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SISTEMAS INTELIGENTES DE TUTORIA NA EDUCAÇÃO EM ENFERMAGEM: PROTOCOLO DE SCOPING REVIEW

INTELLIGENT TUTORING SYSTEMS IN NURSING EDUCATION: A SCOPING REVIEW PROTOCOL

SISTEMAS DE TUTORÍA INTELIGENTE EN LA EDUCACÍON DE ENFERMERÍA: PROTOCOLO DE SCOPING REVIEW

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RESUMO

Introdução: A utilização da inteligência artificial está a evoluir rapidamente e a diversas indústrias, incluindo os setores da saúde e da educação, onde os ambientes de aprendizagem adaptativos e os sistemas de tutoria inteligente permitem personalizar o ensino.

Objetivo: Identificar a extensão da evidência relativa à utilização, aplicação e impacto dos Sistemas de Tutoria Inteligente no ensino de enfermagem, tanto no ensino pré-graduado como pós-graduado.

Métodos: Esta revisão seguirá a metodologia do Joanna Briggs Institute para Scoping Reviews. O desenvolvimento deste protocolo segue os Preferred Reporting Items for Systematic Reviews and Meta-Analisys Protocols. Os critérios de inclusão seguem o modelo População–Conceito–Contexto. A extração de dados incluirá informações como características dos estudos, tipos de Sistemas de Tutoria Inteligente, estratégias de implementação e resultados educacionais. A seleção dos estudos será feita por dois revisores independentes utilizando uma ferramenta pré-definida.

Resultados: Os resultados serão sintetizados e apresentados em tabelas, diagramas e resumos narrativos.

Conclusão: Pretende-se que haja uma contribuição para a compreensão de como os Sistemas de Tutoria Inteligentes são utilizados no ensino de enfermagem, identificar lacunas na literatura e apoiar boas práticas na integração de ferramentas educativas baseadas em Inteligência Artificial nos currículos de enfermagem.

Palavras-chave: ensino de enfermagem; inteligência artificial; sistemas inteligentes; estudantes de enfermagem.

ABSTRACT

Introduction: The use of artificial intelligence is rapidly advancing and revolutionizing many industries, including healthcare and education, where adaptive learning environments and intelligent tutoring systems can personalize instruction.

Objective: Identify the extent of evidence towards the use, application, and impact of Intelligent Tutoring Systems in nursing education for undergraduate and postgraduate students.

Methods: This scoping review will be conducted following the methodological framework established by the Joanna Briggs Institute for scoping reviews. The development of this protocol follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols guidelines. The inclusion criteria followed the Population–Concept–Context framework. Data extraction will include details such as study characteristics, types of Intelligent Tutoring Systems, implementation approaches, and educational outcomes. Studies will be selected by two independent reviewers and extracted using a predefined tool.

Results: Results will be synthesized and presented in tables, diagrams, and narrative summaries.

Conclusion: This scoping review aims to contribute to the understanding of how Intelligent Tutoring Systems are utilized in nursing education, identify gaps in the literature, and inform best practices for integrating Artificial Intelligence-based educational tools into nursing curricula.

Keywords: nursing education; artificial intelligence; intelligent systems; nursing students.

RESUMEN

Introducción: El uso de la inteligencia artificial está evolucionando rápidamente y transformando diversas industrias, incluidos los sectores de la salud y la educación, donde los entornos de aprendizaje adaptativos y los sistemas de tutoría inteligente permiten personalizar la enseñanza.

Objetivos: Identificar el alcance de la evidencia sobre el uso, la aplicación y el impacto de los Sistemas de Tutoría Inteligente en la educación en enfermería, tanto en los niveles de grado como de posgrado.

Métodos: Esta revisión seguirá la metodología del Joanna Briggs Institute para Scoping Reviews. El desarrollo de este protocolo se basa en las directrices de Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols. Los criterios de inclusión siguen el modelo Población–Concepto–Contexto. La extracción de datos incluirá información sobre las características de los estudios, los tipos de Sistemas de Tutoría Inteligente, las estrategias de implementación y los resultados educativos. La selección de los estudios será realizada por dos revisores independientes utilizando una herramienta predefinida.

Resultados: Los resultados se sintetizarán y presentarán en tablas, diagramas y resúmenes narrativos.

Conclusión: Se espera que esta revisión contribuya a comprender cómo se utilizan los Sistemas de Tutoría Inteligente en la enseñanza de enfermería, identificar vacíos en la literatura y apoyar buenas prácticas en la integración de herramientas educativas basadas en Inteligencia Artificial en los planes de estudio de enfermería.

Palabras Clave: educación en enfermería; inteligencia artificial; sistemas inteligentes; estudiantes de enfermería.

Introduction

The use of artificial intelligence (AI) is rapidly advancing and revolutionizing many industries, including healthcare and education, where adaptive learning environments and intelligent tutoring systems can personalize instruction. These systems have shown significant potential to support individualized learning pathways and offer real-time feedback based on students' cognitive profiles. However, there is a lack of knowledge about how these tutoring systems are being applied in nursing education, as well as their outcomes in the learning process.

Over the past few decades, technology has profoundly transformed multiple fields, including healthcare and education. A significant aspect of this technological evolution is Artificial Intelligence (AI), which has changed how health education is practiced (Billingsley et al., 2024). Correspondingly, AI has also manifested as an asset in nursing education, as it is imperative to keep abreast of technological advancements to equip students with the requisite skills necessary for delivering high-quality care in response to the evolving demands of clinical practice (Gagne, 2023; Benfatah et al., 2024).

AI's role in higher education is garnering global attention, with many countries investing in its development (Gagne, 2023). Within the education sector, AI-driven tools are gaining traction as effective methods for improving learning outcomes (Chen et al., 2020). Technologies such as simulators, virtual reality, and Intelligent Tutoring Systems (or AI Tutors) are becoming increasingly popular, providing nursing students with new ways to develop and refine their skills. These tools offer interactive and immersive learning experiences, allowing students to practice clinical scenarios in safe and controlled environments (Lampropoulos, 2025).

Intelligent Tutoring Systems (ITS), defined as "computer-based learning systems that use AI to provide personalized and adaptive instruction for students" (Lin et al., 2023), have evolved significantly since their inception, with their origins traced back to the 1970s, when researchers explored how AI could be used to enhance computer-based education (Hartley & Sleeman, 1973). Early ITS models, such as SCHOLAR, designed by Carbonell (1970), focused on rule-based adaptive learning. They laid the foundation for modern ITS, introducing key principles such as personalized feedback and dynamic adaptation to the users' needs. In recent years, the rise of deep learning and big data analytics has further propelled the development of ITS, as they can identify and monitor students' cognitive and interactive states (Lampropoulos, 2025), and their prior preferences (Lin et al., 2023).

As these systems continue to evolve, their application in various educational domains, such as nursing education, has gained increasing attention due to their potential to enhance skill development (Srinivasan et al., 2024). Compared to traditional educational methods, where students might experience delays in receiving the instructor's feedback, ITS enables real-time analysis of student responses, delivering immediate and adaptive guidance to enhance the learning process (Labrague & Sabei, 2024; Gokcearslan et al., 2024; Okonkwo & Ade-Ibijola, 2021). Moreover, ITS can track student progress over time, helping teachers and students themselves identify areas that need improvement (Okonkwo & Ade-Ibijola, 2021). In nursing education, there's a set of factors that negatively influence learning. These factors can be mitigated, even corrected, with the assistance of ITS, tailored to each student (Labrague & Sabei, 2024). Research has demonstrated that ITS plays a crucial role in personalizing learning experiences, enhancing student engagement, and improving academic performance (Chukwudi et al., 2024). By adapting to each student's cognitive status, ITS can help them learn more effectively, minimizing the time and resources needed compared to conventional teaching methods (Lin et al., 2023).

However, while the benefits of ITS are promising when it comes to nursing education, its "proliferation has spawned many debates about their use and effectiveness" (Rodrigues et al., 2005). To fully grasp their impact, it is crucial to examine where and how these systems are being applied within nursing education, as AI's effectiveness heavily depends on its alignment with the specific context of its application (Wei et al., 2025). Furthermore, exploring the methodologies employed in implementing ITS can reveal best practices and potential barriers to its adoption (Saylor Academy, n.d.). As such, an examination of the existing literature is necessary to fully understand ITS's utilization, application, and impact.

A scoping review was selected as the most appropriate methodological approach given the exploratory nature of the research topic and the limited synthesis available in the current literature, as it aims to map the current evidence on ITS in nursing education, highlight knowledge gaps, and inform its integration into modern educational practice. A preliminary search of CINAHL, MEDLINE, Scopus, the Cochrane Database of Systematic Reviews, PROSPERO, and Open Science Framework was conducted, and no current or underway systematic reviews or scoping reviews on the topic were identified.

1. Methods

This scoping review will be conducted following the methodological framework established by the Joanna Briggs Institute (JBI) for scoping reviews. The development of this protocol follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) guidelines (McKenzie et al., 2021), ensuring transparency and methodological rigor in its planning. Upon completion, the review will be reported following the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist and the associated flow diagram, as recommended by Tricco et al. (2018). These frameworks provide comprehensive guidance for preparing and disseminating scoping reviews, supporting reproducibility and clarity in reporting.

Furthermore, this protocol is registered in Open Science Framework (https://doi.org/10.17605/OSF.IO/YWSU2).

1.1 Review Question

Using the PCC framework, this review seeks to answer the following question:

How have Intelligent Tutoring Systems been developed and applied in nursing education for pre- and post-graduate students?

1.2 Inclusion Criteria

Participants

This review will include studies focusing on nursing students (individuals enrolled in a school of nursing or a formal educational program leading to a degree in nursing) at both pre-graduate (undergraduate) and post-graduate (master's, doctoral, or continuing education) levels. Studies that include nursing educators, clinical instructors, and healthcare professionals involved in implementing or evaluating ITS into nursing education will also be considered.

Studies focusing exclusively on medical or other healthcare students without direct relevance to nursing education will be excluded. Additionally, research that explores general applications of AI in education without specifically addressing its role in nursing education will not be considered.

Concept

The primary concepts of interest are the use, application, and impact of ITS in nursing education. This includes:

- Types of ITS, defined as "computer-based learning systems that use AI to provide personalized and adaptive instruction for students" Lin et al. (2023), include Chatbots, Adaptative Learning Platforms, and Virtual Assistants.
- Application contexts, as theoretical, theoretical-practical, and clinical learning.
- Pedagogical impact, as skill development, learning outcomes, student engagement, and personalized learning.
- Challenges and opportunities include integration strategies, faculty perceptions, and technological barriers.

Studies that discuss AI in nursing education in a general sense, without specific mention of the types of ITS defined above, will be excluded. Research on AI-driven administrative tools or decision-support systems in nursing, rather than direct educational applications, will also not be included.

Context

This review will include studies conducted in academic institutions (nursing schools, colleges, universities) and clinical training environments (hospitals, simulation labs) where ITS are implemented. The context includes both traditional classroom environments and virtual or hybrid settings where ITS are used. Research from various geographic regions will be considered to ensure a broad understanding of ITS in different cultural and educational contexts.

Studies focusing on non-nursing education settings, such as general AI applications in schools, will not be included. Purely theoretical research, with no experimental application of ITS in nursing education, will also not be considered.

Types of sources

This scoping review will consider a wide range of study designs to comprehensively examine how ITS have been applied in nursing education for pre- and post-graduate students. The review will include both experimental and quasi-experimental study designs, such as randomized controlled trials, and non-randomized controlled trials, which provide quantitative evidence regarding the effectiveness and impact of ITS in this context. In addition, analytical observational studies – comprising cohort studies, and case-control studies – will be considered to capture additional quantitative data on the application of ITS in educational settings.

Descriptive observational study designs, including case series, individual case reports, and descriptive cross-sectional studies, will also be included to offer detailed insights into specific implementations of ITS. Moreover, qualitative studies that focus on the experiences, perceptions, and challenges of both educators and students in using ITS will be considered to provide a deeper understanding of the contextual factors influencing ITS integration in nursing education.

In addition, text and opinion papers that discuss theoretical perspectives, development processes, and practical applications of ITS in the field of nursing education will also be included to enrich the discussion and provide broader contextual insights.

Studies that do not focus on formal educational settings or that investigate AI applications solely within clinical or research contexts without an explicit educational focus will be excluded. This comprehensive inclusion strategy will allow the review to map the current state of knowledge, identify gaps in the literature, and provide a robust foundation for understanding how ITS are being applied to enhance personalized learning in nursing education.

1.3 Search Strategy

A comprehensive search strategy will be developed to identify both published and unpublished studies relevant to the review topic, divided into three steps. In the first one, a preliminary search will be performed in MEDLINE (via PubMed), CINAHL (via EBSCOhost), Scopus, and Cochrane Library to identify relevant keywords and indexing terms related to ITS and nursing education, without language or time restrictions, using only terms as "Intelligent Tutoring Systems", "AI Tutors", and "Nursing Education". The text words in titles and abstracts, as well as the index terms used in these articles, will be analyzed and used to develop a complete search strategy.

From this, the refined search strategy (step two) will be systematically applied across Web of Science, MEDLINE (via PubMed), CINAHL (via EBSCOhost), Scopus, and Cochrane Library. In addition, grey literature sources – such as conference proceedings, dissertations, and institutional reports – will be searched in OpenGrey, and Repositórios Científicos de Acesso Aberto de Portugal (RCAAP) to ensure exhaustive coverage. Searches will not be limited by language or time, to provide a broad understanding of ITS in different cultural and educational contexts.

Finally, the reference lists of all included studies and relevant systematic reviews will be screened to identify any additional literature that may have been missed during the initial searches.

1.4 Study/Source of Evidence Selection

Following the execution of the search strategy, all identified citations will initially be uploaded into Rayyan (Ouzzani, et al., 2016) to facilitate the screening process of the studies. Duplicate records will be identified and removed. Subsequently, two independent reviewers will screen titles and abstracts against the predetermined inclusion criteria.

Subsequently, the selected publications will be assembled and uploaded into Zotero 7.0.15 (Stillman, et al., 2024) for reference management, where full texts of eligible studies will be retrieved. These documents will undergo a detailed assessment based on the inclusion criteria by the same two independent reviewers. Reasons for the exclusion of sources of evidence in full text that do not meet the inclusion criteria will be recorded and reported in the scoping review. Discrepancies between reviewers at any stage will be resolved through discussion or by consulting additional reviewer/s. The search results and the selection process will be comprehensively documented and presented in a PRISMA flow diagram (Page, et al., 2021).

1.5 Data Extraction

Data from each included study will be extracted independently by two reviewers using a standardized data extraction form developed specifically for this review on Excel (Microsoft Corporation, 2025, version 16.97). The table will include specific details, as you can see in Table I.

Table I – Characteristics of Studies on ITS in Nursing Education

CHARACTERISTICS	DESCRIPTION	
STUDY CITATION	Author	This provides a reference point and context for the research.
	Year	
	Country	
RESEARCH AIM	Objective of the study, detailing what the research intended to investigate regarding ITS in nursing education.	
PARTICIPANT DETAILS	Information on the target population (e.g., pre-graduate and post-graduate students) and the sample size	
METHODOLOGICAL DESIGN	Study design and analytical approach used	
DATA CHARACTERISTICS	Type of data employed in the study (quantitative, qualitative, or mixed methods), including details on data sources and collection methods.	
SYSTEM EVALUATION METRICS	Performance indicators used to access the ITS, such as accuracy, adaptability, or user satisfaction, where applicable.	
OUTCOME MEASURES	The key outcomes or impacts observed, such as improvements in learning, student engagement, or skill development.	
REPRODUCIBILITY/ACCESSIBILITY	Information on whether the study is available for independent use, replication, or further investigation.	

Any modifications to the data extraction tool will be detailed in the final scoping review. Any disagreements arising during data extraction will be resolved through discussion or by consulting a third reviewer. If necessary, study authors will be contacted to obtain additional data.

1.6 Data Analysis and Presentation

The methodological framework is designed to provide a comprehensive overview of the current state of research on ITS in nursing education. Thereby, it will facilitate the identification of key trends, challenges, and opportunities for future research and practice, guiding stakeholders in the effective integration of ITS into educational settings.

Quantitative findings will be summarized in a descriptive manner, while qualitative findings will be systematically categorized into emergent themes that illustrate the diverse applications of ITS in nursing education. Consequently, data will be presented in both tabular and diagrammatic formats to enhance comparative analysis across studies. A narrative summary will accompany these visual presentations, elaborating on the relationship of the results to the review's objectives and identifying deficiencies in the existing literature.

2. Results

The review is currently at the protocol and preliminary search stage. Preliminary analysis suggests that ITS are being explored for clinical decision-making, knowledge acquisition, and simulation-based learning. Early findings suggest positive impacts on student engagement and performance, although certain challenges, such as limited technological literacy and inadequate infrastructure, remain as barriers to broader adoption.

Building upon the early insights, this scoping review aims not only to map the existing literature, but also to generate meaningful contributions to both research and practice. By identifying how ITS' are being implemented and evaluated, the review will help identify the most effective strategies for implementation, highlight gaps in the current literature, and inform future research priorities. Moreover, it may guide nurse educators and academic institutions in making evidence-informed decisions when adopting AI-based tools, contributing to more personalized, engaging, and efficient learning environments. Ultimately, these insights could support the advancement of nursing curricula, better preparing students for the challenges of modern clinical practice.

Conclusions

This scoping review aims to contribute to the understanding of how ITS' are utilized in nursing education, identify gãos in the literature, and inform best practices for integrating AI-based educational tools into nursing curricula.

Conflicts of Interest

There is no conflict of interest in this project.

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