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SYSTEMATIZATION

OF EXPERIENCES IN VIRTUAL REALITY LABORATORIES

SISTEMATIZACIÓN DE EXPERIENCIAS EN LABORATORIOS DE REALIDAD VIRTUAL

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ABSTRACT

Medix project Lab, implemented at the Specialized Institute of Health Professionals (IEPROES), aims to improve the practical training of nursing students through the use of virtual reality (VR) technology. This lab allows students to practice clinical procedures in a safe, controlled, and realistic environment, helping to reduce the anxiety and stress commonly experienced during hospital internships. Through the use of 3D simulation, students interact with clinical scenarios that allow for procedural repetition and real-time feedback, reinforcing technical skills and increasing confidence before facing real-life situations. The project was implemented at several IEPROES locations, reaching 220 students. Results obtained through surveys and interviews revealed that, although students valued simulation as a valuable complement, they recognized that it cannot fully replace practical experience in hospitals. The project evaluation highlights the importance of incorporating emerging technologies into health education and recommends continued expansion and optimization of the lab.

Keywords:

Virtual reality, nursing education, clinical simulation, educational technology, medical procedures, teaching innovation, practical training, health education.

RESUMEN

El proyecto Medix Lab, implementado en el Instituto Especializado de Profesionales de la Salud (IEPROES), tiene como objetivo mejorar la formación práctica de los estudiantes de enfermería mediante el uso de tecnología de realidad virtual (RV). Este laboratorio permite a los estudiantes practicar procedimientos clínicos en un entorno seguro, controlado y realista, lo que contribuye a reducir la ansiedad y el estrés que comúnmente se experimentan durante las prácticas hospitalarias. Mediante el uso de simulación en 3D, los estudiantes interactúan con escenarios clínicos que permiten la repetición de procedimientos y la retroalimentación en tiempo real, lo que refuerza las habilidades técnicas y aumenta la confianza antes de enfrentar situaciones reales. El proyecto se implementó en varias sedes de IEPROES, alcanzando a 220 estudiantes. Los resultados obtenidos a través de encuestas y entrevistas revelaron que, aunque los estudiantes valoraron la simulación como un complemento valioso, reconocieron que no puede sustituir completamente la experiencia práctica en hospitales. La evaluación del proyecto resalta la importancia de incorporar tecnologías emergentes en la educación en salud, y se recomienda continuar con la expansión y optimización del laboratorio.

Palabras clave:

Realidad virtual, educación en enfermería, simulación clínica, tecnología educativa, procedimientos médicos, innovación en enseñanza, formación práctica, educación en salud.

INTRODUCTION

Nursing education has traditionally been a process that combines theoretical training with practical training in real-life clinical settings, allowing students to acquire essential skills for their professional performance. However, technological advancements and the challenges posed by the COVID-19 pandemic have prompted the need to adapt to new teaching methodologies (González et al., 2022). The global health crisis caused an abrupt change in traditional teaching methods, especially in healthcare settings, where hospital practices were limited due to the risk of contagion. This situation forced educational institutions to seek alternatives that would guarantee the continuity of practical learning without compromising the safety of students and patients.

The reviewed studies coincide in highlighting the value of virtual reality simulation as a transformative educational tool in nursing training. Escandell Rico & Pérez Fernández (2024) conducted a systematic review demonstrating that virtual simulation significantly contributes to the development of clinical competencies by allowing safe and repetitive practice of procedures without putting real patients at risk. The authors emphasize that this methodology fosters the acquisition of technical skills, decision-making in controlled environments, and a reduction in students' anxiety when facing real clinical situations, thus becoming a key component of contemporary medical education.

Similarly, Pastuña-Doicela et al. (2023) analyzed nursing students' perceptions of virtual clinical simulation during the pandemic, finding high acceptance and recognition of its pedagogical value. Their study highlights that, despite technological and connectivity limitations, virtual simulation made it possible to maintain continuity in practical training, encouraging self-directed learning, critical reflection, and adaptation to high-fidelity simulated clinical scenarios. According to the authors, this experience reinforces the notion that digital simulation not only temporarily replaces in-person practice but also expands the possibilities for interactive and collaborative learning.

Choi (2022) evaluated the acceptance and usability of a virtual reality simulation designed for learning wound dressing. The results showed high student satisfaction with the interface and immersive experience, as well as significant improvement in knowledge retention and technical accuracy. The author argues that the combination of interactivity, immediate feedback, and visual realism enhances student engagement and elevates the quality of the learning process, positioning virtual simulation as a viable and effective complement to traditional clinical practice.

Finally, Kiegaldie &Shaw (2023) assessed the effectiveness and feasibility of virtual reality simulation in nursing education, emphasizing its ability to create flexible, safe, and scalable learning environments. Their findings demonstrate that this technology not only improves clinical performance but also increases students' motivation, self-confidence, and satisfaction. The authors stress that implementing these technological resources requires pedagogical planning, faculty support, and continuous evaluation, yet the benefits fully justify their integration as a structural element of health education programs.

Together, these contributions demonstrate that virtual simulation has become an innovative axis in nursing education, combining realism, accessibility, and effectiveness to strengthen both clinical skills and the reflective and emotional competencies of future healthcare professionals.

In this context, the Specialized Institute of Health Professionals (IEPROES) implemented the Medix project Lab, a virtual reality (VR) laboratory focused on training nursing students. Developed with advanced 3D simulation technology, this laboratory offers a controlled environment in which students can practice clinical procedures repeatedly, without the risks associated with real-life practices (Instituto Especializado de Profesionales de la Salud, 2022). Through this innovative tool, students have the opportunity to familiarize themselves with procedures and reduce the anxiety and stress they commonly experience when facing high-pressure situations in hospital settings.

Virtual reality in healthcare education allows for complete immersion in the learning process, providing an interactive experience tailored to each student's needs. Unlike traditional methods that use mannequins or cadavers to practice procedures, virtual simulation offers a higher level of realism, allowing procedures to be repeated as many times as necessary, with real-time feedback. This trial-and-error capability in a safe and controlled environment strengthens students' technical skills, ensuring they are better prepared for their internships in hospitals and other healthcare facilities.

Medix project Lab is part of a global trend toward integrating emerging technologies into healthcare education. Arrieta De La Rosa's (2024) research provides an updated and well-founded view of the use of virtual reality as an innovative tool in the training of nursing professionals, highlighting its potential to improve the acquisition of clinical and procedural skills in safe simulated environments.

The article emphasizes that this technology allows students to practice complex interventions, make decisions in high-pressure settings, and strengthen critical thinking without compromising patient safety. It also highlights that virtual reality enhances learner immersion and motivation, increasing knowledge retention and promoting a more interactive and personalized learning experience. The author also

highlights the associated challenges, such as the need for teacher training, technological investment, and ongoing evaluation of the effectiveness of these virtual environments. Overall, the study provides a solid foundation for advancing the integration of virtual reality into nursing curricula, fostering education aligned with the demands of contemporary healthcare systems and with a focus on quality of care.

In countries across Europe and Asia, the implementation of VR simulators has already proven effective in training healthcare professionals, and Medix Lab is positioned as one of the first initiatives of its kind in Latin America. With this approach, IEPROES seeks not only to innovate in the teaching-learning process, but also to prepare nursing students to face the challenges of the 21st century, where technology will play a key role in healthcare.

This article aims to evaluate the impact of the Medix project Lab in the training of nursing students at IEPROES, highlighting its effectiveness, relevance, and sustainability (IEPROES, 2022). Furthermore, the aim is to identify lessons learned and best practices obtained during the implementation of the lab, in order to provide recommendations for replicating this experience in other educational institutions, both nationally and internationally.

MATERIALS AND METHODS

Medix project Lab, implemented at the Specialized Institute of Health Professionals (IEPROES), employed advanced virtual reality (VR) technology to enhance nursing students' practical learning. To evaluate the impact of this educational tool, a methodological approach combining quantitative and qualitative techniques was adopted, providing a comprehensive understanding of the project and its outcomes.

The study's methodological approach included both quantitative and qualitative analysis. The quantitative phase focused on the administration of structured surveys to students who participated in the use of the VR lab, as well as to teachers who implemented this technology in their classes. The surveys were designed to measure user perceptions of the lab's effectiveness, its usefulness for learning, and its impact on anxiety reduction. The student sample included 220 participants from the three IEPROES locations, selected using stratified random sampling, which allowed for adequate representation of the different regions and academic levels.

On the other hand, the qualitative component of the evaluation was based on in-depth interviews and focus groups, which provided a more detailed insight into students' and teachers' experiences with the laboratory. Interviews were conducted with teachers who implemented Medix. Lab, as well as representatives from IEPROES, the developer VERTEX, and experts from BIDLab , who shared their perspectives on the project's impact and challenges. A focus group was also held with 20 students, in which topics related to user perceptions of the platform, its effectiveness in reducing anxiety and stress, and recommendations for improving the learning experience were discussed.

Data collected from both the surveys and interviews were analyzed in detail. Quantitative data were processed using statistical tools, allowing trends and patterns to be identified in student responses, such as overall satisfaction with the platform and perceptions of its usefulness for practical training. Regarding qualitative data, thematic analysis was used to identify the main categories that emerged during the interviews and focus groups, such as improved technical skills acquisition, repeatability of procedures, and difficulties related to using the technology.

The study population consisted of the 220 students who participated in the use of Medix Lab , as well as teachers and key representatives from IEPROES, VERTEX, and BIDLab . Participant selection was based on probability sampling for students, ensuring a representative sample from the institute's three locations. For teachers and experts, non-probability sampling was used, selecting those who played a key role in project implementation and supervision.

From an ethical standpoint, the confidentiality of the data collected was guaranteed, and all participants were informed about the purpose of the evaluation and gave their consent to participate in surveys, interviews, and focus groups. This methodology provided a holistic view of Medix 's impact. Lab in the training of nursing students, identifying both their strengths and areas that require improvement to optimize their effectiveness.

RESULTS AND DISCUSSION

Medix project Lab was implemented at the Specialized Institute of Health Professionals (IEPROES) with the goal of improving the practical training of nursing students through the use of virtual reality (VR) technology. Given the COVID-19 pandemic, the need for alternatives to in-person practice became even more urgent, prompting the creation of a virtual lab to simulate clinical procedures in a safe environment.

Medix laboratory The Lab was developed using the Simbotic 3D simulation engine, designed to create realistic virtual environments. Students were able to interact with these environments through VR headsets and specialized controls, replicating clinical procedures such as catheter placement or vein cannulation (Instituto Especializado de Profesionales de la Salud, 2022). Throughout the project, nursing students had the opportunity to perform repeated practice sessions, allowing them to become familiar with the procedures and reducing the anxiety associated with real-life hospital placements.

During the initial phase, pilot tests were conducted at the San Salvador campus, involving 50 students and 5 teachers. The tests identified strengths and areas for improvement in the simulation, both from a technical and pedagogical perspective. As the project progressed, implementation was expanded to other IEPROES campuses, reaching a total of 220 students.

Faculty were also actively involved in the implementation, providing feedback on the integration of virtual reality into the academic curriculum (Instituto Especializado de Profesionales de la Salud, 2022). Initial results were positive, with students highlighting the laboratory's usefulness in preparing for real-life clinical placements. However, some mentioned that, although the VR lab was valuable, it could not fully replace direct clinical experience with patients.

Analysis of preliminary results indicated that virtual reality significantly contributed to improving students' technical skills by providing them with a controlled environment in which to practice without the pressure of making mistakes (Instituto Especializado de Profesionales de la Salud, 2022). Furthermore, students reported a decrease in anxiety and stress associated with hospital practices, suggesting that virtual simulation has a positive impact on their confidence and willingness to undertake real-life procedures.

Throughout the project's implementation, adjustments were made to the simulation scenarios, incorporating new procedures and optimizing interaction with the virtual environment. The final phase of the project included a comprehensive evaluation, which provided quantitative and qualitative data on the laboratory's effectiveness. The final project results highlighted the importance of Medix. Lab as a complementary tool that, while not a substitute for in-person practice, reinforces students' preparation before facing real-life situations.

CONCLUSIONS

Medix project Lab has proven to be an innovative and effective educational tool for training nursing students at the Specialized Institute of Health Professionals (IEPROES). The implementation of virtual reality in the teaching-learning process has allowed students to practice clinical procedures in a safe, controlled, and realistic environment, significantly reducing the anxiety and stress associated with hospital practices. Through simulation, students were able to hone their technical skills and increase their confidence before facing real-life situations in healthcare facilities.

The results obtained during the pilot phase and the project expansion indicated that the virtual reality laboratory was perceived as a useful tool for practical learning. Although some students pointed out that the virtual experience cannot completely replace direct practice with patients, most recognized the value of simulation as an essential complement to their training. The ability to perform repeated practice sessions without risk of error, combined with immediate feedback, facilitated more effective and less stressful learning.

The project has also highlighted the importance of integrating emerging technologies into healthcare education, aligning itself with international trends promoting the use of virtual reality in professional training. The collaboration between IEPROES, BIDLab, and VERTEX has been key to the project's success, enabling the development of an innovative and scalable platform that could be replicated in other educational institutions in the region.

To ensure the project's sustainability, it is essential to continue updating the technology, training faculty, and expanding the laboratory to new locations. Furthermore, it is recommended to continue optimizing simulation scenarios and expanding the range of clinical procedures available so that students can receive more comprehensive and diverse training.

In conclusion, Medix Lab represents a valuable addition to the traditional educational model, providing nursing students with more robust and effective preparation before entering real-life practice, and positioning IEPROES as a leader in the integration of technology into healthcare education in El Salvador.

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Conflicts of Interest:

The author declares no conflicts of interest.

Author Contributions:

Ángel Eduardo Medina-Salmerón: Conceptualization, data curation, formal analysis, investigation, methodology, supervision, validation, visualization, writing – original draft, and writing, review, and editing.