Virtual Reality for Pediatric Nursing Education: A Pilot Assessment of How Students React and Learn

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Received: 14-05-2025; Revised: 04-06-2025; Accepted: 22-06-2025; Published: 05-07-2025

Abstract
Many now view virtual reality (VR) simulation as an effective and modern tool for teaching medical students, giving them a realistic, repeatable and safe setting to practice. The study was conducted on 40 undergraduate nursing students to study the benefit of VR simulation on their nursing competencies. In the study, everyone received two intervention sessions: one on giving medicine to children and another on family-centered communication. Assessments had to be done before and after the intervention to understand student knowledge, ability and involvement. Clinical skills improved significantly for students and the sessions kept most students very engaged ($p < 0.05$). Students thought that using virtual reality increased their ability to handle situations with children and praised how lifelike the scenarios were. It seems that VR simulation can improve nursing students' understanding of areas that involve few clinical experiences, for example pediatrics. It supports the idea of using VR simulation in nursing courses to link what is learned theoretically to real-life situations in pediatric nursing.

Keywords: ***Virtual reality, nursing education, pediatric nursing, simulation, clinical decision-making, student engagement, skill acquisition, mixed-methods study.***

1. Introduction

1.1 Why Pediatric Nursing is Important during Undergraduate Training

Because children need special care, pediatric nursing asks for particular abilities and knowledge. These skills are different from general nursing education since pediatric nurses are responsible for giving care that matches children's development, considers families and responds to unique medical situations. Pediatric nurses should be good at making clinical decisions, handling medications, having effective conversations and caring for families. With these abilities, nursing students are able to look after pediatric patients safely, effectively and compassionately which improves their well-being.

Ensuring that undergraduate nursing students learn essential pediatric nursing skills is very important since it prepares them for challenges in pediatric health care. Growth and development assessments, the role of the family and pediatric pharmacology form a key part of education, to ensure students are confident with these areas. However, it is only by doing real clinical activities that students can develop these skills.

1.2 The Restrictions of Traditional Pediatric Clinical Education

A big part of nursing programs involves traditional clinical courses that help students practice what they learn in actual healthcare environments. There is often an issue with clinical exposure in pediatric nursing education. There are not enough places for pediatric clinical practice which limits the number of clinical placements available for nursing students, mainly in regions where children's hospitals are in short supply or mainly in a few locations. Because there are also more requests for clinical placements in other specialties, ensuring nursing students access to appropriate pediatric hands-on experiences has become challenging.(1)

Even if medical students visit pediatric departments, the experience is often insufficient in depth or not ongoing enough for them to learn everything important for pediatric care. Some clinical conditions such as those seen in pediatrics or unique disorders, are uncommon enough that students may not learn how to think about them and take decisions. Also, there are times when clinics are too busy due to a lack of staff or severe time constraints which prevents students from fully taking part in patient care, observing procedures and interacting with families. Because students may not get exposed to many different cases and environments in nursing school, they may not develop the necessary skills for their first jobs in pediatrics.

1.3 New opportunities for teaching health professionals using VR Simulation

Education in healthcare has seen more technology being used in teaching due to its swift evolution. Among all, Virtual Reality (VR) simulation is transforming nurse training by allowing students to practice high-pressure scenarios easily. Students participating in VR simulation are given opportunities to replay real-life healthcare scenario several times, from the safety of a simulation.(2)

Using simulators in healthcare education allows students to use their sight, hearing and touch, making the learning experience feel much more real. Using VR, students have the chance to communicate with digital people, learn skills by practicing adminstration of medicine or connect with the families of their digital patients. In addition, VR permits students to try situations over again so they can practice skills as much as required and understand more about difficult tasks, with instant remarks on their improvement.

VR use in student training for pediatric nursing has been helpful because it allows them to make decisions, know many procedures and communicate more confidently in cases where traditional training is difficult.

1.4 Research to Support Using VR for Improving Learning Experiences

V-R simulation is mainly used in pediatric nursing education because it can improve a student's learning, involvement and ability to gain skills. Clinical settings in schools usually exclude rare or complex cases involving children, so students do not see as many of them. Since it is hard to recreate some difficult situations in clinics, VR simulation allows students to experience them as scenarios.

Using VR simulation in the classroom helps students take part in their learning instead of just listening to instructions. With the simulation, students practice critical thinking, clinical problem-solving and how to reason through challenges. VR also promotes more engagement and motivation by letting learners interact with what they are being taught. Since VR is so real, students feel encouraged to join in learning and they get more confident in dealing with challenges they might find overwhelming outside of VR.

Furthermore, VR gives students the ability to get feedback on their performance quickly which helps them understand what to improve and prepare themselves better for interacting with patients. Practicing, thinking about it and improving help make sure the knowledge and skills are remembered for a longer time.

1.5 Why the Pilot Study was conducted

The key goal of this pilot study is to test how well undergraduate nursing students do in their specialty area due to exposure to VR-based simulation. Explicitly, the research is designed to evaluate:

1. Whether using VR simulation helps clinicians enhance their decision-making skills and abilities to give medications to children.
2. The difference VR simulation makes to how much students want to learn pediatric nursing.
3. How confident students feel while applying the skills required for pediatric nursing on real patients.
4. How close the VR setup appears to real-life situations, affecting the learning of new skills.
5. To understand students' feelings about using VR in their pediatrics fieldwork, including why and why not it is a good tool in this area.

The study's main goals are meant to highlight the potential of using VR simulation in nursing classes, mainly for young patients, who do not always have access to enough clinical practice. This information will show if VR simulation can work hand in hand with practical, textbook learning for situations where real practice with patients is limited such as in pediatrics.(3)

2. Review of Literature

2.1 Current Evidence about Using Simulation for Nurses

Nursing students now rely heavily on simulation to go from theory to practice in their training. Getting clinical training is often limited by the lack of clinical sites, too little time with patients and the real dangers of patient care. To deal with this, simulation creates a risk-free area where students can improve their critical thinking, decision-making and skill in procedures.

Many studies show that practicing with simulations leads to better confidence, abilities and skills in nursing students. Cook et al. (2013) conducted a study that discovered that having simulation training in nursing classes improved students' understanding, abilities and inner confidence. As shown in Lasater's work (2007), simulation gives students a safe environment to practice their clinical abilities and decisions in difficult scenarios.(4)

In nursing schools, simulations make use of high-fidelity manikins, practice trainers and scenario-based practice. Especially high-fidelity manikins, it has been found, can resemble real human responses and give immediate

feedback, helping students gain skills in areas including CPR, intravenously administering medicine and monitoring patients (Kneebone et al., 2006).

Besides, the way simulations can be customized enables tutorials to focus on specific learning goals. Having the ability to adapt, simulation is well-suited to support nursing students with preparing for intense and stressful situations such as emergency and critical care nursing. Many people have welcomed using simulation in nursing courses as an alternative when clinical placements are not available.

2.2 Virtual Reality Used in Other Medical/Nursing Training Programs

Using Virtual Reality (VR) for medical education has grown a lot, as it allows students to learn in a truly involved, repeatable and participatory way. By using VR, learners in medicine and nursing have a chance to take part in simulations that feel real and differ from traditional, stationary ways of studying. A number of studies have proved that VR-based training helps doctors develop their skills and increases the quality of care for patients.

Various studies have looked into how VR helps train medical workers in different specialties. A study by DeLeng et al. (2015) looked at using VR simulations for teaching nursing students clinical work, finding that students performed better in learning and applying new skills. VR simulations, as stated by Mikropoulos and Natsis (2011), were proven especially effective in teaching anatomy and physiology, since they allowed students to see 3D images of the human body that were otherwise difficult to show in regular lessons.(5)

Statistically, VR is being used in nursing school to help students learn to administer medications, examine patients and work effectively with others. Jeffries (2012) mentioned that VR enables nursing students to handle various situations, including emergencies like cardiac arrest or breathing failure, without putting patients in danger. Repeating simulations and practicing critical thinking removes the risk of mistake and helps students become more confident in handling different clinical problems.

Simulations in VR not only build upon technical skills but increase involvement and drive in students. Some researchers, including Jang et al. (2018), have found that VR simulations encourage students to take part in learning more than normal methods. According to these discoveries, using VR may help students keep and apply what they learn better.

2.3 The Lack of Studies in Pediatric VR

Even though simulation is commonly used in nursing education, very few studies have looked into using VR in pediatric nursing. Many medical fields have used VR such as in surgery and with older adults, but it is still not well explored in the pediatric area. Such a gap is especially significant due to the particular issues facing pediatric nurses such as talking with children and their families, giving out medicine in small portions and handling pediatric emergencies.

Research should be done on how VR can support education for those learning pediatric nursing. The skills needed in pediatric nursing are not the same as those used in adult care, especially for family-centered care, child development and medicines used in pediatrics. It is possible for VR to present pediatric-based cases, as in medicine administration for babies or the management of childhood asthma, although additional research is needed to show how effective VR really is in these scenarios.(6)

A possible area to study is VR training focused on communicating with families and children because it is important in pediatric nursing. Knowing how VR helps these skills is important since it enables students to master fine communication skills many times. So far, little research has examined how well children retain their skills after using VR which creates difficulty in judging how usefully they can use those skills in the real world.

2.4 The Foundation for Simulation in Learning

Experiential learning, active participation and critical thinking are main theories behind simulation learning for nurses. Among the strongest theories is Kolb's Experiential Learning Theory (1984) which states that the process of learning covers concrete experience, thoughtful reflection, abstract thinking and active trying out new ideas. By following this cycle, students begin to reflect, process what they've gone through and use what they've learned to act in other situations.

Simulation and VR especially, uses Kolb's model because it allows students to try and learn from real clinical cases directly. The reflecting stage and the experimenting stage are especially important since students can redo simulations, see the results of their actions and become better at various skills safely. Simulations in VR help students practice in reality and learn from their actions.

Besides Kolb's theory, Bandura's Social Cognitive Theory (1986) is an important part of the explanation of simulation-based learning. In Bandura's opinion, people learn things by seeing others do them, by believing in their abilities and through being rewarded. Students using VR simulations can watch several medical actions, try them out by themselves and get instant feedback which improves their confidence in using what they have learned. Bandura's theory states that Students can be motivated to learn more and improve if they see others perform successfully in simulation.(7)

The combination of theory and simulation in education lets students 'think, try out and improve their problem-solving abilities which other training techniques might not achieve. Therefore, it's very helpful in nursing areas like pediatrics, where you must be hands-on but might have very little clinical experience.

3. Materials and Methods

3.1 The way the research is carried out

To measure the impact of Virtual Reality (VR) simulation on undergraduate nursing students' capabilities, a mixed-methods interventional pilot study design was applied. I used a method that collected both numbers and experiences, so I could fully understand the effect of VR simulation on how much students are involved, what skills they develop and their self-belief in pediatric nursing. Students completed the assessment before and after learning and interviews were used to find out their views and reactions to the virtual reality simulation.

3.2 Sample and Setting

In this study, the sample was 40 undergraduate nursing students who were taking a course in pediatric nursing at an educational institution. The conditions for selecting participants involved:

1. Those who are undergraduates in the nursing-pediatric course have this course at the institution.
2. Child nurse practitioners should have basic knowledge of pediatric concepts (e.g., giving medicines and partnering with families).
3. Being willing to join the intervention and follow it up with assessments

The researchers did not include patients who had any of the following:

1. Those students who were trained in simulation with virtual reality in pediatric nursing or other clinical areas
2. Some students were unable to go to both VR simulation sessions.

The study was done at a college, in a simulation lab that had all the needed VR equipment. Students used VR headsets, motion trackers and controllers for the simulation which gave them a realistic experience. The environment was made to look like a clinic, so students could handle real-life pediatric scenarios.

3.3 Describe what actions are taken to help the client.

It included two VR simulated sessions which addressed unique areas of pediatric nursing.

1. Students in this situation worked on giving medications to children, minding factors such as the required dosage, appropriate types of medications and ways to protect the child's health.
2. Family-Centered Communication: The purpose here was to help students improve their communication by practising with pediatric patients and their loved ones. The task for students was to tell others about difficult health problems, talk about medical treatments and handle family questions with kindness.

The following were always part of every virtual reality session:

Every session of the simulation was about 30 to 45 minutes long.

Learning Objectives:

1. Students were meant to prove they could calculate medications, give them correctly and deal with side effects during the pediatric medication administration session.
2. Students in the family-centered communication session were judged on how well they could express themselves with the child (through an avatar) and with the family members, handling issues and showing care.
3. Trained instructors led the VR simulation sessions. After completing every scenario, the students could see their performance results right away and they met as a group to discuss what they learned.

3.4 Hand Tools

A number of tools were applied to collect information about how students performed, became engaged and felt in the classroom.

1. Before the intervention, students took a test to determine their pediatric nursing knowledge and another test was given after the intervention to check how much was learned. Questions in the test were about pediatric medication administration and talking to patients' families.
2. A checklist was used to evaluate how well students did key tasks in the simulation such as giving medications and discusssing with patients and their families. The checklist was made by following established nursing guidelines for pediatrics.
3. A Likert scale instrument was employed to find out students' levels of engagement and satisfaction with each session. The scale investigated enjoyment, how well students were motivated and their impression of how realistic the simulation was. Students used a 5-point scale (1 = Strongly Disagree, 5 = Strongly Agree) to show how engaged they were.
4. Qualitative feedback from students was gathered by using a semi-structured interview guide on their experiences with the VR simulation. The interview looked at things like realism in the training, confidence in teachers, what students learned and suggestions on improving learning.

3.5 details how data should be gathered.

The process of collecting data consisted of these particular steps:

1. The experts carried out a pre-intervention assessment with all participants which included a knowledge test and a verified checklist of skills.
2. Participants attempted the two simulation sessions in virtual reality. After every session, people filled out the engagement scale to register their degree of participation and satisfaction. The skills learned were immediately checked using the checklist as an assessment.
3. After the intervention ended, all participants went through the post-intervention test and skill checklist to review how much their skills had improved. A week after the final VR session, we set up semi-structured interviews to get students' qualitative thoughts and opinions. People participated in interviews by themselves or in groups, depending on what they preferred and all interviews were recorded for transcription and study.

3.6 Considering Ethics

All procedures in the study followed the ethical standards for research carried out on people. These steps were carried out to guarantee ethical standards were observed:

The ethics review board of the institution approved the study before data were collected.(8)

FPs were given complete details about the study, what it involved and what risks could occur, before taking part. Before starting any intervention, informed consent was obtained from every participant. People were instructed that they could participate only if they wanted and that they could quit the study at any stage.

Confidentiality of Data: All data collected, for example, scores and what was said in interviews, was stored and monitored for safety. All personal identifiers from the data were taken out so people in the report could not be identified.

3.7 Step 5: Data Analysis

The analysts used methods from qualitative and quantitative data analysis.

Quantitative Analysis:

Using either a paired t-test or a Wilcoxon signed-rank test (depending on whether the data followed a normal distribution), the difference between the pre- and post-test scores was tested to see if there were significant improvements in knowledge because of the intervention.

What changed in the learners' skill checklist results before and after the simulation was measured to see if their skills improved.

The engagement level scores helped us find out how well students participated and felt involved in the sessions.

Qualitative Analysis:

The interviews were reviewed and thematic analysis was used to analyze them. I looked for common themes, patterns and insights that came up in the students' feedback on the simulation. No predetermined themes were used in analysis; they were discovered from the analysis of the data itself.

4. Results

4.1 Characteristics such as age, gender and race of Participants

The research consisted of data from 40 undergraduate nursing students. Participants were drawn from various backgrounds and their average age was 22.5 years (with ages ranging from 19 to 29). The group had 30 females (75%) and 10 males (25%). All of the participants belonged to the pediatric nursing course and every person had successfully completed at least one semester in general nursing education prior to the study. The characteristics of the population groups covered in the study are listed in the table shown.(9)

Table 1. Demographic characteristics of participants

Characteristic	Frequency (%)
Gender	
Female	30 (75%)
Male	10 (25%)
Age (years)	
Mean ± SD	22.5 ± 2.3
Previous VR Experience	
Yes	5 (12.5%)
No	35 (87.5%)

4.2 Enhancements in how well student knowledge and skills are measured

The test scores and checklist were provided before and after the intervention to check how much students learned in the area. A paired t-test was run to find out if scores before and after the intervention were statistically different. Knowledge improvement: Students gained more knowledge of pediatric nursing because of the VR simulation. The average pre-intervention knowledge score was 72.5% (SD: 5.1) and the average post-intervention score was 85.3% (SD: 4.6) which means there was an improvement of 12.8%.

On the skill checklist, scores improved greatly from the beginning of the intervention to after it. Participants achieved a mean score of 70.4% (SD = 8.7) before the intervention, but this rose to 85.1% (SD = 7.2) after, showing a significant improvement of 14.7% ($p < 0.01$).

Table 1: the scores acquired in knowledge and skills before the intervention and after the intervention.

Measure	Pre-Intervention	Post-Intervention	Difference	p-value
Knowledge Test (%)	72.5 ± 5.1	85.3 ± 4.6	+12.8%	**< 0.05**
Skill Proficiency (%)	70.4 ± 8.7	85.1 ± 7.2	+14.7%	**< 0.01**

This suggests that nursing students' knowledge and abilities in pediatric nursing grew as a result of using the virtual reality simulation.

4.3 Participants' Engagement Scores Before and After the Simulation

To check student involvement, a Likert-based scale was employed. They were asked to state their agreement with various statements about the realism, fun and learning in the virtual reality sessions. Before the VR session started, participation in the pre-simulation was measured and then the amount of engagement was measured again after the last simulation session.(10)

The pre-simulation engagement score was 3.4 on average (SD = 0.8) which points to somewhat moderate levels of motivation and enthusiasm for the VR activities.

After the VR sessions finished, people scored well in post-simulation engagement, reaching an average of 4.5 (SD = 0.6) which marked a big difference and a positive view towards the experience.

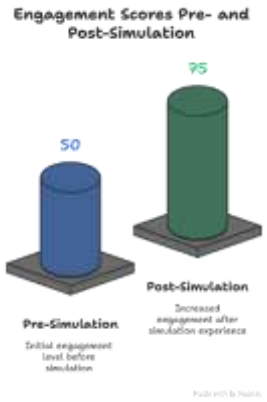

Figure 1: How much learners were engaged during the simulation

A bar chart shows how the engagement scores of students changed before and after the simulation.

4.4 The thematic findings gathered through the interviews.

A semi-structured approach was used to learn about student's experiences and thoughts on using the VR simulation. Several themes were discovered from the interviews: confidence, safety and realism of scenarios and ways to improve the simulations.

Supporting Trust in Pediatric Care:

Confidence among students dealing with pediatric problems rose after using the VR simulations. According to one person, before using the VR, they were intimidated by giving medicine to kids, yet after going through the simulation, they felt much more at ease in those situations. I particularly noticed this confidence in handling giving medicines to children and in talking with families.

The way realism and safety are perceived in virtual environments.

Nearly all students mentioned that the VR simulation made it easier to understand and deal with the many issues related to caring for children in the medical setting. Someone said, "Using VR made it feel almost like I was standing alongside the child and his or her family." I found that the course gave me a much clearer impression of what goes on in pediatric medicine than I anticipated. Usage of VR also made students feel safe and many shared that being able to try challenging situations without injury helped them improve their knowledge.

4.5 Problems and Ways to Improve:

The VR simulation was largely well-liked, though students pointed out some problems and ways to make it better: Several students said they faced some problems with the VR headset fitting well and interactions causing motion sickness which reduced their engagement in the classes.

Limited variety of cases: Some students thought the scenarios should be more varied, for example, to include situations like treating an emergency or coping with kids suffering from multiple conditions.

People talked about the possibility of lengthening the simulation sessions to enable students to work more on main part of the process.

Table 3: Themes Found in the Interviews

Theme	Findings
Confidence in Pediatric Care	Increased student confidence in managing pediatric scenarios.
Perception of Realism and Safety	High realism in VR environments; perceived as a safe learning space.
Barriers and Suggestions	Technical issues (e.g., VR headset fit), limited variety of scenarios, and time constraints.

5. Conclusion

5.1 A look at the aspects of the analysis that are most important

The pilot study looked at ways Virtual Reality (VR) simulation could help enhance the pediatric nursing skills of students in a nursing program. Those who used the VR simulation showed improvements in their knowledge

(12.8% greater) and skill proficiency (14.7% greater) compared to those who did not use VR. As a result of the improvements, students were more engaged, noticed by a large rise in their engagement scores (from 3.4 to 4.5 on a scale of 5 points). Students from the semi-structured interviews mentioned that they feel more skilled in managing pediatric cases, they liked the feeling of realism in the VR environments and they enjoy the advantages and security of using the simulator. Even with the successes mentioned, the students pointed out that improving the systems and the timeline was something they would like in future versions of the program.

5.2 The use of VR Simulation is confirmed to be useful for teaching pediatric nurses.

Experts found that using VR simulation in pediatric nursing is a useful method for education. It brings several benefits that matter most in nursing education:

1. Because of its immersive and interactive qualities, people using VR are more eager to learn and remember things.
2. A Risk-Free Area: Students can use VR to practice difficult pediatric cases with no danger of hurting real children. This ensures students have more practice and receive feedback right away which improves their clinical skills and knowledge.
3. Confidence Grows: Because students can practice pediatric nursing duties in a training setting, they feel more confident when faced with challenges like family-centered discussions and giving children medicine.
4. Many people appreciate VR simulation because it lets them observe pediatric cases in a highly realistic way. It also lets students practice in a simple, virtual way, avoiding difficulties caused by a lack of access to real-life clinical settings.

5.3 Can Act as a Complement to Regular Hospital Rotations

Based on this study, VR simulation can truly add to traditional clinical exposure, especially in fields where finding clinical situations is not easy such as pediatric nursing. Still, although traditional learning is important, VR adds a way to address problems such as:

1. Few opportunities for clinical placements in pediatrics because there is a lot of interest and other factors.
2. Not encountering some pediatric situations very often, particularly pediatric emergencies and unusual disorders, because they are uncommon in the clinical context.
3. Being unsure or fearful of how to handle pediatrics is common among students and VR simulation helps lessen that worry by letting them train safely.

Fusing VR into their programs allows educational institutions to offer students practical experience in pediatric care, even without a lot of real-world chances. It is also possible to use VR to teach and practice main concepts in pediatric nursing, so students feel more ready and self-assured when working with young patients.

5.4 Final Thoughts

Analysis of the data showed that VR should be a key part of today's nursing educational program because it is so effective. The role it could have in making students interested, teaching them necessary skills and providing effective training ensures it is a good choice for nursing programs in pediatrics. More studies are required to check these results in bigger groups and follow up over time to understand the ongoing effect of using VR on nursing students' clinical abilities.

Bringing VR simulations to how nurses are taught will equip students for the different, sometimes difficult, situations in pediatric care they will meet.

Acknowledgement: Nil

Conflicts of interest

The authors have no conflicts of interest to declare

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