



Empowering Nursing through Virtual Simulation for Enhanced Learning and Care Quality in Chronic Conditions (ENViSion Project)

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Abstract

Virtual simulation technologies are increasingly recognized as essential tools in nursing education, providing safe, interactive, and immersive environments for clinical training. These tools enable students to develop decision-making skills, enhance critical thinking, and bridge the gap between theoretical knowledge and real-world clinical practice. This study aimed to explore and characterize the use of the BodyInteract® virtual simulator in nursing education, focusing on students' perceptions of its impact on learning. Using a mixed-methods approach, data were collected from 328 final-year nursing students actively engaging with the platform. Among them, 75 participants completed an online questionnaire, which included Likert-scale items and open-ended questions to capture both quantitative and qualitative insights. Additionally, platform usage reports were analysed, examining metrics such as simulation completion rates, time spent per session, and types of clinical scenarios practised. The findings revealed that students highly valued the simulator as a learning tool, particularly in enhancing their confidence and comprehension of complex clinical situations. Many participants highlighted the simulator's interactivity and its alignment with real-world patient care scenarios as key benefits. However, they also identified areas for improvement, such as the need for better curricular integration and expanded scenario diversity. This study contributes to the growing body of evidence supporting the use of virtual simulation in nursing education. It underscores the importance of incorporating student feedback to refine pedagogical approaches and optimize the simulator's impact. Future research should explore the long-term effects of simulator-based learning on clinical competencies, decision-making skills, and overall care quality.

Keywords: Education, technology, nursing students, digital pedagogy, student perceptions

1. Introduction

Virtual simulation has emerged as a transformative tool in nursing education, reshaping the way students acquire clinical knowledge and develop essential skills. Its impact extends beyond

theoretical learning, significantly influencing students' ability to translate knowledge into effective care. Evidence suggests that virtual simulation enhances nursing students' comprehension and retention of clinical concepts, leading to measurable improvements in learning outcomes. Studies have demonstrated that students who engage in virtual simulation-based training exhibit greater knowledge retention both immediately after the intervention and in long-term assessments when compared to those exposed solely to traditional teaching methods (Padilha et al., 2019). By offering immersive and interactive learning environments, virtual simulation replicates real-world clinical complexities, enabling students to apply theoretical knowledge in meaningful, practice-oriented ways (Jans et al., 2023; Koukourikos et al., 2021).

A key advantage of virtual simulation is its capacity to provide structured, repetitive practice in fundamental clinical procedures. This includes critical skills such as venipuncture, urinary catheterization, airway management, and cardiopulmonary resuscitation, all performed in a controlled, risk-free environment. Unlike traditional skills training, which is often constrained by time and resource limitations, virtual simulation allows students to refine their techniques through repeated exposure to diverse case scenarios. This iterative process reduces procedural errors, enhances skill mastery, and fosters a higher level of preparedness for real-life clinical encounters (Qiao et al., 2023; Rourke, 2020). By engaging with a variety of clinical scenarios, students develop the confidence and competence necessary to manage complex healthcare situations effectively.

Beyond technical proficiency, virtual simulation has been shown to significantly enhance nursing students' self-efficacy—their belief in their ability to perform clinical tasks successfully. Research has indicated that students who regularly utilize virtual simulation tools report up to a 19% increase in confidence levels regarding clinical judgment and decision-making (Jans et al., 2023). This increased self-assurance is crucial in bridging the gap between theoretical knowledge and practical application, helping students transition more smoothly into clinical environments. The ability to engage in independent learning and receive immediate, personalized feedback further reinforces students' sense of preparedness, reducing anxiety and increasing their willingness to engage in hands-on care (Salam et al., 2024; Qiao et al., 2023).

In addition to improving confidence, virtual simulation contributes to higher levels of student engagement and satisfaction. The interactive and immersive nature of these tools fosters active learning, allowing students to experiment with different decision-making strategies and observe the outcomes of their clinical choices. Features such as personalized feedback, scenario repetition, and autonomous practice create a sense of mastery and motivation to learn (Padilha et al., 2019; Qiao et al., 2023). Furthermore, virtual simulation platforms offer flexibility in terms of access, enabling students to practice at their own pace and revisit challenging concepts as needed. This adaptability is particularly beneficial for accommodating diverse learning styles and reinforcing key competencies over time (Jans et al., 2023).

Another benefit of virtual simulation is its role in promoting critical thinking and clinical reasoning. By presenting dynamic, evolving scenarios, these tools require students to assess information, prioritize interventions, and make real-time clinical decisions based on simulated consequences. Structured simulation exercises with explicit learning objectives help students systematically identify problems, anticipate complications, and coordinate appropriate interventions (Padilha et al., 2019). This emphasis on active decision-making strengthens students' problem-solving abilities, preparing them to navigate the complexities of modern healthcare settings with greater autonomy and efficiency (Sim et al., 2022).

Furthermore, virtual simulation addresses significant challenges in clinical education, such as limited access to placements, variability in case exposure, and ethical concerns related to

safety. By providing standardized yet diverse clinical encounters, simulation ensures that students acquire experience in managing a broad spectrum of conditions, including rare or high-risk scenarios that may not be encountered frequently in traditional clinical training (Jans et al., 2023; Rourke, 2020). This exposure is particularly valuable in preparing students for real-world practice, ensuring that they develop the adaptability required to respond to different care contexts.

From a psychological perspective, virtual simulation fosters a safe and supportive learning environment in which students can practice without fear of harm or judgment. This perception of psychological safety is crucial in promoting learning, as it allows students to build confidence, learn from errors, and refine their clinical judgment without the pressure of real-time interactions (Koukourikos et al., 2021; Qiao et al., 2023).

Given its substantial benefits, there is a growing consensus among researchers and educators that faculties should invest in the development and integration of virtual simulation laboratories equipped with advanced technologies. For optimal effectiveness, faculty members should receive specialized training in designing scenarios, facilitating debriefing sessions, and providing evidence-based feedback to enhance learning experiences (Koukourikos et al., 2021; Salam et al., 2024). Additionally, institutions should consider incorporating virtual simulation as a core component of curricula, ensuring that it complements traditional methodologies and aligns with learning objectives.

Therefore, virtual simulation represents a major advancement in nursing education, offering an effective strategy for developing competence, decision-making confidence, and critical thinking skills. Existing evidence supports the sustained benefits of simulation for professional performance and care quality, underscoring the importance of its systematic integration into curricula. However, challenges remain regarding the optimal pedagogical design and implementation of such tools.

In recent years, the BodyInteract® clinical virtual simulator has been adopted by numerous health education institutions worldwide as a tool to enhance training. Presenting interactive case scenarios enables students to engage in realistic decision-making, refine diagnostic reasoning, and develop treatment planning skills within a safe and controlled environment.

Within this context, the present study aimed to explore and characterize the use of the BodyInteract® virtual simulator in nursing education, with a specific focus on students' perceptions of its effectiveness in supporting their learning and clinical preparedness using scenarios of patients with chronic conditions.

2. Methods

A mixed-methods approach was employed to comprehensively analyse data from 328 final-year nursing students, divided into four classes (A, B, C, D), who had active profiles on the BodyInteract® platform. This methodological design allowed for a combination of quantitative and qualitative insights, providing a more comprehensive understanding of students' experiences and engagement with virtual simulation in clinical education. This was the first time that students had contact with the BodyInteract® platform, and an introductory session was conducted to explain its use. During this session, the objectives of the virtual simulation were presented, along with the platform's main features and guidance for completing clinical cases. The aim of this introduction was to ensure that all students had a basic and consistent understanding of the virtual learning environment, thereby promoting a more equitable and informed experience throughout the use of the tool.

2.1. The BodyInteract® Platform

BodyInteract® (<https://bodyinteract.com/>) is an advanced clinical virtual simulator designed to enhance healthcare education by providing interactive patient case scenarios. The platform enables students to engage in realistic decision-making processes, practice diagnostic reasoning, and develop treatment planning skills within a risk-free environment. The simulator features real-time adaptive feedback, allowing learners to assess their clinical decisions and refine their approach based on evidence-based guidelines. Its integration into nursing curricula supports the reinforcement of both theoretical knowledge and practical competencies.

Four distinct clinical scenarios were made available to the students, each addressing the management of a person with a chronic condition. These scenarios were designed to reflect diverse clinical contexts and included cases related to oncological, cardiovascular, respiratory, and endocrine-metabolic diseases. The simulations were structured to represent both inpatient care and outpatient consultation settings, allowing students to engage with a variety of clinical situations and care environments. This diversity aimed to enhance students' clinical reasoning and decision-making skills by exposing them to different trajectories of chronic illness and levels of healthcare provision.

2.2. Data Collection Procedures and Instruments

The students had access to four clinical scenarios, which they were able to solve during classroom sessions. A debriefing was conducted with all students at the end of the class. After the session, students retained access to the platform, allowing them to practice solving clinical scenarios at their own convenience.

Data were gathered from two primary sources: platform usage reports, and online questionnaire.

2.2.1. Platform Usage Reports

Objective data were extracted directly from the BodyInteract® system, including metrics such as the number of simulations initiated and completed, time spent per session, and performance scores in key clinical domains (e.g., physical examination, diagnosis, and treatment planning). These quantitative indicators provided a structured assessment of students' engagement and performance within the simulation environment.

2.2.2. Online Questionnaire

A structured questionnaire developed by the authors was administered to 75 students, incorporating both Likert-scale items (1-5) and open-ended questions. The Likert-scale items evaluated dimensions such as students' perceived understanding of clinical content, confidence in clinical situations, interest in topics, and ease of use. Open-ended responses allowed for qualitative insights into students' experiences, perceptions of platform usability, and suggestions for improvement.

2.3. Ethical Considerations

The study adhered to ethical research principles to ensure the protection of participants' rights and confidentiality. Participation in the study was voluntary, and informed consent was secured from all students. They were provided with detailed information regarding the study objectives, data confidentiality measures, and their right to withdraw at any stage without consequences. To maintain anonymity, all collected data were de-identified and analysed in aggregate form.

2.4. Data Analysis

Quantitative data from platform reports and questionnaire responses were analysed using descriptive statistics, including means, standard deviations, and completion rates, to assess students' engagement and performance within the simulation. Additionally, correlation analyses were conducted to explore relationships between perceived dimensions of the learning experience (e.g., understanding of clinical content and confidence in clinical situations).

Qualitative responses from the open-ended questionnaire items underwent thematic analysis, following Bardin's framework (Valle & Ferreira, 2025), to identify key themes related to students' perceptions of the simulator's strengths, challenges, and suggested improvements.

3. Results

The analysis of platform usage metrics and questionnaire responses provided valuable insights into students' engagement with the BodyInteract® simulator and their performance in virtual clinical scenarios. A total of 300 simulations were initiated by students, of which 172 (57.3%) were successfully completed. The average number of simulations per student was 2.29, with a completion rate of 1.85. The cumulative time spent using the simulator across all participants amounted to 2495 minutes, highlighting a moderate level of engagement with the platform.

3.1. Student Performance in Clinical Simulations

Performance scores varied across different clinical competencies assessed within the simulator, including recommended responses, physical examination, diagnostic activity, and treatment planning. As shown in Table 1, the highest performance was observed in the domain of diagnostic activity, with an average accuracy of 72%, followed closely by treatment planning (72%) and recommended responses (73%). However, performance in physical examination was relatively lower, with an average of 37%, indicating potential difficulties in this domain (Table 1).

Table 1: Simulation Usage and Student Performance

Students' Classes	Recommended Response (%)	Physical Exam (%)	Diagnostic Activity (%)	Treatments (%)	Overall Score (%)
A	81	43	71	74	56
B	72	28	65	63	50
C	69	44	78	75	62
D	71	32	72	77	57
TOTAL	73	37	72	72	56

These findings suggest that while students demonstrated strong clinical reasoning and treatment decision-making skills, challenges remained in conducting comprehensive physical examinations. This may reflect limitations in virtual simulations for assessing hands-on skills or potential gaps in students' clinical assessment training.

3.2. Perception of Impact on Learning

The questionnaire results (Table 2) indicate that students perceived BodyInteract® as an effective tool for enhancing their understanding of clinical content, increasing confidence in clinical situations, and stimulating interest in the covered topics. The highest-rated dimension was "interest in topics" ($M = 4.32$, $SD = 0.70$), suggesting that the interactivity and realism of clinical scenarios were motivating factors for student engagement. This finding reinforces the idea that gamification and interactive technology can enhance interest in learning complex healthcare concepts. Understanding of clinical content was also highly rated ($M = 4.23$, $SD = 0.73$), indicating that the platform facilitated the consolidation of theoretical knowledge and its

application in practical settings. Exposure to interactive clinical scenarios likely helped students reinforce their learning, fostering clinical reasoning and evidence-based decision-making. Confidence in acting in clinical situations received an average score of 4.13 (SD = 0.72), suggesting that practising with the virtual simulator helped students feel more prepared to handle clinical challenges in the future. The simulation allowed for the experimentation of different intervention strategies in a safe environment, free from the risks associated with real-life clinical practice. Additionally, ease of use was positively evaluated (M = 4.13, SD = 0.76), indicating that most students found the navigation and interaction with BodyInteract® intuitive and accessible. However, variability in the number of attempts and cases completed (M = 3.03, SD = 1.72) suggests that engagement with the platform differed among participants, potentially influenced by factors such as time availability, prior experience with simulation, and individual learning preferences.

Table 2. BodyInteract® usage and impact on learning

	N	Mean	SD	Min	Max
D1- Understanding Clinical Contents	75	4.23	0.73	2	5
D2- Confidence in Clinical Situations	75	4.13	0.72	2	5
D3- Interest in Topics	75	4.32	0.70	2	5
D4- Ease of Use	75	4.13	0.76	2	5
Number of Cases and Attempts	75	3.03	1.72	0	10

*5-point Likert scale (1-5)

Correlation analysis (Table 3) revealed statistically significant associations. The strong correlation between understanding clinical content and confidence in clinical situations ($r = 0.76$, $p < 0.01$) suggests that better assimilation of concepts contributes to greater security in practical applications. Similarly, interest in topics showed a positive relationship with both understanding ($r = 0.70$, $p < 0.01$) and clinical confidence ($r = 0.72$, $p < 0.01$), indicating that higher cognitive and emotional engagement can enhance learning and preparedness for clinical practice.

Although the number of attempts and cases completed showed only a weak correlation with understanding ($r = 0.28$, $p < 0.05$) and clinical confidence ($r = 0.27$, $p < 0.05$), these results suggest that increased exposure to the simulator may have a positive impact on learning, though it is not a decisive factor on its own. Therefore, integrating BodyInteract® into the curriculum should focus not only on usage frequency but also on strategies that guide and maximize the learning process.

Table 3. Correlation between platform usage and perception of impact on learning

	D1	D2	D3	D4	D5
D1- Understanding Clinical Contents	1.00				
D2- Confidence in Clinical Situations	0.76**	1.00			
D3- Interest in Topics	0.70**	0.72**	1.00		
D4- Ease of Use	0.56**	0.61**	0.58**	1.00	
Number of Cases and Attempts	0.28*	0.27*	0.21	0.15	1.00

(* $p < 0.05$; ** $p < 0.01$)

3.3. Students' Experiences (Qualitative Data)

Students consistently highlighted the BodyInteract® platform as a dynamic, interactive, and pedagogically valuable tool that enhances clinical learning. Their qualitative responses revealed key thematic areas reflecting both the strengths and challenges associated with its integration into nursing education.

Relevance and Engagement: Participants emphasized the platform's ability to bridge the gap between theoretical concepts and clinical application. The interactive nature of the simulator facilitated active engagement and reinforced critical thinking and decision-making skills, contributing to a more immersive and realistic learning experience. Students particularly appreciated how BodyInteract® exposed them to diverse clinical scenarios, enabling them to practice clinical reasoning in a controlled yet authentic environment.

Technical Challenges: Despite the platform's perceived benefits, students reported encountering technical constraints that hindered their learning experience. These included difficulties with system availability, occasional connectivity issues, and restricted access to a diverse range of clinical cases. Such limitations impacted their ability to engage fully with the simulator and apply their learning in varied contexts.

Suggested Improvements: Several students advocated for increased integration of BodyInteract® into practical teaching sessions. They proposed expanding the range of clinical cases available, ensuring consistent technical support, and allowing extended access beyond scheduled class times to facilitate self-directed learning.

Teaching Strategies: A recurring theme in student feedback was the need for structured and guided learning experiences. Many expressed a preference for instructor-led clinical case simulations rather than fully autonomous group activities, citing the benefits of expert guidance in refining clinical reasoning skills. Additionally, they recommended dedicating more curricular time to BodyInteract®-based learning, reinforcing its role as a core component of nursing education.

4. Discussion

The results of this study provide valuable insights into the role of the BodyInteract® virtual simulator in enhancing nursing students' learning experiences, particularly in terms of understanding clinical content, boosting confidence, and stimulating interest in clinical topics. Overall, the findings suggest that BodyInteract® is a promising pedagogical tool for bridging the gap between theoretical knowledge and clinical practice. These results are consistent with existing literature that underscores the effectiveness of simulation-based learning in healthcare education (McGaghie et al., 2010).

The high score for the impact on promoting interest in topics ($M = 4.32$, $SD = 0.70$) reflects the effectiveness of the BodyInteract® platform in engaging students. The interactive nature of virtual simulations, which replicate real-world clinical scenarios, is often cited as a key factor in enhancing student motivation and engagement (Sim et al., 2022). This finding is consistent with previous research that suggests interactive simulations not only capture attention but also increase intrinsic motivation for learning (Padilha et al., 2019). In nursing education, fostering interest in clinical topics is crucial for deeper learning and long-term retention, particularly in areas that are complex or abstract (Koukourikos et al., 2021). The positive perception of interest can be attributed to the platform's capacity to immerse students in realistic scenarios, stimulating cognitive and emotional engagement with the subject matter.

Results suggested that BodyInteract® significantly contributes to students' comprehension of clinical knowledge ($M = 4.23$, $SD = 0.73$). This aligns with existing literature that demonstrates the effectiveness of virtual simulations in bridging the gap between theoretical learning and practical application (Qiao et al., 2023). Virtual simulators provide an opportunity for students to practice decision-making and problem-solving in a safe environment, which is critical for developing clinical reasoning skills (McGaghie et al., 2010). The ability to engage with

complex clinical cases and receive real-time feedback allows students to consolidate their theoretical knowledge and apply it in realistic contexts, thereby enhancing their understanding (Jans et al., 2023).

Students' confidence in clinical situations was also notably high ($M = 4.13$, $SD = 0.72$), which supports the notion that simulation-based learning plays a critical role in building self-efficacy. Research has emphasized the importance of self-efficacy in learning, particularly in the context of healthcare, where students' confidence in their ability to perform clinical tasks is essential for both learning and eventual clinical performance (Salam et al., 2024). The use of virtual simulation allows students to engage in decision-making and practice clinical skills in a controlled, low-risk environment, which helps to mitigate anxiety and boost confidence (Tolarba, 2021). This finding echoes similar results from studies in healthcare education, where simulation-based learning has been shown to improve students' self-confidence and preparedness for real clinical practice (Padilha et al., 2019).

The ease of use of BodyInteract® ($M = 4.13$, $SD = 0.76$) was highly rated by students, which suggests that the platform's user-friendly design facilitated its integration into the students' learning process. The importance of usability in educational technologies has been well-documented in the literature, with studies showing that students are more likely to engage with platforms that are intuitive and easy to navigate (Co et al., 2023). A positive user experience encourages regular interaction and maximizes the potential educational impact of digital tools (Jans et al., 2023). The ease of use is particularly important in clinical simulation, where a complex or unintuitive interface could create frustration and hinder learning (Rourke, 2020).

The number of attempts and cases completed ($M = 3.03$, $SD = 1.72$) shows variability in student engagement with the platform. This is not surprising, as previous studies have highlighted that while simulation-based learning offers substantial benefits, the level of engagement can vary widely among students due to factors such as personal motivation, time availability, and prior experience with digital learning tools (Koukourikos et al., 2021). For instance, students with higher levels of motivation or those who value self-directed learning may engage more frequently with the platform, while others might require more structured guidance. This variability in usage underscores the need for targeted strategies to increase engagement, such as integrating platform use more fully into the curriculum or providing incentives for active participation (Padilha et al., 2019).

One of the key strengths of this study is the use of a mixed-methods approach, which allowed for both quantitative and qualitative insights into students' perceptions of the BodyInteract® platform. By analysing both usage metrics and subjective student feedback, this study provides a comprehensive evaluation of the platform's impact. Additionally, the high response rate for the online questionnaire (75 students) strengthens the validity of the findings, offering a robust representation of students' experiences.

Nevertheless, the study also has certain limitations. First, the data collection relied on self-reported perceptions, which are subjective and may be influenced by personal biases. While the Likert-scale responses provide useful quantitative insights, students may have provided socially desirable answers that do not fully reflect their true experiences with the platform. Second, the study sample was limited to final-year nursing students using BodyInteract®, which may not fully represent the experiences of students at other stages of their education or in other disciplines. Furthermore, while the study assessed students' perceptions, it did not directly measure the long-term impact of BodyInteract® on clinical performance in real-life settings, which could provide a more comprehensive evaluation of its effectiveness.

Despite these limitations, the study offers valuable contributions to the growing body of research on virtual simulation in nursing education. Future studies could address these limitations by including more diverse student populations, incorporating objective measures of clinical performance, and exploring the long-term effects of virtual simulation on clinical competence and care quality. In addition to the benefits demonstrated in this study, it is crucial to highlight that the effective integration of platforms such as BodyInteract® across diverse educational settings requires targeted pedagogical and institutional strategies. Implementation can be optimized through faculty development initiatives that prepare educators to design and facilitate simulation sessions aligned with specific curricular objectives. Moreover, adapting clinical scenarios to local needs - such as prevalent health conditions or available institutional resources - may enhance the contextual relevance of learning. In institutions with limited access to clinical placements, virtual simulation can serve a compensatory role, strengthening the acquisition of core clinical competencies. Therefore, nursing curricula should progressively incorporate these tools by combining virtual simulation with structured reflection, formative feedback, and integration with supervised clinical practice. This approach may foster more equitable, student-centred learning experiences that are sensitive to institutional and cultural variability in nursing education.

5. Conclusion

This study demonstrates that the BodyInteract® virtual simulator is a valuable tool in nursing education, fostering the development of critical skills such as clinical reasoning, decision-making, and treatment planning. The findings reveal that the platform significantly enhances students' understanding of clinical content, increases their confidence in clinical situations, and stimulates their interest in clinical topics. These outcomes suggest that virtual simulations are an effective means of bridging the gap between theoretical knowledge and practical application in a controlled, risk-free environment. Students' positive perceptions indicate that BodyInteract® can be a useful complement to traditional teaching methods, promoting deeper engagement and facilitating the integration of theory into practice.

The study highlights the importance of integrating such simulation technologies into nursing curricula to strengthen students' clinical competencies. Despite the overall positive feedback, challenges such as technical issues and limited access to clinical cases were identified, indicating the need for further refinement of the platform to enhance its functionality and accessibility. For future research, it would be valuable to assess the long-term impact of virtual simulation on clinical performance in real-world settings. Additionally, exploring the potential of combining virtual simulations with other pedagogic strategies could provide a more comprehensive understanding of how best to leverage these technologies in nursing education.

Acknowledgment

The authors would like to acknowledge the Health Sciences Research Unit: Nursing (UICISA:E), of the Nursing School of Coimbra (ESENfC). This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Ref^a. UIDB/00742/2020.

References

- Co, M., Chiu, S., & Cheung, H. (2023). Extended reality in surgical education: a systematic review. *Surgery*, 174(5), 1175-1183. <https://doi.org/10.1016/j.surg.2023.07.015>
- Jans, C., Bogossian, F., Andersen, P., & Levett-Jones, T. (2023). Examining the impact of virtual reality on clinical decision making—An integrative review. *Nurse Education Today*, 125, 105767. <https://doi.org/10.1016/j.nedt.2023.105767>
- Koukourikos, K., Tsaloglidou, A., Kourkouta, L., Papathanasiou, I. V., Iliadis, C., Fratzana, A., & Panagiotou, A. (2021). Simulation in Clinical Nursing Education. *Acta informatica medica*, 29(1), 15–20. <https://doi.org/10.5455/aim.2021.29.15-20>
- McGaghie, W., Issenberg, S., Petrusa, E., & Scalese, R. (2010). A critical review of simulation-based medical education research: 2003–2009. *Medical Education*, 44(1), 50-63. <https://doi.org/10.1111/j.1365-2923.2009.03547.x>
- Padilha, J., Machado, P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal of Medical Internet Research*, 21(3), e11529. <https://doi.org/10.2196/11529>
- Qiao, J., Huang, C., Liu, Q., Li, S., Xu, J., Li, L., Redding, S. & Ouyang, Y. Q. (2023). Effectiveness of non-immersive virtual reality simulation in learning knowledge and skills for nursing students: Meta-analysis. *Clinical Simulation in Nursing*, 76, 26-38. <https://doi.org/10.1016/j.ecns.2022.12.003>
- Rourke, S. (2020). How does virtual reality simulation compare to simulated practice in the acquisition of clinical psychomotor skills for pre-registration student nurses? A systematic review. *International journal of nursing studies*, 102, 103466. <https://doi.org/10.1016/j.ijnurstu.2019.103466>
- Salam, N., Abdallah, A., & El-Hay, S. (2024). Effect of Video Based Virtual Reality Simulation on Nursing Students Self-Efficacy, Satisfaction and Performance regarding selected procedures. *Tanta Scientific Nursing Journal*, 33(2), 129-147. https://tsnj.journals.ekb.eg/article_351215_92dc8e70d2b22685f2621fa7c5293e2a.pdf
- Sim, J., Rusli, K., Seah, B., Levett-Jones, T., Lau, Y., & Liaw, S. (2022). Virtual Simulation to Enhance Clinical Reasoning in Nursing: A Systematic Review and Meta-analysis. *Clinical simulation in nursing*, 69, 26–39. <https://doi.org/10.1016/j.ecns.2022.05.006>
- Tolarba, J. (2021). Virtual simulation in nursing education: a systematic review. *International Journal of Nursing Education*, 13(3), 48-54. <https://doi.org/10.37506/ijone.v13i3.16310>
- Valle, P., & Ferreira, J. (2025). Content analysis in the perspective of Bardin: Contributions and limitations for qualitative research in education. *Educação em Revista*, 41, e49377. <https://doi.org/10.1590/0102-469849377-t>