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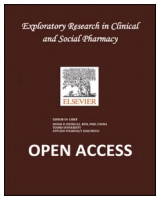

Generative artificial intelligence (Gen-AI) in pharmacy education: Utilization and implications for academic integrity: A scoping review

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ABSTRACT

Introduction: Generative artificial intelligence (Gen-AI), exemplified by the widely adopted ChatGPT, has garnered significant attention in recent years. Its application spans various health education domains, including pharmacy, where its potential benefits and drawbacks have become increasingly apparent. Despite the growing adoption of Gen-AIsuch as ChatGPT in pharmacy education, there remains a critical need to assess and mitigate associated risks. This review exploresthe literature and potential strategies for mitigating risks associated with the integration of Gen-AI in pharmacy education.

Aim: To conduct a scoping review to identify implications of Gen-AI in pharmacy education, identify its use and emerging evidence, with a particular focus on strategies which mitigate potential risks to academic integrity.

Methods: A scoping review strategy was employed in accordance with the PRISMA-ScR guidelines. Databases searched includedPubMed, ERIC [Education Resources Information Center], Scopus and ProQuestfrom August 2023 to 20 February 2024 and included all relevant records from 1 January 2000 to 20 February 2024 relating specifically to LLM use within pharmacy education. A grey literature search was also conducted due to the emerging nature of this topic. Policies, procedures, and documents from institutions such as universities and colleges, including standards, guidelines, and policy documents, were hand searched and reviewed in their most updated form. These documents were not published in the scientific literature or indexed in academic search engines.

Results: Articles ($n = 12$) were derived from the scientific data bases and Records ($n = 9$) derived from the grey literature. Potential use and benefits of Gen-AI within pharmacy education were identified in all included published articles however there was a paucity of published articles related the degree of consideration to the potential risks to academic integrity. Grey literature recordsheld the largest proportion of risk mitigation strategies largely focusing on increased academic and student education and training relating to the ethical use of Gen-AI as well considerations for redesigning of current assessments likely to be a risk for Gen-AI use to academic integrity.

Conclusion: Drawing upon existing literature, this review highlights the importance of evidence-based approaches to address the challenges posed by Gen-AI such as ChatGPT in pharmacy education settings. Additionally, whilst mitigation strategies are suggested, primarily drawn from the grey literature, there is a paucity of traditionally published scientific literature outlining strategies for the practical and ethical implementation of Gen-AI within pharmacy education. Further research related to the responsible and ethical use of Gen-AIin pharmacy curricula; and studies related to strategies adopted to mitigate risks to academic integrity would be beneficial.

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1. Introduction

Chat Generative Pretrained Transformer (ChatGPT)[1]is a large language model (LLM)chatbot by OpenAI which was launched in November of 2022 providing responses to user generated text prompts in several languages.[1] Since its inception, there has been a widespread adoption and accessibility of artificial intelligence (AI) to the general public with current estimates indicating approximately 49% ($n = 3083$ out of 6311) of university students actively engaging with this tool.[2] ChatGPT 3.5 which is the most utilized version by the general public acts as a typical chatbot designed to emulate human conversation in response to user generated text prompts.[3] The almost instantaneous responses generated from this allow for a real-time interaction to occur based directly on the human provided prompt. The development of ChatGPT is based on AI large language models which employ complex AI neural network architecture to comprehend the variety of entered prompts.[4] The responses generated rely on the comprehensive database on which the AI was trained. Currently version ChatGPT 3.5 has access to information inclusive of September of 2021 within its database, with newer iterations of the LLM (ChatGPT 4.0) remains the most current to date.[1]

The use of AI in pharmacy is presently widely used in research and development rather than patient facing pharmacy practice. For example, AI has been adopted as a method of streamlining high throughput screening (a process of rapid, reproducible testing of chemical substances numerous times, reaching many hundreds of thousands of times) for potential drug target candidates as well as assisting in identifying pharmacogenomic implications of certain drugs.[5] Other large-scale language model similar to ChatGPT in design, have been reported to have made advancements in the prediction of protein structures as well as drug interaction studies leading to further therapeutic applications.[5–8]

The potential of such tools is yet to be fully recognized, as even in its infancyLLMs for example, ChatGPT hasbeen reported to have performed well in healthcare education contexts; such as in an undergraduate third-year medical exam as well as pharmacy board accreditation exams, with ChatGPT being able to return a passing result.[9]In clinical scenarios both in hospital and community pharmacy settings, pharmacists play a critical role in the optimization of medication usage as well as ensuring patient safety.[10] ChatGPT and the like have the potential to aid them throughout their evolving and extended scopes of practice.[10] Particularly prescription review, dispensing, monitoring of adverse drug reactions and drug interaction identification are tasks well suited towards LLMs' potential use in practice, allowing pharmacists more time with patients.[11] This has the potential to increase the efficiency of pharmacists in their role, improving decision making and patient care in clinical settings to address the ever-increasing workload demands.[7]However, there is a paucity of research related to Gen-AIutilization in pharmacy education settings and the considerations for potential challengesregarding its use. For example, considerations related to how pharmacy educators monitor student use, and what strategies may need to be considered to mitigate any risks of students breaching academic integrity. Students can breach academic integrity in many forms including academic misconduct, plagiarism both intentionally and unintentionally, outsourced assessments and unpermitted collusion with others.[12,13]Higher educational bodies have needed to develop guidelines to address these concerns. For example, The Australia Tertiary Higher Education body (TEQSA- Tertiary Education Quality Standards Agency) recently developed AI use guidelines with a consideration for the redesign of vulnerable assessment tasks where AI use may pose related risks for academic integrity.[14]

While there may be some challenges for educators to consider when LLMsare available for student use, the published literature reports also on the benefits for educators. For example, in light of the COVID-19 pandemic, there has been a notable increase in the adoption of digital Objective Structured Clinical Examinations (OSCEs) within healthcare education.[15] Here, the integration of artificial intelligence (AI), including ChatGPT, offers a potential solution to address logistical challenges and reduce costs associated with traditional OSCEs. By leveraging AI to generate examination questions and facilitate the exam process, biases can be minimized, and the risk of students resorting to AI for unfair advantages has the potential to be mitigated.[15] This integration may not only streamline the examination process but also enhance its fairness and integrity, marking a significant advancement in education assessment practices.

Conversely, the integration of Gen-AI into educational settings may pose further concerns and limitations that warrant careful consideration. These concerns include (i) the possible hindrance of essential skill development, (ii) the presence of inaccuracies in Gen-AIoutput responses, (iii) the inconsistencies between multiple versions of LLMsand (iv) the unfair advantage for students who are able to access the technology over others who may not have that level of access to the technology.[16,17] Additionally, there is a need to assess the impact of Gen-AI usage on students compared to those who do not utilize it, particularly in fields like pharmacy where hands-on experience and critical thinking skills are paramount.[16,18,19]

Despite the widespread use of Gen-AI, there arelimitations for its usein clinical scenarios. For example, ChatGPT's shortcomings, such as its inconsistency in interpreting complex instructions and managing responses to patient emotions, pose significant challenges to the development of an individuals' clinical skills and knowledge.[20] Additionally, the limitation includes the phenomenon of AI hallucinationswhich should also be considered, whereinGen-AI such as ChatGPTmay generate plausible yet incorrect answers by inventing non-existent references/ citations, further exacerbating these risks and highlights the importance of cautious integration and supplementation of Gen-AI tools within healthcare education.[21]

While the potential benefits of AI in the healthcare setting cannot be ignored there is also a growing concern and subsequent discourse regarding the potential detrimental impact such implementation may have on an individuals' critical thinking processes. If this is the case, and if the uptake Gen-AI becomes the norm, does the professional capability of critical thinking requirement for all future pharmacists(the ability to critically reflect on one's learning to make informed decisions to enhance future learning) become redundant?[19,22–25] Studies have shown that AI assistance has the potential to have a significant "domino" effect, resulting in a negatively impacted ability to make clinical decisions.[26,27]Conversely, some academics believe that embracing the use of Gen-AIwithin pharmacy education may enhance students' critical thinking by engaging students to address the flaws in the parser outputs (the output from the AI tool generated by the human prompt)of some AI bots as well as recognizing the these bots are only as good as the prompts they are provided with.[28]In regard to the academic literature, there is a similar growing concern regarding the use of AI tools in its development and publication. AI generated text detectors largely built into plagiarism identification tools are notoriously unreliable with major publication platforms now requiring acknowledgement of any AI tools utilized. Therefore, the need to implement strategies to minimize the ability of LLMs to reduce student agency, reduce critical thinking and credibility cannot be understated.

The aim of this scoping review is to conduct a scoping review to identify implications of Gen-AI toolsin pharmacy education, identify its use and emerging evidence, with a particular focus on strategies that mitigate potential risks to academic integrity.[29] In particular, to identify the current knowledge gaps, in terms of its diverse use, potential benefits, shortcomings and impact on pharmacy education.

2. Methods

A scoping review search strategy was chosen because of the rapidly changing landscape of AI and its recent emergence in pharmacy education.

Methodology considerations and procedures were guided by the

body of work and framework by Arksey and O'Malley, which was further developed by Levac et al. and outlined in the reporting guidelines by the Joanna Briggs Institute (JBI).[30–33] The scoping review methodology does not involve a quality assessment or appraisal of the included articles, which is consistent with the guidance for conducting scoping reviews.[32–34]This review strategyattempts to identify gaps in the literature, allowing for consideration and inclusion of grey literature.[32,35–37]Scientific databases were searched first, followed by a grey literature search. The grey literature inclusions aretraditionally records that are not published in the scientific data bases but may be useful for the purpose of the review. For example, grey literature may include policy documents, institution guidelines and academic or scholarly records that are not index in the scientific literature.[34]

As per Joanna Briggs Institute (JBI) Manual for Evidence Synthesis scoping review guidelines, a priori scoping review protocol was developed in discussion with the research team, prior to conducting the scoping review.[31] A developed protocol ensures the rigor of the research data extraction, considerations of the data inclusion and exclusion criteria, how relevant data will be extracted and presented. Details of this protocol can be obtained from the corresponding author (RM). As scoping reviews require a minimum of two independent reviewers, this review was undertaken by a reviewer with expertise in the content area (RM) and a second reviewer with an expertise in conducting reviews (CL).[37]The screening of titles, abstracts and full texts were done by the lead researcher (RM) and if there were areas requiring clarification, then the second researcher (CL) provided input and review of full texts. Any discrepancies were discussed by the two researchers until consensus was reached.

2.1. Search strategies: scientific literature search strategy followed by grey literature search strategy

2.1.1. Scientific search strategy

The lead researcher (RM) consulted the higher education institutions' librarian(KP) prior to conducting the review to ensure all relevant data bases were searched and consulted on the relevant search terms. Research was undertaken using a comprehensive research strategy across multiple databases. The research was undertaken from 1 August 2023 through to 20 March 2024 and included all relevant records from 1 January 2000 to 20 February 2024. These dates were identified as appropriate as generative AI models are an emerging area and considerations for this timeframe related to the most widely utilized LLM, ChatGPTwhich was launched in November 2022. The research team decided that comprehensive search dates would commence a significant timeframe prior to ChatGPT inception, being the most widely used Gen-AI chatbot worldwide. Search strategies included both a scientific search strategy to comply with the PRISMA-ScR extension followed by a grey literature search strategy.[35,36]

This scoping review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews reporting guidelines.[38]

Four databases were searched (PubMed, ERIC [Education Resources Information Center], Scopus, ProQuest for relevant articles published between 1 January 2000 and 20 February 2024. The key search terms were ("chatgpt" or "Chat?GPT" or "Generative AI" or "GenAI" or "docgpt" or "Doc?GPT" or "chatbot" or "Artificial Intelligence" or "Machine Learning" or "Large Language Models" or "LLM") AND ("Pharmacy Education" or "Graduate Pharmacy Education" or "Continuing Pharmacy Education" or "Pharmacy Research" or "Pharmacy School") OR ("Ethics" or "Academic Integrity"). The reference lists of the included manuscripts were also reviewed to cross reference any additional records for eligibility. All inclusions and exclusions were discussed between two researchers (RM, CL).

Our selection process involved three steps: 1) removing duplicates from 1497 retrieved articles, 2) screening titles and abstracts, and 3) assessing full texts to identify article meeting our inclusion criteria. Extracted data was subsequently recorded on an Excel sheet prior to transferring to Covidence. A narrative synthesis was employed to summarize key findings (Table 2). Articles identified using the defined search strategies were imported into Endnote 20.[39]

2.1.2. Inclusion criteria

English language articles and records identifying the literature that indicated LLMs such as ChatGPT or similar technology use in pharmacy training and/or education. Literature associated with the use of Gen-AI on the delivery of or for use with pharmacy training and/or education, were eligible for review. Articles were limited to publication during or after the year 2000 with a particular focus being placed on published on or after 30 November 2022 coinciding with the release date of ChatGPT. Furthermore, case reports, peer reviewed articles and commentaries, articles that used mixed methods, such as a mixture of standardized questionnaires, self-report questionnaires, and focus-group discussions and/or participant observation, were examined for eligibility and if applicable to determine whether they were predominantly quantitative or qualitative by nature.

2.1.3. Exclusion criteria

Articles and records were excluded if they (i) were not published in English, (ii) literature pertaining to the use of AI in areas outside of pharmacy education/training, (iii) articles published before 2000 because of limitations in archiving (iv) conference proceedings, (v) articles or records with abstract only and (vi) letters to the editor.

2.1.4. Grey literature search strategy

Given the emerging area of this topic, Grey literature search strategies as outlined by Godin et al. were employed to conduct the grey literature search.[40] The research team discussed search terms and consensus was made for the following terms and record types to be researched: AI policies, AI procedure institutional documents, AI processes from representative organizations such as universities and colleges. These included standards, guidelines, and policy documents in there most updated form and were identified as not published in the scientific literature or indexed in academic search engines. Given the novel emerging area in which Gen-AI has been fast evolving, scholarly records that were not traditionally published in the scientific literature (academic / scholarly evidence-based blogs) which hada focus on strategies to mitigate risks for academic integrity were included in this search.

2.1.5. Eligibility criteria

The review's eligibility criteria for the grey literature search are described below in Table 1.

2.2. Study selection

All citations which met the eligibility criteria derived from each database, as outlined in Table 1 were imported into Covidence for

Table 1
Eligibility criteria.

Inclusion Criteria	Exclusion Criteria
Available in English	Unavailable in English
Most current version of the document	Outdated versions of documents or policies that had been superseded by updated versions,
Related to the potential impact of Gen-AI on pharmacy education	Document was a draft or summary version or has been replaced with another document
	Not related to the potential impact of Gen-AI on pharmacy education
	Related to the impact of Gen-AIon other areas of health education
	Relating to the potential or actual impact technology other than Gen-AI on pharmacy education

manual screening.[41] The screening in the initial phase excluded 287 results, leaving 81 articles for full-text screening, to determine their eligibility for inclusion in the review. This left 12articles that qualified for inclusion in the review. These 12articles focused on LLMs in pharmacy education and were available in English.

3. Results

For the purpose of this review, we designate published literature as "articles" and grey literature as "records." Following our search strategy, a total of twelvearticles were identified and incorporated into the review. It is of note that numerous articles were excluded due to their lack of focus on pharmacy education, rather focusing on a wide array of other health fields or those that focused on pharmacy practice, which could potentially influence the outcomes of this review. Among the included articles, only 4 out of 12 identified deficiencies in generative AI tools and proposed strategies to address them. Nine records were found to meet the eligibility criteria for the grey literature search, these included records such as scholarly/academic blogs which were not indexed within scientific data bases;institutional policies; public statements; and overviews pertaining to relevant governing bodies.

Fig. 1 outlines the Prisma diagram for the Scientific literature search results. Four out of the twelve articles (Table 2) outline some form of strategy to mitigate the potential risks to academic integrity by Gen-AI tools within pharmacy education, with 2 articles recommending redesign of assessment.[16,18,42,43] One article recommended training in the appropriate use of the Gen-AI, however held nil insights into strategies to prevent intentional misuse.[11]

Of the nine records (Table 3)seven outlined potential mitigation strategies to reduce risk toacademic integrity. These included imparting agency on the user through cross referencing, considerations for redesigning assessments, provision of both educator and student training on responsible and appropriate use of Gen-AI; and employing a reflective componentfocusing on the processes to the outputs.[28,44–49]

4. Discussion

To the authors' knowledge, at the time of this manuscript's submissionthere was one other published scoping review related to AI use in pharmacy education however this is the first scoping review to explore the evidence relating to Gen-AI use in pharmacy education with a key focus on strategies to mitigate risks to academic integrity and its impact on implementation within the pharmacy education context.[51]

One of the primary concerns surrounding the utilization of Gen-AI

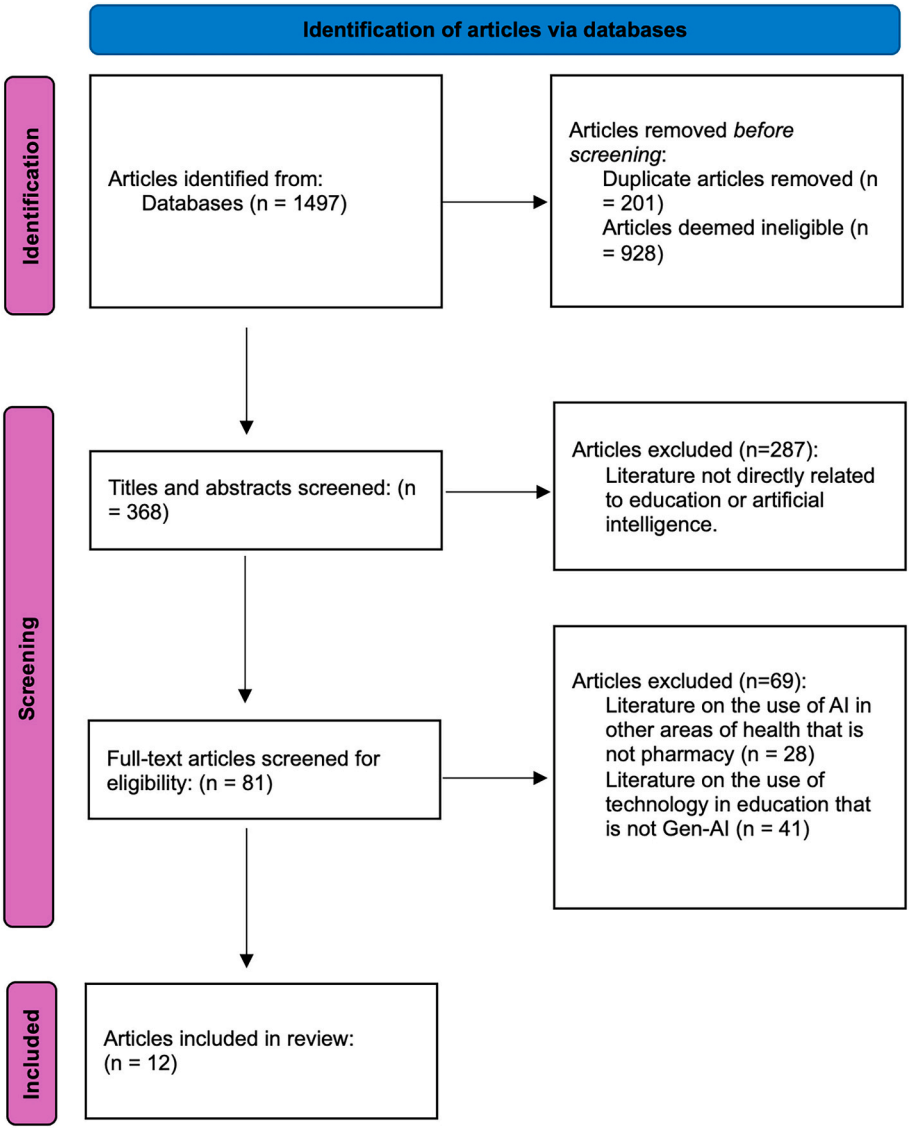

Fig. 1. PRISMA search diagram.

Table 2
Data extraction of published literature articles.

Author(s), year and date	Title	Country of Origin	Type of Study	Study Methodology and sample size	Use of AI in Pharmacy Education	Strategy used to mitigate risk of students breaching academic integrity	Findings
Sallam, M., et al., 2023[43]	ChatGPT applications in medical, dental, pharmacy, and public health education: A descriptive study highlighting the advantages and limitations	Jordan	Quantitative Descriptive Study	Survey	Ease of explanation of complex subjects and issues to improve student understanding. Improved development of patient counselling skills.	Nil strategies to mitigate risk suggested	ChatGPT was found to provide generally useful and helpful responses however, there was no consideration of academic integrity, plagiarism and copyright issues and a lack of personal and emotional interactions which are a key aspect of the health field.
Lim, A.S., et al., 2024[15]	What's been trending with OSCEs in pharmacy education over the last 20 years? A bibliometric review and content analysis	Australia/ Malaysia/ Canada	Review Article	Bibliometric Review	AI tools being used to develop and execute pharmacy OSCE examinations.	Nil strategies to mitigate risk suggested	Artificial intelligence being utilized in the development of communication rubrics may result in the improvement of key communication skills, vital to pharmacy and general healthcare.
Zawiah, M., et al., 2023[20]	ChatGPT and Clinical Training: Perception, Concerns, and Practice of Pharm-D Students	Multinational	Original Research	Cross sectional study involving 211 PharmD students.	Counselling, information gathering, clinical problem solving, medication interaction identification, within the current curriculum.	Nil strategies to mitigate risk suggested	Concerns related to the potential reduction of pharmacy students' development of critical thinking skills if they are to solely rely on these tools at the expense of developing their own critical thinking skills. The use of ChatGPT is shown to be sporadic with no clear measure of the impact which this has had on those who have used this tool.
Sallam, M., 2023[50]	Perspectives of ChatGPT in Pharmacology Education, and Research in Health Care: A Narrative Review	India	Review Article	Narrative Review	Content delivery, manuscript writing, exam proctoring,	Acknowledging the use of ChatGPT in academic journals however, nil strategies recommended to mitigate university level academic integrity.	Recommendations for comprehensive guidelines and strategies aligned to the utilization of these tools.
Huang, X., et al., 2024[42]	Evaluating the performance of ChatGPT in clinical pharmacy: A comparative study of ChatGPT and clinical pharmacists	China	Comparative Study	Survey and clinical scenario answers	Counselling, Adverse Drug Reaction (ADR) identification, prescription review.	Incorporation of clinical pharmacy resources and annotations in ChatGPT to reduce inaccuracies in information and referencing.	As pharmacy education is largely based on the clinical practice of a pharmacist it is reasonable to surmise that the impacts on professional development would mirror to that of educational growth. This article outlines concerns regarding the risks of ChatGPT and the like however there is no suggested guidelines to follow.
Abdel Aziz, M.H., et al., 2024[51]	A scoping review of artificial intelligence within pharmacy education	United States of America	Scoping Review	PRISMA-ScR	AI within the prediction of academic performance, teaching of traditional pharmacy courses as well as within an experiential curriculum.	Nil strategies to mitigate risk suggested	The majority of articles extracted from this review ($n = 5$) identified that AI implementation enabled an increase in skills, 1 record indicated that AI implementation enabled an increase in content knowledge. Considerations on the

(*continued on next page*)

Table 2 (*continued*)

Author(s), year and date	Title	Country of Origin	Type of Study	Study Methodology and sample size	Use of AI in Pharmacy Education	Strategy used to mitigate risk of students breaching academic integrity	Findings
							implications of AI on copyright infringement.
Raza, M.A., et al., 2022[11]	Artificial Intelligence (AI) in Pharmacy: An Overview of Innovations	Pakistan/ China	Review Article	Literature Review	Information gathering, drug specific understanding and education, patient counselling, treatment recommendations.	Continued education of AI beginning in foundational studies to prevent unintentional misuse. Nil strategies to suggest mitigating intentional misuse.	The potential benefits of AI in pharmacy education are clearly outlined however there is limited consideration as to the risks of these tools regarding professional development and learning growth.
Nakagawa, N., et al., 2022[17]	Communication training for pharmacy students with standard patients using artificial intelligence	Japan	Research Note	Original Research among 40 pharmacy students.	Developing student communication skills in OSCE scenarios.	Nil strategies to mitigate risk suggested	While a positive improvement in the assessed skills was observed, this enhancement was not deemed to be significant.
Hamid, H., et al., 2023[18]	Exploratory study on student perception on the use of chat AI in process-driven problem-based learning	Malaysia	Research Note	Original Research among 18 Bachelor of Pharmacy students.	Problem based learning within a Bachelor of Pharmacy program.	Secondary verification of information provided by ChatGPT, formal training programs to improve the efficiency of use. A holistic rubric which encompasses student skills outside of the written response. Clear guidelines and transparent assessment processes are suggested.	While there were positive improvements in collaboration, discussion, and engagement with the material and use of AI, there is a clear concern with inaccuracies and a lack of clarity held by the responses of ChatGPT.
Iwasawa, M., M. Kobayashi, and K. Otori, 2023[16]	Knowledge and attitudes of pharmacy students towards artificial intelligence and the ChatGPT	Japan	Research Article	Original research among 113 pharmacy students utilizing survey.	General use throughout university level Pharmacy course.	Nil strategies to mitigate risk suggested	End users who had an increased understanding of ChatGPT were able to identify the appropriate use cases more accurately for this technology with there being a sustained belief of ChatGPT lacking reliability. This study identified a lack of AI education in pharmacy education curriculums.
Weidmann, A.E., 2024[19]	Artificial intelligence in academic writing and clinical pharmacy education: consequences and opportunities	Austria	Commentary	Commentary surrounding the academic implications of AI in clinical pharmacy education	AI may enable efficient time management which fosters critical thinking, while quick pattern recognition in large datasets may aid drug discovery and clinical decision-making, benefiting patient safety.	Suggested strategies include redesigning assessments as well as moving the focus of pharmacy courses away from majorly content focussed to the development of active creativity and enhancing critical thinking skills.	The debate surrounding AI implementation is multi-faceted, practice and policy needs to and will continue to evolve with time. Whilst the risks are clear the potential benefits were noted for the advancement within the field.
Cain, J., Malcom, D., and Aungst, T., 2023[52]	The Role of Artificial Intelligence in the Future of Pharmacy Education	United States of America	Commentary	Commentary surrounding the implications of AI in clinical pharmacy education	AI used to circumvent written assessment tasks including exams and essays. Utilizing AI to generate examination materials and instigate classroom discussion.	Redesign of assessment methods, to embrace AI use as a method of facilitating student learning.	Training should be provided surrounding the appropriate use of and potential risks of AI within pharmacy education. And preparing graduates in building AI capacity

such as ChatGPT in healthcare education pertains to its impact on academic integrity. While LLMs hold promise in streamlining various processes and enhancing learning experiences, there remains a critical need to strike a balance between leveraging AI-driven technologies for efficiency and preserving the essential elements of hands-on learning and skill development, as well as ensuring ethical use.[52]As an AI-driven platform, ChatGPT has the capacity to generate responses and assist with learning tasks.[19,43] Yet, there exists the inherent risk that the use of ChatGPT may compromise the authenticity and rigor of educational materials and assessments.[55] Without proper guidelines and safeguards in place, there is a potential for students to rely excessively on LLMssuch as ChatGPT, leading to potential dilution of critical thinking skills and a risk to academic integrity.[19,56]

Despite the emerging use of AI in pharmacy practice and research,

Table 3
Grey Literature Data Extraction Table.

Title	Year	Source	Resource Type	Relevance to AI in Pharmacy Education	Key Inclusions
Embracing the future of assessment at the University of Sydney (USYD)[53]	2023	University of Sydney, Australia	Academic / Scholarly Blog Post	Applicable as USYD is a pharmacy course education provider with the suggested principles directly affecting pharmacy	A two-tiered approach to assessment design either with the absence of AI to ensure traditional learning success or integration with AI to focus on productive use of AI in a technology focused future
American Society of Health-System Pharmacists (ASHP) Statement on the Use of Artificial Intelligence in Pharmacy[45]	2020	American Society of Health-System Pharmacists	Public Statement	Key provider of clinical resources and advice provided for the American pharmacy landscape.	The cautious adoption of AI, coupled with human led work is encouraged Completely automated workflow is strongly discouraged. Strategies include encouragement for continuous cross referencing of provided information.
Rethinking Pharmacy Education in the Era of Artificial Intelligence[49]	2023	Keith Loria, Drug Topics	Scholarly Record	Directly highlights the potential impact of AI on the future of pharmacy education.	Strategies include: Formative training for individuals to familiarize themselves with AI tools to be able to utilize them effectively in future practice. Suggestion for Assessment redesign moving forward to accommodate this.
Academic Integrity and Policy on Use of AI[54]	2024	University of North Carolina School (UNC) of Medicine: Pharmacology, USA	Policy Overview	Applicable as UNC is a pharmacy course education provider with these policies directly applying to the delivery of pharmacy content	Acknowledgement of AI usage with the recommended use.
Developing a digitally enabled pharmaceutical workforce[47]	2021	FIP International Pharmaceutical Federation	Professional Body Overview	Global representative body of pharmacists with a focus on education and learning both in formative years and throughout ones' career.	The provision of sound education surrounding AI and its use so as to encourage appropriate ethical behaviour related to its use. Strategies include recommendations for assessment redesign and course work delivery to focus on active knowledge and authentic cases.
ChatGPT and Generative AI[46]	2024	University of South Carolina	Policy Overview	Applicable as the University of South Carolina is a pharmacy course education provider with these policies directly applying to the delivery of pharmacy content	Monitoring student use and utilizing chat logs and active reflection are all suggested methods.
Researchers wield AI to address some of pharmacy's most serious problems[48]	2024	Sonya Collins, Pharmacy Today	Scholarly Record	Published in a popular pharmacy focused journal. Highlights the use of AI within pharmacy education.	Strategies include: Validation of AI tools to increase the accuracy of generated responses. Suggestion of assessment redesign.
Artificial Intelligence Applications in Education and Pharmacy Practice[44]	2022	Nikhil et al., Pharmacy Times	Scholarly Record	Published in pharmacy focused journal with a focus on the use of AI within pharmacy education	Strategies include: Implementing digital health learning throughout curriculums to develop proper use of these tools
Can Artificial Intelligence Teach Students How to Critically Think?[28]	2023	Lucas C, Pulses	Scholarly Record Scholarly Blog	This blog focuses on the impact of AI use in pharmacy education	Suggestion to embrace AI in the learning processes. Employ reflective components. Reflecting on the processes that derive the Gen-AI outcomes is a key strategy to further develop key critical thinking skills.

there remains a paucity of data related to embeddingformal LLM instruction, responsible and ethical use and for integration into pharmacy education. This deficiency may stem from either inadequate reporting by pharmacy educators regarding policies and guidelines related to integration of AI into curriculato build pharmacy student AI capacity, or from a slower pace of adoption within pharmacy education.[19,51,52] The currently suggested guidelines and policies surrounding the use of Gen-AIwithin Pharmacy Education are limited, ranging from complete dismissal of the tools as a learning resource to cautious acceptance outside of graded works.[45,49,53,57–59] The paucity of previous research in this emerging and fast evolving area is perhaps another indication of the uncertainty surrounding the utility of such Gen-AItools. Furthermore, there appears to be some concernwith current educational programsand the emergence of Gen-AI potentially removing future need for certain educator positions.[50,52]

This review has indicated that current research to date that assesses the impact of integrating Gen-AI toolson knowledge acquisition, skill development, educational outcomes, and faculty workload are lacking.[52,56,60]This likely due to the fact that AI formal use and potential risks to assessment integrity is an emerging area for educational institutions worldwide to consider; and educators are awaiting future research studies or case exemplars to fully understand the impact of AI on academic integrity. Moreover, the available literature surrounding the implementation of ChatGPT and similar technologies in healthcare education is for the most part broad, encompassing a wide array of other health fields. The lack of discipline-specific research to the impact of AI in pharmacy education calls into question the applicability and generalizability of the current knowledge, implementation into curriculum, and impact on assessment, due to key differences between health disciplines.

The findings of this review highlight that pharmacy education providers are conscious of the potential risks and benefits associated with the use of Gen-AI.Several strategies were suggested throughout both the scientific and grey literature especially, with a focus largely on practical implementation. These included modification to current methods of assessment, cross-referencing of information, increasing levels of education and training surrounding the capabilities of Gen-AI tools. Previous research has shown that when students engage in reflective activities, their critical thinking and problem-solving skills are enhanced.[22,24,25]This scoping review highlights as a strategyto enhance students' critical thinking in the era of AI to place more weight on the thinking processes rather than thefinal product achieved for the task assigned.[11,19,28,52,61] A crucial step in mitigating the risk of individuals breaching academic integrity with the use of Gen-AIin pharmacy education is to carefully evaluate the assessment task design against the capabilities and limitations of LLMs.[13,47,49,62,63]For example, it would be

beneficial for educators to scrutinize task prompts and processes to identify potential vulnerabilities to Gen-AI-generated responses. This may involve examining the specificity and clarity of prompts, ensuring that they require critical thinking processes and application of course content beyond what Gen-AIcan provide. Based on the findings from research related to assessment task design evaluation, it may be beneficial for educators to consider modifying existing prompts or processes to minimize the risk of Gen-AI-generated responses.[13,47,49,62]Particularly for written assessments which are especially AI vulnerable to academic integrity, it may be beneficial for educators to consider alternative methods to conduct the assessment.[47,48]This may include an oral defence of their work, such as an oral Objective Structured Clinical Examination (OSCE).[15,17]Other strategies may involve educators to reframe questions which require higher-order thinking skills; consider the incorporation of real-world (authentic) scenarios that are less conducive to LLM-generated answers; or introducing elements of ambiguity or complexity that challenge students to demonstrate genuine understanding and problem-solving abilities.[47,54,64,65]Another effective strategy for mitigating the risk to academic integrity with Gen-AI use in pharmacy education assessments is to target higher-order thinking skills that are less amenable to automation.[15,18,44,48,56,60,66,67] Assessment tasks could be designed to require students to analyse, evaluate, and synthesize information, rather than simply restating facts or information readily available through LLMs.[15,23,42,52,68–72] By challenging students to engage in critical thinking, problem-solving, and decision-making processes, educators can align assessments to accurately reflect a students' cognitive abilities and professional readiness.[29] Additionally, educators could embrace programmatic, authentic, and future-focused assessment approaches that align with the evolving needs and expectations of pharmacy practice.[15,28,48,61,64,68,71,73]

Rather than viewing LLMs and Gen-AI as a threat to traditional assessment practices, it may be beneficial for educators to embrace its potential benefits to enhance learning and assessment tasks.[28] One approach is to intentionally incorporate Gen-AI use into assessments transparently and purposefully.[48,74] For example, educators may task students with analysing and critiquing LLM-generated responses, evaluating their accuracy, relevance, and ethical implications within the context of pharmacy education. This may foster and enhancecritical thinking skills while providing valuable insights into the capabilities and limitations of Gen-AI. To reduce the susceptibility of assessment tasks to AI-generated responses, educators could perhaps explore alternative assessment formats that are less susceptible to automation. Assessment tasks could be designed to reflect real-world challenges and scenarios, preparing students for the complexities and uncertainties they will encounter in their professional careers. This may include performance-based assessments, such as simulations, authentic case studies, or practical skills assessments, where students are required to demonstrate their abilities in authentic challenging contexts which is likely to be more resilient to AI.[45,47,48,64] By providing complex patient case-based scenarios that closely mimic clinical practice (authentic assessment), which may test the limits of the capabilities of Gen-AI toolsand prioritizing authenticity may enable educators to create assessment experiences that are meaningful, relevant, and engaging, while also mitigating the risk of Gen-AI-related issues. Another consideration for educators would be to review student Gen-AI prompt logs and request the retainingof their learning records and prompts, however this comes with questionable practicality in obtaining and monitoring these tasks.[46]The guidelines regarding such processes would need to be robust to avoid encroaching on student privacy. Clear instructions to both educators and students regarding the storage and use of these prompts is crucial, along with how this will be addressed in the case of a suspected breachesto academic integrity.[44]

AI tools are constantly evolving, this may still pose a risk as these tools mature. Additionally, incorporating oral examinations or presentations, where individual students are required to defend their work can further deter reliance on LLMgenerated text responses.[15]By placing agency in this manner it does not only require the student to understand the work that they are presenting to a greater degree, but also encourages the student to cross referencetheir materials.[45] Working in this manner may also help students to problem solve, as often LLMs generate inaccuracies in output responses.[42] This is largely due to the inability of these tools to actively discern the accuracy, reliability or integrity of the sources being used. Incorporating open or collaborative assessment processes may also mitigate the risk of LLM-generated responses by emphasizing individual student contributions and insights. Group projects, undertaking peer reviews, and collaborative problem-solving tasks encourage active engagement and collective sense-making, fostering a deeper understanding of course material that extends beyond what LLMscan provide.[11,16,28,44,47,51]By assessing students' contributions within collaborative settings, educators can gauge their ability to apply knowledge collaboratively and communicate effectively.[11,16,28,47,51]

Of the identified articles presented as part of this review, a recurring theme emerged concerning the need for tailored training and ongoing support for pharmacy educators utilizing Gen-AI tools. For example, the research has suggested that emphasis should be placed on the importance of comprehensive education and training programs aimed at familiarizing individuals with the nuances of Gen-AI technology, including its capabilities, limitations, and ethical considerations.[16,20,68] Additionally, there was consensus among the literature regarding the necessity of establishing clear guidelines and protocols for the integration of Gen-AI driven solutions into pharmacy education. Such frameworks would not only help to ensure the safe and effective use of these toolsbut also foster confidence and trust among pharmacy education providers andstudents alike.[56] As the crux of pharmacy education is preparingstudents for eventual practice as a registered pharmacist, one could argue that their clinical practice could be improved by understanding how to appropriately use Gen-AIin their lifelong learning as a pharmacist.

Utilizing Gen-AIhas the potential to enrich pharmacy curricula by streamlining remedial processes and assessing co-curricular activities.[11] Such integration could potentially reduce the workload for faculty and staff, enhance programmatic evaluation, and bolster student engagement within the curriculum. The choice to incorporate Gen-AIwithin curricula will likely vary among programs, contingent upon individual educational priorities and available resources of the institution. It is important to remain true to the nature of academic integrity being that it focuses on building AI capabilities necessary to conduct responsible and ethical scholarship.[73]Therefore, educational institutions incorporating a formal acknowledgement of Gen-AI technology with a clear guidelines as to how to approach the risks to academic integritywould be a necessary requirement.

Strengths of this scoping review included a search strategy for grey literature beyond emerging policies and records derived from key regulatory bodies and institutions. For example, commentaries and educational blogs, that were not indexed in the scientific literature but included emerging case exemplars, were also considered.

Limitations to this scoping review includes that an independent audit of the searchprocess was not undertaken. One researcher (RM) performed the literature retrieval and initial synthesis of the articles and records. Discrepancies and consensus were considered in consultation with the second author (CL). Furthermore, from the time this manuscript was submitted to the time of acceptance, and given the rapidly emerging field of the new era of AI, there would no doubt be articles and case studies that were published during that time and following our research period. Further limitations include that only articles and records which were published in English were included. There may have been non-English articles or records which may have been missed as a result of this exclusion criteria. Also technology or web applications used in pharmacy education which was not considered Gen-AI, were not included in the results. Furthermore, as scoping reviews do not include an appraisal of the literature because the focus is on ensuring the nature,

range and extent of the evidence is covered, this may have also limited the synthesis of the data and interpretation of the results.[36,75,76] Whilst this scoping review strategy has explored the ways in which Gen-AI may impact the training, education, and particularly the learning and assessment procedures associated with pharmacy education, it is important to consider that only official or recognized versions of these procedures and policies have been included as records for the grey literature. Undoubtedly there may be other strategies, guidelines on assessments and AI use implemented across various institutions, however, only those with formal reporting measures have been includedin this scoping review. Finally, the variation in versions of Gen-AI LLMs have also not been considered, for example the scope of parser outputsby the different iterations (ChatGPT 3.5 versus ChatGPT4.0) may have also been a limitation to this scoping review.

5. Conclusion

This scoping review highlights the current lack of formalized processes in pharmacy education to mitigate the potential risks for individuals' breaching academic integrity with the emerging use of Gen-AI technology. There is a perceived level of risk to academic integrity with the use of Gen-AI in higher education, with anotable paucity of pharmacy education specific current research. It would be beneficial for educators to consider redesigning assessment tasks which are fit for purpose andadopting strategies to mitigate risks to academic integrity.[76] However, considerations on the responsible and ethical use of AI in pharmacy education should be at the forefront to build AI capacity for future graduates. It may be beneficial for further research and investigation into the potential and emerging applications of Gen-AI within pharmacy education, its benefits, challenges and subsequently best practice recommendations to address potential compromises to academic integrity.

Credit authorship contribution statement

R. Mortlock: Writing – original draft, Visualization, Resources, Conceptualization. **C. Lucas:** Writing – review & editing, Visualization, Resources, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

1.. OpenAI. *Research GPT-3.5*. 2023.
2. von Garrel J, Mayer J. Artificial intelligence in studies—use of ChatGPT and AI-based tools among students in Germany. *Humanit Soc Sci Communicat*. 2023;10(1):799.
3.. OpenAI. *Model index for researchers*. 2023.
4. Ray PP. ChatGPT: a comprehensive review on background, applications, key challenges, bias, ethics, limitations and future scope. *Internet Things Cyber-Phys Syst*. 2023;3:121–154.
5.. Qureshi R, et al. AI in drug discovery and its clinical relevance. *Heliyon*. 2023;9(7), e17575.
6.. Jumper J, et al. Highly accurate protein structure prediction with AlphaFold. *Nature*. 2021;596(7873):583–589.
7.. Paul D, et al. Artificial intelligence in drug discovery and development. *Drug Discov Today*. 2021;26(1):80–93.
8. Vidhya KS, et al. Artificial Intelligence's impact on drug discovery and development from bench to bedside. *Cureus*. 2023;15(10), e47486.
9. Aidan G, et al. How does ChatGPT perform on the United States Medical Licensing Examination (USMLE)? The Implications of Large Language Models for Medical Education and Knowledge assessment. *JMIR Med Educ*. 2023;9:e45312.
10. Chalasani SH, et al. Artificial intelligence in the field of pharmacy practice: a literature review. *Explorat Res Clin Soc Pharm*. 2023;12, 100346.
11. Raza MA, et al. Artificial intelligence (AI) in pharmacy: an overview of innovations. *Innov Pharm*. 2022;13(2).
12.. University of Technology Sydney. Academic integrity, plagiarism and cheating. cited 2024; Available from: https://www.uts.edu.au/current-students/current-students-information-faculty-engineering-and-it/study-and-assessment-resources/academic-integrity-plagiarism-and-cheating; 2024.
13.. Tertiary Education Quality and Standards Agency. Artificial intelligence: advice for students. cited 2024; Available from: https://www.teqsa.gov.au/students/artificial-intelligence-advice-students; 2023.
14.. Tertiary Education Quality and Standards Agency. Artificial intelligence. cited 2024; Available from: https://www.teqsa.gov.au/guides-resources/higher-education-good-practice-hub/artificial-intelligence; 2024.
15.. Lim AS, et al. What's been trending with OSCEs in pharmacy education over the last 20 years? A bibliometric review and content analysis. *Curr Pharm Teach Learn*. 2024;16(3):212–220.
16. Iwasawa M, Kobayashi M, Otori K. Knowledge and attitudes of pharmacy students towards artificial intelligence and the ChatGPT. *Pharm Educ*. 2023;23(1):665–675.
17.. Nakagawa N, et al. Communication training for pharmacy students with standard patients using artificial intelligence. *Curr Pharm Teach Learn*. 2022;14(7):854–862.
18.. Hamid H, et al. Exploratory study on student perception on the use of chat AI in process-driven problem-based learning. *Curr Pharm Teach Learn*. 2023;15(12):1017–1025.
19. Weidmann AE. Artificial intelligence in academic writing and clinical pharmacy education: consequences and opportunities. *Int J Clin Pharm*. 2024;46:741–754.
20. Zawiah M, et al. ChatGPT and clinical training: perception, concerns, and practice of pharm-D students. *J Multidiscip Healthc*. 2023;16:4099–4110.
21. Alkaissi H, McFarlane SI. Artificial hallucinations in ChatGPT: implications in scientific writing. *Cureus*. 2023;15(2), e35179.
22. Tsingos C, Bosnic-Anticevich S, Smith L. Learning styles and approaches: can reflective strategies encourage deep learning? *Curr Pharm Teach Learn*. 2015;7(4):492–504.
23. Mantzourani E, et al. The role of reflective practice in healthcare professions: next steps for pharmacy education and practice. *Res Social Adm Pharm*. 2019;15(12):1476–1479.
24. Tsingos-Lucas C, et al. The effect of reflective activities on reflective thinking ability in an undergraduate pharmacy curriculum. *Am J Pharm Educ*. 2016;80(4):65.
25.. Tsingos C, Bosnic-Anticevich S, Smith L. Reflective practice and its implications for pharmacy education. *Am J Pharm Educ*. 2014;78(1):18.
26. Giordano C, et al. Accessing artificial intelligence for clinical decision-making. *Front Digit Health*. 2021;3, 645232.
27.. Gaube S, et al. Do as AI say: susceptibility in deployment of clinical decision-aids. *npj Digit Med*. 2021;4(1):31.
28.. Lucas C. Can Artificial Intelligence Teach Students How to Critically Think?. In: *Pulses, Currents in Pharmacy Teaching and Learning*. 2023.
29. Munn Z, et al. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018;18(1):143.
30. Peters M, et al. *Methodology for JBI Scoping Reviews, in the Joanna Briggs Institute Reviewers Manual 2015*. Joanna Briggs Institute; 2015:3–24.
31.. Peters M, et al. Chapter 11: Scoping Reviews. In: *JBI Manual for Evidence Synthesis*. 2020.
32. Peters MD, et al. Guidance for conducting systematic scoping reviews. *Int J Evid Based Healthc*. 2015;13(3):141–146.
33.. Peters MDJ, et al. Scoping reviews: reinforcing and advancing the methodology and application. *Syst Rev*. 2021;10(1):263.
34.. Peters MDJ, et al. Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth*. 2020;18(10):2119–2126.
35. Tricco AC, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467–473.
36.. Moher D, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4(1):1.
37. Lucas C, Desselle S. Considerations in conducting a scoping review in pharmacy education. *Explorat Res Clin Soc Pharm*. 2024;14, 100448.
38.. Page MJ, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev*. 2021;10(1):89.
39.. The EndNote Team, EndNote. *Clarivate: Philadelphia, PA*. 2013.
40.. Godin K, et al. Applying systematic review search methods to the grey literature: a case study examining guidelines for school-based breakfast programs in Canada. *Syst Rev*. 2015;4(1):138.

41.. Innovation, V.H. *Covidence systematic review software*. 2024.
42. Huang X, et al. Evaluating the performance of ChatGPT in clinical pharmacy: a comparative study of ChatGPT and clinical pharmacists. *Br J Clin Pharmacol*. 2024; 90(1):232–238.
43. Sallam M, et al. ChatGPT applications in medical, dental, pharmacy, and public health education: a descriptive study highlighting the advantages and limitations. *Narra J*. 2023;3(1), e103.
44. Nikhil A, Sangave CC, Berkley Ellen. *Artificial Intelligence Applications in Education and Pharmacy Practice*. Pharmacy Times; 2022.
45. Schutz N, et al. ASHP statement on the use of artificial intelligence in pharmacy. *Am J Health-Syst Pharm*. 2020;77(23):2015–2018.
46.. University of South Carolina. ChatGPT and Generative AI. cited 2024; Available from: https://sc.edu/about/offices_and_divisions/cte/teaching_resources/generative_ai/index.php; 2024.
47.. International Pharmaceutical Federation. Developing a digitally enabled pharmaceutical workforce. cited 2024; Available from: https://www.fip.org/file/4958; 2021.
48. Collins S. Researchers wield AI to address some of pharmacy's most serious problems. *Pharmacy Today*. 2024;30(1).
49.. Loria K. Rethinking Pharmacy Education in the Era of Artificial Intelligence: As Al becomes more prevalent, how must the pharmacy world change how it learns?. In: *Drug Topics*. 2023:48.
50. Patel CR, Pandya SK, Sojitra BM. Perspectives of ChatGPT in pharmacology education, and research in health care: a narrative review. *J Pharmacol Pharmacother*. 2023;14(3):171–177.
51.. Abdel Aziz MH, et al. A scoping review of artificial intelligence within pharmacy education. *Am J Pharm Educ*. 2024;88(1), 100615.
52. Cain J, Malcom DR, Aungst TD. The role of artificial intelligence in the future of pharmacy education. *Am J Pharm Educ*. 2023;87(10), 100135.
53.. Liu D, Bridgeman A. Embracing the future of assessment at the University of Sydney, 8 December 2023, cited 2024; Available from: https://educational-innovation.sydney.edu.au/teaching@sydney/embracing-the-future-of-assessment-at-the-university-of-sydney/; 2023.
54.. University of North Carolina. Academic Integrity and Policy on Use of AI. cited 2024; Available from: https://www.med.unc.edu/pharm/graduate-program/graduate-program-outline/academic-integrity-and-policy-on-use-of-ai/; 2024.
55.. Wang Y-M, Shen H-W, Chen T-J. Performance of ChatGPT on the pharmacist licensing examination in Taiwan. *J Chin Med Assoc*. 2023;86(7).
56. Chan CKY. A comprehensive AI policy education framework for university teaching and learning. *Int J Educ Technol High Educ*. 2023;20(1):38.
57.. Elsevier. Publishing Ethics. cited 2024; Available from: https://www.elsevier.com/en-au/about/policies-and-standards/publishing-ethics; 2023.
58.. University of Technology Sydney. Artificial intelligence operations Policy. cited 2024; Available from: https://www.uts.edu.au/about/uts-governance/policies/uts-policy/artificial-intelligence-operations-policy; 2023.
59.. University of New South Wales. Academic Integrity and Plagiarism, 6 December 2023 cited 2024; Available from: https://student.unsw.edu.au/plagiarism/integrity; 2023.
60. Ranchon F, et al. Development of artificial intelligence powered apps and tools for clinical pharmacy services: a systematic review. *Int J Med Inform*. 2023;172, 104983.
61.. Hamid H, et al. Exploratory study on student perception on the use of chat AI in process-driven problem-based learning. *Curr Pharm Teach Learn*. 2023;15(12): 1017–1025.
62.. University of Cambridge. ChatGPT (We need to talk). cited 2024; Available from: https://www.cam.ac.uk/stories/ChatGPT-and-education; 2023.
63.. Shum SB. *GenAI for Critical Analysis: Practical Tools, Cognitive Offloading and Human Agency*. 2024.
64.. Charles Sturt University. Rethinking Assessment Strategies in the Age of Artificial Intelligence (AI). cited 2024; Available from: https://cdn.csu.edu.au/_data/assets/pdf_file/0009/4261293/Rethinking-Assessment-Strategies.pdf; 2024.
65.. Monash University. AI and assessment. cited 2024; Available from: https://www.monash.edu/learning-teaching/teachhq/Teaching-practices/artificial-intelligence/ai-and-assessment; 2024.
66. Sallam M. ChatGPT utility in healthcare education, research, and practice: systematic review on the promising perspectives and valid concerns. *Healthcare (Basel)*. 2023;11(6).
67. Sallam M, et al. ChatGPT applications in medical, dental, pharmacy, and public health education: a descriptive study highlighting the advantages and limitations. *Narra J*. 2023;3, e103.
68. Abdel Aziz MH, et al. A scoping review of artificial intelligence within pharmacy education. *Am J Pharm Educ*. 2024;88(1), 100615.
69.. Alqahtani T, et al. The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research. *Res Social Adm Pharm*. 2023;19(8):1236–1242.
70. Currie GM. Academic integrity and artificial intelligence: is ChatGPT hype, hero or heresy? *Semin Nucl Med*. 2023;53(5):719–730.
71. McArthur J. Rethinking authentic assessment: work, well-being, and society. *High Educ*. 2023;85(1):85–101.
72. Sağın FG, et al. Current evaluation and recommendations for the use of artificial intelligence tools in education. 2023;48(6):620–625.
73.. Deakin C. CRADLE Suggests… Academic integrity, assessment security and digital assessment. Available from: https://figshare.com/articles/online_resource/CRADLE_Suggests_Academic_integrity_assessment_security_and_digital_assessment/12585443; 2020.
74.. University of Technology Sydney. Artificial Intelligence Operations Procedure. Available from: https://www.uts.edu.au/about/uts-governance/policies/uts-policy/artificial-intelligence-operations-procedure; 2023.
75. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci*. 2010;5(1):69.
76. Tricco AC, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467–473.