

New trends in the use of computer tools for teaching-learning in health

Novas tendências na utilização de ferramentas informáticas para o ensino-aprendizagem em saúde

Nuevas tendencias en el uso de herramientas informáticas para la enseñanza-aprendizaje en salud

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ABSTRACT

Introduction: Computer tools have revolutionized health sciences education, allowing students and professionals to acquire knowledge and skills more effectively. This study analyzes new trends in using computer tools for teaching-learning in Health. **Objective:** Analyze new trends in using computer tools for teaching-learning in Health. **Methodology:** A systematic review was carried out using the PRISMA method. Inclusion and exclusion criteria were applied to select relevant articles published between 2020 and 2024 in English and Spanish. Search engines such as Google Scholar, PubMed, Elsevier and SciELO were used. The extracted data were organized in tables with indicators such as title, authors, year, design, results and interpretation. **Results:** Various computer tools used in health education were identified, such as virtual reality, artificial intelligence, gamification, social networks and online learning platforms. These tools demonstrated improvements in knowledge acquisition, clinical skills, student satisfaction, and engagement. However, challenges were identified such as the need for teacher training, technological infrastructure, and ethical considerations. Furthermore, methodological limitations were found in many studies. **Conclusions:** This systematic review analyzed new trends in using computer tools for teaching-learning in Health. The findings suggest that these tools have great potential to improve medical education, but their effective adoption requires addressing challenges such as teacher training, infrastructure, and ethical issues. More robust research is needed, especially in developing countries, to consolidate the evidence and guide new technologies.

Keywords: Medical Informatics; Health Education; Virtual reality; Artificial intelligence; Online Learning.

RESUMO

Introdução: As ferramentas informáticas revolucionaram o ensino das ciências da saúde, permitindo que estudantes e profissionais adquiram conhecimentos e competências de forma mais eficaz. Este estudo tem como objetivo analisar as novas tendências na utilização de ferramentas informáticas para o ensino-aprendizagem em Saúde. **Objetivo:** Analisar as novas tendências na utilização de ferramentas informáticas para o ensino-aprendizagem em Saúde. **Metodologia:** Foi realizada uma revisão sistemática utilizando o método PRISMA. Critérios de inclusão e exclusão foram aplicados para selecionar artigos relevantes publicados entre 2020 e 2024 em inglês e espanhol. Foram utilizados mecanismos de busca como Google Scholar, PubMed, Elsevier e SciELO. Os dados extraídos foram organizados em tabelas com indicadores como título, autores, ano, delimitação, resultados e interpretação. **Resultados:** Foram identificadas diversas ferramentas informáticas utilizadas na educação em saúde, como realidade virtual, inteligência artificial, gamificação, redes sociais e plataformas de aprendizagem online. Essas ferramentas demonstraram melhorias na aquisição de conhecimento, habilidades clínicas, satisfação e envolvimento dos alunos. No entanto, foram identificados desafios como a necessidade de formação de professores, infra-estruturas tecnológicas e considerações éticas. Além disso, limitações metodológicas foram encontradas em muitos estudos. **Conclusões:** Esta revisão sistemática analisou as novas tendências na utilização de ferramentas informáticas para o ensino-aprendizagem em Saúde. Os resultados sugerem que estas ferramentas têm um grande potencial para melhorar a educação médica, mas a sua adoção eficaz exige a abordagem de desafios como a formação de professores, infra-estruturas e questões éticas. É necessária investigação mais robusta, especialmente nos países em desenvolvimento, para consolidar as evidências e orientar novas tecnologias.

Palavras-chave: psicométrica; validade; avaliação educativa; inteligência artificial gerativa.

RESUMEN

Introducción: Las herramientas informáticas han revolucionado la educación en ciencias de la salud, permitiendo a estudiantes y profesionales adquirir conocimientos y habilidades de manera más efectiva. Este estudio tiene como objetivo analizar las nuevas tendencias en el uso de herramientas informáticas para la enseñanza-aprendizaje en Salud. **Objetivo:** Analizar las nuevas tendencias en el uso de herramientas informáticas para la enseñanza-aprendizaje en Salud. **Metodología:** Se realizó una revisión sistemática utilizando el método PRISMA. Se aplicaron criterios de inclusión y exclusión para seleccionar artículos relevantes publicados entre 2020 y 2024 en inglés y español. Se utilizaron motores de búsqueda como Google Académico, PubMed, Elsevier y SciELO. Los datos extraídos se organizaron en tablas con indicadores como título, autores, año, diseño, resultados e interpretación. **Resultados:** Se identificaron diversas herramientas informáticas utilizadas en educación en salud, como realidad virtual, inteligencia artificial, gamificación, redes sociales y plataformas de aprendizaje en línea. Estas herramientas demostraron mejoras en adquisición de conocimientos, habilidades clínicas, satisfacción y compromiso de los estudiantes. Sin embargo, se identificaron desafíos como necesidad de capacitación docente, infraestructura tecnológica y consideraciones éticas. Además, se encontraron limitaciones metodológicas en muchos estudios. **Conclusiones:** Esta revisión sistemática analizó las nuevas tendencias en el uso de herramientas informáticas para la enseñanza-aprendizaje en Salud. Los hallazgos sugieren que estas herramientas tienen un gran potencial para mejorar la educación médica, pero su adopción efectiva requiere abordar desafíos como capacitación docente, infraestructura y cuestiones éticas. Se necesitan más investigaciones robustas, especialmente en países en desarrollo, para consolidar la evidencia y guiar nuevas tecnologías.

Palabras clave: Informática Médica; Educación en Salud; Realidad Virtual; Inteligencia Artificial; Aprendizaje en Línea

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Technology in the health teaching and learning process.

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This review could help to identify the specific challenges and opportunities of technology usage in the health teaching and learning process to develop strategies adapted to current theoretical and practical issues.

Originality/value:

Promote interdisciplinary collaboration among educators, researchers, technology experts, and policymakers to develop effective implementation strategies for informatics tools in health sciences education. This collaboration should address issues such as teacher training, technological infrastructure, ethical considerations, and adaptation to resource-limited contexts.

INTRODUCTION

Currently, computer tools have revolutionized the way education is provided, especially in the field of Health. These tools include online learning platforms, virtual simulators, mobile applications and virtual reality, among others (Martins et al., 2022; Rodríguez García et al., 2019). The implementation of these technologies has allowed students and health professionals to acquire knowledge and skills in a more effective and accessible way (Yeung et al., 2022).

This transformation in the health education paradigm has been supported by empirical evidence suggesting significant improvement in learning effectiveness and knowledge retention (Ruzafa-Martínez et al., 2023). In addition, an increase in student motivation and commitment has been observed when using these technological tools in their training process. In this sense, the use of computer tools for teaching-learning in the field of health is presented as a growing trend, with a positive impact on the quality and efficiency of medical and health education (Rodríguez García et al., 2019; Yeung et al., 2022).

The implementation of computer tools in Health Sciences education has been a global phenomenon in constant evolution. Leading countries such as the United States, the United Kingdom and Australia have stood out for their early adoption and development of educational technologies in this area (Roncal et al., 2023; Zarei et al., 2024). In Latin America, nations such as Brazil, Mexico and Colombia have followed this trend, achieving notable progress in the integration of computer tools in their health education programs (García-Peñalvo et al., 2020). This process reflects a paradigmatic change in health education, where technology plays a fundamental role in improving access, quality and efficiency of medical and health training worldwide (García-Peñalvo et al., 2020; Roncal et al., 2023).

In Ecuador, the implementation of computer tools in the teaching-learning of Health Sciences has presented challenges (Green & Shorer, 2022). According to data from the Ministry of Public Health of Ecuador (MSP), only 35% of higher education institutions in the country have adequate online learning platforms (Ministerio de Salud Pública del Ecuador, 2023). Additionally, the lack of teacher training and limited technological infrastructure have made the adoption of these tools difficult.

As a consequence, the current problem lies in the need to identify and analyze new trends in the use of computer tools for teaching-learning in Health Sciences, in order to improve the quality and accessibility of education in this field (Romero-Sanchez & Barrios, 2022). Despite the progress made, there are still gaps in the implementation and effective use of these technologies, especially in developing countries such as Ecuador (Ministerio de Salud Pública del Ecuador, 2023).

For all this, the World Health Organization (WHO) has recognized the importance of computer tools in Health Sciences education. In its global action plan for health education 2020-2025, the WHO highlights the need to integrate innovative technologies to improve the quality and accessibility of education (World Health Organization, 2020). For its part, the MSP of Ecuador has established as a priority the incorporation of computer tools in the training of health professionals (Ministry of Public Health of Ecuador, 2023).

Likewise, the Technical University of Ambato (UTA), as a leading higher education institution in Ecuador, has recognized the importance of adapting its Health Sciences programs to new technological trends. The UTA has invested in the implementation of online learning platforms and teacher training in the use of computer tools (Technical University of Ambato, 2022). However, there is still work to be done to ensure that all students and teachers have access to these technologies and the skills necessary to use them effectively.

Therefore, this study aims to carry out a systematic review of the literature to analyze new trends in the use of computer tools for teaching-learning in Health, in order to provide recommendations for their effective implementation in higher education.

The objective of this research was to analyze new trends in the use of computer tools for teaching-learning in Health.

METHODS

The approach to be used will be the Systematic Review (S.R.), a research method that follows a thorough and clear process to identify, evaluate and summarize the available evidence related to a specific research question on a given topic. This process will be carried out using the PRISMA method to collect and organize data in a way that guarantees obtaining high-quality information (Linares-Espinós et al., 2018).

The criteria applied to select the articles are described below:

Inclusion criteria:

- Documents that contain titles with the terms New trends, computer tools, teaching-learning in Health.
- They agree with the search equation "New trends AND informatic tools AND teaching-learning in Health".
- Free access articles.
- Articles in English and Spanish languages.
- Articles that have been published between 2020 and 2024.
- Research with a methodological process and criteria that guarantee its rigor.

Exclusion criteria:

- Documents that are in languages that are difficult to translate.
- Articles without academic relevance and scientific verification.
- Documents not related to the topic.
- Repeated investigations

Search engines:

- Academic google, Pubmed, Elsevier, Scielo

Keywords were used as the main search strategy, along with filters that limit the selection of articles according to their year of publication, prioritizing the most recent ones.

The keywords used are specified below:

Table 1. Literature search strategies

Key terms	(New trends) AND (informatic tools) AND (teaching-learning in Health)
Language	English, Spanish
Boolean operators	AND, OR, NOT
Year of publication	Last 5 years, 2020- 2024
Main search sources	Academic google, Pubmed

Source: Prepared by the authors

Likewise, searches were carried out using different variables or search parallels related to the keywords used.

Table 2. Main variables and modifications operated.

Main variables	Modification and implication of variables
New trends in computer tools	Technological innovations in health education
Teaching-learning in Health	Medical education and health sciences training

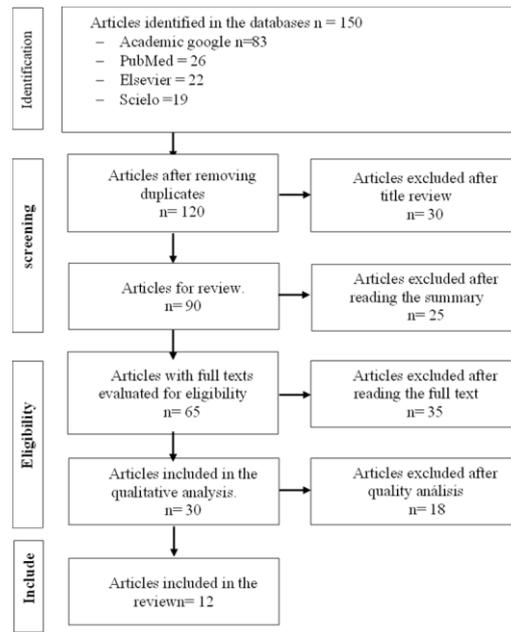
Source: Prepared by the authors

The study selection process is based on the following criteria:

1. Initial reading of the research titles to determine their relevance to the objectives of the study.
2. Subsequently, the summaries of the documents are read, which allows us to delve deeper into the information of the articles and exclude those that are repeated or that do not meet the research inclusion criteria.
3. Finally, a complete and intensive reading of the articles selected for inclusion in the research is carried out. This step ensures a comprehensive understanding of the findings and contribution of each study to the body of knowledge in the area of interest.

After identifying the publications to be used, data were extracted, which were established through tables where the following indicators were proposed to classify the articles: title of the publication, author/s, year of publication/country, design of the study, results and interpretation of the authors.

Figure 1. Prism Diagram.



Source: Prepared by the authors

RESULTS AND DISCUSSION

Table 3. Literature collected and analyzed

Article title	Author/s	Year /Country	Study design	Results	Authors' Analysis
Effects of Medical Education program Using Virtual Reality: A Systematic Review and Meta- Analysis .	Hyeon -Young Kim, Eun -Young Kim.	2023/ South Korea.	Systematic review and meta-analysis of randomized controlled trials (RCTs) (Kim & Kim, 2023) .	A significant improvement in skill level and satisfaction was found in the virtual reality (VR) group. Less immersive VR was more effective for knowledge outcomes than fully immersive VR. The overall effect size for ability was 0.72, which is relatively large. There were no statistically significant differences in the effect of VR on knowledge, self-efficacy, and anxiety (Kim & Kim, 2023) .	Medical education using VR can replace or complement clinical practical education. Maximizing the benefits of VR will increase learning opportunities and complement limited clinical experience, thereby improving medical services. A systematic and efficient VR medical education program will greatly improve students' core competencies.
Methodology for digital transformation, facing the paradigm shift of computerization in health.	Jenny Escalona Suárez, Liusnet Batista Reyes, Omar Mar Cornelio.	2023/Cuba.	Analytical-descriptive with a qualitative approach (Suárez et al., 2023) .	Digital transformation is a strategy that allows improving processes, efficiency in the use of resources and providing health information to diagnose, improve the effectiveness and quality of care. Current digital tools increase patient empowerment, improve their involvement in decisions about their health and disease control, and consequently the efficiency and safety of healthcare. Health information is stored electronically, allowing information to be stored, analyzed and retrieved to diagnose, treat or prevent diseases with fewer errors (Suárez et al., 2023) .	The authors propose the first ideas of a reference model for the adoption of ICT in a health institution in an interactive and incremental way, on which the hospital Digital Transformation process is based. They propose that the analytical-descriptive methodology used with a qualitative approach, using extraction processes, data synthesis and taxonomic classification, allows answering the research questions raised around the digital transformation in health.
Effectiveness of Virtual Reality in Nursing Education : Meta-Analysis .	Feng-Qin Chen, Yu-Fei Leng, Jian-Feng Ge, Dan-Wen Wang , Cheng Li, Bin Chen, Zhi-Ling Sun.	2020/ China.	Meta-analysis of randomized controlled trials (Chen et al., 2020) .	The results indicated that virtual reality (VR) education methods can improve nursing students' knowledge more effectively than control conditions. However, there were no differences between VR and other educational methods in the areas of skills, satisfaction, confidence, and performance time (Chen et al., 2020) .	The authors suggest that VR education methods can improve nursing students' knowledge. However, for the outcomes of skills, satisfaction, confidence, and performance time, there appears to be no difference between VR and other educational methods. Overall, the use of VR should be considered to improve knowledge and as a complement to other simulation strategies to optimize the quality and safety of clinical practice.
Artificial intelligence for healthcare and medical education : a systematic review .	Li Sun , Changhao Yin, Qiuling Xu , Weina Zhao.	2023/ China.	Systematic review (Sun et al., 2023) .	The studies showed that the current application of AI in medical education focuses on clinical specialty training and continuing education, with the main areas of application being radiology, diagnosis, surgery, cardiology and dentistry. Its main role is to assist doctors to improve their efficiency and accuracy. Furthermore, the field of combining AI with medicine/ medical education is constantly expanding, and the most urgent need is for policymakers, experts in medicine, AI and education, and experts from other fields to come together to reach a consensus on ethical issues and develop regulatory standards. Most medical students have a positive attitude towards adding AI-related courses to the existing curriculum. Finally, the quality of research on " AI+medicine /medical education" is poor (Sun et al., 2023) .	This study provides a groundbreaking systematic review of the latest " AI+medicine /medical curriculum." Since the AI+medicine curriculum is not yet regulated, the authors have made some suggestions. They recommend that the government come up with relevant policies to support the development of AI and increase investment in " AI+ Healthcare Education." They also point to the need to develop ethical standards and evaluate the effectiveness, feasibility and economics of AI+ medical/medical education before governments can enact supporting policies.
Gamification of health professions education : a systematic review .	AEJ van Gaalen , J. Brouwer, J. Schönrock -Aderna, T. Bouwkamp-Timmer , A. DC Jaarsma , JR Georgiadis .	2021/ Netherlands.	Systematic review (van Gaalen et al., 2021) .	Of the 5044 articles initially identified, 44 met the inclusion criteria. No negative results were reported from the use of gamification. Almost all studies included evaluation attributes (n = 40), mainly in combination with conflict/challenge attributes (n = 27). Eight studies revealed that this specific combination increased the use of the learning material, sometimes leading to better learning outcomes. A relatively small number of studies were conducted to explain the mechanisms underlying the use of game attributes (n = 7) (van Gaalen et al., 2021) .	The findings suggest that it is possible to improve learning outcomes in health professions education through the use of gamification, especially when game attributes that improve learning behaviors and attitudes are employed. However, most studies lacked well-defined control groups and did not apply or report theories to understand the underlying processes.
Technology applied to nursing care: wearables, apps and robotics	Espín Arguello, Adriana del Pilar, Mas Camacho, María Rosa, Rea Guamán, Mery Rocío, & López Paredes, Silvana Ximena.	2023/ Cuba.	A qualitative approach was used, based on the hermeneutics method, to further the bibliographic review (Espín et al., 2023).	The results are shown in three categories where they were identified: three wearables, eight mobile applications and three robots used in nursing (Espín et al., 2023).	Wearables, mobile applications and robotics are now playing a significant role in healthcare and health care spaces, bringing nursing staff closer to their patients. Technology does not replace nursing care, but it does constitute a support tool in their work.

Digital tools and the teaching of the nursing process	Lozano Dominguez, M. M., Macías Solorzano, C. G., & Oviedo Rodríguez, R. J.	2022/Ecuador	Literature review (Lozano et al., 2022)	In this order of ideas, it is worth highlighting that Nursing has been characterised as an eminently practical profession. Internships are a training period that involves the student's entry into professional life because they are carried out in work contexts in which students work as professionals in their sector. They are linked to direct experience, which is used as a learning tool, and can be developed in both real and simulated work scenarios. ICTs generate a new vision of training and affect the roles played by institutions and participants in the teaching-learning process, the dynamics of knowledge creation and dissemination and many priorities of current curricular concerns (Lozano et al., 2022).	Among the main tools for teaching in the nursing career and especially in the nursing care process, the introduction of e-learning as a teaching mechanism was highlighted, through the use of mobile technology, Apps and clinical simulators. The importance of face-to-face clinical practice was evident, however, these technological tools are key to improving the quality of education.
What is the Role of 3D Printing in Undergraduate Anatomy Education ? Scoping Review of Current Literature and Recommendations .	Jason Yuen .	2020/ United Kingdom	Literature Review (Yuen , 2020) .	The search returned 83 results, which were reduced to 13 articles after applying the exclusion criteria. The literature supported that 3D printing was a useful tool for studying normal, rare, and pathological anatomy. However, limitations include low fidelity in replicating the color and textural physical properties of soft tissues and the trade-off between cost and fidelity. Some studies demonstrated better educational outcomes with 3D models compared to conventional methods, especially when combined with assessment and conflict/challenge attributes. Only a few studies explained the mechanisms underlying the use of game attributes (Yuen , 2020) .	It is believed that 3D printing will become increasingly integrated into undergraduate anatomy education and could also potentially be used in the assessment of anatomical knowledge and clinical skills training. Establishing an online database of 3D models can make it easier for educators to easily make models for specific educational purposes. More medical schools are expected to adopt its use, but it will take time until they can completely replace cadavers due to the aforementioned limitations.
Trend of social media use by undergraduate medical students ; a comparison between medical students and educators .	Sumera Nisar , Asim Muhammad Alshahberi , Ahmed Hafez Mousa, Manal El Said, Fatma Hassan, Areeb Rehman, Shakeel Ahmed Ansari.	2022/ Saudi Arabia	Cross-sectional study (Sumera et al., 2022)	Of a total of 128 participants, 101 medical students and 27 medical educators, the majority had a presence on social networks (89.1% students and 88.8% educators). 69.3% of students and 77.8% of educators believed that social networks were beneficial for learning. The websites most used by students were YouTube (92.1%) and Blackboard (63.3%), while educators preferred Blackboard (59.2%). WhatsApp was the second most used social network by students (71.2%) and educators (62%) for communication. The majority of students (90.6%) used social media for learning at least 1 hour a day. 73% of the participants did not know the ethical guidelines for the use of social networks (Sumera et al., 2022)	Social media has immense potential to improve its role in education. Students in this study preferred YouTube and WhatsApp for their learning and communication, especially during the COVID-19 pandemic. However, to improve its usefulness, it is necessary to choose the appropriate platform, the quantity and quality of information shared to ensure optimal benefit, provide ethical guidelines and professional standards for the use of social networks at the institutional level. These are some of the challenges that need to be addressed.
Effectiveness of simulation in undergraduate nursing programs : Systematic review .	Della John McKittrick , Rasika Jayasekara , Barbara Parker.	2023/ Australia	Systematic review (McKittrick et al., 2023) .	The review included ten randomized controlled trials. Eight studies reported statistically significant improvements in skill performance, knowledge acquisition, clinical performance, self-confidence, critical thinking skills, and communication skills, indicating that simulation is an effective method compared to traditional teaching strategies. However, some studies had methodological gaps, such as small sample sizes, limited data and analyses, and unreliable outcome measurement tools (McKittrick et al., 2023) .	The findings suggest that it is possible to improve learning outcomes in undergraduate nursing programs through the use of simulation, especially when attributes that improve learning behaviors and attitudes are employed. However, most studies lacked well-defined control groups and did not apply or report theories to understand the underlying processes. More robust and robust studies are recommended to explore this area of nursing education. The mechanisms underlying simulated educational interventions should be clarified and theories that could explain the effects of these interventions on learning outcomes should be explored, using well-defined control groups, longitudinally.
Learning Outcomes of Immersive Technologies in Health Care Student Education : Systematic Review of the Literature .	Grace V Ryan, Shauna Callaghan, Anthony Rafferty, Mary F Higgins, Eleni Mangina , Fionnuala McAuliffe .	2022/ Ireland.	Systematic review (Ryan et al., 2022) .	We included 29 randomized controlled trials with a total of 2722 students. Knowledge gain was the same when comparing immersive technologies with traditional learning modalities; however, the learning experience increased with immersive technologies. Virtual reality was the most used form (76%). Knowledge was the primary outcome in 97% of the studies. Approximately 66% used validated instruments and scales to assess secondary outcomes such as satisfaction, self-efficacy, engagement, and perceptions of the learning experience. 66% included medical students, 28% nursing students, and 7% both. There were no studies with obstetrics students. The disciplines were anatomy, basic clinical skills, neurology, respiratory medicine, acute medicine, dermatology, communication skills, internal medicine, and emergency medicine (Ryan et al., 2022) .	Virtual reality, augmented reality, and mixed reality play an important role in the education of undergraduate medical and nursing college students . Compared to traditional educational modalities, the learning gain is the same with immersive technologies. Learning outcomes such as satisfaction, self-efficacy, and student engagement increase with the use of immersive technology, suggesting that it is an optimal tool for education. More research is required to explore its role in midwifery education. With the increasing availability of low-cost immersive tools, their use in health student education is potentially very valuable.
Technologies in nursing education, innovation and use of ICTs: integrative review	Girão, A.L. Araújo, Cavalcante, M.L. Silva Nunes, Oliveira, I. Costa Lima de, Aires, S. Freitas, Oliveira, S.K. Paz de, & Carvalho, R.E.	2020 /Mexico	Systematic review (Girão et al., 2020)	The initial identification of 62 articles was carried out, the exclusion criteria were applied until the sample of 26 articles was established. After reading and analyzing the studies, it was found that technologies are more used together with theoretical classes in classrooms, or as online teaching platforms, or also as auxiliary tools for the practice of realistic simulations (Girão et al., 2020)	The use of the Internet was predominant in the studies, as it favors updating, communication and academic qualification. Regarding digital teaching platforms, the virtual space allows the gathering and integration of various media with different purposes, enabling the creation of varied activities. For teaching through simulations, various benefits of immersion in a professional environment from the university were presented.

Source: Prepared by the authors through the review results

Educational tools

Virtual reality in undergraduate training in the health area means new opportunities and challenges, visualizing itself in the future as a replacement for clinical practice because it provides a greater opportunity for learning, improving its skills, knowledge, self-efficiency, satisfaction and anxiety through the creation of simulated scenarios that promote the student's ability to act immediately in the face of urgent cases (Kim & Kim, 2023), these results agree with the research called a review of the literature on digital transformation to face the paradigm shift of computerization in health in which it refers to how the application of computer tools in the health area has great potential to improve access to health, information in an agile and digitalized way (Suárez et al., 2023).

In a study evaluating the effectiveness of virtual reality in nursing training, they report that it improves knowledge, however, for the results of skills, satisfaction, confidence and performance time, there does not seem to be a difference between virtual reality and other traditional methods such as clinical practice and practice in simulation scenarios, virtual

reality improves the quality and safety of clinical practice, to this is added the concrete experience of the virtual simulation of the patient and the reflection tool, students could understand what they were taught and how to use the new knowledge (Chen et al., 2020).

Currently, a tool that has gained strength among health students and professionals is the application of Artificial Intelligence, considered as the ability to "imitate the human brain" or think through computers, including perception, decision-making, and action, which are reflected through the continuous use of applications such as Apple's Siri, Amazon's Alexa, and autonomous cars. However, its application is reflected on a large scale and is used by students, professionals, researchers, health personnel, etc. In response to the development of intelligent medicine, new medical courses are proposed to meet the needs of future intelligent medicine in clinical practice. The courses cover computer science, coding, algorithms, and electrical engineering (Sun et al., 2023).

With the application of artificial intelligence technology, health education is revolutionized, generating a change in the space-time landscape, modifying the offer of medical education in higher education institutions, personalizing and diversifying traditional methods of health education at both undergraduate and graduate levels (Sun et al., 2023). In a research called Technology applied to nursing care: wereables, apps and robotics, it is indicated that patient self-care is essential, which is why a device called WatchRx was created: a smart watch that collects physiological data from the patient and transmits it directly via the Internet to health professionals involved in the treatment and allows appropriate decisions to be made in real time, as well as assessing the patient's adherence to a certain treatment (Espin et al., 2023).

Robotics is currently considered a fundamental tool in the training of health professionals in pre and postgraduate studies through the creation of simulation scenarios with real clinical chaos that improve the student's ability to react to an emerging case. On the other hand, following the forefront of technological tools, there are care robots as electronic devices that operate totally or partially with the aim of helping the potential user (patient, family members, caregivers and nursing professionals), in the physical, psychological and emotional areas (Espin et al., 2023).

In this way, telenursing through its different criteria such as diagnosis, remote monitoring, treatment and health education, which is why it is considered relevant that nursing staff stay up to date in the use and management of new technological tools that undoubtedly provide multiple benefits for both the professional and the patient (Espin et al., 2023).

In the educational field, the implementation of gamification is evident, which refers to the use of game attributes in a non-playful context, to optimize students' learning outcomes by applying games to improve the learning experience (van Gaalen et al., 2021), this premise agrees with the article called Digital tools and the teaching of the nursing process, where it indicates the breaking down of space-time barriers and welcomes cyberspace, in which communicative interactions take place, so that higher education institutions can offer virtual courses and study programs and extend the possibility of taking them to people or groups that cannot access classrooms, taking them from any place or device that has access to the Internet (Lozano et al., 2022).

Clinical simulation in undergraduate training

When referring to university training for nursing students, research shows that they often face competition due to the limited availability of clinical practices for nursing students. This problem has led university institutions to take alternative solutions to improve the teaching and learning process through innovative, cost-effective and competent strategies for students to develop the skills necessary for clinical practice through the application of clinical simulation (McKitterick et al., 2023).

Clinical simulation was shown to significantly improve "skill performance, knowledge acquisition, clinical performance, self-confidence, critical thinking skills, and communication skills, indicating that simulation is an effective method compared to traditional teaching strategies" (McKitterick et al., 2023).

In a research, the evaluation of the learning outcomes on the use of the various digital platforms in the training of the following disciplines was carried out: anatomy, neurology, respiratory medicine, acute medicine, dermatology, communication skills, internal medicine and emergency medicine, obtaining as a result that the use of digital tools such as virtual, augmented and mixed reality play an important role in the training of university students of preclinical medicine and nursing, however no differences are observed between conventional methodologies with the use of current methodologies, which indicates that the application of both reflects good results in academic training (Ryan et al., 2022).

On the other hand, the use of educational technologies for nursing students provides greater training of their practical skills, the use of digital resources in teaching encourages greater dynamization in the traditional method by maintaining their concentration in the classroom, on the other hand, the use of realistic simulations helps to integrate current technological resources into theoretical-practical nursing classes, and it is believed that this practice helps to develop empathy in students (Girão et al., 2020).

This research concludes that the use of technologies in the educational part has multiple benefits and at the same time weaknesses, however, it highlights the positive contribution to the teaching-learning process, since it promotes interaction, updating and academic qualification through the use of online virtual platforms, realistic simulations, educational videos, digital books, clickers and podcasts (Girão et al., 2020).

Teaching-learning process

The learning process at the undergraduate level is no longer considered a stage of memorizing information obtained in class and becomes a search for updated information that leads to its analysis, and the use of computer tools motivates students to remain active and improves their concentration on academic activities, on the other hand, it is evident that it improves educational effectiveness by having new teaching methodologies and tools, more interactive resources and more information on a certain topic (Lozano et al., 2022). On the other hand, in an investigation, they carried out an analysis on the use of 3D printing in undergraduate anatomy education and concludes that its use improves anatomical knowledge and improves clinical skills (Yuen, 2020). A study analyzed the communication and learning scenarios between students and teachers of the medical career regarding the use of social networks, considered one of the most powerful tools in the recent era, a digital site where endless information is shared, now social networks have immense potential to improve their role in educational environments through which knowledge is generated in a simple and fun way, however, it is important to review the platform used, the quality of information to ensure optimal benefit, providing ethical guidelines and professional standards for the use of social networks at an institutional level are some of the challenges that must be addressed (Sumera et al., 2022).

Among the articles included in the meta-analysis, certain limitations were found that may be used as research topics in the future:

- ✓ There is limited research on clinical management associated with the use of computer tools
- ✓ Effectiveness of telemedicine in patients with urgent pathologies or chronic pathologies
- ✓ Effectiveness of telemedicine in the training of undergraduate students
- ✓ Effectiveness of clinical simulation platforms versus traditional practice
- ✓ Data privacy in consultations through telemedicine
- ✓ Humanized care in telemedicine

FINAL REMARKS

Currently, the implementation of Information and Communications Technologies is an important resource in the teaching-learning process through the use of computer tools such as augmented reality and virtual reality, creating scenarios for teaching applied to clinical simulation. that facilitates the acquisition and improves skills and abilities in health students. The use of these tools is easy to access and use, the implementation of strategies guides significant advances in the education of students and promotes academic results with greater precision and better management of information based on scientific evidence that bases each of the training processes.

A relevant aspect to consider are the research processes in higher education institutions since they promote endless learning scenarios through courses, conferences, workshops, etc., where the integration of knowledge promotes the participation and learning of all staff, Communicative interaction tools with the highest frequency of application were databases, virtual clouds, newsgroups, chat, translation databases, webinars, etc. These tools in university students direct the student to improve their skills by staying constantly updated on the correct use of the different platforms that guide them towards the construction of new academic opportunities after the generation of courses, congresses, conferences that are given through platforms. virtual in synchronous or asynchronous mode, which facilitates the student's study times and space.

However, it must be taken into consideration that the use of traditional tools such as Word, Excel, Power Point and Prezzi is maintained; among the most used bibliographic managers we find Mendeley, Zotero and EndNote, when referring to communication between researchers, teachers and students. institutional email platforms are used.

Telemedicine is currently booming as it is considered a novel tool that provides access to health services quickly and easily through a mobile device that has an internet connection, which meant a change in the paradigm of medical consultation. traditional, which reflects the digital change that society is currently facing with the application of technological tools that undoubtedly facilitate and streamline the lives of patients and promote the learning of undergraduate students.

Another tool that emerged after the COVID-19 pandemic is the mobile health application, live video chats where the patient interacts in real time with the specialist to obtain information about their health, treatment, medication, etc., and a

topic that has generated a constant debate is the use of social networks that, although they are excellent platforms to maintain communication between the doctor and the patient, their indiscriminate use is also evident, calling attention to ethics of the health professional in relation to the content handled within it. The findings of this study reflect the need to explore the topics addressed in this research, being able to expand and deepen the still unresolved situations that have arisen in the results of this article, for which the following research agenda is proposed.

Table 4. Suggested topics for a future research agenda

Topics for future research	
1	Digital transformation in health education applied to clinical simulation scenarios
2	Application of ICT tools in university teachers
3	Effectiveness of health education in virtual environments in higher education institutions
4	Effectiveness of telemedicine in the internship process in relation to the subject in higher education institutions

Source: Prepared by the authors

REFERENCES

- Barranquero Herbosa, M., Abajas Bustillo, R., & Ortega Maté, C. (2022). Effectiveness of flipped classroom in nursing education: A systematic review of systematic and integrative reviews. *International Journal of Nursing Studies*, 135, 104327. <https://doi.org/10.1016/j.ijnurstu.2022.104327>
- Benavente Rubio, A. (2022). El rol de enfermería en la salud digital: Oportunidades y desafíos para la ciencia del cuidado. *Revista Médica Clínica Las Condes*, 33(6), 598–603. <https://doi.org/10.1016/j.rmcl.2022.11.004>
- Chen, F.-Q., Leng, Y.-F., Ge, J.-F., Wang, D.-W., Li, C., Chen, B., & Sun, Z.-L. (2020). Effectiveness of Virtual Reality in Nursing Education: Meta-Analysis. *Journal of Medical Internet Research*, 22(9), e18290. <https://doi.org/10.2196/18290>
- Espín Arguello, Adriana del Pilar, Mas Camacho, María Rosa, Rea Guamán, Mery Rocío, & López Paredes, Silvana Ximena. (2023). Tecnología aplicada al cuidado de enfermería: wearables, apps y robótica. *Revista Cubana de Informática Médica*, 15(1), . Epub 01 de junio de 2023. Recuperado en 12 de agosto de 2024, de http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1684-18592023000100014&lng=es&tlng=es
- García-Peñalvo, F. J., Corell, A., Abella García, V., & Grande, M. (2020). La evaluación online en la educación superior en tiempos de la COVID-19. *Education in the Knowledge Society (EKS)*, 21, 26–26. <https://doi.org/10.14201/eks.23086>
- Girão, A.L. Araújo, Cavalcante, M.L. Silva Nunes, Oliveira, I. Costa Lima de, Aires, S. Freitas, Oliveira, S.K. Paz de, & Carvalho, R.E. Fontenele Lima de. (2020). Tecnologías en la enseñanza en enfermería, innovación y uso de TICs: revisión integrativa. *Enfermería universitaria*, 17(4), 475-489. Epub 24 de septiembre de 2021. <https://doi.org/10.22201/eneo.23958421e.2020.4.763>
- Green, G., & Shorer, T. (2022). Beliefs, emotions, and usage of information and communication technologies in distance learning during the COVID-19 pandemic: Health sciences students' perspectives. *DIGITAL HEALTH*, 8, 20552076221131188. <https://doi.org/10.1177/20552076221131188>
- Kim, H. Y., & Kim, E. Y. (2023). Effects of Medical Education Program Using Virtual Reality: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 20(5), 3895. <https://doi.org/10.3390/ijerph20053895>
- Lin, G. S. S., Tan, W.-W., Tan, H.-J., Khoo, C.-W., & Afrashtehfar, K. I. (2023). Innovative Pedagogical Strategies in Health Professions Education: Active Learning in Dental Materials Science. *International Journal of Environmental Research and Public Health*, 20(3), 2041. <https://doi.org/10.3390/ijerph20032041>
- Linares-Espínos, E., Hernández, V., Domínguez-Escrib, J. L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., & Ribal, M. J. (2018). Metodología de una revisión sistemática. *Actas Urológicas Españolas*, 42(8), 499–506. <https://doi.org/10.1016/j.acuro.2018.01.010>
- Lozano Dominguez, M. M., Macías Solorzano, C. G., & Oviedo Rodríguez, R. J. (2022). Herramientas digitales y la enseñanza del proceso de enfermería. *RECIAMUC*, 6(3), 418-427. [https://doi.org/10.26820/reciamuc/6.\(3\).julio.2022.418-427](https://doi.org/10.26820/reciamuc/6.(3).julio.2022.418-427)
- Martins, J., Bandiera-Paiva, P., Neto, A. R. B., de Carvalho, L. R. B., Padrini-Andrade, L., Machado, V. T., da Silva Junior, A. C., & Sun, S. Y. (2022). Development and validation of a health information system for assistance and research in gestational trophoblast disease. *BMC Medical Informatics and Decision Making*, 22(1), 173. <https://doi.org/10.1186/s12911-022-01916-4>
- McKitterick, D. J., Jayasekara, R., & Parker, B. (2023). Effectiveness of simulation in undergraduate nursing programs: Systematic review. *Science Talks*, 6, 100186. <https://doi.org/10.1016/j.sctalk.2023.100186>
- Ministerio de Salud Pública del Ecuador. (2023). Datos Abiertos del Ministerio de Educación del Ecuador – Ministerio de Educación [Educacion.gob.ec/]. <https://educacion.gob.ec/datos-abiertos/>
- Nisar, S., Alshamberi, A. M., Mousa, A. H., El Said, M., Hassan, F., Rehman, A., & Ansari, S. A. (2022). Trend of social media use by undergraduate medical students; a comparison between medical students and educators. *Annals of Medicine and Surgery*, 81, 104420. <https://doi.org/10.1016/j.amsu.2022.104420>
- WHO (World Health Organization). (2020). Global strategy on human resources for health: Workforce 2030. <https://www.who.int/publications-detail-redirect/9789241511131>
- Rodríguez García, A.-M., Sánchez, F. R., & Ruiz-Palmero, J. (2019). Competencia digital, educación superior y formación del profesorado: Un estudio de meta-análisis en la web of science. *Pixel-Bit. Revista de Medios y Educación*, 54, Article 54. <https://doi.org/10.12795/pixelbit.2019.i54.04>
- Romero-Sanchez, D., & Barrios, D. (2022). Technological Acceptance of Virtual Platforms in University Students: An Analysis in Times of Pandemic. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 17(1), 17–20. <https://doi.org/10.1109/RITA.2022.3149782>
- Roncal, L. E. P., Portal, M. del P. G., Acuña, M. L. L., & Linares, M. V. B. (2023). Las tecnologías de la información y la comunicación (TIC) en educación secundaria: Una revisión sistemática. *Revista Andina de Educación*, 7(1), Article 1. <https://doi.org/10.32719/26312816.2023.7.1.1>

Ruzafa-Martínez, M., Molina-Rodríguez, A., Pérez-Muñoz, V., Leal-Costa, C., & Ramos-Morcillo, A. J. (2023). Effectiveness of the flipped classroom methodology on the learning of evidence-based practice of nursing students: Quasi-experimental design. *Nurse Education Today*, 128, 105878. <https://doi.org/10.1016/j.nedt.2023.105878>

Ryan, G. V., Callaghan, S., Rafferty, A., Higgins, M. F., Mangina, E., & McAuliffe, F. (2022). Learning Outcomes of Immersive Technologies in Health Care Student Education: Systematic Review of the Literature. *Journal of Medical Internet Research*, 24(2), e30082. <https://doi.org/10.2196/30082>

Suárez, J. E., Reyes, L. B., & Cornelio, O. M. (2023). Metodología para la transformación digital, enfrentando el cambio de paradigma de la informatización en salud. *UNESUM - Ciencias. Revista Científica Multidisciplinaria*, 7(2), Article 2. <https://doi.org/10.47230/unesum-ciencias.v7.n2.2023.51-59>

Sumera, N., Asim, M., Areeb, R., Ahmed, M., Shakeel, A. (2022). Trend of social media use by undergraduate medical students; a comparison between medical students and educators. *ELSEVIER. Annals of Medicine and Surgery*. <https://doi.org/10.1016/j.amsu.2022.104420>

Sun, L., Yin, C., Xu, Q., & Zhao, W. (2023). Artificial intelligence for healthcare and medical education: A systematic review. *American Journal of Translational Research*, 15(7), 4820–4828. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10408516/>

Universidad Técnica de Ambato. (2022). Plan Estratégico de Desarrollo Institucional Actualizado. Retrieved from: <https://www.uta.edu.ec/v4.0/images/planes/PLAN ESTRATEGICO DE DESARROLLO INSTITUCIONAL 2022-2025.pdf>

Van Gaalen, A. E. J., Brouwer, J., Schönrock-Adema, J., Bouwkamp-Timmer, T., Jaarsma, A. D. C., & Georgiadis, J. R. (2021). Gamification of health professions education: A systematic review. *Advances in Health Sciences Education*, 26(2), 683–711. <https://doi.org/10.1007/s10459-020-10000-3>

Yeung, A. W. K., Parvanov, E. D., Hribersek, M., Eibensteiner, F., Klager, E., Kletecka-Pulker, M., Rössler, B., Schebesta, K., Willschke, H., Atanasov, A. G., & Schaden, E. (2022). Digital Teaching in Medical Education: Scientific Literature Landscape Review. *JMIR Medical Education*, 8(1), e32747. <https://doi.org/10.2196/32747>

Yuen, J. (2020). What Is the Role of 3D Printing in Undergraduate Anatomy Education? A Scoping Review of Current Literature and Recommendations. *Medical Science Educator*, 30(3), 1321–1329. <https://doi.org/10.1007/s40670-020-00990-5>

Zarei, M., Eftekhari Mamaghani, H., Abbasi, A., & Hosseini, M.-S. (2024). Application of artificial intelligence in medical education: A review of benefits, challenges, and solutions. *Medicina Clínica Práctica*, 7(2), 100422. <https://doi.org/10.1016/j.mcpsp.2023.100422>

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