CCI JOURNAL CRITICAL CARE INNOVATIONS

REVIEW ARTICLE

Crit. Care Innov. 2024; 7(2): 34-54

ISSN 2545-2533

Received: 17.04.2024
Accepted: 09.05.2024
First online: 10.05.2024
Published: 30.06.2024

Approaches for integrating generative artificial intelligence in emergency healthcare education within higher education: a scoping review.

Pippa Furey [1] - A,B,C,F,G,M,L,N,O. ORCID www.orcid.org/0009-0000-3971-3479
Alastair Town [2] - A,B,C,F,N,O. ORCID www.orcid.org/0009-0004-5862-5967
Kacper Sumera [3,4] - A,B,C,F,J,L,N,O. ORCID www.orcid.org/0000-0002-1986-498X
Carl A. Webster [1,4] - A,B,C,F,J,L,N,O. ORCID www.orcid.org/0000-0002-9428-6833

[1] *Nottingham Trent University, Institute of Health and Allied Professions, Nottingham, United Kingdom*
[2] *Nottingham Trent University, Digital Technologies, Nottingham, United Kingdom*
[3] *East Midlands Ambulance Service NHS Trust, Education, Nottingham, United Kingdom*
[4] *European Pre-hospital Research Network, United Kingdom*

Address for correspondence:
Pippa Furey. *Nottingham Trent University, Health and Allied Professions Centre, Clifton Campus, Clifton Lane, Nottingham, NG11 8NS, United Kingdom;* e-mail: pippa.furey@ntu.ac.uk; tel: *+44 (0)115 848 2999*

Author Contributions (CRediTTaxonomy):

Conceptualization - **A**
Data Curation - **B**
Formal Analysis - **C**
Funding Acquisition - **D**
Investigation - **E**
Methodology - **F**
Project Administration - **G**
Resources - **H**
Software - **I**
Supervision - **J**
Validation - **K**
Visualization - **L**
Writing (Draft Preparation) - **M**
Writing (Review & Editing) – **N**
Approved the final version - **O**

ABSTRACT

INTRODUCTION: Gen AI, exemplified by tools like ChatGPT, has transformed various sectors, including healthcare education. Despite its rapid adoption across fields, the utilisation of Gen AI in healthcare education in the UK remains inconsistent, with research predominantly focused on academic integrity and examination performance, rather than exploring its potential benefits in educational practices. Notably, there is a paucity of literature within emergency healthcare education and paramedic courses. Objective - to investigate the integration and impact of Generative AI (Gen AI) within emergency healthcare education, focusing on undergraduate and postgraduate pre-registration courses in the UK.

MATERIALS AND METHODS: Using the JBI methodology and PRISMA-ScR guidelines, the databases MEDLINE, CINAHL, PubMed, and Cochrane were searched. The selection process involved screening by title and abstract, followed by full text review. Thematic analysis identified prevalent Gen AI applications within healthcare education. Inclusion criteria - the review targeted peer-reviewed studies that discuss the use of Gen AI in healthcare education, without publication date or geographical restrictions.

RESULTS: A total of 13 studies were included in the review. These studies demonstrated Gen AI's application in curriculum development, assessment design, student implementation, academic support, and clinical application. Gen AI aids educators in curriculum design and assessment creation, supports students through digital literacy enhancement, and facilitates academic writing and research practices. Additionally, its role extends to practical skill enhancement in clinical scenarios.

CONCLUSIONS: Gen AI offers transformative potential for all healthcare education and applications to the emergency education setting, providing innovative solutions for curriculum design, learning tools, and clinical simulations. While the identified themes are generalisable to healthcare education, they hold particular relevance for individuals seeking to advance the utilisation of Gen AI technologies within the specialised domain of emergency and prehospital care. However, its integration requires careful consideration of legal, ethical, and pedagogical implications.

KEY WORDS: Generative AI, artificial intelligence, education, innovation, healthcare.

INTRODUCTION

Generative Artificial Intelligence (Gen AI) has had a large societal impact since its launch to the public in November 2022. ChatGPT (Chat Generative Pre-Trained Transformer) is the pioneering initiative of a large language model (LLM) with the fastest-growing user base ever recorded, reaching 100 million users within two months [1]. As a Gen AI chatbot, ChatGPT engages with the user-formulated 'prompt' and responds with a predicted best human-like answer [2]. This groundbreaking product has been followed by numerous successors yet remains at the forefront. Moreover, GPT itself has seen its capabilities increase substantially in this time. When released in November 2022, GPT worked on text alone; at the time of writing, GPT can handle text, images, audio clips and files.

As within all subject areas, the integration of Gen AI into emergency healthcare education is expanding rapidly [3]. However, its adoption in the educational landscape is inconsistent, with some institutions limiting its use and others actively incorporating it into their curriculum [4]. Initial literature on Gen AI in healthcare-specific courses remains sparse but growing, reflecting its increasing application in the field [5]. Current research on the use of Gen AI in healthcare education largely focuses on academic integrity issues [6] and its capability of accurately completing examinations [7]. However, there is a paucity of research exploring the positive impacts of utilising Gen AI in educating future paramedics. This is despite an emphasis on modernising and digitalising health services such as the National Health Service (NHS) in the United Kingdom (UK) [8]. AI tools are not a new premise in higher education [9] with previous literature highlighting the significant opportunity it presents to save both students and practitioners time via mechanisms like automated marking [10]. However, it should be noted that this 'traditional' AI is not the same as Gen AI; tools like automated marking or student enrolment rely on traditional machine learning algorithms, created programmatically and able to sort, classify, and manipulate existing datasets. With the ability of Gen AI tools to create entirely new outputs from input data in a multimodal format the possible use cases expand exponentially. Therefore, it is unsurprising that integration of 'artificial intelligence' into higher education remains incomplete [11].

The integration of Gen AI into healthcare education represents a transformative step with the potential to enhance both the delivery and accessibility of educational content. In the dynamic and ever-changing landscape of healthcare there is hope that Gen AI could help bridge the gap between static textbook knowledge and contemporary clinical healthcare. As healthcare systems worldwide face resource constraints and increased demand for services [12], the ability of Gen AI to provide personalised learning experiences becomes even more valuable. It can facilitate remote learning, accommodate diverse learning paces and styles, and provide simulations for hands-on experience without the need for physical presence in a clinical setting [13]. Demand from healthcare employers for an increase in the number of graduates, coupled with the existing trend in pressures of workload in higher education, requires immediate attention and solutions [14].

As a result, this preliminary scoping review looks to identify prevalent approaches of Gen AI in undergraduate and postgraduate pre-registration healthcare courses. By undertaking this research, we aim to identify positive innovations of Gen AI use in medical education and recognise gaps within the literature for further research to apply to emergency healthcare education.

MATERIALS AND METHODS

The scoping review was conducted in accordance with the JBI methodology for scoping reviews [15]. The reporting of the scoping review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews (PRISMA-ScR) to ensure comprehensive reporting of methods and findings [16].

Establishing the Research Question

What are the prevalent approaches of Generative Artificial Intelligence integration in education among pre-registration healthcare courses within Higher Education programmes? The research question was informed by a Population, Concept, Context (PCC) analysis, following the framework outlined by Pollock et al. [17] (see Table 1).

Specifically, the key research question aimed to explore the prevalent approaches of Generative Artificial Intelligence integration in education among pre-registration healthcare courses within Higher Education programmes. This encompasses both undergraduate and postgraduate routes to registration. This approach guided the identification of search terms and focused the investigation on identifying positive applications of Gen AI in higher education settings, particularly within the context of pre-registration healthcare courses.

Identifying Relevant Studies

In consultation with a librarian, a systematic search strategy was developed to capture a wide range of literature relevant to the research question in line with the scoping literature review methodology. The search strategy focused on identifying peer-reviewed studies discussing the use of Gen AI within higher education healthcare courses. On September 11th, 2023, searches were conducted across multiple databases including MEDLINE, CINAHL, PubMed, and Cochrane.

The Boolean search strategy, incorporating terms such as 'Generative Artificial Intelligence,' 'higher education,' and 'healthcare courses,' was consistently applied across all databases. Key terms associated with each branch of the Population, Concept, Context (PCC) framework (see Table 1) was selected, and Boolean operators (AND/OR) and truncations (“”, *) were utilised to broaden the scope of the search. The search was limited to studies published in the English language, with no restrictions on the date of publication, considering Gen AI's recent availability. No country limitations were applied, and only full-text articles were included to ensure comprehensive coverage of contemporary research.

Table 1. PCC analysis for research question synthesis and generation of search terms.

Criteria	Definition	Search Terms
Population	Undergraduate and postgraduate students on healthcare courses	Generative Artificial Intelligence, Generative AI, ChatGPT, Large Language Model
Concept	Approaches of Generative AI use in education	University, Higher Education, Undergraduate, Postgraduate
Context	Current practices within University/Higher Education	Healthcare, Medical Care, Medicine, Health Care

Table 2. Inclusion and exclusion criteria used for screening.

	Include	Exclude
Population	Undergraduate and postgraduate healthcare-related programmes at universities or institutions of higher education	Non-academic healthcare training programmes Non-healthcare related programmes within universities or institutions of higher education
Intervention/Exposure	Papers that discuss the utilisation, application, impact of generative AI, including technologies like ChatGPT or large language models, in healthcare education within a higher education or university setting	Papers that do not specifically focus on Generative AI technologies Papers that discuss other forms of AI not falling under the "Generative AI" category Papers unrelated to healthcare education
Comparator/Context	Papers that address the context of healthcare education in university or higher education settings Papers discussing the integration of Generative AI in healthcare education within the specified contexts Papers discussing pedagogical uses of Generative AI	Papers discussing contexts other than university or higher education settings Papers that discuss Generative AI in non-educational healthcare contexts Papers that discuss the use of Generative AI in completing medical examinations
Outcome	Papers that provide insights into the impact, implications, or applications of Generative AI in healthcare education for undergraduate and postgraduate students Papers that explore the pedagogical uses of Generative AI	Papers that do not discuss outcomes related to Generative AI in healthcare education Papers that do not provide relevant insights into the impact or applications of Generative AI
Study Characteristics	Peer-reviewed journal articles, conference papers, and academic dissertations Papers published in the English language or with translation capabilities Papers where full text is available	Non-academic sources, including blog posts, news articles, and opinion pieces Duplicate papers or those with significant content overlap with other included papers Conference abstracts lacking sufficient detail for a comprehensive review Letters to the editor

Boolean Search

The search focused on Gen AI and healthcare education and therefore utilising specific and comprehensive keywords was essential to create specific Boolean searches. The Boolean search: ("Generative AI" OR "Generative Artificial Intelligence" OR ChatGPT OR "large language model") AND (university OR "higher education" OR undergraduate OR postgraduate) AND (healthcare OR "medical care" OR medicine OR “health care”).

Source of Evidence Selection

Following the search, all identified citations were collated and uploaded to referencing software and duplicates automatically removed. During the screening process, inclusion criteria were applied (Table 2), narrowing the selection to peer-reviewed journal articles, conference papers, and academic dissertations. Titles and abstracts were screened by two independent reviewers (PF and CW) for alignment with the inclusion criteria. Relevant papers underwent a full-text screening, applying predefined inclusion/exclusion (Table 2) criteria for final selection. Any discrepancies in the selection process were resolved through consensus discussions between reviewers (PF and CW), and, when necessary, a third reviewer was involved for resolution (KS). No papers were included that fell outside of the inclusion criteria.

Collating, Summarising and Reporting Results

Thematic analysis, guided by Clarke and Braun’s [18] Six Step Data Analysis Process, was employed to analyse the remaining papers, and emerging themes were identified (Table 3). The groupings encompass similar themes into four components (teaching and assessment design; student implementation; academic and scholarly support; clinical and practical application).

RESULTS

The search yielded 1148 results across all the databases (Figure 1) with 540 duplicates removed. The studies were then screened for relevance based on title and abstract, with 552 being excluded, leaving 56 studies for full-text screening. A further 43 were excluded following full-text screening.

Teaching and Assessment Design

The thematic analysis revealed a theme related to Teaching and Assessment Design in the context of Gen AI integration. This theme encompasses discussions on how educators navigate curriculum development, assessment design, and pedagogical approaches in response to the integration of Gen AI technologies.

Curriculum Development - Findings related to Curriculum Development demonstrate a dynamic shift in the educational landscape Abd Alrazaq et al. [19] recommend that Gen AI be utilised for conducting needs assessments, assisting educators in identifying gaps in the body of knowledge. The prompt can then be evolved for Gen AI to suggest targeted interventions, and support the designing and renovating of curriculum, with the diverse needs of the student identified to create specific learning objectives.

Building on the recommendations for curriculum development, Castonguay et al. [20] emphasise the potential of Gen AI in creating lesson plans and materials, offering a solution that not only streamlines academic workloads but also ensures efficiency in content development. Educators should develop and incorporate interactive tasks such as case-based learning and problem-solving exercises to encourage students to question and analyse Gen AI outputs [21]. Tam et al. [22] promote the use of Gen AI for drafting course materials, study guides, exam questions and essay topics, alongside its utilisation for administrative tasks: email responses and mapping tasks.

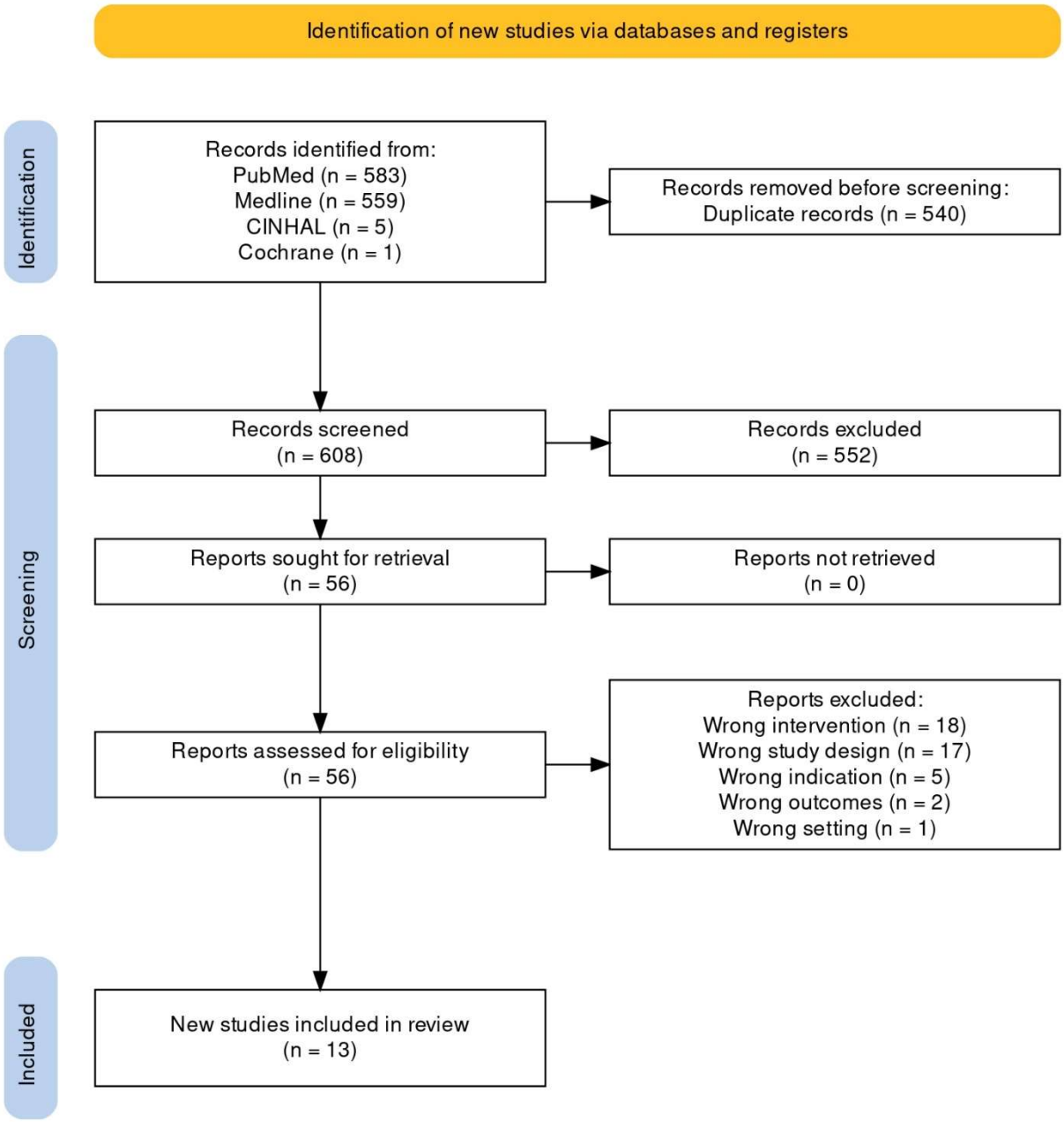

Figure 1. PRISMA-SR diagram.

Table 3. Data extraction for thematic analysis.

Authors	Title	Country	Type of Research	Aim	Population (Size)	Major Themes/Subthemes
Abd-alrazaq A, AlSaad R, Alhuwail D, Ahmed A, Healy P, Latifi S, et al [19]	Large Language Models in Medical Education: Opportunities, Challenges and Future Directions	Qatar	Narrative review	Opportunities and challenges of using LLMs in medical education	Medical Education	**Teaching and Assessment Design:** - *Curriculum Development* - *Assessment Design* - *Pedagogy* **Student Implementation:** - *Students Digital Literacy training* - *Study Plans and Learning Tools* **Academic and Scholarly Support:** - *Academic Writing* - *Research*
Castonguay A, Farthing P, Davies S, Vogelsang L, Kleib M, Risling T, et al. [20]	Revolutionizing nursing education through AI integration: A reflection on the disruptive impact of ChatGPT	Canada	Editorial	Benefit of AI integration in healthcare	Nursing Education	**Teaching and Assessment Design:** - *Curriculum Development* **Student Implementation:** - *Study Plans and Learning Tools* **Academic and Scholarly Support:** - *Academic Writing*
Jamal A, Solaiman M, Khalid Alhasan, Temsah M, Sayed G [21]	Integrating ChatGPT in Medical Education: Adapting Curricula to Cultivate Competent Physicians for the AI Era	Saudi Arabia, USA	Editorial	Solutions for integrating ChatGPT into medical education	Medical Education	**Teaching and Assessment Design:** - *Curriculum Development* - *Pedagogy* **Student Implementation:** - *Students Digital Literacy training*
Tam W, Huynh T, Tang A, Luong S, Khatri Y, Zhou W [22]	Nursing Education in the Age of Artificial Intelligence Powered Chatbots (AI-Chatbots): Are we ready yet?	Singapore, Vietnam	Editorial	Preparing for AI in nursing education	Nursing Education	**Teaching and Assessment Design:** - *Curriculum Development* **Student Implementation:** - *Study Plans and Learning Tools* **Clinical and Practical Application:** - *Patient Simulation and Clinical Vignette*
Sevgi UT, Erol G, Doğruel Y, Sönmez OF, Tubbs RS, Güngor A. [23]	The role of an open artificial intelligence platform in modern neurosurgical education: a preliminary study	USA, Grenada, Turkey	Preliminary study	Reliability of ChatGPT and integration to education	Neurosurgical Education	**Teaching and Assessment Design:** - *Assessment Design* **Academic and Scholarly Support:** - *Academic Writing* **Clinical and Practical Application:** - *Patient Simulation and Clinical Vignette*
Cross J, Robinson R, Devaraju S, Vaughans A, Hood R, Kayalackakom T [24]	Transforming Medical Education: Assessing the Integration of ChatGPT into Faculty Workflows at a Caribbean Medical School	Caribbean	Survey	Integration of ChatGPT	Medical Education	**Teaching and Assessment Design:** - *Assessment Design* **Student Implementation:** - *Study Plans and Learning Tools* **Clinical and Practical Application:** - *Patient Simulation and Clinical Vignette*
Cheung BHH, Lau GKK, Wong GTC, Lee EYP, Kulkarni D, Seow CS, Wong R, Co MTH [25]	ChatGPT versus human in generating medical graduate exam multiple choice questions – A multinational prospective study	Hong Kong, Singapore Ireland and UK	Prospective study	Evaluation of quality in LLM created exam questions	Medical Education	**Teaching and Assessment Design:** - *Assessment Design*

Breeding T, Martinez B, Patel H, Nasef H, Arif H, Nakayama D, Elkbuli A. [26]	The utilization of ChatGPT in Reshaping Future Medical Education and Learning Perspectives: A Curse or a Blessing?	USA	Quantitative survey	Evaluating medical students perception of LLM created articles vs evidence-based sources	Medical students (56)	**Teaching and Assessment Design:** *- Assessment Design* **Academic and Scholarly Support:** *- Academic Writing*
Safranek CW, Sidamon-Eristoff AE, Gilson A, Chartash D. [27]	The Role of Large Language Models in Medical Education: Applications and Implications	USA, Ireland	Editorial	Integration of LLMs within medical education	Medical education	**Teaching and Assessment Design:** *- Assessment Design* **Student Implementation:** *- Study Plans and Learning Tools* **Clinical and Practical Application:** *- Patient Simulation and Clinical Vignette*
Heng JJ, Teo DB, Tan LF [28]	The Impact of Chat Generative Pre-Trained Transformer (ChatGPT) on medical education	Singapore	Narrative review	Impact of ChatGPT on medical education	Medical Education	**Teaching and Assessment Design:** *- Curriculum Development* *- Assessment Design* **Student Implementation:** *- Students Digital Literacy training* *- Study Plans and Learning Tools* **Academic and Scholarly Support:** *- Academic Writing* **Clinical and Practical Application:** *- Patient Simulation and Clinical Vignette*
Boscardin CK, Gin B, Golde PB, Hauer KE. [29]	ChatGPT and Generative artificial intelligence for medical education: Potential impact and Opportunity	USA	Narrative review	Impact and opportunity of LLMs	Medical Education	**Teaching and Assessment Design:** *- Assessment Design* **Student Implementation:** *- Study Plans and Learning Tools* **Academic and Scholarly Support:** *- Research*
Choi EPH, Lee JJ, Ho MH, Kwok JYY, Lok KYW. [30]	Chatting or Cheating? The impacts of ChatGPT and other artificial intelligence language models on nurse education	Hong Kong	Editorial	Impacts of LLMs on nursing education	Nursing Education	**Teaching and Assessment Design:** *- Curriculum Development* *- Assessment Design* **Student Implementation:** *- Students Digital Literacy training*
Sallam M [31]	ChatGPT Utility in Healthcare Education, Research and Practice: Systematic Review on the Promising Perspectives and Valid Concerns	Jordan	Systematic Review	Benefits and risks of integrating ChatGPT into healthcare education	Medical Education	**Academic and Scholarly Support:** *- Academic Writing* **Clinical and Practical Application:** *- Patient Simulation and Clinical Vignette*

Assessment Design - The Assessment Design code encompasses discussions on reimagining evaluation methods in response to the integration of Gen AI. Significant observations encompass the use of LLMs for question generation, emphasising the necessity for deploying them with a comprehensive understanding of the subject matter to guarantee accuracy in the formulated questions [23]. Cross et al. [24] found that multiple-choice questions (MCQs) construction was the most common application of an LLM during a study of academic Gen AI applications at a University in America. Cheung et al. [25] found that ChatGPT could create MCQs that are comparable with an experienced academic, with ChatGPT taking 20 minutes 25 seconds to create 50 questions, compared to two academics taking 211 minutes 33 seconds. In a double-blind study, when comparing the clarity and organisation of ChatGPT-created articles to the textbook retrieved, medical students found that ChatGPT was superior [26]. Despite this, the textbook-retrieved articles were considered more comprehensive, and therefore, ChatGPT was recommended as an adjunct tool only. Safranak et al. [27] propose Gen AI as a valuable tool for students seeking to review MCQs and acquire insights into the accuracy of their chosen answers.

To improve assessment validity, Heng et al. [28] propose creating assessment topics that Gen AI cannot easily answer or moving to in-person viva voce and clinical assessments. Furthermore, designing assessments to inspire critical thinking should be encouraged, with Gen AI case studies/care plans created for student analysis and activity. This paper focused more on utilising reflective practice essays and oral presentations for assessment to reduce over-reliance on LLMs.

While Boscardin et al. [29] agrees with these suggestions, they also recommend that the assessment task is to critique Gen AI-created answers to a topic. For educators, the recommendation is to partially automate scoring with rubrics using Gen AI and create feedback smart phrases. Abd-Alrazaq et al. [19] concur with the automation of feedback and rubrics, furthering this by suggesting creating rubrics within ChatGPT to ensure transparent and consistent understanding and therefore the integration of Gen AI in assessment design calls for a nuanced approach.

Pedagogy - The pedagogical recommendations of Gen AI within Teaching and Assessment Design are seen within other areas of the thematic analysis and will continue to evolve. LLMs can serve as a valuable resource for students seeking immediate clarification on complex topics during lectures, and the authors suggest the utilisation of LLMs to facilitate group discussions, fostering collaborative learning experiences [19]. An innovative idea proposed by these authors is to utilise LLMs as a virtual mentor, with instant feedback and personalised guidance. Castonguay et al. [20] advocate for a comprehensive integration into the curriculum, with their recommendations including formative and summative assessment, tasking students to create resources using AI, and improvement of reading and comprehension skills with Gen AI – with emphasis on non-native English speakers. Jamal et al. [21] recommends immediate integration of ChatGPT into medical education, emphasising prompt inclusion of digital tools and advocating for critical thinking exercises. This recommendation is underscored by ethical considerations and a holistic approach to AI integration.

Student Implementation

The thematic analysis uncovered a significant theme concerning Student Implementation, focusing particularly on digital literacy and the creation of learning tools to maximise Gen AI integration.

Digital Literacy - Abd-Alrazaq et al. [19] suggest that educational institutions ought to conduct training sessions to instruct students and educators on the effective and ethical utilisation of AI tools in medical education. Without elevated digital literacy skills and competencies, a student would be unable to effectively embed Gen AI within their practices, and this may also lead to misplaced trust in LLM outputs. The onus of this training has been put onto the educator by Choi et al [30] and Jamal et al [21], with recommendation for the educator to explain the limitations of Gen AI to students, and create activities to appraise the productions of a LLM. Heng et al [28] remove that responsibility from the educator and instead place it within the curriculum, stating it must be designed to equip students for critiquing AI tools.

Learning Tools - Students can use Gen AI as a search engine to summarise information instead of a search engine and utilise this summarising feature for a self-paced and directed learning experience [22, 25]. Castonguay et al. [20] agree with the above and aiding data analysis, writing skills and interpretation. Complex concepts can be formulated into customised study notes, with sample questions and feedback [22]. Specific to medical education, students can further this summarising of information to gain a more in-depth understanding of pathophysiology and clinical logic through conversation with the Gen AI [27]. Boscardin et al [29] suggest students utilise Gen AI to provide essay templates and act as an editor for grammar and that educators should anticipate learners to use Gen AI for information synthesis. This is supported by Abd-Alzaraq et al. [19] with identifying individual strengths, and tailored action plans, with a suggestion of flash cards and practice questions.

Academic and Scholarly Support

Within the analysis, a notable theme emerged revolving around Academic and Scholarly Support, with a specific emphasis on academic writing and research practices amidst positive Gen AI integration.

Academic Writing - Boscardin et al. [29] and Heng et al. [28] suggest that Gen AI could be used within the research process: initiating the writing process, formulating preliminary research questions, knowledge gap analysis, accelerating the research process and refining scholarly writing. Abd-Alzaraq et al. [19] recommend usage for selecting appropriate language and terminology for a targeted audience, with guidance on writing style and formatting. Recommending Gen AI's use as an adjunct tool, Breeding et al. [26] and Castonguay et al. [20] further advocate for analysis of restructuring sentences, writing quality assurance, and creating concise information for review. Specifically suggested is using Gen AI to review whether a resource would be a strong piece of evidence to support the academic writing and statistical analysis of a resource [20]. Critical thinking can be enhanced by time liberation from using Gen AI to streamline resource access [28]. Sallam [31] conducted a systematic review and agrees with the idea of improved time management to focus on tasks that would not benefit from Gen AI reliance.

This paper also discussed research equity and how utilising Gen AI as a non-native English speaker could improve language skills and, therefore, diversity in research. Sevgi et al. [23] further this to say that Gen AI can support overcoming motivation and anxiety with the use of editing and written text generation; the paper itself used Gen AI to create the title with no adjustment made before publishing.

Research - For uses within research, Abd-Alzaraq et al [19] recommend using Gen AI to access, extract and summarise relevant data from scholarly articles, patient records and a variety of further resources. It is suggested that this will create accurate and reliable data, with a reduction in time and resource management for the tasks. Boscardin et al. [29] also agree with this paper, with further recommendations for using Gen AI to paraphrase texts with an aim for time reduction.

Clinical and Practical Application

This theme explores the innovative approaches adopted by educators to simulate real-world clinical scenarios, enhancing students' practical skills and preparing them for professional practice in healthcare settings.

Patient Simulation and Clinical Vignette - Gen AI can be used to create clinical vignettes and patient simulations, creating a safe learning environment for clinical thinking and accessibility for customisable virtual experiences [28]. Cross et al. [24] found that 54% of academic respondents to their questionnaire were using Gen AI for clinical vignette construction. Gen AI models can play the role of the simulated patient, with students able to interact, clarify and develop the situation given with a constructivist learning theory [27]. Tam et al. [22] recommends simulation creation as a problem-based learning pedagogical method, challenging students to find solutions through critical thinking, facilitating communication, assessment and intervention skills. When used to create patient presentations, Sevgi et al. [23] did not find significant errors in workflow for the created history and examination by Gen AI when given a prompt, although recommended oversight from a subject matter expert, nevertheless. Utilising Gen AI in this manner would be a valuable educational source without costly execution [31].

DISCUSSION

Present Circumstances of AI Applications in Healthcare

From examining the landscape of Gen AI applications in healthcare education, this scoping review found several proposed positive uses within the healthcare education setting, all within varying stages of implementation, that could be positively applied to emergency healthcare education. The wider NHS is exploring the integration of Gen AI into its healthcare systems, aiming to incorporate it within NHS England, such as within Ambulance Service Trusts, safely and sustainably, while adhering to guidance and regulations to safeguard patients. NHS England [32] have created an NHS AI Lab, seeking a collaborative environment to develop research within the field, and provide Gen AI related resources for the general public and organisations. Whilst this is a bigger overview on endorsed projects, there are studies outside of this organisation also being undertaken.

Clough et al. [33] conducted a feasibility study with mock patients to create discharge summaries, 25 created with Gen AI and 25 by junior doctors. The results revealed that all discharge summaries crafted by Gen AI were deemed of acceptable quality, surpassing the 92% acceptability rate in the junior doctor section. Whilst only being a small study based on clinical vignettes, it demonstrates the possibility for Gen AI supplementing the administration workload matching the quality of discharge summaries produced by trained individuals. As recommended, incorporating Gen AI into healthcare education programmes to create clinical vignettes not only aligns with these findings, but also highlights the potential for future research opportunities. By cultivating a workforce with digital literacy in Gen AI, healthcare professionals can actively contribute to and participate in research and trials utilising Gen AI-created clinical vignettes, marking a significant stride towards realising the broader applications of AI in healthcare administration. By educating our students on Gen AI usage, we not only enhance their communication skills but also normalise the integration of Gen AI as a commonplace technological tool. This approach aligns with the recommendation for Gen AI to be utilised when conveying clinical information to non-native speakers to reduce a language barrier, although currently empirical trials to validate this application are currently lacking [34].

An illustrative case of Gen AI's application for patient well-being involves its utilisation as a coaching resource for health preservation. In a trial conducted by Al-Anezi [35], ChatGPT was employed to assist a cohort managing chronic diseases. The model presented educational opportunities in areas such as life-long learning, enhanced health literacy, improving accessibility to information, and support for behavioural change. However, it's important to acknowledge limitations in this study—specifically, the challenge of discerning Gen AI's information sources, which raises the potential risk of providing inaccurate information. The proposed integration of Gen AI into healthcare education throughout their programme of study becomes essential as Gen AI future develops as a norm within healthcare. Equipping healthcare professionals with the knowledge of how to navigate Gen AI ensures that they can guide patients effectively, mitigating potential risks associated with misinformation. Whilst this is not a comprehensive list of trials and recommendations for uses, it does give a view of the current landscape and different areas beyond what a trained AI model can focus upon.

Challenges and Limitations

The intersection between healthcare education and AI presents a spectrum of challenges and limitations for consideration. There is currently no standardisation across universities within the UK for the approach to including Gen AI within programmes. Universities appear to be creating individual guidance documents, with a lack of legislative background at the present time. The UK Government have created an Office for Artificial Intelligence with published guidance documents, such as a National AI [36]. The European Parliament have made strides toward an Artificial Intelligence Act, creating protections for citizens' rights and democracy, and this will be adopted into law having been agreed in December 2023 [37]. The evolution of Gen AI is evident in the ongoing development of guidance and legislation, reflecting a dynamic approach to its integration and interaction. As the proposed uses highlighted in this scoping review find potential adoption

within healthcare education programmes, it becomes imperative for the curriculum to maintain currency with the latest guidance and legislation. This ensures that students are equipped with up-to-date knowledge, aligning their education with the evolving landscape of Gen AI. This approach is essential to cultivate a responsive and informed healthcare workforce overtime capable of navigating emerging AI technologies in accordance with the most current ethical and legal frameworks.

Due to the lack of transparency in disclosing Gen AI model datasets by the owning companies, identifying potential biases in the source of information, such as over-reliance on English-written sources, becomes challenging. Additionally, this scoping review, by excluding non-English papers, may inadvertently omit insights into how Gen AI is utilised, if at all, in healthcare education programmes within non-English-speaking countries. This dual limitation underscores the need for caution in generalising findings, emphasising the importance of a more inclusive examination of Gen AI applications in diverse linguistic and cultural contexts.

Gen AI may exhibit a bias in outputs, not necessarily a reflection of the model itself being inherently prejudiced, but rather a reflection of the unknown data that the model is trained upon [38]. This risk is applicable across all uses of Gen AI, demanding user awareness. Particularly, individuals involved in building clinical vignettes or developing healthcare curriculum have responsibility to acknowledge potential bias to prevent the reinforcement of healthcare-related biases. While this bias can be associated with demographic, geographical, cultural, or societal and political factors, it is crucial to recognise that as information becomes outdated, Gen AI might disproportionately favour older data, potentially influencing its outputs due to the training on historical data. Staying vigilant to these nuances is essential for creating unbiased and appropriate outputs in healthcare and educational applications.

When used for teaching and assessment design, the biases within the training data of the Gen AI may lead to an unintended reinforcement of gaps of knowledge. To combat this, Boscardin et al [29] discuss changing the assessment to use Gen AI to create a case for students to critically appraise. This would then mitigate risk of a Gen AI not capturing the context or adapting to educational requirements, as it could be prompted to create standalone resources that are then evaluated.

There can be a lack of personalisation with the output from a Gen AI, and therefore it may require time to edit outputs to students' individual needs. Tailoring content to diverse learning styles and preferences may be difficult, although on an individual basis, Gen AI is being heralded as an innovative source of support. For example, Botchu et al. [39] talk about Gen AI’s potential applications for students with dyslexia as a learning need and recommend Gen AI creating personalised learning tools, improving creativity to develop new ideas and improve engagement by removing the potential for criticism and comparison to their peers. Ciampa et al [40] supports this idea, stating it allows access to materials whilst reducing frustration and potential embarrassment during the writing process. This aligns with the results found in the scoping review supporting the use of Gen AI for individual study plans.

There are ethical concerns about any emerging technology, and users should be aware of these issues prior to using Gen AI. The creation of human-like responses, exemplified by Gen AI, poses the risk that readers may not recognise them as outputs generated by a LLM. The user also needs to remain aware that the Gen AI has an ability to learn from the interaction, with the aim of improving the quality and acceptability of the created response [41].

The debate on ethics concerning Gen AI encompasses key areas: privacy, fairness, transparency and accountability [42]. Privacy concerns arise from Gen AI's potential utilisation of individuals details without prior knowledge or consent. To safeguard privacy when sharing data with Gen AI, it is imperative to anonymise the information [43]. In the context of healthcare educational utilising Gen AI, the most significant privacy risk is associated with inputting student or patient-specific data. This risk can be mitigated through practices of anonymisation, aggregation of information, compliance with General Data Protection Regulation (GDPR) or relevant data protection laws, and limiting sensitive data provided to Gen AI. There has been criticism of certain Gen AI models over privacy concerns, with developments to allow users to now opt out of contributing the inputted data for training purposes, although this development is in a minority of Gen AI models [38]. Additionally, user education, involving the development of digital literacy skills, plays a crucial role in mitigating potential risks.

Implications for Emergency Healthcare

The integration of AI technologies, particularly Gen AI, has begun to create transformative changes in the landscape of emergency healthcare. Firstly, Gen AI can revolutionise the support available to clinicians for administration tasks and supporting clinical-decision making. Clinical decision support (CDS) technology is a system with a variety of tools to assist clinicians in the decision-making process and recommendations for care, with systematic review finding that the systems improve clinical practice in 68% of trials analysed [44]. Zhang and Boulos [45] recommend that Gen AI can revolutionise CDS, assisting clinicians in formulating suggestions for optimising decision-making, with an expectation for improvement on patient outcome and overall quality of healthcare services. It is recommended that it would serve as a diagnostic assistant, generating a list of possible diagnoses and treatment plans for the presentation. The paper gave several examples of Gen AI being inbuilt into electronic health records, resulting in Gen AI assisted clinical documentation, automation of administration tasks, analysing and annotating of scans and tissue samples. This has released clinicians to prioritise patient care over screen time, enabling them to hone their diagnostic skills through ongoing learning opportunities, which is vital within the realm of the emergency setting. While this provides a brief overview of some current applications within healthcare, it's important to recognise that Gen AI is continually being integrated into various technological advancements. Undoubtedly, there will be additional innovative uses emerging in the future.

As evidenced in the results section, Gen AI holds promise to enhance the learning opportunities and create immersive educational experiences, especially within simulation and clinical scenario education. The recent evolution of technology has led to a shift in educational practices, with virtual reality (VR) increasingly

utilised to supplement, and in some cases, substitute clinical experiences [46]. Saab et al. [47] conducted a qualitative study to understand nursing students' perceptions of the utilisation of VR within education. They found the students regarded VR as novel, straightforward, and an enjoyable tool, often more memorable than conventional education strategies. Moreover, students perceived VR to accommodate various literacy skills and learning styles. These findings parallel the potential impact of Gen AI's implementation within education. Gen AI's adaptability to the prompt creates an accessibility to all learning styles, while the ability to engage in human-like conversation caters to a range of needs. Unlike VR, which has shown success in education but requires specialised and initially costly equipment [48], Gen AI is accessible to learners with internet-enabled devices. The integration of Gen AI technology could revolutionise the simulation of emergency situations, providing learners with a safe yet realistic environment for practicing crucial dialogue exchanges. Gen AI can be utilised as an immersive experience that allows students to engage dynamically with scenarios, enhancing their decision-making skills and clinical leadership within a controlled setting. Additionally, VR has been associated with side effects such as dizziness and motion sickness [49], further highlighting the advantages of Gen AI in terms of accessibility and ease of use.

In higher education, interdisciplinary collaboration is crucial for preparing future healthcare professionals. Gen AI not only fosters collaboration within healthcare education but also addresses barriers to interdisciplinary communication. Liaw et al. [50] demonstrated the potential of Gen AI models in VR to overcome institutional barriers to interprofessional education. By simulating interactions between nurses and medical students represented as avatars, Gen AI-created training scenarios provide a safe environment to address challenges like scheduling conflicts and varying cohort sizes. When put into practice, nursing students found the Gen AI avatar to offer structured teaching and guidance, recommending its use as a pre-learning tool to build confidence before interacting with medical student avatars. This approach can unite stakeholders for virtual exercises, promoting interprofessional collaboration within healthcare courses. One recommendation is to simulate multidisciplinary team meetings, with representatives presented as Gen AI avatars if absent. Communication remains an imperative skill to healthcare professionals, and whilst Gen AI currently has limited known uses as a communication tool, it is a promising cost-effective solution to barriers [51]. As students become proficient in utilising Gen AI throughout their educational journeys, incorporating experiences such as this into their curriculum will require less adjustment or adaptation, therefore reducing the learning curve associated with its integration.

Pedagogical strategies and approaches

Where Gen AI is being used in an individual basis, three paradigms of Gen AI use can be found (table 4). The first finds the user as the recipient of Gen AI; the second where the user is the collaborator; and the final where the user is the leader [52]. In the third paradigm, there is a dynamic collaboration that involves the user with instructions and information to utilise the technology to enhance their intelligence. The term user is more appropriate than learner, whilst this aligns with the results found in the student implementation theme, users who are educators can also align with the paradigms.

Table 4. Paradigms with associated learning theory.

Paradigm	Learning theory	Explanation
Recipient of Gen AI	Cognitive Learning	User is a passive recipient of Gen AI services
Collaborator with Gen AI	Cognitive and Social Constructive Learning	User is supported by Gen AI, facilitating learning through collaboration
Leader of Gen AI	Connectivism and Inquiry-Based Learning	AI empowers Users to take agency of learning

Within the recipient paradigm, users primarily receive information, guidance or support from Gen AI to facilitate the learning process. Where the user is a student, potentially Gen AI would be used for personalised learning pathways, highlighting inputted data for strengths, weaknesses, and generate study plans [19]. With the model providing real-time feedback and recommendations for assignments, projects and assessments, the students will receive personalised suggestions for improvement, additional resources of alternative approaches [29]. Additionally, direct interaction in conversational exchanges employs Gen AI as a virtual tutor, unlike the above pathways, this use offers personalised one-on-one instruction and support to students in a less formal manner, through interactive conversations and engagement in a virtual environment [53].

As a collaborator with Gen AI, users actively engage in collaborative tasks or projects, working together to achieve objectives. Figoli, Mattioli and Rampino [54] state that including Gen AI in the creative process of design therefore overcomes human limitation, improving creativity and allocation of resource. The user inputs into the Gen AI, and output is received, and therefore input is gained for the user, creating output. Nagy et al. [55] investigated the use of Gen AI as a partner in collaborative course development, finding that human-AI partnerships produce a superior quality of work in terms of creativity, originality and efficiency than if the user or Gen AI was to work alone. Whilst Gen AI can also be utilised as an assistant for collaborative writing projects, it's debated as to whether it is considered a co-author. Authorship entails specific requirements, including accountability of the created content, and therefore at times has been considered a ghost writer after an initial rebuttal when declared as a co-author [56]. Currently there appears to be no mass agreement, with journals updating their policies to reflect their requirements for declaration of the extent Gen AI has been used.

In the final paradigm, users take on leadership roles in directing and guiding Gen AI to accomplish specific tasks of projects. Such uses can include user led inquiry projects, with Gen AI used to explore topics of interest, allowing independent inquiry and critical thinking [57]. In this paradigm, users may seek to customise the Gen AI application to address particular learning needs and challenges. Typically, this involves training the Gen AI based on prompts.

Limitations

This scoping review, although systematic in its approach to identifying relevant literature, encountered several limitations. One limitation was the limited number of studies that met the inclusion criteria (table 2), which highlights a substantial gap in research on the use of Gen AI in healthcare education. Additionally, no review protocol was registered before the initiation of this review. The restriction to English-language publications may also constrain the review's breadth, potentially overlooking valuable insights from non-English sources. It is critical to acknowledge that the technology of Gen AI is rapidly evolving, which could affect the relevance and applicability of the findings in future research. There were limited studies on the use of Gen AI specifically in emergency education, and so a broader scoping review was used encompassing other healthcare education.

CONCLUSIONS

In conclusion, this scoping review has explored the current state and potential and potential of Gen AI applications within healthcare education, revealing a promising landscape of innovation and practical utility for use in emergency healthcare. The exploration of Gen AI's role across various facets of healthcare education and administration has demonstrated its capacity to enhance learning experiences, streamline administrative processes, and facilitate a more efficient and personalised approach to healthcare delivery. The journey towards widespread adoption of Gen AI in emergency healthcare education is not without its challenges. Legal and ethical considerations, particularly around privacy, fairness, transparency, and accountability, necessitate a careful and deliberate approach to incorporating Gen AI into educational curricula and educational practices. The need for standardisation, policy, and legislative support is evident, as is the importance of addressing the wider limitations and potential biases inherent in Gen AI technologies. The review highlights the need for digital literacy and ethical awareness in preparing healthcare professionals, such as paramedics, for a future where Gen AI is likely to play a central role.

The implications of Gen AI for emergency healthcare education extends beyond the adoption of new technologies. It requires a reimagining of pedagogical strategies and underscore the importance of interdisciplinary collaboration, leading to the future of a dynamic, inclusive, and responsive healthcare education. There are undoubtedly concerns surrounding its implementation, as well as the huge opportunity to enhance the quality of healthcare delivery and patient outcomes, making it well worth pursuing.

SUPPLEMENTARY INFORMATION

Funding: *No fund was received related to this study.*
Institutional Review Statement: *The study was conducted according to the guidelines of the Declaration of Helsinki.*
Informed Consent Statement: *Not applicable*
Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.*
Conflicts of Interest: *The authors declare no conflicts of interest.*

.

REFERENCES

[1] Loh E. Chatgpt and Generative AI Chatbots: Challenges and opportunities for Science, medicine and medical leaders. BMJ Lead. 2023: leader-2023-000797.
doi: https://doi.org/10.1136/leader-2023-000797

[2] Briganti G. How CHATGPT works: A mini review. Eur Arch Otorhinolaryngol. 2024; 281(3): 1565-1569.
doi: https://doi.org/10.1007/s00405-023-08337-7

[3] Preiksaitis C, Rose C. Opportunities, challenges, and future directions of Generative Artificial Intelligence in Medical Education: Scoping review. JMIR Med Educ. 2023; 9: e48785.
doi: https://doi.org/10.2196/48785

[4] Dixon S, Stephen M. Don't panic (yet): The implications of ChatGPT for Education Studies in the UK. Edu futures. 2023; 14(1): 96-106.
doi: https://doi.org/10.1111/j.1365-2648.2012.05967.x

[5] Dave M, Patel N. Artificial intelligence in healthcare and education. Br Dent J. 2023; 234(10): 761-764.
doi: https://doi.org/10.1038/s41415-023-5845-2

[6] Cotton DR, Cotton PA, Shipway JR. Chatting and cheating: Ensuring academic integrity in the era of chatgpt. Innov Edu Teach Internat. 2024; 61(2): 228-239.
doi: https://doi.org/10.1080/14703297.2023.2190148

[7] Kung TH, Cheatham M, Medenilla A, Sillos C, De Leon L, Elepaño C, et al. Performance of chatgpt on USMLE: Potential for AI-assisted medical education using large language models. PLOS Digit Health. 2023; 2(2): e0000198.
doi: https://doi.org/10.1371/journal.pdig.0000198

[8] National Health Service. The NHS Long Term Plan. NHS choices. 2019.
[WWW]: https://www.longtermplan.nhs.uk/publication/nhs-long-term-plan
(accessed 08 January 2024)

[9] Huang J, Saleh S, Liu Y. Promotion of artificial intelligence technology. Int J Learn High Educ. 2021; 28(1): 85-95.
doi: https://doi.org/10.18848/2327-7955/CGP/v28i01/85-95

[10] Mason J, Peoples BE, Lee J. Questioning the scope of AI standardization in learning education and training. J. ICT Standard. 2020; 8(2): 107-122.
doi: https://doi.org/10.13052/jicts2245-800X.822

[11] Algerafi MAM, Zhou Y, Alfadda H, Wijaya TT. Understanding the factors influencing higher education students' intention to adopt artificial intelligence-based robots. IEEE Access 2023; 11: 99752–99764.
doi: https://doi.org/10.1109/ACCESS.2023.3314499

[12] Leite H, Lindsay C, Kumar M. COVID-19 outbreak: Implications on healthcare operations. The TQM J. 2020; 33(1): 247-256.
doi: https://doi.org/10.1108/TQM-05-2020-0111

[13] Michel-Villarreal R, Vilalta-Perdomo E, Salinas-Navarro DE, Thierry-Aguilera R, Gerardou FS. Challenges and opportunities of generative AI for higher education as explained by ChatGPT. Edu Sci. 2023; 13(9): 856.
doi: https://doi.org/10.3390/educsci13090856

[14] Bothwell E. Work-life balance survey 2018: long hours take their toll on academics. In: Times Higher Education.
[WWW]: https://www.timeshighereducation.com/features/work-life-balance-survey-2018-long-hours-take-their-toll-academics
(accessed 08 January 2024)

[15] Peters MDJ, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Chapter 11: Scoping Reviews (2020version). In: Aromataris E, Munn Z (Editors). JBI, 2020.
doi: https://doi.org/10.46658/JBIMES-20-12

[16] Tricco AC, Lillie E, Zarin W, O'Brien K, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-SCR): Checklist and explanation. Ann Intern Med. 2018; 169(7): 467–473. doi: https://doi.org/10.7326/M18-0850

[17] Pollock D, Peters MDJ, Khalil H, McInerney P, Alexander L, Tricco AC, et al. Recommendations for the extraction, analysis, and presentation of results in scoping reviews. JBI Evid Synth. 2023; 21(3): 520-532. doi: https://doi.org/10.11124/JBIES-22-00123

[18] Clarke V, Braun V. Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. The Psychologist. 2013; 26(2): 120-123.

[19] Abd-alrazaq A, AlSaad R, Alhuwail D, Ahmed A, Healy P, Latifi S, et al. Large language models in medical education: Opportunities, challenges, and future directions. JMIR Med Educ. 2023; 9: e48291. doi: https://doi.org/10.2196/48291

[20] Castonguay A, Farthing P, Davies S, Vogelsang L, Kleib M, Risling T, et al. Revolutionizing Nursing Education through AI integration: A reflection on the disruptive impact of chatgpt. Nurse Educ Today. 2023; 129: 105916. doi: https://doi.org/10.1016/j.nedt.2023.105916

[21] Jamal A, Solaiman M, Khalid A, Temsah M, Sayed G. Integrating chatgpt in medical education: Adapting curricula to cultivate competent physicians for the AI era. Cureus 2023; 15(8): e43036. doi: https://doi.org/10.7759/cureus.43036

[22] Tam W, Huynh T, Tang A, Luong S, Khatri Y, Zhou W. Nursing education in the age of Artificial Intelligence Powered Chatbots (AI-Chatbots): Are we ready yet? Nurse Educ Today. 2023; 129: 105917. doi: https://doi.org/10.1016/j.nedt.2023.105917

[23] Sevgi UT, Erol G, Doğruel Y, Sönmez OF, Tubbs RS, Güngor A. The role of an open artificial intelligence platform in modern neurosurgical education: A preliminary study. Neurosurg Rev. 2023; 46(1): 86. doi: https://doi.org/10.1007/s10143-023-01998-2

[24] Cross J, Robinson R, Devaraju S, Vaughans A, Hood R, Kayalackakom T, et al. Transforming Medical Education: Assessing the integration of CHATGPT into faculty workflows at a Caribbean Medical School. Cureus 2023; 15(7): e41399. doi: https://doi.org/10.7759/cureus.41399

[25] Cheung BHH, Lau GKK, Wong GTC, Lee EYP, Kulkarni D, Seow CS, et al.. ChatGPT versus human in generating medical graduate exam multiple choice questions - A multinational prospective study (Hong Kong S.A.R., Singapore, Ireland, and the United Kingdom). PLoS ONE 2023; 18(8): e0290691. doi: https://doi.org/10.1371/journal.pone.0290691

[26] Breeding T, Martinez B, Patel H, Nasef H, Arif H, Nakayama D, et al.. The Utilization of ChatGPT in Reshaping Future Medical Education and Learning Perspectives: A Curse or a Blessing? Am Surg. 2024; 90(4): 560-566. doi: https://doi.org/10.1177/00031348231180950

[27] Safranek CW, Sidamon-Eristoff AE, Gilson A, Chartash D. The Role of Large Language Models in Medical Education: Applications and Implications. JMIR Med Educ. 2023; 9: e50945. doi: https://doi.org/10.2196/50945

[28] Heng JJ, Teo DB, Tan LF. The impact of chat generative pre-trained transformer (CHATGPT) on medical education. Postgrad Med J. 2023; 99(1176): 1125-1127. doi: https://doi.org/10.1093/postmj/qgad058

[29] Boscardin CK, Gin B, Golde PB, Hauer KE. ChatGPT and Generative Artificial Intelligence for Medical Education: Potential Impact and Opportunity. Acad Med. 2024; 99(1): 22-27. doi: https://doi.org/10.1097/ACM.0000000000005439

[30] Choi EPH, Lee JJ, Ho MH, Kwok JYY, Lok KYW. Chatting or cheating? The impacts of ChatGPT and other artificial intelligence language models on nurse education. Nurse Educ Today. 2023; 125: 105796. doi: https://doi.org/10.1016/j.nedt.2023.105796

[31] Sallam M. CHATGPT utility in healthcare education, research, and practice: Systematic review on the promising perspectives and valid concerns. Healthcare 2023; 11(6): 887.
doi: https://doi.org/10.3390/healthcare11060887

[32] National Health Service England. The NHS AI lab - NHS transformation directorate, NHS AI Lab.
[WWW]: https://transform.england.nhs.uk/ai-lab/
(accessed 04 March 2024)

[33] Clough RAJ, Sparkes WA, Clough OT, Sykes JT, Steventon AT, King K. Transforming healthcare documentation: harnessing the potential of AI to generate discharge summaries. BJGP Open 2024; 8(1): BJGPO.2023.0116.
doi: https://doi.org/10.3399/BJGPO.2023.0116

[34] Teixeira da Silva JA. Can CHATGPT rescue or assist with language barriers in healthcare communication? Patient Educ Couns. 2023; 115: 107940.
doi: https://doi.org/10.1016/j.pec.2023.107940

[35] Al-Anezi FM. Exploring the use of ChatGPT as a virtual health coach for chronic disease management. Learn Health Sys. 2024: e10406.
doi: https://doi.org/10.1002/lrh2.10406

[36] Department for Science, Innovation and Technology. National AI Strategy.
[WWW]: https://www.gov.uk/government/publications/national-ai-strategy
(accessed 04 March 2024)

[37] European Parliament. Artificial Intelligence Act: deal on comprehensive rules for trustworthy AI.
[WWW]: https://www.europarl.europa.eu/news/en/press-room/20231206IPR15699/artificial-intelligence-act-deal-on-comprehensive-rules-for-trustworthy-ai
(accessed 04 March 2024)

[38] Gupta M, Akiri C, Aryal K, Parker E, Praharaj L. From ChatGPT to ThreatGPT: Impact of Generative AI in Cybersecurity and Privacy. IEEE Access. 2023; 11: 80218-80245.
doi: https://doi.org/10.1109/ACCESS.2023.3300381

[39] Botchu B, Iyengar KP, Botchu R. Can chatgpt empower people with dyslexia? Disabil Rehabil Assist Technol. 2023: 1-2.
doi: https://doi.org/10.1080/17483107.2023.2256805

[40] Ciampa K, Wolfe ZM, Bronstein B. ChatGPT in education: Transforming digital literacy practices. J Adol Adult Liter. 2023; 3: 186-195.
doi: https://doi.org/10.1002/jaal.1310

[41] Stahl BC, Eke D. The ethics of CHATGPT – exploring the ethical issues of an emerging technology. Internat J Info Manag. 2024; 74: 102700.
doi: https://doi.org/10.1016/j.ijinfomgt.2023.102700

[42] Kirova VD, Ku CS, Laracy JR, Marlowe TJ. The Ethics of Artificial Intelligence in the Era of Generative AI. J Sys Cyber Info. 2023; 21(4): 42-50.
doi: https://doi.org/10.54808/JSCI.21.04.42

[43] Bale A, Dhumale RB, Beri N, Lourens M, Varma RA, Kumar V, et al.. The Impact of Generative Content on Individuals Privacy and Ethical Concerns. Internat J Intellig Sys Applic Engin. 2023; 12(1s): 697-703.

[44] Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ. 2005; 330(7494): 765.
doi: https://doi.org/10.1136/bmj.38398.500764.8F

[45] Zhang P, Kamel Boulos MN. Generative AI in Medicine and Healthcare: Promises, opportunities and challenges. Future Inter. 2023; 15(9): 286.
doi: https://doi.org/10.3390/fi15090286

[46] Luca A, Giorgino R, Gesualdo L, Peretti GM, Belkhou A, Banfi G, et al.. Innovative Educational Pathways in Spine Surgery: Advanced Virtual Reality-Based Training. World Neurosurg. 2020; 140: 674-680. doi: https://doi.org/10.1016/j.wneu.2020.04.102

[47] Saab MM, Landers M, Murphy D, O'Mahony B, Cooke E, O'Driscoll M, et al. Nursing students' views of using virtual reality in healthcare: A qualitative study. J Clin Nurs. 2022; 31(9-10): 1228-1242. doi: https://doi.org/10.1111/jocn.15978

[48] Farra SL, Gneuhs M, Hodgson E, Kawosa B, Miller ET, Simon A, et al.. Comparative Cost of Virtual Reality Training and Live Exercises for Training Hospital Workers for Evacuation. Comput Inform Nurs. 2019; 37(9): 446-454. doi: https://doi.org/10.1097/CIN.0000000000000540

[49] Chattha UA, Janjua U, Anwar F, Madni TM, Cheema MF, Janjua SI. Motion Sickness in Virtual Reality: An Empirical Evaluation. IEEE Access. 2020; 8: 130486-130499. doi: https://doi.org/10.1109/ACCESS.2020.3007076

[50] Liaw SY, Tan JZ, Lim S, Zhou W, Yap J, Ratan R, et al.. Artificial intelligence in virtual reality simulation for interprofessional communication training: Mixed method study. Nurse Educ Today. 2023; 122: 105718. doi: https://doi.org/10.1016/j.nedt.2023.105718

[51] Stamer T, Steinhäuser J, Flägel K. Artificial Intelligence Supporting the Training of Communication Skills in the Education of Health Care Professions: Scoping Review. J Med Internet Res. 2023; 25: e43311. doi: https://doi.org/10.2196/43311

[52] Adiguzel T, Kaya MH, Cansu FK. Revolutionizing education with AI: Exploring the transformative potential of CHATGPT. Contemp Edu Tech. 2023; 15(3): ep429. doi: https://doi.org/10.30935/cedtech/13152

[53] Baidoo-Anu D, Owusu Ansah L. Education in the era of Generative Artificial Intelligence (AI): Understanding the potential benefits of CHATGPT in promoting teaching and learning. J AI. 2023; 7(1): 52-62. doi: https://doi.org/10.61969/jai.1337500

[54] Figoli FA, Mattioli F, Rampino L. Artificial Intelligence in the design process: The impact on creativity and Team Collaboration. Milano, Italy: FrancoAngeli; 2022.

[55] Nagy S, McInnes R, Airey L. Gen-ai: A transformative partner in collaborative course development. Int J Innov Online Edu. 2023; 7(2): 57-73. doi: https://doi.org/10.1615/IntJInnovOnlineEdu.2023051048

[56] Bozkurt A. Genai et al.: Cocreation, authorship, ownership, academic ethics and integrity in a time of Generative AI. Open Praxis. 2024; 16(1): 1-10. doi: https://doi.org/10.55982/openpraxis.16.1.654

[57] Pedaste M, Mäeots M, Siiman LA, de Jong T, van Riesen SAN, Kamp ET, et al.. Phases of inquiry-based learning: Definitions and the inquiry cycle. Edu Res Rev. 2015; 14: 47-61. doi: https://doi.org/10.1016/j.edurev.2015.02.003