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REVIEW

Virtual reality versus traditional methods in nursing competency development: A Rapid Review

Realidad virtual versus métodos tradicionales en el desarrollo de competencias de enfermería: una revisión rápida

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ABSTRACT

Introduction: the COVID-19 pandemic has required a readaptation of teaching methods. This readaptation, together with the exponential growth of technology in recent years, has brought about a possible new way of teaching nursing, using virtual reality. By analyzing this new approach, we will be able to understand whether this new methodology has advantages for being adapted to current teaching.
Objective: to map the evidence on the contribution of virtual reality to the development of both clinical and instrumental skills in nursing students compared to traditional methods.
Method: a rapid review was carried out with research carried out between March 2023 and May 2023. The Business Source Complete [EBSCO], National Institutes of Health [NIH] and B-ON platforms were used to carry out the research. To assess the quality of the articles, we used the JBI guideline.
Results: six articles of quasi-experimental and systematic review typology were analyzed.
The use of virtual reality allows students to develop their nursing skills in a dynamic, interactive and safe way. The results can be enhanced when combined with high-fidelity simulation.
Conclusions: this Rapid Review demonstrates how Virtual Reality can be used in nursing education, understanding its benefits in terms of clinical and personal skills. However, it also recognizes the difficulties that may limit the use of Virtual Reality and the need for greater scientific evidence that is less randomized.

Keywords: Nursing Student; Virtual Reality; Simulation; High-Reliability Simulation; Skills; Traditional Methods.

RESUMEN

Introducción: la pandemia de COVID-19 ha requerido una readaptación de los métodos de enseñanza. Esta readaptación, junto con el crecimiento exponencial de la tecnología en los últimos años, ha dado lugar a una nueva forma de enseñar enfermería mediante la realidad virtual. El análisis de este nuevo enfoque permitirá comprender si esta nueva metodología presenta ventajas para su adaptación a la docencia actual.
Objetivo: mapear la evidencia sobre la contribución de la realidad virtual al desarrollo de habilidades clínicas e instrumentales en estudiantes de enfermería, en comparación con los métodos tradicionales.
Método: se realizó una revisión rápida con investigaciones realizadas entre marzo y mayo de 2023. Fueram utilizadas las plataformas Business Source Complete [EBSCO], National Institutes of Health [NIH] y B-ON. Para evaluar la calidad de los artículos, se utilizó la guía del JBI.
Resultados: se analizaron seis artículos de tipología cuasiexperimental y de revisión sistemática. El uso de la realidad virtual permite a los estudiantes desarrollar sus habilidades de enfermería de una manera dinámica, interactiva y segura. Los resultados pueden mejorarse cuando se combina con simulación de alta fidelidad.
Conclusiones: esta revisión rápida demuestra cómo se puede utilizar la realidad virtual en la formación en enfermería, comprendiendo sus beneficios en términos de habilidades clínicas y personales. Sin embargo, también reconoce las

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dificultades que pueden limitar el uso de la Realidad Virtual y la necesidad de mayor evidencia científica menos aleatoria.

Palabras clave: Estudiante de Enfermería; Realidad Virtual; Simulación; Simulación de Alta Fiabilidad; Habilidades; Métodos Tradicionales.

INTRODUCTION

Virtual Reality (VR) has been widely explored as an innovative teaching tool, providing immersive environments that favor interaction and active learning. VR can be defined as an advanced interaction interface between the user and a computer-generated three-dimensional environment, in which the multisensory response can be enhanced by auxiliary devices.[1] This technology allows realistic scenarios to be simulated, promoting the development of cognitive, psychomotor and emotional skills in students.[2]

In the context of higher education, the integration of VR with e-learning platforms has shown significant advantages in adapting teaching methodologies to the needs of students.[2,3]

This combination can optimize the acquisition of knowledge, allowing educational objectives to be achieved more efficiently. VR encompasses different technological approaches, including Immersive Reality (IR), Mixed Reality (MR) and Augmented Reality (AR), each with specific characteristics that influence the user's interaction with the virtual environment.[3,4]

To better explain how these technologies work, there is a triangle developed in 1994 by Burdea which comprises 3 strands: Interaction, imagination and immersion.[5]

VR only exists if the person is surrounded by stimuli and in order to perceive these stimuli they need to understand what each one means. Immersion is the person's perception of the digital world, Imagination is what the software author aims to stimulate so that the customer perceives what they are experiencing as "real", Interaction is everything the customer can interact with in the virtual world.[3,4,5]

Although simulation-based teaching is widely used in healthcare training,[6] it is clear that the use of VR can improve learning by allowing the repetition of procedures, immersion in realistic clinical scenarios and the development of technical skills without putting clients at risk.

Although VR brings numerous advantages, it requires institutional investment, both in infrastructure and in teacher training, as well as adequate technical support for its effective use[7] and should not be considered an absolute substitute for traditional teaching methods. The traditional approach, centered on the teacher-student relationship, continues to play a fundamental role in the construction of knowledge, but has limitations in stimulating critical thinking and student autonomy.[8] Thus, VR can act as a complementary resource, enabling the practical application of theoretical content in controlled and safe environments, favoring more active and meaningful learning.

Given the relevance of this topic, this rapid review aims to map the available evidence on the contribution of VR to the development of clinical and instrumental skills in nursing students, compared to traditional methods. To understand the impact of this technology on the teaching-learning process will allow us to assess its potential in the training of future nurses and the conditions necessary for its effective implementation.

METHOD

This study was conducted in accordance with the guidelines of the Rapid Review Guidebook[9,10], following the rapid literature review methodology. This type of methodological approach allows for a rapid analysis of the available evidence, optimizing the management of time and resources, without compromising scientific quality.[11] To carry out this RR, the following eight fundamental steps were followed: definition of the research, refinement of the subject, definition of exclusion/inclusion criteria, search strategy, study selection, data extraction, assessment of the risk of bias and synthesis of the results.[10]

Definition of the research question

In order to carry out this research, the following review question was formulated: "What is the contribution of teaching with virtual reality to the development of clinical/instrumental skills in nursing students, compared to traditional methods?". This question was based on the acronym PICO (Population, Intervention, Comparison/Control, Outcome), as shown in table 1. The research was carried out on May 16, 2023, following a structured approach to ensure rigor in the identification and analysis of available evidence.

Table 1. Search terms

Population/Patient (P)	Intervention (I)	Comparison (C)	Outcome (O)
Nurse Student (Estudante de enfermagem) Future Nurse* (Futuro enfermeiro) Student* during the nurse course (Estudantes de enfermagem durante o curso de enfermagem)	Virtual reality in nursing (Realidade virtual em enfermagem) Virtual reality (Realidade virtual) Immersive reality (Realidade imersiva) Mixed reality (Realidade mista)	Traditional method in nursing (Metodos tradicionais em enfermagem) Traditional method* (Métodos tradicionais) Teacher oriented (Orientado pelo professor)	Assist in development (Auxiliar no desenvolvimento) Confidence (Confiança) Skill development (Desenvolvimento de habilidades)

Definition of inclusion and exclusion criteria

When conducting the research, the selection of evidence was restricted to studies that investigated one of the following aspects:

- The impact of virtual reality and high-fidelity simulations on the development of competencies and skills in nursing students;
- The effectiveness of e-learning in acquiring knowledge compared to traditional teaching methods in nursing training.

Only studies that explicitly addressed at least one of these topics were included, ensuring relevance and alignment with the aim of the review.

Exclusion criteria for the selection of studies were: publication period of less than 2018. (only studies published in the last five years, January 2018 to December 2024, were included, ensuring that the evidence was up-to-date), language (only studies available in English or Portuguese were considered) and keywords (the search was limited to studies that necessarily included the terms "Nursing education" and "Nursing students", ensuring that the content was relevant to the review question).

Search

A rapid search was carried out in the EBSCO, CINAHL, PUBMED and B-ON databases, however, the selected studies were taken exclusively from B-ON, as the other databases showed a shortage of relevant publications. The results presented on the other platforms were not included because they were not aligned with the objectives of this rapid review or because they did not provide sufficient evidence for critical data extraction. The search strategy was based on the use of search equations with Boolean operators OR and AND.

Screening and selection of studies

The articles identified on the B-ON platform were exported to the Mendeley tool and then organized on the Covidence platform in order to optimize data sorting and management. The review was conducted by two independent reviewers, who analyzed all the articles posted on the Covidence platform. Any disagreements were resolved by consensus between the reviewers, ensuring greater methodological rigor. To make it easier to understand the results, the PRISMA flowchart shown in figure 2 was used. The studies were screened in two distinct phases. In the first phase, the studies were analyzed based on the title and abstract, resulting in the exclusion of five studies that did not meet the inclusion criteria. In the second phase, the remaining 15 studies were assessed in full.

Data extraction

Data extraction was carried out using the Covidence platform, allowing data from the included studies to be organized. After analyzing and selecting the studies, six met the established criteria and were retained for the review. These were subjected to a methodological quality assessment based on the criteria established by the Joanna Briggs Institute[12] and Camp and Legge.[13] The assessment was initially carried out by one of the reviewers and then revised by the second reviewer. As no significant divergences were identified, the intervention of a third reviewer was not necessary.

Ethical considerations

As this study is an RR and is based exclusively on the analysis of secondary data, it does not involve the collection of primary data or the direct participation of human beings, and approval by the Ethics Committee is not required.

RESULTS

To optimize the coordination process between the two reviewers and minimize the risk of error, the Covidence platform was used, allowing for greater reliability in the selection and analysis of studies.

In the search carried out on the B-ON platform, using the Boolean terms defined in table 1, 8,671 studies were initially identified. To ensure the relevance and timeliness of the evidence, time limiters were applied, reducing the sample to 20 studies. After the full review, only 6 studies were considered eligible for inclusion in this Rapid Review.

Based on the assessment of the risk of bias, the six studies included had high methodological quality (above 70 %), ensuring the robustness of the findings. The selected studies were classified into two methodological typologies: quasi-experimental studies and systematic reviews. To better understand the evidence identified in this rapid review, the selected studies were analyzed in terms of population, intervention, study design, methodological quality and main results. Table 2 presents a structured synthesis of these data, allowing a comparative view of the approaches used in the different studies. This analysis facilitates the identification of patterns in the findings, highlighting the contributions of virtual reality to nursing education, as well as its limitations and potential areas for improvement.

Table 2. Sample data for data extraction

Author (Year)	Population	Interventions	Study Design/ Quality	Results
Azizi et al. (2022) [14] IR	122 nursing students	Creation of 2 different groups, one with traditional methods.	Quasi- experimental /High (90 %)	The use did not show significant differences in the tests, however, showed an improvement in the students' skills.
Jallad et al. (2021) [15] IE	Not applicable	Literature review on skill building, confidence, satisfaction, anxiety levels, knowledge and self-efficacy	Systematic review / High (90 %)	VR can be considered a good learning tool and beneficial for promoting retention and learning skills. It is necessary for both students and teachers to gain knowledge of how to work with this technology.

Labrague et al. (2019)[16] OM	Not applicable	Literature literature on the simulation	Systematic review/ High (80 %)	High-fidelity simulation was effective in increasing confidence and decreasing anxiety in nursing students. By creating a hybrid experience between traditional methods and high-fidelity simulation, the teachers play a key role in guiding the sessions.
Park et al. (2022)[18] KR	52 nursing students	Two groups were created, one of which first underwent a simulation and then a combination of virtual simulation. And the other group the other way around.	Quasi- experimental/ Alta (90 %)	He points out that the future students of the MZ generation (1981-2005) are already familiar with the technology, which requires the teaching team to adapt their teaching practices. The mixture of the two types of VR adds to the improvement of learning, but the author recommends starting with VR first and then high-fidelity simulation..
Ashouri *et al.* (2018)[18] IR	60 nursing students	Criação de dois grupos, um com os métodos tradicionais de ensino e o outro, com ensino *e-learning* com métodos tradicionais.	Quasi- experimental/ High (90 %)	The study highlighted that the mixed use of learning between traditional methods and e-learning leads to an increase in nursing skills.
Widiasih et al. (2022) [19] ID	140 nursing students	Creation of two groups, one with access to a 3D simulator and the other with classes using traditional methods.	Quasi- experiemntal/ High (90 %)	Simulation-based learning can meet the situations and conditions that nursing students may encounter in their internships. This study showed positive evidence of the use of simulators in learning, but more studies with similar applications are needed to create more relevant evidence.

DISCUSSION

The analysis of the studies included in this rapid review made it possible to map the relevant evidence that answers the research question and contributes to understanding the contribution of VR in nursing education.

The literature highlights VR as an innovative tool in the training of nursing students, providing immersive environments that favor active learning. According to Azizi et al.[14], VR consists of creating a computer-generated three-dimensional model, allowing the user to experience realistic virtual immersion experiences. The comparison between traditional learning and simulation-based teaching reveals that, although the results in knowledge tests are equivalent, VR promotes a significant increase in self-efficacy in technical skills. Azizi and colleagues[14] reported a 58 % increase in the manual dexterity and confidence of students subjected to this methodology, showing that virtual immersion can boost the development of practical skills over time.

Authors such as Jallad et al.[15] corroborate this perspective when they analyzed 23 studies on the application of VR in nursing education, finding that 92 % of the investigations reported significant improvements in students who used virtual simulation. Among the benefits observed were increased safety in carrying out clinical procedures, a more effective response in emergency situations, improved psychomotor skills and greater knowledge retention. In particular, VR had a positive impact on training in tracheostomy care, intravenous catheterization and medication administration, making it an effective complementary resource to traditional teaching.

In addition to the acquisition of technical skills, VR also influences students' anxiety and confidence levels. Studies cited by Jallad et al.[15] and Nielsen and Harder [20] indicate that virtual simulation can reduce anxiety levels during clinical experiences (CE), as it allows students to familiarize themselves with realistic scenarios beforehand, exposing them to complex situations before direct contact with patients.

Despite the favorable evidence, VR does not yet have sufficient scientific support to fully replace traditional teaching methods and should be used as a complementary strategy. The literature suggests that the most effective approach involves integrating hybrid methodologies, combining high-fidelity simulation with VR-based learning. Labrague et al.[16] demonstrated that high-fidelity simulation contributes to a significant increase in student confidence, promoting a greater ability to respond in emergency contexts. In this sense, a study conducted by Hollenbach[21] reinforces this conclusion by showing that students with no previous clinical experience who used high-fidelity simulation showed a significant reduction in anxiety over a seven-week period.

The implementation of VR in nursing education, however, presents significant challenges. Among the main obstacles identified are the need for specific equipment, such as VR goggles and high-performance computers, as well as the availability of software adapted to nursing training.[17] In addition, the predominance of the English language on most digital platforms is a barrier for students and teachers who do not master this language, making accessibility and adaptation to the technological resource difficult.

Despite these limitations, there is a consensus in the literature on the importance of institutional investment to enable the implementation of VR in nursing education. According to Park et al.[17], students who carry out laboratory practices using virtual and high-fidelity simulation develop sharper critical thinking and benefit from the possibility of recording and reviewing the procedures carried out, allowing for self-assessment and continuous improvement. The author suggests that the ideal sequence for hybrid teaching should start with VR simulation, followed by practice in a high-fidelity environment, in order to maximize learning effectiveness.

With the growing adoption of e-learning driven by the COVID-19 pandemic, several studies have explored the feasibility of combining traditional and virtual teaching. However, as noted by Ashouri et al.[18], digital-only teaching has not proven to be as

effective as the hybrid approach, requiring a combination of e-learning and face-to-face activities to ensure greater knowledge retention and a better learning experience for students.

A study carried out in Indonesia compared two groups of nursing students: one subjected exclusively to traditional methodologies and another that used interactive software to train intravenous catheterization and fluid therapy. The results indicated that the group that used digital technology showed greater involvement and better retention of knowledge, reinforcing that virtual simulation can be an effective tool in developing technical skills.[19] However, the authors warn of some methodological limitations, namely the risk of contamination between the groups due to the sharing of information and the dependence on a stable internet connection, factors that can compromise the effectiveness of the method.

Thus, this rapid review suggests that VR has a positive impact on nursing training, favoring the development of technical, behavioral and reflective skills, which are essential for the provision of safe, high-quality healthcare. However, its implementation must be accompanied by strategies that mitigate limitations, ensuring balanced integration with traditional teaching methods.

This rapid review could contribute to future improvements in nursing education, promoting the development of technical and psychosocial skills essential for safe and qualified practice.

Contribution to practice

The findings of this rapid review indicate that VR has significant potential to transform nursing education, providing opportunities for the development of clinical and emotional competencies. In addition to improving technical skills, VR demonstrates benefits in managing anxiety and strengthening students' self-confidence, preparing them for clinical practice more safely and effectively.

However, for VR to be fully integrated into nursing education, it is essential to invest in the acquisition of suitable equipment, including specific hardware and software, as well as in training teachers to use these technologies effectively. Implementing innovative teaching strategies that combine virtual simulation, e-learning and traditional methodologies could contribute to more dynamic, interactive teaching that is in line with the demands of contemporary professional practice.

Limitation

One of the main limitations of this rapid review was the scarcity of scientific evidence in the databases initially consulted. To mitigate this limitation, the B-ON platform was used, which made it possible to identify studies that were up-to-date and relevant to the topic under analysis.

Despite this restriction, the studies included showed high methodological quality, being predominantly quasi-experimental and systematic reviews, which reinforces the credibility of the findings and their relevance to the research question outlined.

However, as mentioned by several authors, more robust and methodologically refined studies are needed to minimize the risk of bias and cross-contamination between the groups assessed. One of the methodological limitations identified is the fact that most of the research analyzed was conducted in higher education institutions, which increases the possibility of sharing information between participants, which could compromise the validity of the results obtained.

It is therefore recommended that future studies adopt methodologies that allow control of variables, heterogeneous samples and a prolonged follow-up time, in order to strengthen the available evidence on the impact of virtual reality on nursing education.

CONCLUSIONS

This rapid review allowed us to map the evidence on the use of VR in nursing education. Although VR represents an innovative tool in nursing education, it cannot yet completely replace traditional teaching. The integration of VR as a complementary strategy can bring significant benefits, especially when combined with high-fidelity simulation.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Daniel Barros, Helena José.
Data curation: Daniel Barros.
Formal analysis: Daniel Barros, Helena José.
Research: Daniel Barros, Helena José.
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Writing - proofreading and editing: Daniel Barros, Ricardo Mestre, Susana Valido, Isabel Rabiais, Sandy Severino, Luís Sousa, Helena José.

REFERENCES

1. Tori R, Kirner C, Siscoutto RA. Fundamentos e tecnologia de realidade virtual e aumentada. Porto Alegre: Editora SBC; 2006.

2. Netto AV, Machado LD, Oliveira MC. Realidade virtual-definições, dispositivos e aplicações. Universidade de São Paulo; 2000. [cited 2025 Mar 16]; Available from: https://repositorio.usp.br/directbitstream/eea56bbf-fdf6-4a65-9681-47497e5d3544/ND_54.pdf

3. Al Rawashdeh AZ, Mohammed EY, Al Arab AR, Alara M, Al-Rawashdeh B. Advantages and disadvantages of using e-learning in university education: Analyzing students' perspectives. Electron. J. e-Learn. 2021 [cited 2025 Mar 16]; 19(3):107-17. Available from: www.ejel.org

4. Cunha CR, Martins C, Mendonça V. Using extended reality in experiential learning for hospitality management education. Procedia Comput. Sci. 2023 Jan 1;219:634-41.

5. Burdea GC, Coiffet P. Virtual reality technology. Int. J. e-Collab. 2006 Jan;2(1):61-4.

6. Filho IMM, Carneiro KK, dos Santos OP, Arantes AA, Félis KC, Guilherme IS. Simulação realística como instrumento no processo de ensino-aprendizagem de enfermagem. Revisa. 2019 Nov 1;8(3):273-84.

7. Semião D, Tinoca L. A utilização das tecnologias digitais nas aulas do século XXI. Rev. Educ. Quest. 2021 Jul;59(61),25689. https://doi.org/10.21680/1981-1802.2021v59n61id25689

8. Marques HR, Campos AC, Andrade DM, Zambalde AL. Inovação no ensino: uma revisão sistemática das metodologias ativas de ensino-aprendizagem. Avaliação. 2021 Sep;26(3):718–41. https://doi.org/10.1590/S1414-40772021000300005

9. Dobbins M. Rapid review guidebook. Natl Collab Cent Method Tools. 2017 [cited 2025 Mar 16]; 13:25. Available from: https://www.nccmt.ca/uploads/media/media/0001/02/800fe34eaedbad09edf80ad5081b9291acf1c0c2.pdf

10. Garritty C, Hamel C, Trivella M, Gartlehner G, Nussbaumer-Streit B, Devane D, et al. Updated recommendations for the Cochrane rapid review methods guidance for rapid reviews of effectiveness. BMJ [Internet]. 2024 Feb 6 [cited 2025 mar 15];e076335. Available from: https://www.bmj.com/content/384/bmj-2023-076335

11. Sousa LMM de, Firmino CF, Marques-Vieira CMA, Severino SSP, Pestana HCFC. Revisões da literatura científica: tipos, métodos e aplicações em enfermagem. Rev Port Enferm Reabil. 2018 [cited 2025 mar 15];1(1):45–55. Available from: https://rper.aper.pt/index.php/rper/article/view/20

12. Joanna Briggs Institute. Critical Appraisal Tools [Internet]. JBI. 2020[cited 2025 mar 15]. Available from: https://jbi.global/critical-appraisal-tools

13. Camp S, Legge T. Simulation as a tool for clinical remediation: An integrative review. Clin Simul Nurs. 2018 Mar 1;16:48-61. https://doi.org/10.1016/j.ecns.2017.11.003

14. Azizi M, Ramezani G, Karimi E, Hayat AA, Faghihi SA, Keshavarzi MH. A comparison of the effects of teaching through simulation and the traditional method on nursing students' self-efficacy skills and clinical performance: a quasi-experimental study. BMC Nurs. 2022 Oct 20;21(1). https://doi.org/10.1186/s12912-022-01065-z

15. Jallad ST, Işık B. The effectiveness of virtual reality simulation as learning strategy in the acquisition of medical skills in nursing education: a systematic review. Ir J Med Sci. 2021 Jul 5; 191(3): 1407–1426. https://doi.org/10.1007/s11845-021-02695-z

16. Labrague LJ, McEnroe-Petitte DM, Bowling AM, Nwafor CE, Tsaras K. High-fidelity simulation and nursing students' anxiety and self-confidence: A systematic review. Nurs Forum. 2019 Mar 10;54(3): 358–368. https://doi.org/10.1111/nuf.12337.

17. Park S, Hur HK, Chung C. Learning effects of virtual versus high-fidelity simulations in nursing students: a crossover comparison. BMC Nurs. 2022 Apr 27;21(1): 1–9. https://doi.org/10.1186/s12912-022-00878-2

18. Ashouri E, Sheikhaboumasoudi R, Bagheri M, Hosseini S, Elahi N. Improving nursing students' learning outcomes in fundamentals of nursing course through combination of traditional and e-learning methods. Iran. J. Nurs. Res. 2018;23(3):217-21.

https://doi.org/10.4103/ijnmr.IJNMR_79_17

19. Widiasih R, Komariah M, Pramukti I, Susanti RD, Agustina HS, Arifin H, et al. VNursLab 3D Simulator: A Web-Based Nursing Skills Simulation of Knowledge of Nursing Skill, Satisfaction, and Self-Confidence among Nursing Students. Sustainability. 2022 Apr 19;14(9):4882. https://doi.org/10.3390/su14094882

20. Nielsen B, Harder N. Causes of Student Anxiety during Simulation: What the Literature Says. Clin Simul Nurs. 2013 Nov;9(11):e507–12. https://doi.org/10.1016/j.ecns.2013.03.003

21. Hollenbach PM. Simulation and Its Effect on Anxiety in Baccalaureate Nursing Students. Nurs Educ Perspect. 2016;37(1):45-47. https://doi.org/10.5480/13-1279