاء الاصطناعي"، "التعليم

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المخصص"، "التعلم التكيفي"، "نظم التعليم الذكية"، "تعلم الآلة"؛ وقد أشارت نتائج هذه الدراسة إلى ان يمكن الأستفادة من تطبيقات الذكاء الاصطناعي والتعليم المخصص في المناهج الطبية بطرق مختلفة : مثل تحسين فهم الطلاب للمفاهيم الطبية المعقدة، وتطوير نظم التعليم الذكية التي توفر تعليقات وإرشادات مخصصة للطلاب فى المجال الطبى ، وتحليل بيانات الطلاب ،وتقديم توصيات للتعليم المخصص، ودعم عمليات التقييم والتقويم. كما يمكن للذكاء الاصطناعي أيضًا أن يعزز نتائج التعلم وتفاعلية الطلاب ورضاهم من خلال تخصيص مدخلات التعليم لاحتياجاتهم الخاصة. ومع ذلك، تواجه الذكاء الاصطناعي والتعليم المخصص في المناهج الطبية العديد من التحديات؛ التي يجب معالجتها من أجل مرعاة الاعتبارات الأخلاقية الفعالة للذكاء الاصطناعي والتعليم المخصص في المناهج الطبية؛ ويشمل ذلك سرية بيانات الطلاب والحاجة إلى الشفافية والتحيز والتمييز المحتمل. ولذلك يجب أن تركز الأبحاث المستقبلية على تطوير أفضل الأستراتيجيات لدمج الذكاء الاصطناعي والتعليم المخصص في المناهج الطبية، ومعالجة الأعتبارات الأخلاقية، وتدريب المعلمين على استخدام هذه التقنيات بشكل فعال، فالذكاء الاصطناعي لديه القدرة على تحسين نتائج التعلم.

الكلمات المفتاحية: الذكاء الاصطناعي، نظم التعليم الذكية، تعلم الآلة، التعليم المخصص، المناهج الطبية.

1. Background:

Artificial intelligence (AI) is defined as the multidisciplinary approach of computer science and linguistics that aspires to create machines capable of performing tasks that normally require human intelligence (Russell,Norvig , 2016, p 4). These tasks include the ability to learn, adapt, rationalize, understand and fathom abstract concepts, as well as the reactivity to complex human attributes such as attention, emotion, creativity, etc.

New generations of medical students require learning experiences aligned with their profiles (e.g., previous knowledge, learning styles), interests, and experiences that approximate real-life contexts (Cardenas, et al (2022). Personalised learning is a method that leverages existing learning theories and the practical experience of educators and students to modify the learning environment to meet students' needs (Walkington & Bernacki, 2020). Integrating the vision of the students and the teaching team allows for the customisation of experiences that support students' learning processes.

Medical education is a field where personalized education and the use of artificial intelligence (AI) have the potential to transform the way students learn. AI can be used to analyze student data and provide personalized feedback and recommendations for individualized instruction. Additionally, personalized education in medical curricula can improve students' understanding of complex medical concepts, leading to better learning outcomes. The purpose of this systematic review is to synthesize the existing literature on the role of AI and personalized education in medical curricula and to provide insights into the current state of research and future directions. AI can open new horizons in curricula, teaching strategies, and educational technologies for all fields of knowledge (Mahmoud, 2020).

2. Theoretical Framework and Literature Review :

Advancements in medical Curriculum and Technology in the era of the fourth industrial revolution are led by artificial intelligence (AI) and machine learning, aimed to enable the 4P model of medicine: predictive, preventive, personalized, and participatory (Briganti, Le Moine 2020). The development of AI tools already aids certain processes in the practice of several medical professions, such as radiology (, dermatology, ophthalmology, and pathology(Topol,2019). Radiology, in particular, has undergone dramatic, revolutionary changes driven by technological innovations in the past – the relevant achievements in AI are the latest breakthrough poised to become a part of widespread everyday practice, to improve the efficiency and (broadly defined) accuracy of radiologists and accessibility to their services. Among AI-based algorithms are some that have achieved impressive reliability in diagnosing specific conditions, with specificity and sensitivity comparable to those of human experts for in-practice applications (Topol,2019).

According to Grunhut et, al (2019), Medical school curricular changes are difficult to implement due to resistance to change. This resistance is justified by a lack of consensus on how to incorporate change and an already busy curriculum. For this reason, proposing additional courses or workloads will likely be met with criticism from medical education faculty in the best interest of medical students. On a level of national infrastructure, these issues can be supported by leaders of medical education and organizations. These perceptions can be clarified easily through the addition of 1-3 questions on the annual Association of American Medical Colleges Graduation Questionnaire to gauge interest and ability over time from students. For example, the questionnaire can ask for agreement on whether AI should be taught during UME, what year of training it should be taught in, and how it should be incorporated. These can translate into accreditation requirements and drive change forward.

2.1. Current Applications of Artificial Intelligence in Medical Curriculum:

Knowledge and skills are the main domains that medical students need to master to practice medicine. From the invention of the stethoscope and X-ray machines to the development of searchable electronic databases to the use of lasers in surgery, technological advancements have been instrumental in improving the knowledge, diagnostic and management capability of medical students to care for patients. While this changes the role of the doctor, giving patients access to an evidence-based e-health website can have positive repercussions by reducing doctor visits and empowering patients (Chen, J. (2017).

Also, Diagnosis is a skill that takes medical students years if not decades to master and may increasingly be taken over by machines. Artificial intelligence and machines that are capable of deep learning hold significant promise. Now, machines can answer questions posed in natural language and respond with a precise accurate answer. Google's AlphaGo was able to use machine learning and neural networks to pick moves and win at a game previously thought to be too complex for a machine.

Cardiology: Invading the teaching of AI and ML in the Cardiology Curriculum provides the early detection of atrial fibrillation, which was one of the first applications of AI in the medical Curriculum. AliveCor was approved in 2014 for their mobile application Kardia allowing for a smartphone-based ECG monitoring and detection of atrial fibrillation (Halcox, et al. 2017). They mentioned that remote ECG monitoring with Kardia in ambulatory patients is more likely to identify atrial fibrillation than routine care. Apple Watch (series 4) also is a kind of technology; which allows for easy acquirement of ECG and detection of atrial fibrillation that can be shared with the practitioner of choice through a smartphone, that's why it should be a part of their clinical practice that emerged from the medical curriculum (Turakhia, 2019).

Cardiovascular Risk Applied to electronic patient records, AI has been used to predict the risk of cardiovascular disease; for instance, acute coronary syndrome and heart failure better than traditional scales (Huang, Chan and Dong. (2017).

Pulmonary Medicine: The interpretation of pulmonary function tests has been reported as a promising field for the development of AI applications in the Pulmonary Medicine Curriculum. Topalovic (2019)reported how AI-based software provides more accurate interpretation and serves as a decision-support tool in the case of interpreting results from pulmonary function tests.

Nephrology: Artificial intelligence has been applied in several settings in Clinical Nephrology. For instance, it has been proven useful for the prediction of the decline of glomerular filtration rate in patients with polycystic kidney disease (Niel ,et al. 2018)

2.2.Augmented medicine:

Intelligent medical technologies (i.e., AI-powered) have been met with enthusiasm by the general population partly because it enables a 4P model of medicine (Predictive, Preventive, Personalized, and Participatory) and therefore patient autonomy, in ways that could not be possible (Briganti & Le Moine,2020). The development of intelligent medical technologies includes the creation of a new field in medicine: Augmented medicine; which improves different aspects of

clinical practice. Augmented medicine is not only enabled by AI-based technologies in medical curricula but also by several other digital tools, such as surgical navigation systems for computer-assisted surgery, and virtuality-reality continuum tools for surgery, pain management and psychiatric disorders. (Briganti & Le Moine ,2020)

2.3.Personalised Education \Learning in Medical Curricula:

Martínez-Hernández et al. (2016), defined tools that facilitate building personalised education or learning, such as information management through curated network resources, content creation, and interconnectivity to share the information acquired. Accordingly, this study defines personalised learning as integrating three relevant points of view or theoretical frameworks. First, per UNESCO International Bureau of Education (2017), personalised learning consists of paying particular attention to students' prior knowledge, needs, capacities, and perceptions during the teaching-learning processes to adapt future contents to their identified learning requirements, problems, or needs. In other words, personalised learning prioritises each student's needs and goals, and tailors instruction to address those needs and goals. These needs, goals, and progress towards meeting them, are apparent and easily accessible to the professors and students. The purpose of personalised learning is that medical students can apply practical and personal meaning to what they learn and have the possibility of choosing. As illustrated in Figure 1 , Personalised learning solutions must include or emphasise: (i) what medical students learn, (ii) when they learn, (iii) where and with whom they learn, and (iv) how they learn.

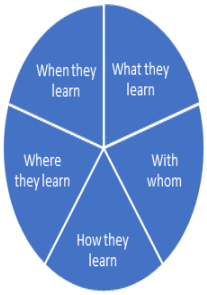

Figure 1. Purpose of personalised learning

Adaptive learning is a personalisation method, which according to Lowendahl et al. (2016), is a process that dynamically adjusts how content is presented to students. With adaptive learning, the content is adapted according to

the students' understanding of the material, their evaluation results, and their preferences of materials (e.g., videos, audios, text). For Dziuban et al. (2016), it is a process in which the courses are organised as a series of nodes or learning packages that include content and evaluations. The different packages form a learning path, with a unique sequence for each student depending on the chosen learning package. The assessments in each package determine which package will be recommended to the students next. Students can also select the package they want to study, however, they must first demonstrate the required performance level (Dziuban et al., 2018).

According to Cardenas, et al, (2022), The School of Medicine and Health Sciences at Tecnologico de Monterrey recognised that new students have different entry levels of knowledge in the core courses of cell biology and chemistry, in the Bachelors of Biosciences, Nutrition and Biosciences of Clinical and Health Psychology, Surgeon and Dental Surgeon programs. Therefore, it developed a personalised learning model to equate the students' entry knowledge to ensure they have the same level of knowledge by the end of the first academic period. This study's innovative objective was to develop a personalised learning model to help students acquire and fortify the basic knowledge in cell biology and chemistry necessary for the first year of health sciences. The study also aimed to create educational experiences that adapt the teaching-learning process to the specific knowledge needs of the student, using a variety of digital learning resources.

2.4.Natural Language Processing in Healthcare Curriculum:

Smart healthcare is a healthcare Curriculum that exploits emerging technologies, such as artificial intelligence (AI), blockchain, big data, cloud/edge computing, and the internet of things (IoT), for realizing various intelligent systems to connect healthcare participants and promote the quality of healthcare (Tian, et al,2019). Major participants in smart healthcare can be classified into three categories, i.e., the public, healthcare service providers (Medical Students who will become physicians), and third-party healthcare participants. Related to the participants, representative smart healthcare scenarios include smart homes, smart hospitals, intelligent research and development for life science, health management, public health, rehabilitation therapy, etc. NLP has become a trend research area which has attracted widespread attention from many research communities in the past several years. As human language is a general form of data entry for intelligent systems, NLP enables machines to understand human language and interact with humans, making it essential to smart healthcare.

3. Research Objectives :

This Systematic review aims to :

1. Identify the Role of Artificial Intelligence in Medical Curriculum.
2. Identify the Role of Personalized Education in the Medical Curriculum
3. Identify the application of AI and PL in the Medical Curriculum.
4. Identify the challenges of using AI and PL in the Medical Curriculum.

4. Research Questions :

This Systematic review tries to answer these questions:

1. What is the Role of Artificial Intelligence in Medical Curriculum?
2. What is the Role of Personalized Education in the Medical Curriculum?
3. What is the application of AI and PL in the Medical Curriculum?
4. What are the challenges of using AI and PL in the Medical Curriculum?

5. Methodology:

To conduct this systematic review, a comprehensive search was conducted in major databases such as PubMed, Scopus, Web of Science, etc. The search terms used were "artificial intelligence", "personalized education", "medical education", "adaptive learning", "intelligent tutoring systems", "machine learning", "deep learning", "neural networks", and "natural language processing". Studies were included if they investigated the role of AI and personalized education in the medical curriculum, including its impact on learning outcomes, engagement, and satisfaction. A total of 25 studies were included in the final review. The inclusion criteria included articles published between 2013 and 2023, written in English, and focused on the previous research terms.

Table 5.1 The Search process details

Search Engine	Number of Artides	Field	Number of included studies according to Inclusion criteria
Egyptian Knowledge Bank	400	Medical Curriculum	10 = 50 %(of total studies)
Google Scholar	50	Medical Education	4= 20 %
Scopus	10	Artificial Intelligence and Education	2 =10%
Web of Science	15	Medical Curriculum	2=10%
Pubmed	50	Medical Education	2 =10%
Total	525		20 study

The first stage is the review plan: it is based on the identification and jointing of all studies of the systematic review to execute the appropriate strategies after defining the potential databases and research engines. The first step, in this stage, is considered as defining of research question with an appropriate understanding of the research topic. Then it was followed by choosing the

Inclusion and Exclusion Criteria; the selection of the particular studies regarding this specific systematic review was based on the identification and establishment of certain criteria for the evaluation using the Prisma checklist. Conducting the review is the second stage; all of the 525 articles(resulting from the search process) were screened and reviewed independently by the researcher. The data was extracted from the selected articles, 25 articles according to the inclusion criteria, including the study design, sample size, AI techniques used, and outcomes using the PRISMA model; which has its values but is presumed to be more appropriate for systematic reviews and meta-analyses. The articles were then analyzed thematically to identify the opportunities and challenges of using AI, ML, PL and NLP in medicine and its curricula. Then it was followed by the third stage which is the Evaluation of the Risk in Biasness. The final stage was writing and editing the Review Report.

6. Results :

Table 6.1 indicates the results of the analysis among the selected studies, which describes the role and applications of AI and PL in Medical Curricula; mentioning the potential challenges that medical educators may face.

Table 6.1: Analysis of the Selected Studies

N	Study	Research Focus	Methodology	Results	Applications	Challenges
1	Cardenas, et al, (2022)	Personalised learning or Education model to equate students' entry-level knowledge in the School of Medicine and Health Sciences and emulates adaptive learning and provides flexibility and autonomy to students for acquiring knowledge	Non-experimental, observing the phenomenon; using an interval-type scale (quantitative) questionnaire.	The analysis of the learning model's results showed an increase in the students' knowledge and satisfaction and demonstrated the model's usefulness for understanding educational content.	This study presents a personalised learning model-specific knowledge requirements in cell biology and chemistry courses to enrich knowledge and improve academic performance.	Mastery of the Medical Courses
2	Dumić-Čule et al, (2020)	To assess the attitude about the importance of introducing education on artificial intelligence (AI) in medical schools' curricula among physicians whose everyday job is significantly impacted by AI.	An anonymous questionnaire	A large majority of participants—89.6% (95% Agresti-Coull confidence interval 0.83-0.94) agreed on the need for education on AI to be included in medical curricula	Medical schools should indeed take steps to keep pace with technological progress in medicine by including education on AI in their curricula, be it as part of existing or new courses to be updated with modern technology.	Medical education did not undergo the necessary changes. It is still largely based on traditional curricula comprising of various courses demanding, mostly, memorization of biomedical and clinical facts

N	Study	Research Focus	Methodology	Results	Applications	Challenges
3.	Zhang et al. (2021)	Natural language processing	Systematic review	In the context of smart healthcare applications employing NLP techniques, we introduce representative smart healthcare scenarios, including clinical practice, hospital management, personal care, public health, and drug development.	AI can facilitate the development of personalized learning environments in medical education	Lack of Infrastructure and Ethical Consideration
4.	Briganti & Le Moine (2020)	The benefits, future opportunities and risks of established artificial intelligence applications in clinical practice on physicians, healthcare institutions, medical education, and bioethics.	Systematic review	Aside from basic medical education, there is a need for implementation of ongoing educational programs regarding digital medicine and targeting graduated physicians, to allow retraining in this growing field.	The implementation of artificial intelligence in clinical practice is a promising area of development.	Lack of education in digital medicine and wrong stereotype about the replacement of doctors by Artificial Intelligence or smart medical technologies
5.	Reid, J. R. (2023).	Radiology students must sort through an enormous volume of web-based information and learning resources amidst expanding volumes and complexity of clinical cases	Systematic review	This study reviewed the historical evolution of personalized education including Intelligent Tutor, the first-of-its-kind machine-learning-based model for radiology designed to replace the one-size-fits-all approach to education and training.	Personalized Learning is based on an adaptable computer-based system to deliver contextual knowledge to support every learner based on their preferences, prior experience, and evolving knowledge	Lack of education in digital medicine
6	Noorbakhsh-Sabet.(2019)	AI's future role in medical practice	Systematic review	Cognitive programs are impacting medical practice by applying natural language processing to read the rapidly expanding scientific literature and collate years of diverse electronic medical records.	AI may optimize the care trajectory of chronic disease patients, suggest precision therapies for complex illnesses, reduce medical errors, and improve subject enrollment in clinical trials.	AI has the potential to support personalized learning and improve student outcomes, but there are challenges related to data privacy and ethical consideration
7	Paranjape ,et al (2019)	AI is needed to enable healthcare professionals to effectively use this knowledge to practice medicine	Systematic review	This paper addressed the state of medical education at present and recommended a framework on how to evolve the medical education curriculum to include AI.	The use of data to improve clinical decision-making will grow, pushing the need for skilful medicine-machine interaction. As the rate of medical knowledge grows, technologies	Medical professionals need to be adequately trained in this new technology, its advantages to improve cost, quality, and access to health care, and its shortfalls such as transparency

N	Study	Research Focus	Methodology	Results	Applications	Challenges
					such as AI are needed to enable healthcare professionals to effectively use this knowledge to practice medicine.	and liability. AI needs to be seamlessly integrated across different aspects of the curriculum.
8	Seth, et al. (2023)	How to incorporate central concepts in data science into their core curricula to train physicians of the future.	Systematic review	The study outlined major content domains and associated learning outcomes in data science applicable to medical student curricula,	This study suggests ways to incorporate these themes into existing curricula and note potential implementation barriers and solutions to optimize the integration of this content.	Ethics and Cybersecurity Effective implementation of these learning outcomes will require attention to the local context of the medical school, geography, and health system in which the students are being trained.
9	Grunhut et, al (2019)	The practice of medicine is entering the age of AI in which the use of data to improve clinical decision-making will grow, bringing forth the need for skilful medicine-machine interaction	Systematic review	The current and future advancements of AI in medicine oblige undergraduate medical educators to act and implement AI in the curriculum.	The ethical implications of AI in medicine must be at the forefront of any comprehensive medical education.	Medical school curricular changes are difficult to implement due to resistance to change.
10	Wiljer (2019)	Developing an Artificial Intelligence-Enabled Health Care Practice	Systematic review	Healthcare professionals have an opportunity to inform, shape, and direct the knowledge, skills, and attitudes required to optimize and enable AI for better patient	These technologies include expert systems, robotic process automation, natural language processing, machine learning, and deep learning. Healthcare professionals and organizations must build their capacity and capabilities to understand and appropriately adopt these technologies. This understanding starts with basic AI literacy, including data governance principles, basic statistics, data visualization, and the impact on clinical processes	There is an urgent and emerging need for education and training so that appropriate technologies can be rapidly adopted, resulting in a healthier world for our patients and our communities.

N	Study	Research Focus	Methodology	Results	Applications	Challenges
11	Grunhutm, et al. 2023	Implement AI in the medical education curriculum.	An integrative review	There are few plans or implementations reported on how to incorporate AI in the medical curriculum.	Medical students need to be sufficiently proficient in AI, and its advantages to improve healthcare expenses, quality, and access.	how to successfully equip medical students with knowledge in AI.
12	Van de Venter (2023)	This study aimed to evaluate and discuss a postgraduate-level module on AI developed in the UK for radiographers.	Participatory action research methodology	Participants' professional and educational backgrounds influenced their experiences, b. participants found the learning experience meaningful concerning module design, organisation, and pedagogical approaches,	AI modules can assist educators/academics in developing similar AI education provisions for radiographers and other medical imaging and radiation sciences professionals.	Formal AI education for radiographers is lacking. some module design and delivery aspects were identified as barriers to learning
13	Oksana Iliashenko, Zilia Bikkulova and Alissa Dubgorn (2019).	This study an overview of existing cases of usage of artificial intelligence (hereinafter AI) in healthcare is made, and opportunities for AI technologies and challenges	Statistical observation by studying sources about current projects in the AI market.	AI in healthcare is most commonly used to perform the following tasks: 1) diagnosis assistance; 2) management of healthcare enterprises; 3) keeping a healthy lifestyle. T	.There's also a factor of the background of the country: we can judge the progress of AI in healthcare in each country only by considering the level of the general development of this country, its economic condition etc.	e. The main challenges for the usage of AI in healthcare are 1) the necessity for specific architecture at enterprises; 2) prejudice towards AI in mass consciousness; 3) the necessity of providing privacy and information safety; 4) the necessity of providing high reliability and high quality of services
14	Chen, J. (2017).	the technological landscape of healthcare and examine the issues undergraduate medical education may have to address.	Case study	IPE and TBL should be integrated into the medical curriculum, to form IPTBL (interprofessional team-based learning) in a deliberate effort to prepare students for the future reality of multidisciplinary team-based care.	Empowering medical graduates with the capabilities to thrive in the future.	There is a need for the human physician to do what machines cannot, to bring that third pillar of competency, practical wisdom, to the doctor-patient encounter.

N	Study	Research Focus	Methodology	Results	Applications	Challenges
15	Khosravi, (2023).	Artificial intelligence in neuroradiology: a scoping review of some ethical challenges	Systematic review	This study provides a brief overview of AI methods used in neuroradiology and segue into key methodological and ethical challenges.	Specifically, it discusses how the ethical principles affected by AI approaches to human neuroscience and provisions that might be imposed in this domain	The autonomous use of AI models introduces ethical challenges regarding the scope of informed consent, risks associated with data privacy and protection, potential database biases, as well as responsibility and liability that might potentially arise.
16	Kolachalam a VB and Garg PS (2018)	Machine learning and medical education.	Systematic review	This article is just meant to provide an outline and a potential curricular structure to embed ML content within a medical school, this list is by no means exhaustive. Also, things not covered here are the type of ML techniques and assessments that should be included throughout the training. When students complete this introductory experience, they should be in a position to confidently ask a clinical question, analyze the AI tools that exist, and approach several types of biomedical datasets using various ML techniques.	Any curriculum designed to address ML should aim for machine learning literacy rather than proficiency.	Lack of student access to ML content
17	Kolachalam a V. B. (2022).	Machine learning and pre-medical education	Systematic review	Medical schools as well as residency and fellowship programs should continue to find ways to offer machine learning training modules despite their overly tight schedules. A forward-thinking initiative will be to offer introductory machine learning courses as part of pre-medical education at accredited institutions. This article can be viewed as a call to the community to pursue these recommendations	Educating clinicians and care providers with the right foundational courses in machine learning as part of postsecondary education will likely transform them into high-tech physicians and care providers of the future	Lack of Introductory Machine Learning

N	Study	Research Focus	Methodology	Results	Applications	Challenges
18	Blease, et al .,(2022)	Machine learning in medical education:	A paper-based, cross-sectional survey of the experiences and opinions	Based on the results of a Mann-Whitney U test, male respondents were more likely to plan to learn about AI/ML than female participants.	Improvements in digital education will help prepare tomorrow's doctors to lead policy and practice advances on the role of AI/ ML-enabled tools in the health professions and patient care.	Medical students reported limited awareness and education on AI/ML
19	Wood, et al (2019).	The need for a machine learning curriculum for radiologists.	Systematic review	It is therefore imperative that imaging experts understand the potential, as well as the limitations, of ML, to appropriately integrate it into the clinical workflow.	Radiologists will be expected to effectively interpret the model output as a part of their daily practice .	A framework for educating the next generation of radiologists on how to interface with ML technology has not been established, leaving radiologists potentially will-prepared to fully leverage these tools safely and effectively
20	Waldman ,et al (2022)	Artificial intelligence in healthcare: a primer for medical education in radiomics.	Systematic review	It involves AI, what data are suitable for AI research, how to prepare a dataset for training and how to determine if the output has clinical utility.	This study focused on an example of how medical imaging is employed in designing a machine learning model.	AI's potential and limitations for enhancing clinicians' skills in research, applied statistics and care delivery.

6.1. The role of AI and Personalized Education or Learning in Medical Curricula:

The results of the review indicate that the role of AI and personalized education in medical curricula is promising. AI can be used to analyze student data and provide personalized feedback and recommendations for individualized instruction. Additionally, personalized education in medical curricula can improve students' understanding of complex medical concepts, leading to better learning outcomes. AI can also be used to develop intelligent tutoring systems that provide personalized feedback and guidance to students. Cardenas, et al, (2022) presents personalized learning model-specific knowledge requirements in cell biology and chemistry courses to enrich knowledge and improve academic performance.AI can be used to analyze large amounts of data on student performance and behaviour, and to provide real-time feedback and guidance to students. AI-powered tutoring systems can also provide personalized instruction to students based on their learning styles and preferences. 80% of the studies considered AI and PE\L as a necessity for facilitating the development of personalized learning environments in medical education.AI and PE\I role and applications in medical Curricula as follows:

- The implementation of artificial intelligence in clinical practice is a promising area of development.
- Personalized Learning is based on delivering contextual knowledge to support every learner based on their preferences, prior experience, and evolving knowledge. (Zhang et al. (2021)
- AI may optimize the care trajectory of chronic disease patients, suggest precision therapies for complex illnesses, reduce medical errors, and improve subject enrollment in clinical trials.
- AI usage of data helps to improve clinical decision-making will grow, pushing the need for skilful medicine-machine interaction. As the rate of medical knowledge grows, technologies such as AI are needed to enable healthcare professionals to effectively use this knowledge to practice medicine.
- The ethical implications of AI in medicine must be at the forefront of any comprehensive medical education. These technologies include expert systems, robotic process automation, natural language processing, machine learning, and deep learning. Healthcare professionals and organizations must build their capacity and capabilities to understand and appropriately adopt these technologies. This understanding starts with basic AI literacy, including data governance principles, basic statistics, data visualization, and the impact on clinical processes
- Medical students need to be sufficiently proficient in AI, and its advantages to improve healthcare expenses, quality, and access.
- AI modules can assist educators/academics in developing similar AI education provisions for radiographers and other medical imaging and radiation sciences professionals.
- There's also a factor of the background of the country: we can judge the progress of AI in healthcare in each country only by considering the level of the general development of this country, its economic condition etc.
- Empowering medical graduates with the capabilities to thrive in the future.
- Specifically, they discuss how the ethical principles affected by AI approaches to human neuroscience and provisions that might be imposed in this domain.
- Radiologists will be expected to effectively interpret the model output as a part of their daily practice.

6.2 Challenges of using AI and PL\E:

Several challenges need to be addressed to fully realize the potential of AI in personalized education; These include concerns about privacy and data security, as well as the need to ensure that AI algorithms are transparent, explainable, and unbiased. These include concerns about data privacy and security, the need for transparency and interpretability of AI algorithms, and the potential for bias and discrimination. Additionally, there is a lack of consensus on how to effectively integrate AI and personalized education into medical curriculum, and how to train educators to effectively use these technologies. The main challenges to the usage of AI in healthcare are:

1) There is a need for the human physician to do what machines cannot,
2) prejudice towards AI in mass consciousness
3) the necessity of providing privacy and information safety
4) the necessity of providing high reliability and high-quality services.
5) Ethical Considerations.
6) The mastery of the medical content
7)High cost and lack of Infrastructure
8.) Medical students reported limited awareness and education on AI/ML

7. Recommendations :

- Any curriculum designed should address ML should aim for machine learning literacy rather than proficiency.
- Educating clinicians and care providers with the right foundational courses in machine learning as part of postsecondary education will likely transform them into high-tech physicians and care providers of the future
- Improvements in digital education will help prepare tomorrow's doctors to lead policy and practice advances on the role of AI/ ML-enabled tools in the health professions and patient care.
- ML-related content can be embedded within a larger curricular construct that is focused on competence in using information technology to improve patient care.
- Curricular leaders should include ML curricula in medical education, which could begin with a focus on population health and the impact it can have on disease prediction, risk stratification, and management.
- Students could initially be introduced to ML through courses focused on population health and evidence-based medicine in which ML becomes an additional tool for the clinician to provide care.

- It is time for medical schools to consider including content focused on AI \ML and its applications as part of their curriculum. This will only become a reality when medical schools begin to create curricular time for AI with an acknowledgement of the changes to come in healthcare, and there is no better time to do it than now.

8. Conclusion:

AI can support Personalized Education by enabling adaptive learning experiences. However, further research is needed to identify best practices for integrating AI into Personalized Education and to address the ethical and practical challenges associated with the use of AI in education; with the potential to enhance learning outcomes, engagement, and satisfaction. However, several challenges and concerns need to be addressed to ensure the ethical and effective integration of AI and Personalized Education into the medical curriculum. Future research should focus on developing best practices for integrating AI and Personalized Education into medical curricula, addressing ethical concerns, and training educators to effectively use these technologies.

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