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SYSTEMATIC REVIEW

IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN NURSING EDUCATION: A NARRATIVE REVIEW

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Abstract

Background: As technological advancements continue to reshape various industries, the integration of AI in healthcare education emerges as a crucial facet in preparing future nursing professionals. This narrative review aims to elucidate the numerous ways AI technologies are being utilized in nursing education.

Methodology: A search in two internet databases was conducted for relevant studies, using keywords. The inclusion criteria encompassed studies published within the last 5 years, written in English, and focused on the integration of AI technologies in nursing education settings. The selected articles underwent a systematic screening process.

Results: Of the 523 papers retrieved, 7 were included in the final synthesis. These studies evaluate the implementation of AI methods in undergraduate nursing students. The AI method usually used was a Chatbot. In 4 studies, a 3D avatar was incorporated into the AI tool to serve as a Virtual Patient. The studies focused on various learning objectives, with 4 studies emphasizing communication skills enhancement. The remaining 3 studies used the AI tool to assess students' knowledge and clinical skills. Clinical scenarios were predominantly used, and in studies with a 3D avatar, scenarios addressed theoretical knowledge, critical thinking, and decision-making in escalating clinical conditions. Endpoints of AI implementation were assessed using self-reported questionnaires, interview and direct feedback from the Chatbot. Consistent endpoints included students' self-efficacy, knowledge of the learning objective, students' satisfaction and attitudes toward the learning style.

Conclusions: As technology continues to advance, the potential for AI in nursing education is becoming increasingly evident. Given that nursing is an interactive science, it seems that AI Chatbots are more useful in nursing education. Further AI implementation will enrich our understanding of how its integration will serve nursing education.

Keywords: Artificial Intelligence implementation, nursing, education, undergraduate students.

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INTRODUCTION

Artificial Intelligence (AI) was introduced to the world in the 1950s and a few years later made its way into almost every scientific field.[1]Mathematician Alan Turing devised the 'Turing test' as a way to measure the intelligent behaviour of a machine in the 1950s and the term AI was fathered by John McCarthy and others in 1956.[2,3]Turing's work on 'thinking computers' which was both revolutionary and challenging, paved the way for AI to flourish.[2]Nowadays, AIis a trending and rapidly evolving multidisciplinary field, where machines learn human behaviour, reasoning, and intelligence but also have the ability to produce intelligent and human-like outcomes.[4]Regardless of controversial discussions that frequently arise about AI implementation, its use as a powerful tool in higher education is underpinned.[1,5]Hence, several countries are investing in the integration of AI in higher education and research by launching national AI development plans or promoting certain future action plans.[1,6]AI education investment around the world aims to develop leadership in each field and better equip students for the demanding real-life working environment.[1]

Nursing education let AI into its world in the 1980s with cautiousness and also rather late in comparison to other scientific fields.[7]The integration of AI into nursing navigates through a wide range of opportunities as shown by recent studies.[7,8]Scoping and systematic reviews of current AI applications or users' perception of AI implementation in nursing have demonstrated its somewhat slower development.[7,8]The implementation of AI technologies in nursing is still in its early phase, underscoring constrained nurse involvement.[7]Nursing science combines theoretical knowledge, practical and critical thinking skills, clinical implementation, multidisciplinary communication, and rather frequently, all of them at once, whilst racing against the clock when it comes to emergencies.[9–11]Nursing education encompasses all the aforementioned. Only four studies out of one hundred forty that were included in O'Connor's systematic review published in 2022,were about implementing AI in nursing education.[12–15]More specifically, three of them discussed AI implementation in predicting nursing students' academic failure or attrition.[12,13,15]

Nursing students are the future registered nurses, and the duty to appropriately equip and prepare them to take on their professional role should fall on the shoulders of the educational system. AI implementation in nursing education curricula could make students' experience more personalized and more realistic of what they will encounter in real-life situations in the clinical setting.[1,16]In this narrative review, we aim to discuss the implementation of AI tools in nursing undergraduate students' education and provide a comprehensive overview to put that information into perspective. This review provides insights into how AI is implemented in undergraduate nursing curricula and highlights challenges and opportunities for the future. We aim to address the following research question: "How is AI implemented in nursing students' education in the last 5 years?".

CONCEPTUAL DEFINITIONS

Artificial Intelligence

AI has been defined as "software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions".[17]AI is an umbrella term in Computer Science, which is mainly focused on the automation of intelligent behavior.[18]AI attempts to achieve cognitive and sensory human-like behaviours including abstract reasoning, learning, autonomous decision-making, communicating in natural language, as well as interacting with the natural world.[8]

Natural Language Processing

Natural Language Processing (NLP) uses computational linguistic techniques to analyse large amounts of natural language.[18]It is a sub-field of AI that interprets speech (voice) or text, analysis input, and then produces answers in a human-like natural language, which spurs real-time conversation.

Chatbot

AI chatbots, also known as conversational agents, engage dialogue systems to enable natural language conversations with

users by speech, text or both.[19]A conversational agent is a program that uses AI technology to simulate human interactions.[20]Powered by NLP and cloud computing infrastructures, AI chatbots may participate in a broad range of communication types, structured or not.[19,21]In a systematic review conducted by Li et al. in 2023,it is shown that Chatbots are "feasible, acceptable, and have positive effects on physical functioning, healthy lifestyle, mental health, and psychosocial outcomes".[20]Conversational agents can be used in various healthcare interventions, including skills training and healthcare education.[22]Well-known examples of conversational agents include voice-activated systems like Apple's Siri or Amazon's Alexa.[21]

METHODS

We searched PubMed and Scopus database between September and December of 2023 for studies published within the last 5 years, using the following research terms: ((Artificial Intelligence) AND (nurs*)) AND (education), (artificial AND intelligence AND nursing AND education AND implementation). The search revealed 436 titles from PubMed and 189 titles from Scopus. When duplicates were removed using the Zotero reference manager, we screened the 523 titles for relevance, as shown in the flow diagram.

After title screening, we assessed the remaining 198 full-text articles for eligibility according to certain criteria and finally included 7 articles in the qualitative synthesis.

The included studies focused on implementing AI-based technologies in nursing students' education. The studies were experimental or observational using qualitative, quantitative, or mixed methods design. Articles presented a clear description of the relationship with and the potential impact on nursing students' education. For instance, studies that focused on certain key phases within AI development and application (technology development, testing, implementation, or operation phase) were included. We excluded studies and reviews irrelevant to undergraduate nursing students' education. We also excluded studies that focused on the recruitment and retention of nursing students and investigated solely their views or perceptions of AI implementation.

RESULTS

The majority (N=4) of studies included in the review were published in 2023. All 7 studies incorporated pre & post-test designs to assess implementation endpoints. There was one randomized controlled trial and 3 mixed methods studies. Most of the studies (N=4) were designed as quasi-experimental. The number of students who participated in the included studies varied from 32 to 150. All included studies' data are summarized in Table 1.[23-29]

All 7 studies investigated the implementation of a certain AI method in undergraduate nursing students' curriculum. The AI method used was Chatbots developed through NLP. Conversational agents were first trained to analyse either voice or text language and interact with nursing students in certain clinical case scenarios. In 4 of these studies, a 3D avatar was also added to the AI tool to act as a Virtual Patient (VP). The stages of the creation of VPs included preparation, design, and development, followed by a testing phase before the official implementation. As reported in all studies, there was a preliminary operation phase where the AI-based tool was developed and then evaluated by nursing education experts for reliability and content, regardless of whether there was a VP or not. Researchers reported easy usage and reliable content of the Chatbots used in all studies.

Regarding the learning objectives, 4 studies used the AI-based technology for communication skills enhancement purposes among nursing students. To do so, either they solely focused on that learning objective (3 out of 4 studies), or they used interprofessional training on a certain clinical condition (1 study) while simultaneously evaluating communication skills. The remaining 3 studies implemented the AI-based tool to assess students' knowledge and clinical skills in a certain topic guided by their semester's curriculum. Clinical scenarios were used in 5 of the studies, whilst in the other 2, learning activities such as multiple-choice questions, were employed in the AI chatbot. All 4 studies that engage 3D avatars used clinical scenarios, which would address theoretical knowledge, critical thinking, and decision-making in escalating clinical conditions.

As shown in Table 1, two research groups have published more than one study in the past 5 years regarding AI implementation in nursing students' education. Shorey et al. published in

2019[23]their AI-based tool implementation study in a cohort of 150 students, and in 2023, they published their follow-up study of another student cohort.[28]Similarly, Liaw et al. published in 2023 their two studies[26,27] first implementing the AI tool to assess communication skills[26]and then assessing breast self-examination skills[27] among nursing students.

Endpoints of AI implementation were assessed in all studies through various tools, including self-reported questionnaires, interviews (in mixed-method studies), and direct feedback from the Chatbot. Students' self-efficacy was assessed in all studies, as well as knowledge of the learning objective. Shorey et al. additionally assessed students' attitudes toward this learning style, in both of their studies. In two studies, students' satisfaction was also assessed.[23,28]Certain endpoints were consistent in all studies, showing only minor differences, and were mostly focused on students' overall learning experience.

DISCUSSION

The integration of AI into nursing education represents a transformative shift in the way healthcare professionals are trained. This narrative review explores the multifaceted aspects of AI implementation in nursing education, discussing its potential benefits, challenges, and overall impact on the nursing profession. By integrating AI into nursing education, institutions and educators can provide students with personalized learning experiences tailored to their individual needs.

Our review revealed 3 dimensions of outcomes. Firstly, the common AI methods used for undergraduate nursing students were Chatbots and 3D Avatars which act as VPs. The implementation of AI in nursing education, as indicated using Chatbots, 3D avatars, and VPs, represents an outstanding approach aimed at enhancing the learning experience for nursing students. Each component contributes distinctively to create a comprehensive and interactive educational environment.

Similarly to the nursing community, Al Kahfl et al. in their single-centre open post-test randomized controlled trial among 426 fourth-year medical students found that students' performance significantly improved when they had access to Chatbots, and even more when they employed them.[30]

In addition, Nassir KM et al. found in their study that when students in diagnostic imaging courses used an AI chatbot, called Dibot, the learning process was improved. Also, Dibot assisted students in reviewing diagnostic imaging modalities like computed tomography, magnetic resonance imaging, and X-rays in an efficient manner.[31]

3D avatars can be employed to simulate anatomical structures, medical procedures, and patient scenarios. This visual representation allows students to explore and understand complex concepts in a more tangible and interactive way, potentially enhancing their spatial awareness and comprehension of different topics. The incorporation of VPs implies the integration of simulated clinical scenarios into the educational framework. VPs can provide a risk-free environment for students to practice clinical decision-making, critical thinking, and communication skills. This approach allows students to apply theoretical knowledge to realistic patient situations, bridging the gap between theory and practice. A mixed method study from Sweden among 49 medical students, divided into groups, revealed that an interprofessional VP facilitated insights into team collaboration and boosted understanding of other professions. Students learning in an online, remote learning environment appeared to be enhanced by the interprofessional VP.[32]

Overall, the utilization of these AI components in nursing education signals a shift towards more dynamic, technology-driven learning experiences. The integration of AI tools reflects an effort to prepare nursing students for the complexities of healthcare practice through innovative and interactive teaching methodologies.

AI-based clinical scenarios were used in most studies of our review, to help undergraduate nursing students to boost their clinical and communication skills. Such an approach had a mixed impact on students' behaviour may be due to a lack of familiarization with the AI mentality.

In a randomized clinical trial among 70 medical students a Virtual Operative Assistant (VOA) was used to evaluate the effectiveness of AI tutoring systems in surgical training contrasted with traditional methods. When compared to remote expert instruction, VOA feedback showed better performance outcomes and skill transfer, with equal Objective Structured Assessment of

Technical Skills scores and cognitive and emotional responses, suggesting benefits for its usage in simulation training.[33]

Using AI to develop communication skills is both feasible and promising because it can be used to build a variety of training scenarios tailored to real-world circumstances.[34]MaicherK.R. et al. created a virtual standardized patient system that could comprehend, reply, categorize, and assess students' success in medical history talking skills. They found that in comparison to human raters, the computer system's total accuracy was 87%, while theirs was 90%.[35]These results go along with our second-dimension results about the enrichment of students' communication skills.

Moreover, the outcomes of the use of AI in nursing students were evaluated using a variety of instruments and methods such as questionnaires, interviews or directly from Chatbot. In other specialties, the same thing seems to be occurring. Using electronic questionnaires, 263 undergraduate medical students expressed their opinions regarding AI and its possible applications and effects on radiology and medicine.[36] Numerous studies assessed healthcare students' attitudes toward AI with combined qualitative and quantitative analysis.[22,37,38]Tsopras R. et al. paper presented the implementation of AI Clinical Decision Support Systems (AI-CDSS) in a small group of 15 undergraduate medical students. 66% of them felt more comfortable using technology, and 74% said they had learned new abilities that would be beneficial in their clinical work. Students' involvement in this program increased their motivation and enthusiasm to a great extent for working with AI technology.[39]The outcomes listed above are all consistent with what our review has found.

Considering all these, the implementation of AI in nursing education has positive effects across various domains, specifically enhancing communication skills, clinical skills, student satisfaction, and knowledge acquisition. The positive impact on communication skills suggests that AI tools are likely facilitating the interaction between students and VPs, Chatbots, or other AI-driven components. This may include opportunities for practicing effective communication in different healthcare scenarios, contributing to the development of interpersonal and patient-centred communication skills. The implementation of AI in nursing education seems to be a holistic approach, positively influencing both soft skills (communication) and hard skills (clinical competencies). Additionally, the reported increased student satisfaction suggests that students perceive AI-enhanced education as valuable and engaging. These findings collectively support the idea that AI technologies can be effectively integrated into nursing education to enhance the overall learning experience and better prepare students for their future roles in healthcare.

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ANNEX

FIGURE 1. Prisma flowchart diagram

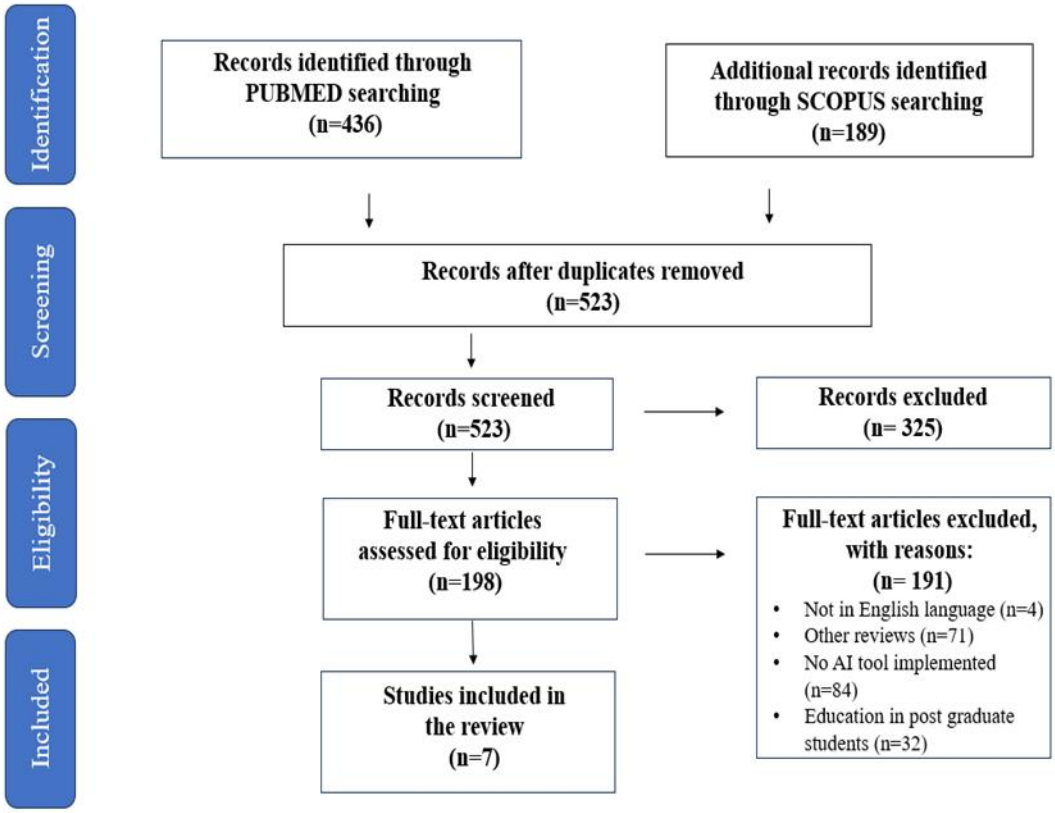

TABLE 1. Summary of the included studies

Study (year)	Design	Number of students	AI method	AI tool/software	Learning objectives	Implementation endpoints
Shorey S. et al. (2019)[23]	Mixed methods, quasi experimental, pre & post test	150	Voice Chatbot 3D Avatar (by 3D Unity)	Natural Language Processing (engine: Google Cloud's Dialogflow)	Communication skills enhancement	Improvement of • Performance • Attitudes • Perceived self-efficacy
Chang C.Y. et al. (2021)[24]	Mixed methods, quasi experimental, pre & post test	36	Chatbot (mobile)	Natural Language Processing	Prenatal education: handling obstetric vaccine cases	Promoting • Learning achievement • Self-efficacy • Learning experience
Han J.W. et al. (2022)[25]	Quasi experimental, pre & post test	61	Chatbot	Natural Language Processing	Electronic fetal monitoring	Enhancement of • Knowledge • Clinical reasoning competence • Confidence • Feedback satisfaction
LiawS.Y. et al. (2023a)[26]	Mixed methods, pre & post test	32	Voice Chatbot 3D Avatar (by 3D Unity)	Natural Language Processing (engine: Google Cloud's Dialogflow)	Interprofessional communication skills	Try to optimize • Communication knowledge • Self-efficacy in interprofessional communication
LiawS.Y. et al. (2023b)[27]	Prospective 2-arm Randomized Controlled Trial, pre & post test	64	Voice Chatbot	Natural Language Processing (engine: Google Cloud's Dialogflow)	Sepsis interprofessional team training	Increase • Communication knowledge • Sepsis care performance • Sepsis care knowledge • Self-efficacy in interprofessional communication
Shorey S. et al. (2023)[28]	Longitudinal, Quasi experimental, pre & post test	93	Voice Chatbot 3D Avatar	Natural Language Processing (engine: Google Cloud's Dialogflow)	Communication skills	Improvement of • Learning attitude • Self-efficacy • Clinical communication skills
Simsek-Cetinkaya S. &Cakir S.K. (2023)[29]	Comparative intervention trial	103	AI Assisted Interactive Screen-Based Simulation (AI-AISBS) 3D Avatar	Natural Language Processing	Breast self-examination skills	Increase • Breast self-examination skills • Student satisfaction and self-confidence in learning scale • Spielberger's state and trait anxiety scale