Salud, Ciencia y Tecnología. 2024; 4:945
doi: 10.56294/saludcyt2024945

METHODOLOGICAL ARTICLE

Enhancement of clinical skills through virtual reality: a proposal for training certified nursing assistant

Mejora de las habilidades clínicas a través de la realidad virtual: una propuesta para la formación de técnicos de enfermería

Miriam Tesouro Dorribo[1], Isabel Alonso-Rodríguez[1], María Carmen Martínez-Murciano[2], Anthea Gara Santos-Álvarez[3], David Pérez Jorge[3]

[1]University Francisco de Vitoria, Madrid, Spain.
[2]University Fernando Pessoa Canarias, Las Palmas de Gran Canaria, Spain.
[3]University of La Laguna, Santa Cruz de Tenerife, Spain.

Cite as: Tesouro Dorribo M, Alonso-Rodríguez I, Martínez-Murciano MC, Santos-Álvarez AG, Pérez DJ. Enhancement of clinical skills through virtual reality: a proposal for training certified nursing assistant. Salud, Ciencia y Tecnología. 2024; 4:945. https://doi.org/10.56294/saludcyt2024945

Submitted: 06-01-2024 **Revised:** 25-03-2024 **Accepted:** 16-05-2024 **Published:** 17-05-2024

Editor: Dr. William Castillo-González

ABSTRACT

Introduction: integrating virtual reality (VR) in education is emerging as a transformative tool to improve practical learning. This proposal asks about its application within the training of certified nursing assistant to improve students' practical skills in training.
Objectives: the main objective is to assess whether VR technology can improve understanding of complex concepts and skills in nursing education. This involves evaluating the effectiveness of VR in fostering meaningful, self-directed learning experiences that potentially prepare students more effectively for the health workforce.
Methods: implementing a pilot VR program within a controlled educational environment is proposed. The impact of this integration will be assessed through surveys and analysis of academic performance, focusing on the acquisition of professional skills and competencies.
Results: expected outcomes include greater student participation and better learning outcomes. The work highlights the benefits of VR in improving in-depth understanding of procedures and concepts through immersive experiences.
Conclusions: the expected benefits after the incorporation of VR in nursing training include an improvement in the professional qualifications of students and an innovation through the introduction of immersive learning methodologies. Despite the potential challenges of its implementation, the results are expected to support the integration of VR as a complementary educational tool, reducing the gap between traditional learning and technological advancement in nursing education.

Keywords: Education; ICT; Innovation; Nursing Assistant; Simulation; Virtual Reality.

RESUMEN

Introducción: la integración de la realidad virtual (RV) en la educación se perfila como una herramienta transformadora para mejorar el aprendizaje práctico. Esta propuesta se plantea su aplicación dentro de la formación de técnicos auxiliares de enfermería para mejorar las habilidades prácticas de los estudiantes en formación.
Objetivos: el objetivo principal es evaluar si la tecnología de RV puede mejorar la comprensión de conceptos y habilidades complejas en la formación de enfermería. Se trata de evaluar la eficacia de la RV para fomentar experiencias de aprendizaje significativas y autodirigidas que potencialmente preparen a los estudiantes de forma más eficaz para el personal sanitario.

Métodos: se propone la implementación de un programa piloto de RV dentro de un entorno educativo controlado. El impacto de esta integración se evaluará mediante encuestas y análisis del rendimiento académico, centrándose en la adquisición de habilidades y competencias profesionales.
Resultados: los resultados esperados incluyen una mayor participación de los estudiantes y mejores resultados de aprendizaje. El trabajo destaca los beneficios de la RV para mejorar la comprensión en profundidad de procedimientos y conceptos a través de experiencias inmersivas.
Conclusiones: los beneficios esperados tras la incorporación de la RV en la formación enfermera incluyen una mejora en la cualificación profesional de los estudiantes y una innovación a través de la introducción de metodologías de aprendizaje inmersivo. A pesar de los retos potenciales de su implementación, se espera que los resultados apoyen la integración de la RV como herramienta educativa complementaria, reduciendo la brecha entre el aprendizaje tradicional y el avance tecnológico en la formación de enfermería.

Palabras clave: Auxiliar de Enfermería; Educación; Innovación; Realidad Virtual; Simulación; TIC.

INTRODUCTION

The paradigm shift in education triggered by the New School movement in the late 19th century and the subsequent advance of the constructivist model, has profoundly altered teaching and learning perspectives. This paradigm shift, as argued by,[1] emphasises the need for a more active role of students and aligns with the vision,[2] who highlight the importance of methodologies that promote bidirectional interaction in the learning process.[1,2] For several decades now, the phenomenon of digital transformation has been affecting society, and more specifically classrooms.[3,4] A clear example is the use of Extended Reality (XR-VR and AR) as it provides qualitative changes in knowledge construction, bringing dynamism and facilitating the understanding of theoretical content.[5,6]

The healthcare professions have not been left untouched by these advancements. Simulation, as highlighted by,[7] is an established method that allows healthcare students to practice clinical skills without compromising patient safety. This technique is particularly appropriate in the Vocational Training cycle of certified nursing assistant, where Virtual Reality (VR) emerges as a natural evolution of simulation, providing immersive practical experiences that enhance student preparation for real patient contact.[7,8]

Vocational Training (VT), within which certified nursing assistant is framed, faces the challenge of incorporating innovative methodologies that are in line with the ongoing digital trans-formation, as is the case with other teaching or courses belonging to the Spanish educational system.[9-11]. As[12] also emphasizes the importance of using technology as a didactic resource to improve the educational process. In particular, VR offers an opportunity to overcome the limitations of space and resources which often restrict the conduct of practical exercises.[13,14]

The potential of VR to strengthen the practical teaching of certified nursing assistant is supported by labor market data reflecting high demand in this sector.[15] Therefore, VT needs to provide not only theoretical knowledge but also practical skills where VR can play a key role in education by fostering the experience of content through visualization.[16,17,18]

However, the introduction of VR in VT poses significant challenges. It is imperative that both students and teachers develop digital skills and receive the appropriate institutional support for the effective integration of these technologies into education.[19] Thus, the use of ICT in the classroom leads to a change in the role of teachers, becoming facilitators and guides in the teaching-learning process.[10,20]

Studies by[21] and[22] suggest that although the presence of VR in education is increasing, there is a lack of comprehensive and systematic research examining its impact on teaching and learning processes. Existing research tends to focus on small samples and specific contexts, limiting the generalizability of findings.

This gap in the scientific literature indicates a significant opportunity for the development of this proposal. It is proposed to design a thorough study that not only does assess the efficacy of VR as an educational tool in certified nursing assistant, but also explores students' and teachers' perceptions of its use and examines the necessary conditions for its effective implementation. It will seek to answer fundamental questions about how VR can enhance meaningful learning, which pedagogical strategies are most effective in its integration, and how the use of VR can influence students' academic and professional performance.

The relevance of this research lies in its potential to influence educational policies and pedagogical practices at both national and international levels. If VR effectively implements, it could revolutionize the way future healthcare professionals are trained in competencies for their promotion and in the confidence needed to face current challenges of work environment.[23,24,25]

The methodology to be used will include both quantitative and qualitative analyses, ranging from controlled experiments to case studies and surveys. Differences be-tween traditional education and that incorporating VR

will be examined to provide a detailed assessment of its impact. The perspectives of students and teachers will be considered to ensure that the results are relevant and applicable.

Ultimately, the proposed research seeks to bridge the gap in existing literature, provide empirical data to substantiate the adoption of VR in VT, and develop a framework for the implementation of this technology that can be replicated and adapted to other educational contexts. The convergence of education and digital technology is inevitable and potentially transformative; this study aims to pave the way for VT in certified nursing assistant to successfully and responsibly lead this change.

Proposal for the development of innovation

The Vocational Training Centre in Ourense is seeking to innovate in its teaching of the Intermediate certified nursing assistant cycle through the integration of Virtual Reality (VR) to enrich both theoretical and practical learning. VR will facilitate the understanding of anatomy and physiology, proving especially beneficial for students with and without Specific Educational Support Needs (SESN). Tools such as Paint 3D and CoSpaces will be used. The implementation will be evaluated with an experimental group and a control group to measure the effectiveness of VR in the educational process, all within a detailed timetable of activities.

The proposed innovation project for the Vocational Training Centre in Ourense aims to integrate Virtual Reality (VR) technology into the teaching of the Intermediate Level of certified nursing assistant, where health and administrative training are currently offered. This integration aims to complement teaching methodologies and provide a more interactive and realistic approach.

The center, which is private and subsidized, hosts 60 certified nursing assistant students distributed in two classes of 30 students each. The predominant methodology is lecture-based classes supported by textbook content projections and includes dynamics such as clinical simulation and the use of mannequins. Techniques such as Game-Based Learning and gamification are also applied, with resources such as explanatory videos and five desk-top computers per workshop-classroom.

The inclusion of VR in the classroom is considered beneficial for both neurotypical students and those with Specific Educational Support Needs (SESN), enhancing tangibility and realism in the learning of theories and practices. Recent studies, such as those,[26,27] highlight the benefits of VR in the education of students with Autism Spectrum Disorder (ASD) and dyslexia, improving motivation, social interaction, perception, orientation, memory, and attention. However, warn of the need for an initial assessment to adapt digital resources to the specific needs of each student.[26,27,28]

The general objective of this proposal is to design an intervention programme that implements VR in certified nursing assistant classrooms. The specific objectives are to improve learning in anatomy and physiology, to foster motivation through virtual simulations, to implement practical methodologies to achieve greater autonomy in learning, and to improve the perception of academic competence through virtual immersion.

To achieve these objectives, tools such as Paint 3D, Google's Blocks, and "CoSpaces Solutions" are proposed, the latter offering a gallery of designed 3D objects allowing their properties to be modified. In addition, the "VISALio Project" of the National Autonomous University of Mexico provides computed tomography images for teaching anatomy, accessible through both VR headsets and mobile devices.

VR will be implemented in the Basic Nursing Techniques Training Module, integrating into all the Work Units dealing with anatomy and physiology. Activities will be carried out that will cover all the specific objectives, changing the anatomical area of study for each one.

The initial evaluation will serve on the one hand, to analyze the center’s situation, and, on the other hand, to detect any existing needs. Subsequently, certified nursing assistant, Group A will act as the experimental group with VR, while Group B will serve as a control and will not receive VR, which means it will continue with a traditional methodology. The final evaluations will measure the outcomes after the implementation or non-implementation of VR and will assess the differences at the beginning and the end of the course (or before and after implementation).

For effective integration into the classroom, sessions will be organized where students can view anatomical structures in VR after the theoretical exposition. In addition, weekly VR review sessions will be set up for each unit for two months to reinforce learning throughout the school year. With the use of this approach, it is expected that knowledge will be consolidated and intensified over time.

At last, a final evaluation will be carried out to analyze the results of the implementation and to develop conclusions from the data obtained. A general timeline will provide a temporal guide of all to the phases and tasks of the project (table 1).

Table 1. Timetable

Project phases		Sept	Oct	Nov	Dic	Jan	Feb	Mar	Abr	May	Jun
Reality analysis		X									
Programme development and design		X									
Implementation	Actions										
	1		X	X							
	2			X	X						
	3				X	X					
	4					X	X				
	5						X	X			
	6							X	X		
	7								X	X	
Final assessment, results and conclusions											X

In order to implement this innovative project this innovative project, it is essential to restructure the certified nursing assistant classroom to create an environment conducive to learning with virtual reality (VR). With a space of 150m² available, the classroom will be divided into three specific zones: an 80m² area for theoretical teaching, a 35m² area for traditional practice, and another 35m² area especially equipped for VR sessions, to ensure the safety of the students.

With the current classroom equipment, which includes five desktop computers and a projector, and the acquisition of economical VR glasses like Google Cardboard, which can be used with smartphones provided by either the students or the center, the integration of VR into the study of anatomy and physiology can begin. The Trinus Cardboard VR application will allow the connection of PCs and smartphones (available at https://trinusvirtualreality.com), while the Holotomy software from the VISALio project (available at https://www.visalio.com) and the Anatomy Learning application (available at https://anatomylearning.com), offering free content, will be the main re-sources for the VR sessions. These technological resources will be incorporated into all the activities planned for the project (figure 1).

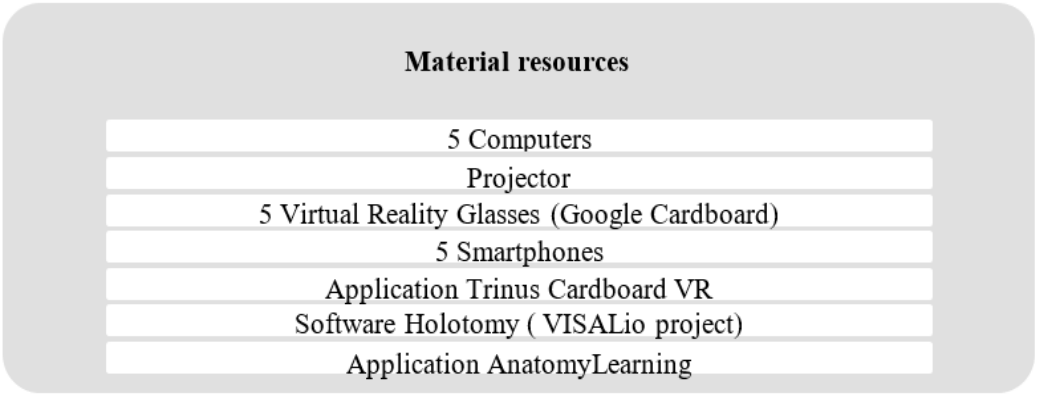

Figure 1. Material resources for each of the activities

Additionally, it is essential to train teachers in the efficient use of Virtual Reality (VR) methodologies in order to maximize their educational potential.[29] With the acknowledgement of the benefits derived from this pedagogical innovation, it would be appropriate to extend the application of VR beyond the experimental group. The goal would be to incorporate it into other thematic areas and subjects, increasing its impact on the learning process, which would require support in the form of co-financing for new programs and educational materials, as well as investment in specialized teacher training, thus ensuring a comprehensive use of technological resources for educational development.

In conclusion, this proposed innovation project for the Vocational Training center in Ourense seeks to revolutionize certified nursing assistant health education through the implementation of VR, benefiting learning and inclusion, and providing a more interactive and comprehensive approach to the health curriculum, with a special focus on the learning of human anatomy and physiology.

https://doi.org/10.56294/saludcyt2024945

Implementation procedure

The integration of Virtual Reality (VR) into the curriculum for the Basic Nursing Techniques course of the certified nursing assistant cycle represents a cutting-edge pedagogical approach. The initiative requires, in its initial phase, the commitment of the center's management and board of directors to facilitate the necessary funding for the required materials, which, while economically accessible, are essential to acquire. Subsequently, the faculty, students, and families will be in-formed about the benefits of incorporating this innovative project.

Teacher training in VR and digital skills to deliver content effectively is funda-mental, and this can be achieved through face-to-face, online, or blended training modalities, depending on what best suits the faculty's needs.

The success of the implementation of VR depends not only on the preliminary phase, but also on the progressive involvement of the entire faculty of the training cycle. It is necessary to address the decrease in motivation and commitment observed in students in recent years by introducing active and innovative methodologies that encourage greater attention and understanding of the educational material.[30] In addition, methodological adaptations necessary for students with Specific Educational Support Needs will be considered.[31,32]

For this, a comprehensive analysis will be carried out that will allow for designing and implementing an effective intervention, based on an initial needs assessment, thus facilitating the development of an action plan that will culminate in tangible results and valuable conclusions.

The use of VR will focus on the teaching of anatomy and physiology, aiming to promote a deeper and more meaningful understanding of concepts. Seven structured activities are planned to cover the contents of the musculoskeletal, neuroendocrine, cardiovascular, lymphatic, sensory organs, digestive, respiratory, and genitourinary systems. Each activity will consist of three sessions in which students, divided into groups of six, will interactively explore anatomical structures using VR glasses.

The proposed methodology represents an advancement over the traditional pedagogical practices of the center, which until now have incorporated emerging technologies such as gamification. By adding VR, the teaching-learning process is enriched, providing an immersive experience complementary to current educational techniques.

The participants of this project will be the faculty of the Basic Nursing Techniques module, who will receive prior training in VR; the center's management and board of directors, who will guarantee the necessary resources; and the students, whose motivation and active participation will be crucial for becoming the focus of the learning process.

Proposal for the analysis of results

An initial diagnostic assessment would be carried out for groups A and B, focusing on the fundamental aspects of anatomy and physiology, with the aim of determining the prior level of knowledge of the students at the beginning of the academic year. This assessment will consist of a multiple-choice test (pretest) that will cover the topics to be developed during the course. At the end of the implementation of the project with the experimental group, the same test (posttest) will be applied to both groups, A and B. In addition to gathering information on academic content, other scales will be ad-ministered, which are explained below.

Proposed instruments

Throughout the project, ongoing assessment will be carried out, documented weekly, to monitor progress and adapt the methodology as necessary. Finally, a comparative evaluation will be conducted, using pre- and post-intervention tests, and reevaluating the motivation and learning strategies scales to measure the impact of using Virtual Reality on learning. The academic results of the VR and non-VR groups will be compared to determine the effectiveness of this educational technology.

The project contemplates the use of three specific tools to evaluate several aspects of learning and student perceptions:

- EME-S Scale: Assesses academic motivation in post-compulsory secondary education through 28 items, using a scoring scale from 1 to 7 to measure the degree of agreement with the statements.
- Academic Competence subscale of PALDS-16: Measures the perception of academic competence in students with 4 items, also scored from 1 to 7 in terms of correspondence.
- Autonomous Work Strategies Questionnaire (CETA): This questionnaire analyses the autonomous learning strategies of students through 45 items distributed in 6 factors, with a scale from 1 to 5 that assesses the frequency of these strategies.

Additionally, the overall impact of the project will be assessed through a final questionnaire directed at students, teachers, and management, which will examine the effectiveness of the implementation of Virtual Reality (VR) in the educational process and its acceptance among those involved.

DISCUSSION

Augmented Reality (AR) and Virtual Reality (VR) are redefining traditional educational paradigms, offering considerable promise for enhancing student motivation and engagement in learning. The study by[33] in Córdoba, Spain, highlights the potential of these technologies to reinforce attention and knowledge retention among high school students. Such findings are consistent with the literature that points to VR as a means to increase educational quality, offering an immersive experience that goes beyond traditional teaching methods.[34]

The impact of VR on learning becomes even more evident when we consider its practical application in the healthcare sector. Authors as[35] highlight how VR enables experiences that closely mimic medical practice, contributing to meaningful and deep learning. This immersion in high-fidelity practical simulations,[36] not only improves academic performance but also prepares students for reallife situations, promoting the acquisition of crucial skills for their future professional lives.

Despite these benefits, the effective integration of VR in education requires a nuanced approach that takes into account the different abilities, experiences, and learning styles of students. For instance,[37] found that many students, although familiar with VR technology, are not aware of its educational potential. This suggests that familiarity with technology does not necessarily translate into an appreciation of its pedagogical value, which emphasises the need for carefully designing the implementation strategies. A relevant aspect in the adoption of VR in education is the change in the role of teachers. According to,[38] technology has transformed the educational environment, shifting the focus from the teacher as the central figure of knowledge to a role where the student becomes the protagonist of their own learning. This shift demands that teachers not only be facilitators but also designers of learning experiences that integrate VR effectively and meaning-fully into the curriculum.

Therefore, teacher training in VR is a key element for the success of its implementation. The training should not only focus on the technical handling of the technology but also on the design of pedagogical activities that use it as a tool to achieve specific learning outcomes. The study by[39] highlights a manifest need for more effective training plans that increase the satisfaction and competence of teachers in the use of ICT in the classroom.

However, the implementation of VR in the classroom is not without its challenges. Authors as[40] points out that the cost of VR simulators and their maintenance represents a significant barrier. In addition, the creation of high-quality 3D content can be costly and technically demanding. As[41] suggest seeking low-cost alternatives that can be equally effective, although they may not offer the same quality of simulation as the more expensive options.

In terms of content, it is imperative to address the ethical concerns that arise, especially in health sciences training. The use of VR simulators to study anatomy,[42] should never completely replace direct experience with human bodies, as this could lead to a disconnection between theory and actual practice, affecting the quality of medical education.

Moreover, we must be cautious about the addictive potential of immersive technologies. As[43] warn about the risk of addiction to VR among young people, which could have negative consequences for their physical and psychological well-being. It is crucial, then, to balance the integration of these technologies in education with a conscious approach to their possible adverse effects.[44]

In brief, the incorporation of VR and AR in the classroom, while promising, must be carefully considered and executed. It should be part of a holistic approach that includes training and professional development for teachers, thoughtful curricular integration, and continuous assessment to ensure that educational benefits are maximised, and potential risks are minimised. Education, through VR and AR, has the potential to enrich the learning experience, but it is informed and reflective pedagogy that will ensure that this potential is fully realised.

CONCLUSIONS

Simulation has been a key pedagogical tool in the health professions, and its evolution has enabled the integration of Virtual Reality (VR) as an innovative and powerful mechanism in health personnel training. This advancement has had a particularly significant impact on the preparation of certified nursing assistant, where VR has become a cornerstone for the practical study of anatomy and physiology, offering realistic and personalized experiences that were previously unattainable without physical presence in a lab or real clinical environment.

The integration of VR into healthcare education responds to the need to adapt teaching methods to the demands of a society that is in constant technological evolution. Education cannot remain oblivious to these changes, especially in a field as critical as health. VR stands as an educational solution that satisfies both the needs of the modern student, immersed in a digital world from birth, and the demands of specialized and rigorous training.

The proposal for innovation in the training of certified nursing assistant through VR at this specific educational

center has several advantages, among which are the increase in student motivation and attention, the promotion of meaningful learning, and the transformation of the student's role from a passive agent to an active one. This is added to the ability of VR to energize the educational process, improving communication between teacher and student, and adapting methodologies to a more interactive and visual model. Additionally, VR enables constructivist learning, generating new skills and competences that are fundamental in the health sector.

However, the path towards the implementation of this technology is not without obstacles. Identified drawbacks include the high initial economic cost of some simulators and their maintenance, the scarcity of applications, the difficulty in creating specific three dimensional scenarios, and the need for mobile devices with the internet access. However, these challenges, are not insurmountable and can be tackled with a progressive and collaborative implementation strategy.

For these changes to be successful, it is essential synergy between the Public Ad-ministration, the management team, the teaching staff, and the students for these changes to be successful. A pragmatic approach might be the initial use of low-cost simulators or tools, which allow a gradual introduction of technology into the classrooms and facilitate the adaptation of all those involved.

Guidelines for the effective incorporation of VR into certified nursing assistant classrooms include the gradual introduction of this technology into the Basic Nursing Techniques Training Module, carrying out activities throughout the school year to ensure continuous and profound learning. Furthermore, a modification of the current classroom infrastructure is proposed to incorporate the necessary equipment, while taking advantage of the free applications available for the study of anatomy.

Teacher training is another fundamental pillar of this proposal, as it guarantees that facilitators are prepared to guide and optimize the use of VR in the educational process. The assessment of changes perceived by the students and the resulting academic performance will serve to adjust and improve the proposal, thus ensuring that VR becomes a true catalyst for educational quality and academic performance in the center.

In summary, the implementation of VR in certified nursing assistant training is an innovative pedagogical strategy that promises to improve the quality of education and prepare students for a healthcare labor market that increasingly demands more digital and specialized technical skills. With the right guidance, resources, and institutional support, certified nursing assistant will be able to benefit from an enriched learning environment that will ultimately lead to better patient care and attention.

REFERENCES

1. Narváez E. Una mirada a la escuela nueva. Educere. 2006;10(35):629-636

2. Cárdenas Cordero NM, Guevara Vizcaíno CF, Moscoso Bernal SA, Álvarez Lozano, MI. Metodologías activas y las TICs en los entornos de aprendizaje. Revista Conrado. 2023;19(91): 397-405. https://conrado.ucf.edu.cu/index.php/conrado/article/view/2971/2864

3. León FM, Barberán JM, Pérez-Jorge D, Leiva JJ. Videoconference in academic tutoring: A case study. Asian Social Science. 2018;14(2):49. https://doi.org/10.5539/ass.v14n2p49

4. Area-Moreira M, Santana Bonilla PJ, Sanabria Mesa AL. La transformación digital de los centros escolares. Obstáculos y resistencias. Digital Education Review. 2020;37:15-31. https://doi.org/10.1344/der.2020.37.15-31

5. Coicaud SM. Ampliar, mezclar, virtualizar. Perspectivas digitales inmersivas para aprender y enseñar. Educação em Foco. 2019;22(38):139-157. https://doi.org/10.24934/eef.v22i38.2896

6. Yusef Contreras VA, Sanhueza Ríos GA, Seguel Palma FA. Importancia de la simulación clínica en el desarrollo personal y desempeño del estudiante de enfermería. Ciencia y Enfermería. 2021; 27:1-13. https://doi.org/10.29393/CE27-39ISVF30039

7. Urra Medina E, Sandoval Barrientos S, Irribarren Navarro F. El desafío y futuro de la simulación como estrategia de enseñanza en enfermería. Investigación en Educación Médica. 2017;6(22):119-125. https://doi.org/10.1016/j.riem.2017.01.147

8. Idrovo-Iñiguez EP, Moscoso-Bernal SA. Realidad virtual en el desarrollo de enseñanza-aprendizaje en estudiantes de odontología. Revista Interdisciplinaria de Humanidades, Educación, Ciencia y Tecnología. 2022;8(4):243-266. https://doi.org/10.35381/cm.v8i4.851

9. Pérez-Jorge D, Gutiérrez-Barroso J, Castro-León F, Rodríguez-Jiménez MC, Márquez-Domínguez Y, González AI. Herramienta síncrona de comunicación para la mejora del asesoramiento, seguimiento y tutorización

del alumnado universitario: la experiencia del uso del WhatsApp. In Vega A, Stendardi D, (Coords.). De la innovación imaginada a los procesos de cambio (pp- 369-378). Universidad de La Laguna.

10. Pérez-Jorge D, Rodríguez-Jiménez M, Marrero-Rodríguez N, Pastor-Llarena S, Peñas MM. Virtual Teachers' Toolbox (VTT-BOX)-the experience of the Costa Adeje International School and the University of La Laguna. Int J Interact Mobile Technol. 2020a;14(13):212-229. https://doi.org/10.3991/ijim.v14i13.14109

11. Pérez-Jorge D, Rodríguez-Jiménez MC, Gutiérrez-Barroso J, Castro León F. Training in digital skills in early childhood education teachers. The case of the University of La Laguna. International Journal of Interactive Mobile Technologies. 2020b;14(20):35-49. https://doi.org/10.3991/ijim.v14i20.17339

12. Rodríguez Izquierdo RM. Repensar la relación entre las TIC y la enseñanza universitaria: Problemas y soluciones. Profesorado. Revista de Currículum y Formación de Profesorado. 2011;15(1):9-22. https://www.redalyc.org/pdf/567/56717469002.pdf

13. Oliveros-Castro S, Núñez-Chaufleur C. Posibilidades educativas de la realidad virtual y la realidad combinada: Una mirada desde el conectivismo y la bibliotecología. Revista Saberes Educativos. 2020;(5):46-62. https://doi.org/10.5354/2452-5014.2020.57783

14. Romero López D, De Benito Crosetti B. Diseño de una propuesta didáctica para el uso de simuladores virtuales en la rama sanitaria de Formación Profesional. Revista Interuniversitaria de Investigación en Tecnología Educativa. 2020;(8):1-16. https://doi.org/10.6018/riite.383431

15. Boletín Trimestral del Mercado de Trabajo Estatal 4o trimestre 2022 (Observatorio de las Ocupaciones del SEPE). Servicio Público de Empleo Estatal; 2022. Recovered from: https://sepe.es/HomeSepe/que-es-el-sepe/comunicacion-institucional/publicaciones/publicaciones-oficiales/listado-pub-mercado-trabajo/boletin-trim-mercadotrabajo.html

16. Aznar Díaz I, Romero Rodríguez JM, Rodríguez García AM. La tecnología móvil de Realidad Virtual en educación: Una revisión del estado de la literatura científica en España. EDMETIC, Revista de Educación Mediática y TIC. 2018;7(1):256-274. https://doi.org/10.21071/edmetic.v7i1.10139

17. Nieto Maldonado J. Sistema VR configurable para entrenamiento en enfermería [Thesis degree]. Cataluña: Universitat Politècnica de Catalunya. Departament de Ciències de la Computació; 2020. Recovered from: http://hdl.handle.net/2117/192817

18. Valarezo-Guzmán GE, Sánchez-Castro XE, Bermúdez-Gallegos C, García-Alay R. Simulación y realidad virtual aplicadas a la educación. RECIMUNDO. 2023;7(1):432-444. https://doi.org/10.26820/recimundo/7.(1).enero.2023.432-444

19. Zempoalteca Durán B, Barragán López JF, González Martínez J, Guzmán Flores T. Teaching training in ICT and digital competences in Higher Education System. Apertura. 2017;9(1):80-96. https://doi.org/10.32870/Ap.v9n1.922

20. Magallanes Rodríguez JS, Rodríguez Aspiazu QJ, Carpio Magallón ÁM, López García MR. Simulación y realidad virtual aplicada a la educación. RECIAMUC. Saberes del Conocimiento. 2021;5(2):101-110. https://reciamuc.com/index.php/RECIAMUC/article/view/651

21. Menjivar Valencia E, Sánchez Rivas E, Ruiz Palmero J, Linde Valenzuela T. Revisión de la producción científica sobre la Realidad Virtual entre 2016 y 2020 a través de Scopus y WOS. EDMETIC. 2021;10(2):26-55. https://doi.org/10.21071/edmetic.v10i2.13422

22. Marrero Galván JJ, Hernández Padrón M. La trascendencia de la realidad virtual en la educación STEM: Una revisión sistemática desde el punto de vista de la experimentación en el aula. Bordón. Revista de Pedagogía. 2022;74(4):45-63. https://doi.org/10.13042/Bordon.2022.94179

23. Pérez-Jorge D, Barragán-Medero F, Herrera-Hernández JM, Falcón-Chueca S. Health Programme Evaluation and the Improvement of Quality of Care: An OrthogeriatricsProgramme Case Study. Eurasia Journal of Mathematics, Science and Technology Education. 2019;15(11):2-13. https://doi.org/10.29333/ejmste/108330.

24. Pérez-Jorge D, González-Luis MA, Rodríguez-Jiménez MC, Ariño-Mateo E. Educational Programes for the Promotion of Health at School: A Systematic Review. Int. J. Environ. Res. Public Health. 2021;18(20):10818. https://doi.org/10.3390/ijerph182010818

25. Rodríguez Torres ÁF, Orozco Alarcón IKE, Delgado Campoverde ME, Curay Carrera PA, Barros Castro HA. La simulación clínica en la formación de profesionales de la salud: Una oportunidad para aprender a aprender. Domino de las Ciencias. 2023;9(2):438-454. https://doi.org/10.23857/dc.v9i1

26. Lorenzo Lledó G, Lorenzo-Lledó A, Lledó Carreres A, Pérez-Vázquez E. Creación de un entorno de realidad virtual inmersiva para la comunicación e interacción social: Estudio piloto en alumnado con trastorno del espectro autista. Revista de Educación a Distancia (RED). 2023;23(73). https://doi.org/10.6018/red.539141

27. Rodríguez Cano S, Delgado Benito V, Casado Muñoz R, Cubo Delgado E, Ausín Villaverde V, Santa Olalla Mariscal G. Tecnologías emergentes en educación inclusiva: Realidad virtual y realidad aumentada. Proyecto europeo FORDYSVAR. Revista INFAD de Psicología. International Journal of Developmental and Educational Psychology. 2021;2(1):443-450. https://doi.org/10.17060/ijodaep.2021.n1.v2.2093

28. Silva Sández G, Rodríguez Miranda FDP. Una mirada hacia las TIC en la educación de las personas con discapacidad y con trastorno del espectro autista: Análisis temático y bibliográfico. EDMETIC, Revista de Educación Mediática y TIC. 2018;7(1):43-65. https://doi.org/10.21071/edmetic.v7i1.10030

29. Sousa-Ferreira R, Campanari-Xavier RA, Rodrigues-Ancioto AS. La realidad virtual como herramienta para la educación básica y profesional. Revista Científica General José María Córdova. 2021;19(33):223-241. https://doi.org/10.21830/19006586.728

30. Pérez-Jorge D, Martínez-Murciano MC. Gamification with Scratch or App Inventor in Higher Education: A Systematic Review. Future Internet. 2022;14(12):374. https://doi.org/10.3390/fi14120374

31. González-Herrera AI, Pérez-Jorge D, Díaz-Fuentes Y, Rodríguez-Jiménez MDC, Ariño-Mateo E. Dealing with stress and intervention models in families with children with autism spectrum disorder. Humanities and Social Sciences Communications. 2021;8(1):1-6. https://doi.org/10.1057/s41599-021-00988-3

32. Pérez-Jorge D, González-Herrera AI, González-Afonso M, Santos-Álvarez AG. Reality and Future of Interculturality in Today's Schools. Education Sciences. 2023;13(5):525. https://doi.org/10.3390/educsci13050525

33. Marín-Díaz V, Sampedro Requena BE, Vega Gea E. La realidad virtual y aumentada en el aula de secundaria. Campus Virtuales. 2022;11(1):225-236. https://doi.org/10.54988/cv.2022.1.1030

34. Campos Soto N, Ramos Navas-Parejo M, Moreno Guerrero AJ. Realidad virtual y motivación en el contexto educativo: Estudio bibliométrico de los últimos veinte años de Scopus. Alteridad. 2019;15(1):47-60. https://doi.org/10.17163/alt.v15n1.2020.04

35. Lara Alcívar DK, Muñiz Toala JP, Giler Alcívar MF, Alcívar Solorzano DM. La realidad virtual como recurso y herramienta útil para la docencia y la investigación Virtual reality as a useful resource and tool for teaching and research A realidade virtual como recurso e ferramenta útil para ensino e pesquisa. Polo del Conocimiento. 2022;7(8):594-606. http://sedici.unlp.edu.ar/handle/10915/14205

36. Toala-Palma JK, Arteaga-Mera JL, Quintana-Loor JM, Santana-Vergara MI. La Realidad Virtual como herramienta de innovación educativa. EPISTEME KOINONIA. 2020;3(5):270. https://doi.org/10.35381/e.k.v3i5.835

37. Miguélez-Juan B, Núñez Gómez P, Mañas-Viniegra L. La Realidad Virtual Inmersiva como herramienta educativa para la transformación social: Un estudio exploratorio sobre la percepción de los estudiantes en Educación Secundaria Postobligatoria. Aula Abierta. 2019;48(2):157-166. https://doi.org/10.17811/rifie.48.2.2019.157-166

38. García Sánchez M del R, Reyes Añorve J, Godínez Alarcón G. Las Tic en la educación superior, innovaciones y retos / The ICT in higher education, innovations and challenges. RICSH Revista Iberoamericana de las Ciencias Sociales y Humanísticas. 2018;6(12):299-316. https://doi.org/10.23913/ricsh.v6i12.135

39. Álvarez JF. Evolución de la percepción del docente de secundaria español sobre la formación en TIC. Edutec. Revista Electrónica de Tecnología Educativa. 2020;71:1-15. https://doi.org/10.21556/edutec.2020.71.1567

40. Ortega-Rodríguez PJ. De la Realidad Extendida al Metaverso: Una reflexión crítica sobre las aportaciones a la educación. Teoría de la Educación. Revista Interuniversitaria. 2022;34(2):189-208. https://doi.org/10.14201/teri.27864

41. Raya L, Toharia P, García M. Metodología de enseñanza de Realidad Virtual mediante un laboratorio de bajo coste. Actas de las I Jornadas de Innovación y TIC Educativas. 2010;1(1):69-72. http://www.gmrv.es/~lraya/actasJITICE.pdf

42. Zambrano Ferre A. Aspectos Éticos del uso de la Realidad Virtual en la Enseñanza de la Anatomía Humana. Fermentum. Revista Venezolana de Sociología y Antropología. 2005;15(44): 426-438. https://www.redalyc.org/articulo.oa?id=70504408

43. Sucari Sucari YV, Quispe Mamani U, Duran Ponce GS. El ensayo: Impactos del Metaverso en la sociedad. Waynarroque - Revista de ciencias sociales aplicadas. 2022;2(4):103-109. https://doi.org/10.47190/rcsaw.v2i4.41

44. López García C. El desarrollo de la competencia digital. Una reflexión desde el punto de vista de la adicción a las TIC en la educación. In: López García C, Manso J. editores. Transforming education for a changing world (pp. 1-380). Adaya Press; 2018. https://doi.org/10.58909/ad18638271

FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; David Pérez-Jorge.
Data curation: Isabel Alonso-Rodríguez; David Pérez-Jorge; María Carmen Martínez-Murciano.
Formal analysis: Isabel Alonso-Rodríguez; David Pérez-Jorge; Anthea Gara Santos-Álvarez.
Research: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; David Pérez-Jorge.
Methodology: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; David Pérez-Jorge; Anthea Gara Santos-Álvarez.
Project management: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; María Carmen Martínez-Murciano.
Resources: Isabel Alonso-Rodríguez; Anthea Gara Santos-Álvarez.
Software: Miriam Tesouro Dorribo.
Supervision: Isabel Alonso-Rodríguez; David Pérez-Jorge; Anthea Gara Santos-Álvarez.
Validation: Isabel Alonso-Rodríguez; David Pérez-Jorge.
Display: Miriam Tesouro Dorribo.
Drafting: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; David Pérez-Jorge.
Writing: Miriam Tesouro Dorribo; Isabel Alonso-Rodríguez; David Pérez-Jorge; Anthea Gara Santos-Álvarez.