Original Article

The Impact of Virtual Patient Education on Enhancing Clinical Reasoning in Nursing Students

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Abstract

Background: This study investigated the effect of Virtual Patient (VP) education on improving Clinical Reasoning (CR) skills among nursing students, addressing a major challenge in nursing education, particularly within the context of an oncology course. **Materials and Methods:** This quasi-experimental, two-group, pretest–posttest study was conducted in 2021 at the School of Nursing of Isfahan University of Medical Sciences, Iran. A total of 148 fourth- and fifth-semester nursing students were selected through a census sampling method. After obtaining informed consent, the subjects were randomly assigned to either the intervention or control group. After the pretest, five VPs (cancer module), designed and validated by eight nursing experts, were provided to the intervention group for 6 weeks, followed by a posttest. Data collection tools included two series of 23-item tests (KF) designed to assess CR skills, with a CVI = 0.94 and CVR = 0.84. The collected data were analyzed in SPSS software using correlation tests and t-tests. **Results:** The mean (SD) of pretest scores was 25.01 (2.51) in the intervention group and 25.03 (2.71) in the control group, with no significant difference ($p > 0.05$). After training, posttest scores increased significantly in the intervention group, 32.22 (3.47), compared to the control group, 25.18 (2.47) ($p \leq 0.05$). The intervention group showed significant improvement from pretest to posttest ($p \leq 0.05$). **Conclusions:** The use of VPs in nursing education can effectively improve students CR skills and provide a foundation for enhancing nursing education.

Keywords: *Clinical reasoning, computer simulation, neoplasms, nursing students*

Introduction

Cancer is a significant health issue worldwide and in Iran, necessitating specialized nurses who can provide high-quality care.[1] It is important that cancer nurses have the required clinical skills before being allowed to care for patients as trial and error has no place in actual patient care. Clinical Reasoning (CR) skills are essential for minimizing patient safety risks, and nursing students must acquire these skills during and after their studies.[2,3] CR involves integrating knowledge from different sources to identify and diagnose patient problems, make clinical decisions, and achieve positive outcomes; however, understanding the CR process can be difficult for nursing students.[3] Studies indicate a need for CR skills among nurses; thus, it can be concluded that current educational approaches do not quickly improve nurses' CR.[4] Simulation is a new educational strategy that might help students improve their CR skills without compromising patient safety by reducing the stress of directly interacting with actual patients.[2] The Virtual Patients (VPs) simulation is one of the tools utilized to this end.

VPs is a valuable tool for learning, teaching, and evaluating CR in health care education.[3,5] It is an online and interactive computer simulation of patient interaction that can help turn theoretical knowledge into clinical practice. VP is used to develop CR skills in health care education through interactive scenarios that do not harm the patient.[6,7] Students can acquire specialized skills through thinking, evaluating, problem-solving, decision-making, and data analysis using VP.[8,9] It can stimulate active learning experiences in nurse education, support deep learning, and improve comprehension.[8,10,11] Studies have shown that VP education can actively teach the CR process.[8,12] However, other evidence shows no difference in obtaining students'

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knowledge scores through VP education with traditional methods.[13] The discrepancy in findings may stem from virtual learning offering more opportunities for CR practice and feedback, while also presenting challenges like weaker communication skill development, lower engagement, simplified cases, and lack of physical examination.[14]

Due to the growing trend of cancer statistics and the challenges in teaching theoretical and clinical nursing of cancer courses, it is essential to empower (undergraduate) nursing students in the field of cancer using new educational technology. At the undergraduate level of nursing, only about 1 unit (16 hours) is devoted to teaching the theory of cancer which does not correspond to the topics provided by the Ministry of Health as some topics are summarized or omitted by teachers. Moreover, there are very few opportunities for the internship of this course in specialized and subspecialized cancer centers and they do not meet the educational needs of students. Novice nurses are only sometimes capable of caring for complex patients upon graduation. A possible cause for this deficit is a gap in nursing education. Therefore, it is essential to pay more attention to this issue.[15]

Although VP education is being developed worldwide, it has not yet been fully explored in cancer nursing,[2] especially in Iran. Due to challenges such as rapid knowledge evolution, reduced training time, limited opportunities to develop skills in practice, and ethical concerns about patients as educational topics, there is a need for further changes in cancer nursing education. The purpose of this study was to examine how VP education can enhance nursing students' CR in the cancer nursing unit.

Materials and Methods

The present research was conducted in the School of Nursing and Midwifery, affiliated with Isfahan University of Medical Sciences, Iran, from May to July 2020. The study was a quasi-experimental project with two groups and is a part of a mixed method study entitled 'design, implementation, and evaluation of a VP-based educational assistance program in undergraduate students' cancer course. The sample size was calculated based on *a priori* power analysis, aiming for a 95% confidence interval (CI) and 80% power to detect significant differences between groups. The calculated sample size required a minimum of 144 participants, which was sufficient for the power of the study. The study initially involved 180 nursing students. After excluding 32 participants, 148 students remained. These students were randomly assigned to two groups of 74: an intervention group and a control group. Each group included students from both the fourth and fifth semesters; specifically, the intervention group consisted of 37 students from the fourth semester (4B) and 37 from the fifth semester (5B), and the control group included 37 students from the fourth semester (4A) and 37 from the fifth semester (5A). The inclusion criteria were completion of the cancer nursing internship and willingness to participate in the study. The exclusion criteria included dropping the course at the end of the semester or being absent for more than two sessions during the use of the designed VP.

The reason for dividing the groups into 4A, 4B, 5A, and 5B is as follows. The study included four groups of nursing students: two groups from the 4th semester and two groups from the 5th semester, all of whom were undertaking the cancer nursing internship course. Out of these four groups, one group from the 4th semester and one from the 5th semester were randomly selected to form the intervention group, while the remaining two groups were assigned to the control group. This division ensured that the impact of the semester variable was controlled and that any differences observed were not due to the semester level.

Topics with higher priority in cancer nursing courses were mastectomy, chemotherapy, radiotherapy, hypercalcemia, spinal cord compression, cardiac tamponade, and superior vena cava syndrome. The VPs were designed for five scenarios based on the nursing process in three sequences (signs and symptoms, diagnosis, and interventions). VPs were designed based on the VPNDM in three layers (patient information, CR, and feedback to student reasoning) and using the Open Labyrinth (OL) application. The OL application is an open-source online activity modeling system that allows users to create interactive educational activities such as VPs. Figure 1 shows how the sample size was allocated in this study.

Researchers have created a 5-minute clip that teaches students how to work with a VP during the Coronavirus pandemic. The clip includes how to log in to OL with an account, familiarity with different parts of the VP, how to access educational content in the VP, and how to evaluate themselves. In addition, five educational booklets on VP topics were provided for the control group. Each educational booklet was provided for the control group at the same time as the VP of the intervention group in the Navid system and virtual channel. Researchers created a privileged account for all students on the VP site, allowing each student to enter the workplace with their details. The pretest and posttest included all topics related to 5 VPs and lasted 120 minutes for both groups.

The study involved two groups of students, an intervention group and a control group. The intervention group was given access to VPs through the OL system and Navid system for 6 weeks. Each week, a new VP was given to the intervention group until all VPs were provided on the last week. The researchers asked the students to report any problems related to working with the VP via short message service or call so that they could be handled quickly. The control group was asked to study the same topics related to VPs using specified references by professors. At the end of the sixth week, all VPs were deactivated by the researchers

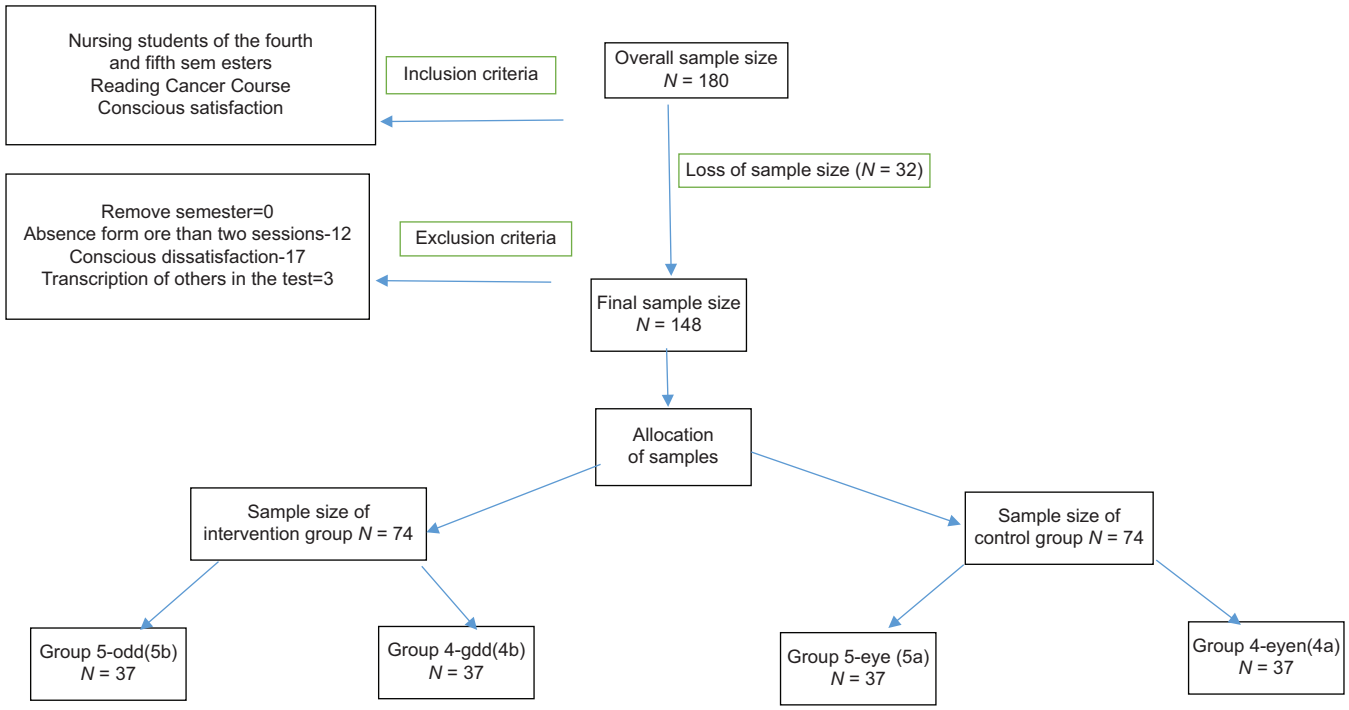

Figure 1: Allocation of the sample size

and a posttest link was uploaded and activated in the Navid system for all four classes. The students were given the correct answers to the questions at the end of the tests.

The tool consisted of two series of researcher-made Key Features (KF) tests, each of which consisted of 23 questions that were conducted as a pretest and posttest. The questions were made according to the essential topics of cancer nursing identified in a previous step and results reported in another article.[6] Each question contained 10 to 15 options, and the essential topics of the critical features tests were mentioned according to eight cancer nursing specialists' learning objectives of the educational curriculum. Necessary topics were identified and prioritized based on participants' CR, the importance of the topic, and the frequency of the topic in caring for cancer patients. Table 1 shows the details of the pretest and posttest KFs questions. In scoring this test, the value and importance of the correct answers to a question are the same. The content validity similarity of the two sets of KFs questions was assessed by experts using researcher-developed checklists. Additionally, to determine the parallelism of the two test sets, the researchers employed Pearson's correlation coefficient. Furthermore, blinding procedures were employed to minimize bias in the evaluation process. Scoring and assessment were conducted by independent evaluators who were unaware of group assignments.

The process of designing critical features tests involves selecting the clinical problem, appropriate problem information, determining the KFs of the problem, writing the scenario, and writing the guiding question. These tests consist of a short scene designed to collect the learner's information, followed by several multiple-choice questions (15 to 20 options) about the scenario in which learners must choose at least 1 and at most 5 answers. Using a checklist, two series of questions were validated qualitatively by essential nursing resources and eight nursing specialists. These tests have high reliability for two reasons: They cover many clinical issues and include questions with options of 10–15 items.[16] To evaluate the similarity of the two series of questions, they were evaluated by a pilot group (37 students), confirmed by $r = 0.94$ and $p \leq 0.001$, indicating the equivalence of pretest and posttest questions. VP topics are presented in Table 1.

Statistical data were analyzed in SPSS software (Version 20; IBM Corp., Armonk, NY, USA) using Pearson correlation coefficient and paired *t*-test.

Ethical considerations

This research study was approved by the ethics committee of Isfahan University of Medical Sciences (IR.MUI.RESEARCH.REC.1398.431). The statement mentions that the purpose and benefits of the study were explained to all participants, informed consent was obtained from all participants, and voluntary participation was ensured. Ethical principles were followed throughout the study, and confidentiality of information was maintained. At the end of the study, nursing students in the control group also received VP.

Results

The mean and standard deviation (SD) of age, Grade Point Average) GPA (score, work experience of participants, and other demographic information are reported in Table 2.

Table 1: The details of the pretest and posttest key features questions

Essential topics	Number of pretest questions	Pretest score	Number of posttest questions	Posttest score
Diarrhea	2	3	2	2
Neutropenia	2	2	1	1
Pancytopenia	1	4	1	4
Mucositis	2	7	2	5
Pain	1	3	1	3
Nursing concepts in cancer (tumor grade and stage)	2	9	2	10
Chemotherapy	2	6	2	8
Cardiac tamponade	1	3	1	2
Hypercalcemia	2	4	2	4
Spinal cord pressure	2	5	1	4
Vena cava pressure syndrome	1	5	2	3
Nausea	2	6	2	7
Radiation therapy	1	5	2	7
Mastectomy	2	6	2	6
Total	23	66	23	66

Table 2: Frequency distribution of demographic variables of the participants

Demographic variables	Group	
	Intervention (*n*=37)	Control (*n*=37)
Gender, *n* (%)		
Male	35 (23.65%)	33 (22.30%)
Female	39 (26.35)	41 (27.70)
Age (year)		
Mean (SD)	25.54 (2.72)	25.67 (2.80)
GPA score		
Mean (SD)	15.25 (2.22)	15.04 (2.59)
Work experience		
Mean (SD)	3.63 (3.24)	2.11 (3.44)

The findings indicated that the mean and SD of CR scores before the training were 25.01 (2.51) in the intervention group and 25.03 (2.71) in the control group. Following the training, these scores rose to 32.22 (3.47) for the intervention group and 25.18 (2.47) for the control group. Notably, the mean pretest CR scores were higher in the fifth-semester intervention group (I5) compared to the fourth-semester intervention group (I4). However, the mean and SD of the posttest scores were greater in the fourth-semester intervention group (I4) than in the fifth-semester intervention group (I5). Statistical analysis showed no significant difference between the mean pretest scores of the intervention and control groups ($p \geq 0.05$). However, a significant difference in the mean posttest scores between these groups was observed following VP-based training ($p \leq 0.05$). The difference in mean CR scores in the control group before and after the training was not statistically significant ($p > 0.05$). However, a significant difference was observed in the mean CR scores in the intervention group ($p \leq 0.05$). A comprehensive comparison of the CR scores for the intervention and control groups before and after the training is provided in Table 3.

The results of the Pearson correlation coefficient test indicated that the CR test scores had a weak significant correlation with the demographic variable of work experience in the groups before and after the intervention ($p \leq 0.05$; $0.17 \leq r \leq 0.23$).

Discussion

In this study, a significant positive correlation was observed between the mean CR scores and the work experience of students. The findings of some previous studies are in line with this finding.[17] Clinical experience, through exposure to complex situations and rapid decision-making, enhances students' analytical skills and critical evaluation, aiding them in promoting continuous learning and improving CR.

The mean CR scores in the intervention and control groups before the training with the VPs did not show significant differences, which can be attributed to both groups utilizing traditional learning methods. However, after the training, a significant difference in the mean CR scores was observed between the intervention and control groups. These findings are consistent with the results of several studies,[18,19] but have been contradicted by some studies.[20] The lack of alignment between our findings and theirs may be attributed to the short duration of training for students and the small sample size in their studies. Utilizing virtual clinical simulations in nursing education can lead to an enhancement in clinical knowledge and CR over time and also increase nursing students' satisfaction with their learning experiences.

Prior to the intervention with the VPs, the intervention group (I5) possessed a higher level of clinical knowledge and experience compared to the intervention group (I4) due to having completed an additional semester; therefore, their CR scores were higher in the pretest. Some studies were in accordance with this finding,[21] while others were not.[19]

Table 3: Comparison of clinical reasoning scores between study groups

Group	Pretest				Posttest			
	Mean (SD)	*t*	df	*p*	Mean (SD)	*t*	df	*p*
Control								
Control (C4)	25.02 (2.45)	0.12	36	0.92	25.29 (2.40)	11.18	36	<0.001
Control (C5)	25.05 (2.97)				35.27 (4.02)			
Intervention								
Intervention (I4)	24.97 (2.71)	0.14	36	0.88	25.08 (2.54)	8.26	36	<0.001
Intervention (I5)	25.05 (2.32)				29.18 (2.80)			
Intervention (Total) and control (Total)								
(C4 & C5) (Total)	25.03 (2.71)	0.09	73	0.90	25.18 (2.47)	10.80	73	<0.001
(I4 & I5) (Total)	25.01 (2.51)				32.22 (3.47)			

Intervention group (Term 5=I5, Term 4=I4), Control group (Term 5=C5, Term 4=C4)

It can be concluded that as students advance through their semesters, they gain more practical experience in clinical settings, which likely leads to increased practice of CR skills. However, following the intervention, the (I4) group demonstrated a significant increase in their CR scores due to their more frequent practice (spending more time) with VPs and acquiring greater knowledge and experience. This indicates that frequent interaction with VPs has assisted students in achieving more active learning experiences, thereby enhancing their clinical knowledge and experience as key elements of CR. The results of several studies support this finding.[8,19,20]

This study demonstrated that VP training effectively improves the CR abilities of students, which is consistent with the findings of previous studies.[2,6,8,13,19,20] The design of the VP, through the use of targeted questions, guides students in clinical practice and decision-making while creating an active and constructive environment for deeper learning. This educational approach enhances clinical and reasoning skills, providing high-quality learning opportunities and improving memory retention for students. Statistical results indicate a significant increase in the mean scores of the intervention group after VP training compared to the control group.

This study faced several limitations, including the inability of the OL software to generate individual user performance reports. The researchers addressed this issue by utilizing Excel to provide the necessary reporting and improved internet speed challenges by compressing and eliminating animations.

Conclusion

This study demonstrated that VP training effectively enhances the CR skills of nursing students. The purposefully designed VP provides an interactive learning environment that facilitates deep learning and the practice of CR, resulting in improved clinical skills and memory retention. Statistical results confirmed a significant increase in the scores of the intervention group. Given the critical role of CR in patient safety, integrating VPs into educational programs can enhance the professional preparedness of students prior to their entry into clinical settings. Future research should explore the long-term impact of VP training on the retention of CR skills and its effectiveness when applied in real-world clinical practice among nursing students.

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Conflicts of interest

Nothing to declare.

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